

**44<sup>th</sup> International Conference  
ON ORGANIZATIONAL SCIENCE DEVELOPMENT**

**Human Being, Artificial Intelligence  
and Organization**

**44. mednarodna konferenca  
O RAZVOJU ORGANIZACIJSKIH ZNANOSTI**

**Človek, umetna inteligenca  
in organizacija**

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# ANALIZA PROMOCIJE ZDRAVJA IN PREVENTIVE NA PODROČJU RAKA V SKLOPU PROJEKTA CANCON JA

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Evropska unija, ki je zibelka promocije in preventive ter nacionalnih programov za obvladovanje raka, je kot kontinuirano razvijajoča se skupnost uvedla precej projektov in programov, za nadzor uspešnosti, izdelave ključnih dokumentov, namenjenih političnim odločevalcem pri oblikovanju ukrepov na področju celostne obravnave raka. Dokumenti ponujajo možnosti izboljšav in pridobivanja finančnih sredstev za obvladovanje te bolezni. Področji preventive in promocije raka temeljita na dobri complianci družbe in imata v času hitrega tehnološkega napredka veliko prostora za izboljšave. Trenutno stanje in pretekli napori na področju razširjenosti raka so vidni v raziskavi z imenom European Guide on Quality Improvement in Comprehensive Cancer Control – CanCon JA, raziskava pa ponudi tudi primerjavo na področju preventive in promocije med številnimi Evropskimi državami. Cilj prispevka je primerjava promocije in preventive slovenskega Državnega programa za obvladovanje raka s programi držav z dolgoletno tradicijo ter analiza rezultatov.

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# ANALYSIS OF HEALTH PROMOTION AND CANCER PREVENTION WITHIN THE CANCON JA PROJECT

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The European Union, which is the cradle of the promotion and preventive and national programs for cancer control, as a continuously developing community, has introduced a number of projects and programs for performance control, the production of key documents intended for political decision-makers in the formulation of measures in the field of comprehensive treatment of cancer. The document offers possibilities for improving the acquisition of financial resources for disease control. The fields of preventive and promotional cancer are based on the good compliance of society and have a lot of room for improvement in the time of rapid technological progress. The current state and past efforts in the field of cancer prevalence can be seen in the research called European Guide on Quality Improvement in Comprehensive Cancer Control - CanCon JA, and the research also offers a comparison in the field of prevention and promotion between many European countries. The aim of the paper is to compare the promotion and prevention of the Slovenian national program for cancer control with the programs of the countries with a long tradition and to analyze the results.



## 1 Uvod

Rak, kot eden večjih izzivov sodobne družbe predstavlja veliko področje, kjer se prepletajo naporci človeka kot posameznika in organizacije družbe v celoti, da bi skupaj dosegli zmanjšano pojavnost bolezni ter posledice, ki jo spremljajo. Ta prispevek se osredotoča na analizo obsežne raziskave, ki je potekala od 2014 do 2017 v sklopu projekta, poimenovanega European Guide on Quality Improvement in Comprehensive Cancer Control (Evropski vodič za izboljšanje kakovosti celostnega obvladovanja raka), skrajšano CanCon JA. Evropski projekt, čigar cilj je bil med drugim zmanjšati določene obstoječe razlike na področju obvladovanja raka se je osredotočil tudi na področji promocije in preventive rakavih obolenj v Evropi. Prispevek je pripravljen z željo, da analiza raziskave prikaže priložnosti za organizacijske izboljšave v izvedbi promocije in preventive na področju raka v Sloveniji, v primerjavi z nekaterimi drugimi razvitimi državami (Jelenc, idr., 2022, Jelenc, idr., 2020, Jelenc, idr., 2016).

## 2 Preventiva in promocija zdravja v sklopu CanCon JA

V raziskavo o vsebini nacionalnih programov za obvladovanje raka (NPOR), v sklopu projekta skupnega ukrepanja CanCon JA je bilo povabljenih 35 držav, 5 se jih žal na vabilo ni odzvalo (Bolgarija, Grčija, Slovaška, Škotska in Severna Irska). Nizozemska in Hrvaška sta bili v času raziskave edini državi, ki nista imeli nikakršnih dokumentov za obvladovanje raka, kot je to NPOR oziroma dokumentov, povezanih z rakom, ki temeljijo na mednarodnih priporočilih, so prilagojeni politiki države in so namenjeni celostnemu obvladovanju raka na določenem geografskem področju (Jelenc, idr., 2022, Jelenc, idr., 2020).

Osemindvajset Evropskih držav z omenjenimi dokumenti, vključenih v CanCon JA so predstavljale Avstrija, Belgija, Ciper, Češka, Danska, Estonija, Finska, Francija, Nemčija, Madžarska, Islandija, Irska, Italija, Latvija, Litva, Luksemburg, Malta, Črna gora, Norveška, Poljska, Portugalska, Romunija, Slovenija, Španija, Švedska, Turčija, Anglija in Wales. Države so v svoje nacionalne programe za obvladovanje raka ter druge dokumente povezane z rakom vključile področja: primarne preventive, promocije zdravja, sekundarne preventive, zgodnjega odkrivanja, diagnostike, zdravljenja, psihosocialne onkološke nege, preživetja, rehabilitacije, paliativne oskrbe, politik, financiranja, vzrokov raka, informacij in podatkov o raku, raziskav,

epidemioloških trendov ter dostopa do inovativnih zdravljenj ter opolnomočenja pacienta. Potrebno je poudariti, da sta v Nemčiji področji primarne preventive in promocije zdravja zajeti v drugih dokumentih in zato nista del dokumentov o raku, vendar se kljub temu izvajata (Jelenc, idr., 2022, Jelenc, idr., 2020).

Preventiva je bila v dokumente o raku vključena v naslednjih državah: Avstrija, Ciper, Češka, Estonija, Finska, Francija, Madžarska, Islandija, Irska, Italija, Latvija, Litva, Luksemburg, Malta, Črna gora, Norveška, Poljska, Portugalska, Romunija, Slovenija, Španija, Švedska, Turčija, Anglija in Wales. Belgija in Danska nimata vključenega področja preventive v NPOR (Jelenc, idr., 2022, Jelenc, idr., 2020, Jelenc, idr., 2016).

Države, ki so imele vključeno področje promocije zdravja v dokumente o raku so bile: Avstrija, Belgija, Ciper, Češka, Danska, Estonija, Finska, Francija, Madžarska, Islandija, Irska, Italija, Latvija, Litva, Luksemburg, Malta, Črna gora, Poljska, Portugalska, Romunija, Slovenija, Španija, Švedska, Turčija, Anglija in Wales, področje promocije ni vključeno na Norveškem (in v Nemčiji) (Jelenc, idr., 2022, Jelenc, idr., 2020, Jelenc, idr., 2016).

Med začetnice NPOR štejemo Anglijo, Norveško in Francijo. Omenjene države so postavile temelje na tem področju. Glavni področji razlik v NPOR so finančne in kadrovske zmožnosti, ki omogočijo prednjačenje večjih in bolj razvitih posameznic (Jelenc, idr., 2016).

### **3 Primerjava preventive in promocije zdravja v Sloveniji z nekaterimi drugimi državami**

Vključenost preventive in promocije zdravja v slovenski Državni program za obvladovanje raka (DPOR) smo primerjali z nacionalnimi programi dveh razvitih držav, Anglije in Francije. Omenjeni državi sta namreč med pionirji uvedbe nacionalnih programov za obvladovanje raka. Zaradi dolgoletne tradicije pa sta Anglija in Francija vodilni tudi na področju kvalitete nacionalnih programov za obvladovanje raka.

### 3.1 Slovenija

Slovenski državni program za obvladovanje raka (DPOR), objavljen s strani Ministrstva za zdravje Republike Slovenije, ki zajema obdobje od 2022 do 2026, preventivo deli na primarno in sekundarno. Incidenca raka je odvisna predvsem od uspešnosti ukrepov s področja primarne preventive, torej dejavnosti in aktivnosti, ki jih izvajamo posamezniki, ko smo še zdravi, ter sekundarne preventive, kjer s presejalnimi programi odkrivamo predrakave spremembe in jih odstranjujemo (DPOR, 2017).

Ukrepi na področju primarne preventive so se v Sloveniji začeli izvajati konec devetdesetih let, in so statistično pomembno vplivali, da se incidenca raka večja počasneje. Ukrepi vključujejo zakonodajo, primarno zdravstveno varstvo z referenčnimi ambulantami, centre za krepitev zdravja, cepljenje proti HPV in hepatitisu B, ter druge. S primarno preventivo namreč lahko preprečimo do 40% vseh rakov, in sicer z obvladovanjem ključnih dejavnikov tveganja, kot so kajenje, škodljiva in tvegana raba alkohola, nezdrava prehrana, pomanjkanje telesne aktivnosti ter čezmerna teža in debelost, prekomerno sončenje, izpostavljenost karcinogenom v delovnem in bivalnem okolju. Predlagani cilji in ukrepi na področju primarne preventive upoštevajo priporočila Evropskega kodeksa proti raku. Posamezni dejavniki tveganja so na ravni države ali Evropske unije že natančno opredeljeni in je njihovo obvladovanje predmet strateških ali pravno zavezujočih dokumentov. Cilji zajemajo zmanjšano rabo tobaka, zaželeno je znižanje odstotka kadilcev med prebivalci, starimi 15 let in več, s 23% v letu 2019 na 17,5 % v letu 2026 in znižanje odstotka mladostnikov, ki kadijo tobak vsaj enkrat na teden ali pogosteje. Naslednji cilj je usmerjen v zmanjšano rabo alkohola, ki je dokazano dejavnik tveganja za veliko število rakov, kot so rak ustne votline, grla, žrela, požiralnika, jeter, debelega črevesja in danke ter dojke pri ženskah. Zastavljeno je zmanjšati delež oseb, starih od 15 do 64 let, ki pijejo čez meje manj tveganega pitja, kar vključuje mladoletne osebe, ki popijejo katero koli količino alkohola, ter odrasle osebe, ki se opijejo vsaj enkrat v letu in/ali v povprečju popijejo na dan več kakor eno (velja za ženske) ali več kakor dve enoti alkohola (velja za moške), s 45% v letu 2018 na 42% letu 2026. Zmanjšati delež 15-letnikov, ki so že pili alkohol pri 13 letih ali prej, z 31% v letu 2018 na 26% v letu 2026. Nadaljnji cilji in ukrepi so usmerjeni v izboljšanje diete oziroma prehrane, redno telesno vadbo, zmanjšanje onesnaževanja okolja, zmanjšanje izpostavljenosti nevarnim snovem in sevanju,

radonu, azbestu, zmanjšanje izpostavljenosti ultravijoličnemu sevanju, nadzoru nad nalezljivimi boleznimi povezanimi z rakom in cepljenju proti njim. Prav tako je cilj okrepitev primarne preventive na primarni ravni zdravstvenega sistema tako, da bi v ambulantah družinske medicine dopolnili vsebine o preventivnih pregledih odraslih s področja rakavih obolenj, v centrih za krepitev zdravja in zdravstveno-vzgojnih centrih pa izvajali usposabljanje za obravnavo in podporo bolnikov z rakom pri spreminjanju in vzdrževanju zdravega življenjskega sloga. V centrih za duševno zdravje bi izvajali usposabljanje za obravnavo in podporo bolnikov z rakom, z uvajanjem novih vsebin pa kadrovske okrepili time na primarni ravni (DPOR, 2017, Petkovšek, 2023).

Na področju sekundarne preventive imamo v Sloveniji na državni ravni vpeljane tri presejalne programe, za katere obstaja dovolj dokazov o smiselnosti uvedbe organiziranega presejanja za učinek na prebivalstvo. To so: Državni program zgodnjega odkrivanja predrakavih sprememb materničnega vratu Zora, Državni presejalni program za raka dojke Dora, Državni program presejanja in zgodnjega odkrivanja predrakavih sprememb in raka na debelem črevesu in danki Svit. Program Zora deluje v Sloveniji od leta 2003, od leta 2009 pa deluje tudi program Svit. Oba programa dosejata visoke standarde kakovosti, sta brezplačna za ciljne skupine, velika možnost za napredek pa je področje promocije in višanje udeležbe ciljne populacije na presejalnih testiranjih. Uspešnost delovanja programov se kaže v zmanjšanju incidence rakov, saj zgodnje odkrivanje predrakavih sprememb in njihova odstranitev, pomembno vpliva na število bolnikov, ki zbolijo z rakom. Incidenca se je pri moških med letoma 2008 in 2010 povečevala za 8,2% letno, od leta 2010 do 2017 pa se zmanjšuje za 3,7% letno. Rak debelega črevesa in danke je bil tako po pogostosti novih primerov raka (brez nemelanomskega raka kože) v letu 2009 na prvem mestu, leta 2017 pa na četrtem, kar nakazuje na veliko pomembnost sekundarne preventive. Prav to je razlog, da želimo v Sloveniji uvesti nove presejalne programe, torej novo aktivnost na področju sekundarne preventive, eden izmed omenjenih programov je presejalni program za raka pljuč (Jelenc, idr., 2022, Jelenc in Albrecht, 2020, DPOR, 2017).

Promocija na področju rakavih obolenj v veliki meri poteka tudi preko nevladnih organizacij, ki se pogosto osredotočajo na določene tipe rakov. Društvo bolnikov s krvnimi boleznimi Slovenije ozavešča ljudi o krvnih rakih; promocija deluje preko socialnih omrežij, mesečnih spletnih predavanj, strokovnih srečanj, ter izdajo

vodnikov (14 v zadnjih petih letih), vodene aktivnosti in socialnih programov (financiranih s strani članov društva). Društvo onkoloških bolnikov Slovenije, ki pri promociji sodeluje z ministrstvom za zdravje ter oglašuje preko množičnih medijev. Europa Donna, s pomočjo svetovalne telefonske linije (delno sofinancirane s strani ministrstva za zdravje) nudi pomoč bolnicam ter pomaga pri ozaveščanju raka dojke. V Sloveniji imamo več kot 12 nevladnih organizacij na področju raka z dolgo tradicijo in številnimi člani, ki premikajo mejnike na vseh področjih celostnega obvladovanja raka, od financiranja do oglaševanja in psihološke podpore ter drugih področij. Promocija in poslanstvo nevladnih organizacij imata še veliko večji potencial, v kolikor bi bila zagotovljena dodatna finančna sredstva in usposobljeno osebje v samih organizacijah (DPOR, 2017).

Eden izmed najboljših in najbolj medijsko odmevnih državnih presejalnih programov je program SVIT. Slednji slovi po izjemno širokem naboru aktivnosti na področju promocije, ki je vzor številnih Slovenskim in tujim presejalnim programom. Prvo orodje, ki programu SVIT pomaga pri promociji, je njegova spletna stran (<https://www.program-svit.si>). Tam najdejo ljudje informacije o dogodkih, kot je Svitov dan, promocijskih dogodkih z napihljivimi modeli črevesa, srečanja z ambasadorji, pogovornih oddajah o programu SVIT, video vsebine ter podrobno predstavitev, poslanstvo in statistične podatke programa. SVIT z javnostjo komunicira na številne načine: preko klicnega centra, pošte (skrbi, da posamezniki v ciljni skupini med 50. in 74. letom starosti pravočasno prejmejo vabilo v program), informacijske podpore (vključujoč spletno stran), območne enote NIJZ, ambasadorjev, podpornikov, nevladnih organizacij, strokovne javnosti, splošne javnosti ter medijev. Zanimiva strategija promocije je možnost organizacije Svitovega dogodka, kar lahko posameznik stori preko spletne strani, kjer izpolni obrazec. O uspešnosti promocije programa priča tudi podatek, da je bilo leta 2023 presejane 60,81% povabljenе populacije (SVIT-Za zdravstvene delavce, 2023).

### 3.2 Anglija

Izkušnje držav z dolgoletno tradicijo načrtov in programov za obvladovanje raka, kot so npr. Francija, Anglija in Norveška so utrle pot za razpravo o potrebi po vzpostavitvi nacionalnih ali regionalnih programov, načrtov ali strategij za obvladovanje raka v vseh evropskih državah. V primerjavi s Slovenskim DPOR se tudi program za obvladovanje raka angleške Nacionalne zdravstvene službe (*angl.*

*National Health Service-NHS*) osredotoča na promocijo zdravega življenjskega sloga in preventivo na primarni in sekundarni ravni (Jelenc, idr., 2016).

Med prebivalstvo širijo znanje o škodljivih vplivih kajenja in pozitivnih učinkih prenehanja, vsem kadilcem nudijo izdelavo brezplačnega personaliziranega načrta za prenehanje kajenja in vzdrževanje abstinence. Razvili so brezplačno mobilno aplikacijo NHS Quit Smoking, ki je dostopna na vseh mobilnih napravah. Kadilcem pomaga pri soočanju s kajenjem in vzdrževanju abstinence. Tej primerljiva je aplikacija, poimenovana Try dry (*ime aplikacije v angl. The Dry January app*) ustvarjena v sklopu kampanje, poimenovane Suh januar (*angl. Dry January*), ki spodbuja k popolni abstinenci od alkohola vsaj vseh 31 dni tega meseca, podobno kot imamo v Sloveniji projekt 40 dni brez alkohola. Vsi uporabniki aplikacije si lahko beležijo dneve ko niso pili alkohola in koliko česa so spili, kadar so pili. Aplikacija je brezplačna in dostopna vse leto. Poleg dnevnika je opremljena z nasveti za prenehanje uživanja alkohola in informacijami o prednostih abstinence ter neželenih učinkih prekomernega pitja (NHS, 2020, Try Dry, NHS, 2021).

Vse že omenjene dejavnosti so preplet delovanja NHS na področjih promocije zdravja in rakavih bolezni ter primarne preventive. Dolgoletno tradicijo ima tudi sekundarna preventiva in presejalni programi za odkrivanje raka in predrakavih sprememb. Tako kot v Sloveniji tudi njihovi presejalni programi vključujejo raka dojka, debelega črevesa in danke ter materničnega vratu. Poleg slednjih je njihov nacionalni presejalni komite javnosti predstavil presejalni program za tarčno odkrivanje pljučnega raka, ki je bil zasnovan na podlagi obsežnega Evropskega poizkusa NELSON, ki je deloval na principu CT slikanja oseb z večjim tveganjem za razvoj pljučnega raka. Rezultati so pokazali zmanjšanje mortalitete pri osebah z večjim tveganjem, ki so bile testirane. Tako so v Angliji, leta 2023 presejanje začeli izvajati tudi sami. K sodelovanju v programu so povabljeni vsi, ki imajo oziroma so v preteklosti imeli v osebem zdravstvenem kartonu pri družinskem zdravniku zabeleženo zgodovino kajenja in so stari med 55 in 74 let. Njihov cilj je do leta 2025, vključiti 40% ciljne populacije in do marca 2030 vso. Predvidevajo, da bodo, ko bo program v polnem teku, raka pljuč odkrili pri kar 9000 bolnih in letno opravili kar milijon presejalnih testov ob enem pa želijo bolnikom omogočiti tudi zgodnejše zdravljenje (Cancer research UK, 2024).



Ciljna skupina presejalnega testiranja za raka debelega črevesa in danke, ki ga izvajajo od leta 2006, so trenutno vsi državljani med 54 in 74 letom. Presejanje želijo v naslednjih letih razširiti tudi na nekoliko mlajše (od 50. leta naprej), podobno kot je praksa že vrsto let v Sloveniji. Vso ciljno prebivalstvo je k sodelovanju povabljen pisno na vsaki dve leti. Na vabilo se je med letoma 2022 in 2023 odzvalo 70% povabljenih, kar je manj kot pri njihovih drugih presejalnih programih (Cancer Research UK, 2023, Cancer Research UK, 2024).

Presejalnega programa za testiranje raka dojke, ki je v Angliji najpogostejši rak med ženskami, se je v istem obdobju udeležilo 65% povabljenih. Kar je nekoliko pod pričakovanji organizacije, ki ocenjuje, da z presejanjem preprečijo kar 1300 smrti letno. V ciljno skupino so vključene vse ženske med 50. in 70. letom starosti. Vabilo prejmejo vsaka tri leta. Samoiniciativno je sodelovanje, omogočeno tudi vsem ženskam po 70. letu. Letno je testiranje omogočeno vsem tistim, ki imajo večje tveganje za razvoj bolezni kot ostali del ciljne skupine. Program so začeli leta 1988 (Cancer Research UK, 2024).

Presejalno testiranje za odkrivanje raka materničnega vratu so začeli leta 1964. K sodelovanju so povabljene vse ženske med 25. in 64. letom starosti, na vsaka tri leta. Dodatno so na testiranje poslane tudi tiste z visokim tveganjem za razvoj bolezni. Slednje oceni družinski zdravnik ali pa ginekolog. Ocenjujejo, da s presejanjem letno zaradi raka materničnega vratu preprečijo okoli 2000 smrti (Cancer Research UK, 2022).

V začetku izvajanja presejalnih programov so v prvih letih ugotovili precejšnjo razliko v udeleževanju pri slednjih. Zato so za zmanjšanje teh razlik, npr. med moškimi in ženskami, za družinske zdravnike izdali posebna navodila, kako morajo k sodelovanju spodbuditi tudi skupine ljudi, ki se testiranj udeležujejo manj (Cancer Research UK, 2023).

### **3.3 Francija**

Kot omenjeno je ena izmed držav z dolgoletno tradicijo NPOR tudi Francija. Njihova najnovjša strategija za desetletno obvladovanje raka zajema obdobje od 2021 do 2030. V dokumentu Francozi izpostavljajo pomen preventive, ki ga razdelijo na raziskovalni napredek, personalizirano izvedbo preventive, zaupanje v ljudi, da

bodo prenehali kaditi, zmanjševanje škodljive rabe alkohola, zdravo dieto, dostopno za vse, zmanjševanje bremena infekcijskih bolezni povezanih z rakom, in druga področja. V omenjenih strategijah preventive je ena izmed bolj zanimivih in tehnološko naprednih idej in cilj Francije, da do leta 2040, preprečijo 60,000 rakov, tudi na račun kontrole prodaje tobaka mladoletnim s pomočjo elektronskih naprav. Na področju presejalnih programov raka želijo uveljaviti naprave za samovzorčenje, vključevanje tehnoloških inovacij na področju presejanja, brez zamika, takoj po strokovni odobritvi inovacije. Razviti želijo natančnejše presejanje rakov, bolj prilagojeno posamezniku. Prav tako, podobno kot Slovenija, želijo uvesti presejalni program za raka pljuč (The French National Cancer Institute, 2025).

S strani promocije je cilj podpreti multidisciplinarne raziskave z namenom pridobitve novega znanja, ki bi lahko privedlo do ključnih odkritij, nato pa bolnikom čimprej omogočiti dostop do le-teh. Pri tem podpirajo "open science" pristop, ki temelji na odprtem sodelovanju, zagovarja čimprejšnjo in čim širšo izmenjavo znanj, rezultatov in orodij. Na podlagi ciljev izpostavljenih v Francoskem NPOR, lahko opazimo, da so precej podobni Slovenskim. Potrebno je izpostaviti, da imajo vsekakor večje finančne in tehnološke zmožnosti na področju samih raziskav in inovativnih tehnologij, na katere se v veliki meri želijo usmeriti tudi v naslednjih petih letih (The French National Cancer Institute, 2025).

## 4 Zaključek

V skladu s CanCon JA ugotovitvami, tudi nadaljnji postopki raziskovanja NPOR v državah EU in Angliji, potrjujejo, da je organizacija na visoki ravni. Tehnološki in družbeni naporji so zagotovo veliki, z upanjem, da se bo incidenca raka zmanjšala. Države se bremena raka zavedajo in preventiva in promocija zdravja sta pomemben element NPOR ter slovenskega DPOR.

Spodbudne so ugotovitve, da Slovenija v veliko pogledih na področjih promocije in preventive prednjači, tudi pred finančno in populacijsko veliko bolj zmognimi državami.

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# TOOLS AND GUIDELINES FOR SUSTAINABLE STUDENT MOBILITY

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The increasing international mobility of students poses significant challenges to sustainability efforts due to the environmental impact of travel and daily activities. In response, universities and stakeholders are increasingly emphasizing environmentally friendly practices to reduce the carbon footprint of students studying abroad. This paper provides a comprehensive overview of the available tools, initiatives and guidelines to promote sustainable behaviours of students participating in international mobility programs. Through a structured review of available literature, guidance and case study analysis, this paper identifies existing resource gaps and highlights best practices for promoting environmentally sustainable behaviours. The findings highlight the need for a user-friendly benchmarking tool that integrates different dimensions of sustainability, including transportation, energy consumption, waste management and community engagement. This study contributes to the broader discourse on sustainable student mobility and is a foundation for developers of a useful tool to drive meaningful environmental change in higher education.

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## 1 Introduction

Educational migration has increased substantially in recent years (Lipura & Collins, 2020), and despite the significant disruptions caused by the pandemic (Yıldırım et al., 2021), it continues to be a significant driver of cross-border collaboration, cultural exchange, and knowledge-sharing for younger generations (Lopes et al., 2024). As students begin their educational journeys, which often include periods of study abroad or student mobility, it is increasingly important to consider the environmental impact of their lifestyle choices (McCollum, & Nicholson, 2022).

International student mobility (ISM) plays an important role in higher education (HE) in two main ways: it promotes cultural exchange between countries and encourages academic collaboration across international borders. However, ISM also raises concerns about sustainability, especially regarding the carbon footprint generated by international travel and the daily activities of mobile students (Gümüş et al., 2020). Therefore, universities should adopt proactive measures to address these environmental impacts related to ISM (Shields & Lu, 2024).

Universities have a unique opportunity to foster sustainable practices among their student communities, setting an example for society (Popescu, 2019). Universities foster sustainable activities and promote sustainable behaviour by the faculty and students in their local environment (Achoura et al., 2024; Qi et al., n.d.). However, when students or staff participate in exchange programs at other institutions, they are most likely unfamiliar with local lifestyles and cannot maintain their preferred sustainable habits.

Higher focus on sustainability challenges higher education institutions (HEIs) to include different tools and guidelines in their practices to promote environmentally responsible behaviours among their students. The present study examines contemporary strategies and resources that encourage sustainable practices among students engaged in international mobility, reviews existing literature and evaluates current practices to synthesise the available knowledge in this area. As such, the paper provides a foundation for developing a practical tool within the SuMoS Erasmus+ project that empowers students to make environmentally conscious decisions during their time abroad.

## **2 Literature review**

Adopting pro-environmental behaviours among university students can be influenced by cultural background, social norms, and institutional support (Akhtar et al., 2022; Kim, 2024). Research from Rumbley (2020) indicates that international students tend to have a higher average carbon footprint than domestic students, primarily due to travel-related emissions. For instance, a study from McCollum, & Nicholson (2022) revealed that international students' travel contributes significantly to their overall greenhouse gas emissions. HEIs can promote their sustainable activities to international students on mobility through various options. The International Education Sustainability Group (IESG) has developed the Climate Action Barometer, a tool enabling institutions to measure and reduce their climate impacts on international student mobility. The tool relies on self-reporting from participating institutions and enables them to benchmark their performance against an index of key metrics related to sustainability efforts in international education (ICEF, 2023).

### **2.1 Student mobility and environmental impact**

The United Nations (2025) states that transportation and mobility are central to sustainable development. Moreover, transportation is recognised as a primary concern within student mobility. Students, staff, and visitors commuting to and from campus significantly impact the environment. Research by McCollum, & Nicholson (2022) found that international students emit approximately 7.17 tonnes of CO<sub>2</sub> per year, significantly more than the 4.63 tonnes emitted by domestic students. This difference is primarily due to the long-distance flights home during breaks, while international students typically rely on public transportation for their daily commutes. A study conducted at a Spanish university revealed that most long-distance journeys were made using public transport, suggesting that students are open to adopting more sustainable modes of transportation (Cruz-Rodríguez et al., 2020).

## 2.2 Sustainable transport options for students

According to the European Environment Agency (European Commission, Directorate General for Climate Action, 2025), passenger cars are responsible for approximately 16% of the total emissions of CO<sub>2</sub> in the EU. The Sustainable Mobility for All platform (SuM4All, 2021) provides detailed reports on sustainable personal transport in individual countries. The present study focuses on the partner countries involved in the Erasmus+ SuMoS project: Croatia, France, Serbia, the Slovak Republic and Slovenia. Table 1 provides an overview of the sustainable mobility rankings in the countries under consideration.

**Table 1: Sustainable mobility ranking**

Country	Overall ranking #	Index	Strengths	Weaknesses
France	7	81.4	Extensive rail network	Urban air pollution
Slovak Republic	33	63.7	Railroad density, increasing passenger rail usage	Limited air transport connectivity
Slovenia	38	61.3	Effective port and road connectivity	High transport-related CO <sub>2</sub> emissions per capita
Croatia	40	60.8	Exceptional rural access and road connectivity index	High dependency on road transport
Serbia	47	57.1	Efficient road transport	Poor quality of railroads

Source: (SuM4All, 2021)

In addition to limited sustainable mobility options available in the countries under consideration, the recent pandemic resulted in a radical shift from public to private transport modes (Das et al., 2021). Nevertheless, 64% of Europeans are willing to use public transport for environmental purposes (European Investment Bank, 2025). In addition, Europe is expected to witness significant growth in its Public Transportation market in the coming years (Statista, 2025). The EU Green Deal (European Commission, 2021) aims to achieve sustainable transport by prioritising users' needs and providing them with more affordable, accessible, healthier and cleaner alternatives to their current mobility habits.



In addition to considerations of personal mobility in general, it is imperative to address sustainability in the context of student mobility, as mobile students' transportation decisions substantially impact carbon emissions and resource consumption. Integrating sustainability into mobility practices is, therefore, not only aligned with global climate objectives but also equips future generations with environmentally sound habits. Therefore, it is recommended that public transport and low-emission travel options be promoted to foster green mobility practices among students and contribute to broader institutional sustainability goals.

### **2.3 Beyond Travel Sustainable Living Practices for International Students**

A range of sustainable activities are available for ISM students, extending beyond transportation, including:

- *Waste Reduction and Recycling*: International students frequently encounter difficulties adapting to local waste management systems due to their unfamiliarity with recycling practices (Beltran et al., 2022). McCollum & Nicholson (2022) emphasise the role of universities in providing clear guidance on local recycling programs and waste reduction strategies.
- *Energy Conservation*: Energy use in student accommodations is another significant aspect of promoting sustainability. According to McCollum, & Nicholson (2022), international students are not showing high level of energy-saving behaviours due to a lack of awareness or differing cultural norms regarding energy conservation.
- *Sustainable food choices*: Research indicates that international students may increase their consumption of processed or imported foods due to unfamiliarity with local cuisines or limited access to fresh produce (McCollum, & Nicholson, 2022). However, they tend to maintain their sustainable eating and community values abroad (Nemeth et al., 2019).

However, international students may have limited information about sustainable practices in their host country. This lack of awareness hinders their engagement in more environmentally friendly behaviours while studying abroad (Diekmann & Karaiskos, 2022).

### 3 Methodology

This study aims to identify, analyse and synthesise existing tools, initiatives, and guidelines for promoting sustainable practices in ISM. The objective is to establish a foundation for developing a benchmarking tool that supports environmentally conscious decision-making among students. A review of relevant policy documents, projects, reports and tools was conducted to explore existing initiatives related to green practices in ISM. The existing digital tools, including the Green Erasmus Portal, the Personal Ecological Footprint Calculator, and the CO<sub>2</sub> Visualization Tool from Erasmus Goes Green, were analysed to evaluate their features, usability, and effectiveness. The analysis focused on identifying these tools' main features and usage to inform the design of a benchmarking tool within the SuMoS project.

### 4 Erasmus programme and green initiatives in the EU

The Erasmus+ is the EU's programme to support education, training, youth and sport in Europe. As such, the programme fosters international mobility and cultural exchange among students, educators, and institutions across Europe. The programme's fundamental objective is to promote education, inclusivity and sustainable practices (European Commission, 2025a). In alignment with the objectives of the Erasmus Student Network<sup>1</sup>, the Erasmus+ EU programme<sup>2</sup> provides funding and facilitates international mobility and collaboration. Erasmus+ is one of several European initiatives promoting sustainable practices, as evidenced by the term "green" appearing in the 2024 and 2025 Erasmus+ guides, appearing 146 and 149 times, respectively (European Commission, 2024a, 2025b).

The Green Erasmus Report on the Habits of Erasmus Students (Diekmann & Karaïskos, 2022) highlights key findings about the environmental behaviours of Erasmus students. Most students (81.7%) travel internationally during their mobility, often by plane, contributing significantly to carbon emissions. The study stresses the crucial role of beliefs, attitudes, and social norms in shaping students' environmental behaviours. Although many students express environmental concerns, their actions are often not aligned with sustainable practices. This problem is made worse by a

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<sup>1</sup> <https://www.esn.org/>

<sup>2</sup> <https://erasmus-plus.cc.europa.eu/>

lack of understanding of sustainable practices in their host countries, which makes it harder for them to act in an environmentally responsible way.

Both the Erasmus+ and the European Solidarity Corps<sup>3</sup> programmes have been instrumental in promoting sustainability among young people. To this end, a document has been published which provides an overview of activities in both programmes that contribute to the green transition (European Commission, 2024b). The promotion of environmentally friendly behaviour is facilitated by several initiatives and guidelines within the Erasmus programme, owing to issues that have been identified. For instance, the Green Travel Top-Up initiative offers supplementary financial assistance to students opting for sustainable modes of transportation, such as trains or buses, to reach their Erasmus destination. Furthermore, students may receive up to four days of additional individual support to accommodate extended travel times (Erasmus Student Network, 2025). A range of guidelines are also available for students. The Handbook for Sustainable Internationalisation offers guidelines for HEI and students on integrating sustainability into international mobility practices, including travel recommendations and strategies to reduce carbon emissions (Green Erasmus, 2025). The Erasmus Goes Green<sup>4</sup> project has issued policy recommendations to reduce the programme's environmental impact, advocating for measures such as increased support for green travel options and implementing sustainable practices across all levels of the Erasmus+ programme (Alves & Terzieva, 2022).

Two ongoing Erasmus+ projects promoting environmentally sustainable behaviour among students during mobility have been identified. The Erasmus+ SET project (Sustainable Erasmus+ Travel) aims to enhance students' opportunities to adopt more environmentally sustainable habits during their mobility and to change how they think about the trip to the mobility destination. The gamified version of the Green Skills repository is available to discover the competencies that can be acquired when travelling greenly to a mobility destination (Dermati, 2024). The Erasmus+ SuMoS project (Strengthening the Ecosystem for Sustainable Student Mobility) aims to promote sustainable practices among students participating in international mobility programs by developing tools and resources that encourage environmentally friendly behaviours during their studies abroad.

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<sup>3</sup> [https://youth.europa.eu/solidarity\\_en](https://youth.europa.eu/solidarity_en)

<sup>4</sup> <https://esn.org/erasmus-goes-green>

Several other initiatives and guidelines are available in addition to the Erasmus initiatives. The European Association for International Education (EAIE, 2025) provides some recommendations on how student learning can drive sustainable study abroad. Moreover, UNESCO (2024) has issued guidance on the incorporation of sustainability principles into academic curricula, to achieve a 90% adoption rate of green national curricula by 2030. The expected learning outcomes for each age group, including the 18+ age group, have been delineated.

## **5 Digital tools for promoting sustainability in ISM**

Various tools and resources are available online to encourage students to adopt environmentally friendly and sustainable practices during their international mobility experiences.

The Green Erasmus<sup>5</sup> portal is an excellent example of such a resource. It provides helpful materials to support students in adopting sustainable practices before, during, and after their time abroad. This portal includes educational resources, fun interactive games, and quizzes to increase students' awareness of environmental issues (Green Erasmus, 2025).

### **5.1 Overview of existing web applications and portals**

The Ecological Footprint webpage<sup>6</sup> comprises several footprint calculators, among them the Personal Ecological Footprint, which would be the most appropriate for students (Graz University of Technology, Institute of Process and Particle Engineering, 2025). The footprint is calculated using the Sustainable Process Index methodology (Nardoslawsky & Krotscheck, 1995). The Personal Ecological Footprint calculator requires substantial user input, including general information about the individual and details regarding environmentally related training, housing, mobility and food. Specifically, values are required when reporting on housing and mobility. Lifestyle habits are also included. The result of this calculator is the personal ecological footprint compared to the available area in the selected country and the average footprint per person in Austria.

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<sup>5</sup> <https://www.greenerasmus.org/>

<sup>6</sup> <https://www.fussabdrucksrechner.at/en/calculation/personal/5>

The CO<sub>2</sub> Visualization Tool, developed within the Erasmus Goes Green project (Erasmus Goes Green, 2022) calculates the carbon footprint for different travel options, enabling informed decisions that minimize environmental impact. The tool is similar to the Personal Ecological Footprint Calculator in that it requires a significant amount of input from students regarding their housing, various types of transport, and secondary carbon footprint factors, along with consumption estimations in different categories. The personal footprint is subsequently calculated based on the values entered by the user.

The LifeStyle Test<sup>7</sup> application was developed by the Finnish Innovation Fund (PSLifestyle, 2025) and provides an evaluation of the impact of lifestyle choices on environmental footprint. Rather than providing specific values, the app utilizes a descriptive multiple-choice format for each question. The user-friendly interface has multilingual capabilities and a comprehensive approach to sustainable behaviour. The test results are presented as a personal carbon footprint, alongside a proposed target for 2030. The test results in the provision of personalised recommendations for sustainable behaviour. The user can accept or reject the proposed activity or mark it as already doing this. The selection is reflected in the updated results of the carbon footprint calculator, which typically show lower CO<sub>2</sub> emissions.

Despite the U-Mob Life project (U-MOB LIFE, 2018) promoting the CO<sub>2</sub> emission tool as one of their deliverables, it is currently not operational. The survey on mobility is available in a document format, including some general suggestions, mainly to support institutional sustainability.

## **5.2 Analysis of Website Traffic or Environmental Footprint Calculators**

The website traffic analysis for the three selected environmental footprint calculators employed the Similarweb<sup>8</sup> tool and produced interesting results. While the Personal Ecological Footprint (Graz University of Technology, Institute of Process and Particle Engineering, 2025) recorded 772 identified monthly visits in December 2024, the Lifestyle test app (PSLifestyle, 2025) received 13,275 visits. Conversely, the Erasmus Goes Green tool website recorded no traffic in December 2024. The average visit duration on the former is marginally less than two minutes. In

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<sup>7</sup> <https://www.lifestyletest.eu/>

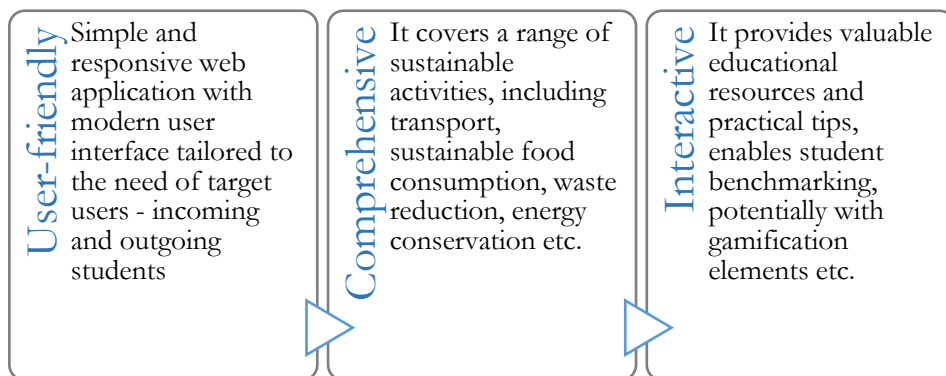
<sup>8</sup> <https://www.similarweb.com/>

comparison, the average visit duration on the latter is more than five minutes, indicating a higher level of interest. Furthermore, the bounce rate (the percentage of users viewing only one page before leaving the website) stands at 42% for the Personal Ecological Footprint website and 19% for the Lifestyle test app. This concise analysis provides a preliminary evaluation of the tool's usability and provides the basis for the development of a benchmarking tool for mobile student's environmental footprint within the SuMoS project.

## **6 Discussion and conclusions**

Student mobility is an important aspect of higher education, fostering the development of future problem-solvers, and providing a physical space for observation, debate and networking (EAIE, 2025). As Alves (2021) emphasizes, HEIs should adopt measuring methods to help them better understand the impact of their internationalisation-related emissions. Providing supplementary information on local sustainable practices and activities, including flea markets, recycling habits, and bulk markets, would also benefit their incoming students. For instance, the Green Guide by Ghent University (2025) comprehensively addresses all aspects of students' needs, including transport, food, shopping, and waste recycling, along with valuable tips and resources.

The Green Erasmus Report (Diekmann & Karaiskos, 2022) emphasizes the need for targeted interventions to make international student mobility more sustainable. Therefore, the availability of specially designed, user-friendly web applications would be most valuable for both outgoing and incoming students. While most sustainable international mobility initiatives are centred on sustainable transport, the web application should encompass additional aspects, such as sustainable food consumption, waste reduction, and related areas. It is acknowledged that specific existing tools are overly complex for students with limited knowledge of their energy consumption habits, public transport distances, etc. In contrast, other tools require search engine optimisation to facilitate enhanced accessibility.



**Figure 1: Characteristics of practical and useful digital tool for enhancing student environmental awareness**

Source: Own

The analysis of existing tools shows limited usage; therefore, additional effort is needed to develop a user-friendly and practical application for enhancing student environmental awareness, with the characteristics as summarized in Figure 1.

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# PREUČEVANJE IMPLEMENTACIJE »PRAVICE DO ODKLOPA« V PRAKSI

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Prispevek obravnava implementacijo pravice do odklopa (PDO) v Sloveniji, uzakonjene novembra 2024. Izvedena je bila raziskava, katere cilj je bil ugotoviti njene prednosti, priložnosti, slabosti in grožnje na delovne procese, zaposlene v izbranih organizacijah javnega in zasebnega sektorja. S pomočjo strukturiranih intervjujev s kadrovskimi managerji smo identificirali različne prakse implementacije, kot so prilagoditev pravilnikov o delovnem času, uvedba samodejnih odzivnikov za e-pošto ter ločevanje službenih in zasebnih komunikacijskih sredstev. Rezultati so pokazali, da so izbrane zasebne organizacije večinoma hitreje in učinkoviteje implementirale PDO, medtem ko so izbrane organizacije javnega sektorja zaznamovali dodatni izzivi, kot je bila plačna reforma. SWOT analiza je razkrila prednosti PDO, kot so natančno definiran delovni čas in večja ozaveščenost zaposlenih, ter opozorila na slabosti, kot je delo na daljavo, ki zaradi celodnevne opraviljanja del in nalog, vodi v preobremenjenost zaposlenih. Zaključujemo, da je PDO pomemben korak k bolj trajnostnemu delovnemu okolju, vendar bo za njeno uspešno implementacijo potrebno nenehno prilagajanje pravilnikov, ozaveščanje zaposlenih in usklajevanje praks v organizacijah.

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# EXAMINING THE IMPLEMENTATION OF THE "RIGHT TO DISCONNECT" IN PRACTICE

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The research examined the implementation of the Right to Disconnect (RTD) in Slovenia, legislated in November 2024. The goal was to identify its advantages, opportunities, weaknesses, and impact on the work processes and employees in selected public and private sector organizations. Through structured interviews with HR managers, various implementation practices were identified, such as adjusting working time regulations, introducing automatic email responders, and separating work and personal communication tools. The results revealed that private sector organizations were generally better prepared for implementing RTD, whereas public sector organizations faced additional challenges, including administrative constraints and wage reform. The SWOT analysis highlighted the benefits of RTD, such as clearly defined working hours and increased employee awareness, while pointing out weaknesses like remote work, which, due to continuous accessibility, leads to employee overburdening. In conclusion, RTD represents an important step toward a more sustainable work environment. However, its successful implementation will require continuous adjustment of regulations, employee awareness-raising, and harmonization of practices within organizations.



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## 1 Uvod

Sodobni delovni procesi se vse bolj prepletajo z osebnim življenjem zaposlenih, kar pogosto povzroča izzive pri zagotavljanju ravnovesja med delom in prostim časom (Kurzynoga, 2024; Marica, 2022). Hiter razvoj informacijsko-komunikacijske tehnologije (IKT) je bistveno preoblikoval načine dela in poslovanja v različnih sektorjih, organizacijah in področjih (Palvalin et al., 2013). V odgovor na te spremembe se je oblikoval koncept Pravice do odklopa (PDO), ki predstavlja sodoben pristop k reševanju težav, povezanih z ločevanjem poklicnega in zasebnega življenja (Büchler et al., 2020). Kljub temu, da je PDO zakonsko urejena, ostaja njena implementacija v praksi ključna za razumevanje njenega vpliva na delovno okolje, zadovoljstvo zaposlenih in učinkovitost organizacij. Le z učinkovitim uresničevanjem te pravice je mogoče zmanjšati tveganje za preobremenjenost zaposlenih (Lerouge & Trujillo Pons, 2022; Urbane, 2023)

Z raziskavo smo želeli preučiti, kako izbrane organizacije, tako v javnem kot zasebnem sektorju, implementirajo PDO in s kakšnimi izzivi se pri tem soočajo. Osredotočili smo se na dve raziskovalni vprašanji: (1) Kako so organizacije implementirale pravico do odklopa? (2) S kakšnimi izzivi so se organizacije srečale pri uvedbi pravice do odklopa? Na podlagi teh vprašanj smo izvedli kvalitativno analizo, katere rezultati so predstavljeni v obliki tabel, ki ponazarjajo pravice in obveznosti zaposlenih ter glavne izzive v povezavi s PDO.

Za celovito razumevanje problematike smo oblikovali tudi SWOT matriko, ki razkriva prednosti, slabosti, priložnosti in grožnje PDO v praksi. Ugotovitve iz SWOT matrike so nam predstavljale hkrati tudi glavni cilj naše raziskave. Ta sistematičen pristop nam je omogočil vpogled v širšo sliko implementacije PDO v delovne procese ter identifikacijo področij, kjer so potrebne nadaljnje izboljšave. S tem prispevkom želimo prispevati k poglobljenemu razumevanju implementacije PDO in spodbuditi razpravo o dobrih praksah, izzivih in možnih rešitvah na področju PDO.

## 2 Pravica do odklopa

PDO je koncept, natančneje pravna ureditev, ki si prizadeva zaščititi zaposlene pred neprestano dosegljivostjo s starni delodajalca in sodelavcev. PDO zahteva odklop od službenih nalog izven delovnega časa (*Pravica do odklopa - podrobnejša pojasnila in*

*smernice* | GOV.SI, 2024). Ta pravica je vse bolj prepoznana kot pomemben ukrep za zagotavljanje ravnovesja med poklicnim in zasebnim življenjem ter ohranjanje dobrega duševnega zdravja v sodobnem delovnem okolju (Marica, 2022; Varela-Castro et al., 2022).

PDO, uzakonjena v Sloveniji novembra 2024, predstavlja pomemben korak k zaščiti zaposlenih pred prekomerno obremenitvijo zaradi stalne dosegljivosti (*Pravica do odklopa - podrobnejša pojasnila in smernice* | GOV.SI, 2024). Podobne zakonodajne rešitve so že uveljavljene v nekaterih drugih državah članicah EU in ostalih državah po svetu, kjer so dosegle pozitiven vpliv na delovno okolje in dobrobit zaposlenih. Države, ki izvajajo PDO, so Francija, Španija, Portugalska, Irska, Belgija, Italija, Grčija, Avstralija, Kanada itd. (Kurzynoga, 2024; *The Right to Disconnect around the World - Ius Laboris*, n.d.).

PDO je tudi ključna za doseganje trajnosti. Pripomore k boljšim pogojem za delo, izboljšuje duševno zdravje in pripomore k varnemu in pravičnemu delovnemu okolju (Hopkins, 2024). Trajnost dosega s pomočjo zdravih in delovno željnih zaposlenih, kateri ne povzročajo večjih fluktuacij v organizacijah (Staniškiene & Stankevičiūtė, 2018). Zaposleni imajo svoje potrebe, želje (Helfat et al., 2009), ki jih poleg svojega poklica želijo izvajati v svojem prostem času. Z dobrim ravnovesjem med poklicnim in zasebnim življenjem se poveča tudi pripadnost, izboljša se organizacijska klima in kultura (Kwantes & Glazer, 2017; Tohidian & Rahimian, 2019).

Zakon o delovnih razmerjih (ZDR), je zakon, ki ureja pravice in obveznosti zaposlenih in delodajalcev, organizacij v Sloveniji s področja delovnega prava (*Pravica do odklopa - podrobnejša pojasnila in smernice* | GOV.SI, 2024) Od novembra 2024 ureja tudi obveznosti iz naslova PDO.

PDO pomeni, da morajo organizacije spoštovati prosti čas zaposlenih in se vzdržati poseganja v njih med dnevnim ali tedenskim počitkom, letnim dopustom, bolniško odsotnostjo ali drugo upravičeno odsotnostjo z dela. Pravica nalaga organizacijam tudi dolžnost, da sprejmejo ustrezne ukrepe, kot so določitev časovnih omejitev za službeno komunikacijo ter izobraževanje zaposlenih in vodstva o pomembnosti spoštovanja te pravice (*Pravica do odklopa - podrobnejša pojasnila in smernice* | GOV.SI, 2024).

Ustrezne ukrepe predstavljajo sprejete dopolnitve obstoječih pravilnikov, aneksov. O sprejetih ukrepih za namen PDO morajo zaposlene obvestiti preko oglasnih mest, na sestankih, zborih (*Bližja se uveljavitev pravice do odklopa. Te pomembne informacije morate poznati, da ne boste v prekršku.*, n.d.). Na lastnih informacijskih portalih in e-pošti kasneje obveščajo zaposlene o kakršnih koli spremembah in dopolnitvah teh pravilnikov, aneksov. Tisti, ki pravice do odklopa ne upoštevajo tvegajo denarno kazen (Rabuza, 2024).

### 3 Metodologija

Da bi ugotovili ali je nova dopolnitev ZDR na temo pravice do odklopa smiselna, smo izvedli skupno osem strukturiranih intervjujev v organizacijah javnega in zasebnega sektorja. Z njimi smo želeli ugotoviti, ali je implementacija tega dela zakona v praksi dosegla svoj namen ali ne. Intervjuje smo izvedli s kadrovske managerji v organizacijah na Gorenjskem v mesecu decembru 2024 in januarju 2025. Intervjuji so potekali preko telefonskih pogovorov ali v živo. Bili so sestavljeni iz sedmih vprašanj, od katerih so imela nekatera tudi dodatna podvprašanja. Vsebina intervjujev se je nanašala na mnenja intervjuvanih kadrovske managerjev glede na stanje pred uzakonitvijo, postopek implementacije, prednosti in priložnosti, slabosti in grožnje, odzive zaposlenih in mnenja o prihodnosti PDO.

Štirje intervjuji so bili izvedeni v zasebnem, štirje pa v organizacijah javnega sektorja. Primerjali smo, kako so v posameznem sektorju delodajalci implementirali PDO. Zaradi majhne številčnosti intervjuvanih kadrovske managerjev, izbranih organizacij in končnih rezultatov nismo posebej primerjali še z velikostjo in aktivnostjo, dejavnostjo v katerih organizacije delujejo.

V zasebnem sektorju smo za odgovore zaprosili kadrovske managerje iz treh proizvodnih in ene informacijsko-tehnološke (IT) organizacije. V javnem sektorju smo odgovore na vprašanja intervjuja dobili od dveh visokošolskih izobraževalnih ustanov - fakultet, enega od ministrstva ter enega od upravne enote (UE). Imen organizacij nismo posebej navajali, saj so nekatere organizacije želele ostati anonimne.

Oblikovali smo naslednji raziskovalni vprašanja (RV):

RV1: Kako so organizacije implementirale pravico do odklopa?

RV2: S kakšnimi izzivi so se organizacije srečale pri uvedbi pravice do odklopa?

Na RV1 in RV2 smo odgovorili s pomočjo transkriptov intervjujev ter izdelali SWOT matriko, ki je predstavljala cilj in hkrati rezultat raziskave, saj je razčlenila prednosti, slabosti, priložnosti in grožnje, ki jih PDO prinaša organizacijam in zaposlenim.

#### 4 Raziskava

Z namenom zagotovitve čim kakovostnejših rezultatov smo s pomočjo izvlečkov pridobljenih iz posameznih intervjujev v obliki tabel zapisali rezultate. V tabeli 1 in 2 je razvidno, v koliko organizacijah smo izvedli intervjuje s kadrovske managerji, v katerem sektorju delujejo ter s katerimi aktivnostmi in dejavnostmi se posamezna organizacija ukvarja. Zaradi velike različnosti med aktivnostmi in dejavnostmi organizacij nismo mogli neposredno primerjati. Predvsem smo se osredotočili na to, kako so posamezne izbrane organizacije implementirale PDO, katere so po sprejetju PDO pravice in obveznosti zaposlenih in kaj je organizacijam predstavljalo glavne izzive pri PDO. Vsi izvlečki, rezultati so prikazani v tabeli 1 in tabeli 2, ki hkrati predstavljata tudi posreden strukturiran odgovor na RV1 in RV2.

V tabeli 1 so prikazani rezultati raziskave, ki so se nanašali na prvo raziskovalno vprašanje (RV1). Ker nas je zanimala implementacija PDO, smo tabelo 1 razdelili na pet stolpcev. V prvem stolpcu je zapisano število organizacij, v drugem stolpcu je zapisan sektor v katerem organizacije delujejo (javni, zasebni), v tretjem stolpcu je zapisana vrsta aktivnosti, dejavnosti v kateri organizacije delujejo, četrti stolpec zajema način implementacije PDO v posameznih organizacijah, peti stolpec pa prikazuje pravice in obveznosti zaposlenih po zakonitvi, implementaciji PDO.



**Tabela 1: Značilnosti izbranih organizacij, implementacija pravice do odklopa**

	Sektor	Aktivnost, dejavnost	Implementacija PDO	Pravice in obveznosti zaposlenih po zakonitvi, implementaciji PDO
1	Javni	Upravna enota	Dopolnjen pravilnik o delovnem času	<ul style="list-style-type: none"> <li>– Definiran delovni čas.</li> <li>– Obvezna prisotnost v času uradnih ur delovanja UE za stranke, občane.</li> <li>– Delo na daljavo</li> <li>– Zaposlenim ni potrebno odgovarjati na e-pošto po koncu delovnega časa.</li> </ul>
2	Javni	Visokošolsko izobraževalna ustanova - Fakulteta	Dopolnjen Pravilnik o delovnem času + Aneks h Kolektivni pogodbi za negospodarske dejavnosti v Republiki Sloveniji	<ul style="list-style-type: none"> <li>– Telefonski klici in e-pošta v pon. – pet. med 6.00 in 16.30).</li> <li>– Pravica do odklopa se upošteva med prazniki, vikendi, med bolniško zaposlenih in dopustom.</li> <li>– E-poštni samodejni odzivniki v primeru odsotnosti.</li> <li>– Sestanki se sklicujejo vsak delovni dan med 8.00 in 16.00, vsaj 48 ur pred sestankom.</li> <li>– Zaposlene na sestankih opozarjajo na pomembnost PDO.</li> <li>– Zaposlenim ni potrebno odgovarjati na e-pošto po koncu delovnega časa.</li> </ul>
3	Javni	Visokošolsko izobraževalna ustanova - Fakulteta	Aneks h Kolektivni pogodbi za negospodarske dejavnosti v Republiki Sloveniji	<ul style="list-style-type: none"> <li>– Dostopnost zaposlenih v času uradnih ur. Te so določene za stik z javnostjo (npr. govornilne ure).</li> <li>– Neopravljanje dela izven delovnega časa zaposlenih, kamor spada tudi neobvezno komuniciranje preko telefona in e-pošte.</li> <li>– Zaposleni lahko izven delovnega časa izključijo službene telefone, prenosne računalnike ali druge naprave.</li> <li>– Zaposlenim ni potrebno odgovarjati na e-pošto po koncu delovnega časa.</li> </ul>
4	Javni	Ministrstvo	Dopolnjen pravilnik o delovnem času.	<ul style="list-style-type: none"> <li>– Avtomatski odzivniki za primere odsotnosti.</li> <li>– Dostopnost zaposlenih v času uradnih ur. Te so določene za stik z javnostjo (npr. govornilne ure).</li> </ul>
5	Zasebni	Informacijsko tehnološka (IT) organizacija	Dopolnjen pravilnik o delovnem času.	<ul style="list-style-type: none"> <li>– Zaposlenim ni potrebno odgovarjati na e-pošto po koncu delovnega časa.</li> <li>– Plačane vse nadure.</li> <li>– Poklicna in zasebna številka telefon.</li> </ul>

	Sektor	Aktivnost, dejavnost	Implementacija PDO	Pravice in obveznosti zaposlenih po zakonitvi, implementaciji PDO
6	Zasebni	Proizvodnja	Dopolnjen pravilnik o delovnem času.	<ul style="list-style-type: none"> <li>– Zaposlenim ni potrebno odgovarjati na e-pošto po koncu delovnega časa.</li> <li>– V času dežurstva ali stalne pripravljenosti zaposleni nimajo PDO, zaradi nujnih primerov (nezgode, okvare kritične infrastrukture, izredni dogodki).</li> <li>– E-poštni samodejni odzivniki v primeru odsotnosti</li> <li>– Zaposleni, ki delajo na daljavo, imajo enake pravice do odklopa kot tisti, ki delajo v pisarni.</li> <li>– E-izobraževanje</li> </ul>
7	Zasebni	Proizvodnja	Dopolnjen pravilnik o delovnem času.	<ul style="list-style-type: none"> <li>– Dežurno delo je izključeno iz PDO</li> <li>– Na e-pošto se ne odgovarja izven delovnega časa</li> <li>– E-izobraževanje</li> </ul>
8	Zasebni	Proizvodnja	Aneks h Kolektivne pogodbi na ravni dejavnosti v kateri organizacija deluje	<ul style="list-style-type: none"> <li>– Na e-pošto se ne odgovarja izven delovnega časa.</li> <li>– Do 18.00 so režijski zaposleni dosegljivi na telefone.</li> </ul>

Nekatere organizacije so implementacijo PDO izvedle z dopolnitvijo pravilnika o delovnem času, nekatere pa z aneksom h kolektivni pogodbi na ravni dejavnosti v kateri delujejo. V dopolnitvah so definirale obvezno prisotnost, ko morajo biti zaposleni prisotni ali pa dosegljivi, definirale so tudi, kolikokrat mesečno imajo lahko zaposleni delo na daljavo. Eden izmed intervjuvanih kadrovskih managerjev je zatrdil, da si zavzemajo celo ukiniti delo na daljavo, saj ugotavljajo, da le ta predstavlja povod v celodnevno delo in nezmožnost izključitve opravljanja dela tudi po koncu delovnega časa.

V dopolnitvah so organizacije definirale, da se PDO upošteva med prostim časom, prazniki, vikendi in, ko so zaposleni na dopustu, bolniški odsotnosti. Vsi kadrovski managerji so zatrdili, da v skladu z internimi dogovori, le v nujnih primerih pokličejo svoje zaposlene. To storijo takrat, ko imajo primanjkljaj zaposlenih zaradi bolniških odsotnosti, dopustov ali, ko pride zaradi pomembnih rokov do večje količine dela. Vsi intervjuvani kadrovski managerji so pojasnili, da sodelavce, zaposlene kličejo le izjemoma.

Ena izmed javnih organizacij je vpeljala pravilo, da se sestanki sklicujejo vsaj 48 pred sestankom, med 8.00 in 16.00 v času delovnih dni. Vpeljali so tudi časovnico, kjer delovni dan poteka med 6.00 in 16.30, po tem času imajo v e-pošti vključene avtomatske odzivnike o nedosegljivosti. Tudi nekatere zasebne organizacije imajo avtomatske odzivnike, hkrati pa so ločili službene in zasebne telefonske številke zaposlenih. Če so zaposleni odsotni, se pošiljatelje ali klicatelje preusmeri k drugim odgovornim osebam, ki pokrivajo, nadomeščajo področje zaposlenih, kateri so odsotni.

Veliko organizacij je že pred uzakonitvijo PDO imelo urejeno ali pa dogovorjena interna pravila glede izven službene komunikacije, spoštovanja zaposlenih, ki so bili odsotni zaradi različnih razlogov, spoštovanja ne-pošiljanja poznih e-sporočil in poznih telefonskih klicev. Predvsem v zasebnem sektorju ima večina organizacij nenapisano pravilo, da je po 18.00 konec službenih obveznosti. Vseh osem organizacij pa je že pred PDO imelo urejen čas obvezne prisotnosti na delovnem mestu, ki dnevno traja približno med 4 do 5 ur.

Ker smo intervju izvedli med tremi proizvodnimi organizacijami, je PDO prišla manj do izraza na delovnih mestih, kjer imajo stalen 8 urni delovnik. Seveda imajo tudi ti zaposleni nadure, vendar so le te ustrezno nagrajene. V IT organizaciji vsem zaposlenim izplačajo nadure, saj se delovne obveznosti lahko zamaknejo v čas po koncu delovnega časa. Po mnenju kadrovskega managerja gre za velik bonus zaradi katerega zaposleni nimajo problema dvigniti klica ali odgovoriti na e-pošto v svojem prostem času.

Nekatere organizacije, ki imajo za kritične delovna mesta, so vpeljala pravila, kdaj za zaposlene na teh mestih ne velja PDO. Gre predvsem v primerih, ko potekajo dežurstva ali pa zaposleni morajo biti v stalni pripravljenost, zaradi nujnih primerov (nezgode, okvare kritične infrastrukture, izredni dogodki).

Glavni cilj izbranih organizacij je bil, ko so implementirale PDO, da imajo spočite, ne preobremenjene zaposlene. To dosežajo s stalnim ozaveščanjem, kot so sestanki in e-izobraževanja ter opozarjanjem zaposlenih, ki ne upoštevajo predpisov glede PDO.

S kakšnimi izzivi so se organizacije srečale pri uvedbi PDO, prikazuje tabela 2, ki se navezuje na drugo raziskovalno vprašanje (RV2). Iz omenjene tabele razberemo, da so imele organizacije iz javnega sektorja več izzivov v zvezi s PDO. Ugotovljeno, to izhaja iz naslova plačne reforme za javni sektor, ki je nastopila z začetkom leta 2025 in se, povedo po pravici, kadrovske managerji niso imeli časa poglobljeno ukvarjati s PDO. Dva kadrovska managerja sta namreč priznala, da pravilnikov v zvezi s PDO v organizaciji še nimajo dokončanih, dopoljenih.

**Tabela 2: Izzivi organizacij v zvezi s pravico do odklopa**

	Sektor	Izzivi
1	Javni	– Dokončno urediti pravilnik.
2	Javni	– Zaposlene navaditi na dolžnosti, pravice in obveznosti z naslova PDO.
3	Javni	– Dopolniti pravilnik o delovnem času. – Določiti časovno obdobje v delovnih dneh za pošiljanje e-pošte in telefonske klice.
4	Javni	– Dokončno urediti pravilnik.
5	Zasebni	– Ni posebnih izzivov.
6	Zasebni	– Zmanjšati količino dela od doma. – Pravno pripravljenost v primeru zlorab PDO.
7	Zasebni	– Ni posebnih izzivov.
8	Zasebni	– Ni posebnih izzivov.

Manjši izziv je drugi javni organizaciji predstavljala peščica zaposlenih, ki se niso zmenili za časovno določene ure elektronskega ali mobilnega komuniciranja, saj so kljub uvedbi pravilnika za PDO, velikokrat komunicirali z ostalimi zaposlenimi tudi izven delovnega časa za nenujne naloge.

Organizacije iz zasebnega sektorja niso imele večjih izzivov, saj so že pred uzakonitvijo PDO sprejele, dopolnile pravilnike oziroma dodale anekse za spremembo kolektivne pogodbe na ravni dejavnosti v kateri organizacija deluje.

Ena izmed organizacij se zavzema za zmanjšano količino dela na daljavo, saj veliko zaposlenih, ki delajo od doma ne znajo prekiniti dela in posledično delo opravljajo cel dan. Ista organizacija si prizadeva s pomočjo pravnika delovne procese prilagoditi in ovrednotiti, da bi v prihodnje prihajalo do čim manj zlorab, tožb na račun neupoštevanja PDO.

V tabeli 3 so prikazane glede na tabelo 1, tabelo 2 in ostale odgovore na vprašanja intervjujev, prednosti, priložnosti, slabosti in grožnje PDO v javnem in zasebnem sektorju. Tabela je zapisana v obliki SWOT matrike.

**Tabela 3: SWOT matrika na temo pravice do odklopa**

<b>Prednosti:</b> <ul style="list-style-type: none"> <li>– Definiran delovni čas.</li> <li>– Definirane ure dosegljivosti na e-pošto in telefon.</li> <li>– Nastavitev samodejnih odzivnikov za e-pošto.</li> </ul>	<b>Slabosti:</b> <ul style="list-style-type: none"> <li>– Delo na daljavo</li> <li>– Dosegljivost med prazniki, vikendi, bolniško odsotnostjo, dopustom.</li> <li>– Plačane nadure.</li> </ul>
<b>Priložnosti:</b> <ul style="list-style-type: none"> <li>– Ločitev službenih in zasebnih telefonskih števil.</li> <li>– Napoved sestankov.</li> <li>– E-izobraževanja</li> </ul>	<b>Grožnje</b> <ul style="list-style-type: none"> <li>– Zlorabe</li> <li>– Tožbe</li> </ul>

Iz tabele 3 je možno razbrati, da glavne prednosti PDO predstavlja natančno definiran delovni čas, in definirane ure dosegljivosti na e-pošto in telefon, kar pomeni, da po določeni uri, razen v izrednih razmerah zaposleni, niso več dosegljivi in na razpolago organizaciji. Po koncu določene ure v delovnem dnevu, lahko pa tudi v času dopusta, bolniške odsotnosti ali med vikendi imajo zaposleni vklopljene samodejne odzivnike za e-pošto, ki pošiljateljem sporočijo odsotnost, nedosegljivost.

Priložnosti PDO predstavljajo predvsem izboljšave na področju ločevanja službenih in zasebnih telefonskih števil, napovedi sestankov (npr. vsaj 48 ur pred sestankom) in povečanje ozaveščenosti zaposlenih o PDO. Ozaveščenost se doseže z opozarjanjem in opominjanjem posameznih zaposlenih, ki se za pravice in obveznosti PDO do ostalih zaposlenih ne zmenijo in komunicirajo zaradi nenujnih del z njimi tudi po koncu delovnega časa. Nekatere izbrane organizacije ozaveščenost spodbujajo tudi z e-izobraževanji.

Med slabosti PDO glede na SWOT matriko, ena izmed organizacij uvršča celo delo na daljavo, saj pri večini zaposlenih ugotavljajo, da je delo na daljavo glavni krivec za celodnevno delo, dosegljivost. Prizadevajo si ga celo ukiniti. Glede na intervju trdimo, da izbrana organizacija nima podrobneje definirane razlike med delom od doma in delom na daljavo. Prvi izraz pomeni, da zaposleni delajo od doma, v času

njihovega definiranega delovnega časa, v strogem okviru urnika dela in imajo strožji nadzor s strani organizacije (Yang et al., 2023). V tem primeru do celodnevne dela pride težje, saj se delovni pogoji za zaposlene v primerjavi z delom na lokaciji organizacije, razlikujejo samo v lokaciji dela in prevoza.

V primeru dela na daljavo, katere glavne značilnosti so prilagodljivost delovnega časa, urnika, povečane avtonomije zaposlenih itd. (Vartiainen, 2021), pa zaradi slabe samodiscipline ali deloholičnosti, prihaja do celodnevnega opravljanja dela zaposlenih, kar vodi v njihovo preobremenjenost in izogorelost (Palumbo, 2020).

Druga slabost je dosegljivost zaposlenih med prazniki, vikendi, bolniško odsotnostjo in dopustom. Medtem ko imajo nekatere organizacije to urejeno s samodejnimi odzivniki, pravilniki, druge organizacije tega ne upoštevajo. Velikokrat zaposlenim to ustreza, saj je dosegljivost v izbranih organizacijah, plačana. Dosegljivost nekatere organizacije vrednotijo kot nadure oziroma del plače za stalno pripravljenost, dežurstvo. Nadure na tak način vrednotijo tudi organizacije, katere nimajo delovnih mest namenjenih dežurstvom, stalni pripravljenosti. Organizacije tako lahko v zameno za plačilo prezirajo PDO in preobremenjujejo svoje zaposlene.

Kot so zatrdili nekateri intervjuvani kadrovske managerji bo zaradi preziranj organizacij ali pa zaradi iskanja »luknje v zakonu« vodilo do tožb posameznih zaposlenih. Ker se z njimi do sedaj izbrane organizacije na temo PDO še niso srečale, se na njih pripravljajo s pomočjo pravnikov in predvidevanjem situacij, ki so že v preteklosti iz naslova drugih kršitev vodile v tožbe.

## 5 Zaključek

Na podlagi izvedene raziskave in analize implementacije PDO v izbranih organizacijah je razvidno, da so organizacije, ne glede na sektor, prepoznale pomembnost spoštovanja poklicnega in zasebnega časa zaposlenih. Implementacija PDO se kaže kot kompleksna naloga, saj vključuje prilagoditev obstoječih pravilnikov, delovnih procesov ter uvajanje novih praks. Kljub temu so v številnih primerih izbrane organizacije že pred uzakonitvijo PDO imele določene interne dogovore, ki so zagotavljali omejevanje dosegljivosti zaposlenih izven delovnega časa.

Rezultati so pokazali, da organizacije uporabljajo različne pristope za uveljavljanje PDO, od aneksov h kolektivnim pogodbam do novih pravilnikov o delovnem času. Uvedene spremembe so vključevale definicije ur dosegljivosti, uporabo samodejnih odzivnikov za e-pošto ter ločevanje službenih in zasebnih komunikacijskih sredstev. Kljub pozitivnim spremembam pa izzivi, kot so delo na daljavo, dosegljivost v času odsotnosti in neupoštevanje pravil s strani nekaterih zaposlenih, ostajajo ključne točke za nadaljnje izboljšave.

Zasebni sektor je pokazal večjo prilagodljivost pri implementaciji PDO, medtem ko je javni sektor naletel na težave zaradi sistemskih sprememb, kot je plačna reforma. SWOT analiza je poudarila potrebo po ozaveščanju zaposlenih in doslednem spremljanju izvajanja PDO.

Zaključujemo, da je implementacija PDO, korak v pravo smer za zagotavljanje ravnovesja med poklicnim in zasebnim življenjem zaposlenih. Vendar je za dolgoročno uspešnost ključno sprotno prilagajanje pravilnikov, usklajevanje praks ter vzpostavljanje ustreznih kontrolnih mehanizmov. Nadaljnje raziskave na to temo bi lahko prispevale k poglobljenemu razumevanju učinkov PDO na zadovoljstvo zaposlenih, organizacijsko učinkovitost ter širši družbeni kontekst.

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# CAN AI BRIDGE THE PRODUCTIVITY GAP OF AN AGING WORKFORCE?

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The aging global workforce poses significant challenges for organizations striving to sustain productivity amidst the physical and cognitive decline associated with aging. Artificial intelligence (AI) emerges as a transformative tool, offering solutions to enhance the capabilities of older employees, automate routine tasks, and support informed decision-making. This paper explores the potential of AI to counteract productivity losses linked to workforce aging through a comprehensive review of existing research. It synthesizes insights on the effects of aging on employee productivity, examines how AI can complement and augment the contributions of older employees, and evaluates the broader implications of AI integration on organizational efficiency. By exploring the interplay between AI's potential and workforce aging and providing recommendations for inclusive AI implementation, the paper aims to contribute to the ongoing discourse on how AI can foster a sustainable, productive, and inclusive work environment in the face of demographic changes.

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## 1 Introduction

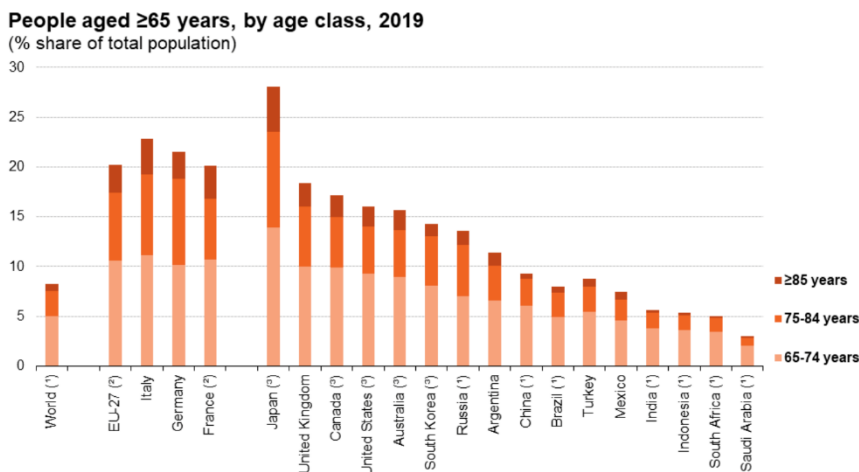
As global demographics shift towards an older population, there is an observable increase in the proportion of older workers, potentially affecting productivity dynamics within the labor force (WHO, 2021; OECD, 2021). The combination of workforce aging and technological advancement necessitates innovative solutions to maintain productivity, underlining the urgency of integrating Artificial Intelligence (AI) into workplace processes. AI, which is a technology that simulates human intelligence in machines, offers promising avenues by enhancing the capabilities of older workers through automation and cognitive support (Calo, 2022). However, effective AI deployment requires strategic management to address skill gaps and organizational resistance (Criado et al., 2024). While the long-term effects of AI on productivity remain uncertain, early evidence indicates its potential to revolutionize labor dynamics (Brynjolfsson & McAfee, 2017). The transformative potential of AI to augment and even replace certain human tasks positions it as a revolutionary tool for addressing productivity declines due to workforce aging (Abril-Jiménez et al., 2022; Jong-Wha et al., 2021; Milanez, 2020).

This paper aligns with research emphasizing the opportunities of AI to counteract this demographic challenge and sustain economic growth (McKinsey Global Institute, 2020). The purpose of this paper is to explore how AI can bridge the productivity gap created by an aging workforce. Specifically, it seeks to analyze how AI can augment the productivity of older employees and what practical challenges are associated with this transformation. By addressing these aspects, this paper contributes to the broader understanding of how AI can be strategically utilized to enhance productivity in aging workforces. The overarching research question guiding this paper is: How can AI be effectively utilized to mitigate the productivity challenges associated with an aging workforce?

## 2 Population Aging

Population aging is a universal phenomenon, though its progression varies significantly across regions. Developing nations are experiencing a much more rapid pace of demographic transition compared to the historical patterns observed in developed economies (United Nations, 2020). Among developed regions, Japan is widely recognized as the most advanced example of demographic aging. Following

closely behind is the European Union (EU), which demonstrates distinct aging trends that reflect decades of low fertility rates and increased life expectancy (Eurostat, 2020).



**Figure 1: Population Aging**

Source: Eurostat, 2022

The G20 countries present a diverse demographic landscape, spanning various stages of economic and population development. Figure 1 illustrates the share of older individuals (aged 65 years or more) within the total populations of G20 countries. As of 2015, older adults constituted 8.2% of the global population. Japan stood out with more than a quarter of its population aged 65 years or older (28.0% in 2018), followed by the EU-27, where older people comprised 20.3% of the population in 2019 (OECD, 2021). In contrast, several non-EU G20 countries recorded older population shares above the global average, including the United States (16.0% in 2018) and China (9.3% in 2015). Conversely, emerging economies like Mexico (7.4% in 2019), India (5.6% in 2015), Indonesia (5.4% in 2015), South Africa (5.0% in 2015), and Saudi Arabia (3.0% in 2015) reported relatively small proportions of older populations, reflecting their youthful demographic profiles and growing labor forces (United Nations, 2019).

## 2.1 Aging Workforce and Labor Productivity

The aging workforce represents a critical aspect of demographic change, posing significant implications for labor markets and organizational structures worldwide. The World Health Organization (WHO) projects that by 2050, the number of individuals aged 60 and over will rise to 2 billion, a nearly threefold increase from 2000 (WHO, 2021). Moreover, in developed countries, the share of workers aged 55 and over is projected to increase by 23% between 2018 and 2030 (OECD, 2021). This demographic shift has profound implications for the functioning and performance of organizations. To address these challenges, organizations must develop effective strategies for managing their aging workforce (Kim & Feldman, 2015). The implications of workforce aging on labor productivity are multifaceted, with significant debates surrounding the direction and magnitude of its impact. Productivity outcomes associated with an aging workforce depend on a balance between the benefits of accumulated experience and the potential drawbacks of age-related physical and cognitive decline.

Moreover, theoretical perspectives on age-related productivity effects are divided. Proponents of the experience-based hypothesis argue that older workers contribute positively to productivity due to their extensive knowledge, expertise, and problem-solving abilities accumulated over decades of employment. This view is particularly relevant in sectors that rely heavily on tacit knowledge and mentorship (Skirbekk, 2008; Börsch-Supan, 2013). Conversely, detractors highlight that the productivity of older workers may decline due to health deterioration, slower adaptation to technological advancements, and skill obsolescence (Bloom et al., 2010). Empirical studies indicate that productivity typically peaks in middle age, with significant variation across occupations and industries (Lazear, 2020; Göbel & Zwick, 2012).

Furthermore, evidence from longitudinal analyses suggests that workforce aging negatively influences aggregate productivity, primarily through reductions in total factor productivity (TFP). Using data from European countries spanning 1950 to 2014, studies have shown that a five-percentage-point increase in the proportion of workers aged 55–64 correlates with a three-percent decline in labor productivity (Aiyar et al., 2016). These results emphasize the structural challenges posed by demographic shifts, particularly in economies with rapidly aging populations. Breaking down labor productivity into its components—physical capital, human

capital, and TFP—research consistently identifies TFP as the primary mechanism through which workforce aging exerts its impact. TFP, which measures the efficiency of input utilization, is crucial for sustained economic growth. An aging workforce has been associated with a 2–4% reduction in TFP, reflecting inefficiencies in adapting to technological change and innovation (Aiyar et al., 2016; Acemoglu & Restrepo, 2017).

## **2.2 Effects of Aging on Employee Performance**

The productivity of older workers has become a key focus of research, driven by the need to balance the benefits of accumulated experience with potential declines in physical and cognitive capabilities (Calvo-Sotomayor et al., 2019). While certain cognitive functions, such as memory and processing speed, may decline with age, other skills, including problem-solving, leadership, and emotional intelligence, often improve (Skirbekk, 2008). These attributes significantly contribute to workplace productivity, particularly in roles requiring interpersonal communication, strategic thinking, and decision-making (Harvard Business Review, 2022).

One of the most pressing challenges for aging workers is the growing skill gap, particularly as technological advancements reshape workplace requirements. Research indicates that older employees often face difficulties in adapting to new digital tools, with barriers such as limited access to training opportunities and resistance to change exacerbating the issue (Brynjolfsson & McAfee, 2014). Older workers are less likely to participate in skill development programs, leading to disparities in technological proficiency (Charness & Czaja, 2006). Resistance to change can stem from fear of failure or unfamiliarity with emerging technologies, further hindering adaptation to modern workplaces (Czaja & Sharit, 2012). This has profound implications for productivity at the individual level. Workers who struggle to adapt to new technologies may experience reduced efficiency and heightened stress. Moreover, their limited digital literacy can hinder collaboration in technology-driven workflows, diminishing their contributions to team productivity (Eurofound, 2020). For example, in industries where digital tools dominate, older employees who are not digitally proficient may face challenges in meeting performance expectations (Davenport & Kirby, 2016).

### 3 Artificial Intelligence

As Kreutzer and Sirrenberg (2020) explain, AI encompasses machines' ability to perform complex cognitive tasks, such as perception, reasoning, and independent learning. This allows AI to perform many tasks traditionally done by humans more efficiently and cost-effectively. As outlined by McKinsey Global Institute (2018), AI's transformative impact is evident through several facets including augmentation of human capabilities, substitution of human labor with automated solutions, and the development or enhancement of products and services. AI has the potential to reshape industries and economies, as well as everyday life of individuals (Kreutzer and Sirrenberg, 2020). AI has rapidly advanced, with applications in diverse areas transforming how we interact with technology and data.

Despite the positive potential of AI, there are concerns regarding its integration. Research from the USA suggests that about 80% of the workforce could have at least 10% of their tasks automated with the introduction of large language models, while nearly 20% of employees could see at least 50% of their tasks automated (Brynjolfsson et al., 2021). Unlike previous waves of automation, jobs requiring higher skills, including those of older employees, are more at risk. The European context poses unique challenges; while technology is essential for preserving the European social model amid demographic changes, AI without proper skills development and adaptation for the aging workforce could threaten jobs. Nearly 70% of participants in a Eurofound (2023) survey favored imposing restrictions on AI to protect jobs, indicating widespread anxiety about the displacement effects of technology. The exposure to AI has been generally positive in Europe, enhancing rather than replacing the workforce, although challenges remain in adapting to these changes as the workforce ages.

#### 3.1 Artificial Intelligence and Aging Workforce

The dynamic between aging workforce and AI integration in the work environment is nuanced, presenting both opportunities and challenges in the labor market. AI already automates routine tasks and mimics complex human decision-making, reshaping the labor market through simultaneous job creation and displacement (Hunt et al., 2021; Rammer et al., 2022; Brynjolfsson et al., 2018). While AI facilitates operational efficiencies and the transformation of job roles and employment

structures, it raises concerns the threat of replacing many tasks, particularly among older workers (Agrawal et al., 2019). Nevertheless, it offers promising solutions for addressing skill gaps and improving workability and productivity of older workers, particularly in the context of an aging workforce.

AI plays a pivotal role in providing innovative solutions for upskilling and reskilling, optimizing workloads, and enabling the retention of an aging workforce, which are critical in addressing labor shortages and adapting to a changing work environment. Studies confirm that older workers proficient in ICT and job-related training experience higher productivity and wages, emphasizing the need for policies that promote lifelong learning to mitigate the adverse effects of aging and support adaptation to technological advancements (Milanez, 2020; Jong-Wha et al., 2021). Personalized learning solutions are essential for integrating older employees into rapidly digitizing workplaces, where continuous skill development is paramount, as challenges such as low digital literacy and limited prior exposure to technology can hinder older employees from fully utilizing AI solutions (Acemoglu & Restrepo, 2020). Addressing these barriers requires targeted training programs designed to foster AI literacy and equip late-career workers with the skills necessary to thrive in a digital economy (Chetty, 2023).

AI-driven learning platforms, as demonstrated by Morandini et al. (2023), offer personalized, adaptive training programs tailored to organizational needs, fostering engagement and helping older employees acquire new competencies at their own pace. By emphasizing user-friendly interfaces and practical applications, these platforms help older workers overcome barriers often associated with traditional training methods (Charness & Czaja, 2006; Davenport & Kirby, 2016), enabling them to remain competitive and contribute to dynamic workplaces (Van Roy et al., 2022).

Beyond skill development, AI supports older workers by optimizing workload management. Automating repetitive or physically demanding tasks can alleviate the cognitive and physical strain that often accompanies aging. For instance, AI-powered tools designed for data analysis and administrative tasks not only enhance operational efficiency but also enable older employees to focus on high-value responsibilities that align with their strengths (Muro et al., 2019). This dual function of AI—facilitating skill acquisition and reducing workload—positions it as a critical

resource in maintaining productivity among older employees, even in roles heavily influenced by technological transformation (OECD, 2021).

Moreover, AI can enhance the quality of life and workplace participation of aging employees by addressing health-related challenges. Human-Centered AI, for example, focuses on creating adaptive tools that support older workers by monitoring health, mitigating occupational hazards, and promoting long-term functional well-being (Yang & Shen, 2015; Czaja & Ceruso, 2022). These solutions not only improve workability but also contribute to organizational sustainability by reducing absenteeism and retaining experienced employees. AI's ability to simultaneously address individual needs and organizational goals underscores its transformative potential in managing an aging workforce (Abril-Jiménez et al., 2022).

### **3.2 Artificial Intelligence and Productivity Enhancement**

Organizations utilizing AI have seen net productivity gains with minimal negative impacts on overall employment, suggesting that AI's role extends beyond mere automation to enhancing the workforce with new skills and capabilities (Necula et al., 2024; Czarnitzki et al., 2023; Jong-Wha et al., 2021; McGowan and Corrado, 2019). AI enhances decision-making, helping humans »think and work faster«, potentially leading to higher productivity in complex and strategic roles (Trabelsi, 2024; Agrawal et al., 2019), while it also plays a crucial role in automating repetitive tasks (Alderucci et al., 2020; Parteka & Kordalska, 2023; Brynjolfsson et al., 2021; McKinsey Global Institute, 2018) and managing more information, documents and projects effectively (Parteka & Kordalska, 2023; Alderucci et al., 2020), which improves operational efficiency. This operational boost can improve job satisfaction, as employees are engaged in more meaningful and fulfilling activities that utilize their unique skills and capabilities (McGowan & Corrado, 2019), enabling and empowering them to concentrate on higher-value tasks (Kreutzer & Sirrenberg, 2020).

AI-driven improvements can transform the workplace into a more efficient and dynamically productive environment (Comunale & Manera, 2024; Hunt et al., 2022). By fully integrating AI into daily operations, organizations can harness its potential to drive employee efficiency and performance (Kreutzer & Sirrenberg, 2020; McGowan & Corrado, 2019; McKinsey Global Institute, 2018). Despite the



optimism, productivity growth in advanced economies remains low, challenging the effectiveness of AI in driving economic growth (Necula et al., 2024; Saam, 2024). Regardless of the obvious benefits, the broader impact of AI on employment and productivity is complex and context-dependent. While AI offers promising avenues for boosting productivity, its success largely depends on organizational strategy concerning AI implementation and the ability to adapt workforce skills accordingly (Hunt et al., 2021; Rammer et al., 2022). Thus, the challenge for organizations is not merely to integrate AI but to strategically harness its capabilities to enhance productivity while fostering an adaptable workforce, prepared for the evolving technological landscape (Tasheva & Karpovich, 2024).

#### **4 Can Artificial Intelligence Compensate for Productivity Loss due to Aging?**

The ongoing developments and applications of AI technologies hold the promise of continuous productivity improvements, paving the way for innovative future of work (Comunale & Manera, 2024; Hunt et al., 2022) and long-term workability of older workers by addressing factors that influence workability positively and negatively (Abril-Jiménez et al., 2022). In terms of supporting an aging workforce, human-centered AI tools are designed to improve long-term workability by enabling personalised learning, mitigating occupational hazards and aiding older workers in managing functional decline, supporting the evolving needs of aging employees (Abril-Jiménez et al., 2022; Dimitrios et al., 2019). AI supported automation can compensate for the decline in physical capabilities associated with aging, enabling older workers to remain engaged in meaningful work, thus extending their productive years (McGowan & Corrado, 2019). Nevertheless, empirical results on the link between AI use and productivity show mixed outcomes, indicating that whether AI can compensate for productivity loss due to aging is a complex question with no straightforward answer.

While some studies note significant productivity increase (measured by various output indicators) connected to AI use (Necula et al., 2024; Babina et al., 2024; Czarnitzki et al., 2023; Calvino & Fontanelli, 2023; Rammer et al., 2022; Alderucci et al., 2020), some do not see universally corresponding rise (Xie & Yan, 2024; Parteka & Kordalska, 2023), suggesting that AI's benefits might depend on more factors rather than use of AI alone. The effectiveness of AI in enhancing

productivity seems closely tied to its integration level within firms; Necula et al. (2024) and Calvino and Fontanelli (2023) argue that substantial productivity gains are achievable when AI tools are fully embedded into the daily workflows, while Xie and Yan (2024) and Comunale and Manera (2024) highlighted regional and industry-related differences in AI effectiveness. Necula et al. (2024) concluded that the age of employees is as a significant factor predicting improved productivity with the use of AI, with younger workers more adaptable to AI tools, while Van Roy et al. (2022) argue that access to AI assistance increases productivity for all employees, with the greatest benefits enjoyed by the less experienced and those nearing retirement. Regarding the challenges of AI adoption among older employees, Necula et al. (2024) recommend targeted training programs for various age groups to maximize the benefits of AI. Therefore, strategic AI integration is vital not only for leveraging its technical potential but also for preparing the workforce, irrespective of age, for future technological shifts (Tasheva & Karpovich, 2024).

Maximizing the potential of older workers requires integrating AI solutions with comprehensive age management strategies, which can maintain human capital and mitigate productivity declines associated with aging (Hernæs et al., 2023; Calvo-Sotomayor et al., 2019). Lifelong learning initiatives are crucial for empowering older employees to remain competitive and engaged in evolving labor markets (World Economic Forum, 2020). This involves fostering an inclusive workplace culture, providing ergonomic adaptations and encouraging intergenerational collaboration to leverage the diverse strengths of a multigenerational workforce (Eurofound, 2020). By adopting a holistic approach that combines technology-driven solutions with supportive policies, organizations can mitigate productivity challenges associated with aging. Together, AI integration and skill development can help balance the negative impacts of an aging workforce with productivity gains, offered by AI (Dimitrios et al., 2019; Abril-Jimenez, et al., 2022), not only enhancing individual performance but also ensuring long-term organizational development amid rapid demographic and technological changes (Brynjolfsson & McAfee, 2014).

## 5 Conclusion

A strategic approach to AI integration can transform AI from a potential disruptor into a powerful ally for addressing demographic challenges. Realizing AI's benefits requires a comprehensive approach, focused on continuous learning and adaptation,

ensuring a workforce that remains robust, dynamic and capable of evolving with technological advancements. While AI can enhance productivity, integrating it in a way that supports and complements human workers, rather than replacing them, is essential for maximizing its benefits and unlocking new opportunities for growth and innovation in the context of demographic changes. To conclude, the productivity challenges associated with an aging workforce can be effectively mitigated through strategic interventions, fostering sustained economic vitality and long-term organizational growth.

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# THE IMPACT OF ENTERPRISES OPEN DATA MATURITY LEVEL ON THE ATTAINMENT OF SUSTAINABLE DEVELOPMENT GOALS - THEME ANALYSIS

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Over the past two decades, open data has become a key element of digital transformation and innovation in enterprises. The Open data in enterprises enables them to grow economically, enhance social responsibility, and engage in environmental sustainability programs. The effective use of open data within organizations enables improved decision-making processes, business optimization, and thus creation of added value. However, a question arises: how does the maturity level of organizations for the use of open data influence the attainment of Sustainable Development Goals (SDGs). This paper provides a comprehensive definition of the problem. With the use of Soft Systems Methodology it analyzes the process, from publishing the open data to its use, for the attainment of SDGs and the various stakeholders involved. This establishes a foundation for further research on how an enterprise's maturity to use open data impacts the attainment of SDGs.

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## 1 Introduction

Open data have in the last two decades become one of the key elements of digital transformation and innovation. Organizations that know how to effectively use open data, have the possibility to create new opportunities for economic growth, social responsibility and environmental sustainability. However, a question remains whether higher maturity level for the use of open data in organizations facilitates the achievement of sustainable development goals.

Despite the many advantages reported by academic society regarding the use of open data, ranging from product to organizational innovations (Apanasevic, 2021; Chang et al., 2022; Fasli et al., 2023; Janssen et al., 2012; Kitsios et al., 2017; Wieczorkowski, 2019) very little is known about its use in enterprises (Koski, 2015; Zuiderwijk et al., 2015) and the use for the purpose of attaining sustainable development goals (Fasli et al., 2023). The governments are investing into opening its data in a way that the data will be as useful as possible to as many stakeholders as possible (Attard et al., 2016; Fleiner, 2018; Jetzek et al., 2014). However, measuring the impact of open data is challenging due to many reasons: the use of open data does not have to be reported; the impacts cannot be expressed in tangible benefits and there are no standardized metrics to evaluate the impact of open data (Koski, 2015; Welle Donker, 2018). This highlights the first problem, which is the insufficient knowledge about the actual use of open data among enterprises, including whether enterprises use open data and the reasons for their potential non-use. To address this we need to determine whether the enterprises possess the capabilities to use open data for various purposes.

One of the desired uses of open data is to help enterprises to achieve sustainable development goals (SDGs). The SDGs are defined by the United Nations and include the eradication of poverty, reducing inequalities, addressing climate change and other social, environmental and economic difficulties while stimulating economic growth (United Nations, 2025). Large and listed enterprises are required to report about their environmental, social and governance (ESG) practices in corporate sustainability reports. These reports are mandated by corporate sustainability reporting directive (CSRD) (European Commission, 2022). The CSRD provides a framework in accordance with European sustainability reporting standards (ESRS) to facilitate enterprise reporting. CSRD framework demands



enterprises to define their corporate actions based on their impact on environment, social life and governing structure (European Commission, 2022). Enterprises are being called upon; to act sustainable and through the CSRD reporting they can align their activities with the SDGs. This leads us to the identification of the second problem, which is: how can enterprises ease themselves to achieve the SDGs?

By integrating the two identified problems we define the issue addressed in this study: How enterprises maturity to use open data impacts the attainment of SDGs? To explore this, we will apply the soft system methodology to clarify the root definitions – the process, the actors involved in the process, and the environment in which the enterprises operate. This will help understand the depth of the problem and lay foundations to further research of the topic.

The structure of this paper is organized as follows. In section two we will outline the methodology selected to address the problem. In section three we will apply the chosen methodology to our problem and present the results. After that a discussion about the results and conclusions derived will be described.

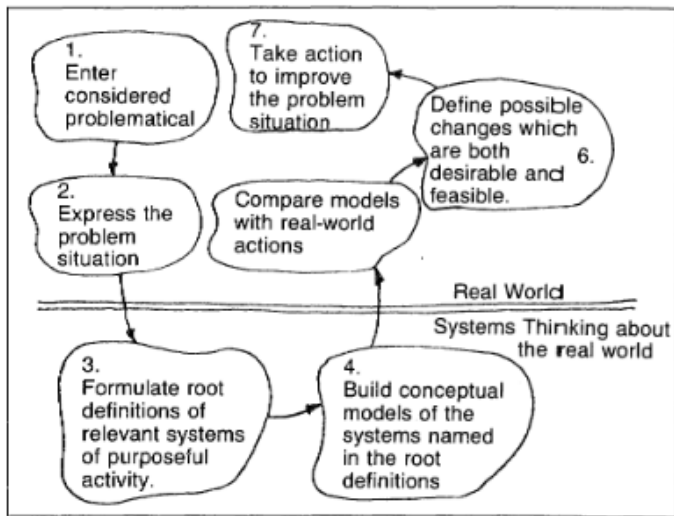
## **2 Methodology**

The chosen methodology for establishing the current state of the problem is soft system methodology (SSM). This methodology presents “an approach for tackling problematical, messy situations of all kinds. It is an action oriented process of inquiry into problematic situations in which users learn their way from finding out about the situation, to taking action to improve it.” (Checkland & Poulter, p. 201, 2020) The methodology was designed as a learning system, where “the learning is about a complex problematical human situation, and leads to taking purposeful action in the situation aimed at improvement, action which seems sensible to those concerned” (P. B. Checkland, p. 278, 1989).

How mature is an organization to use open data depends on various factors ranging from its ability to establish an organizational culture that supports and rewards employee initiative for the implementation and use of new technologies, to its infrastructural capabilities. Another issue highlighted in this study is how to ease the enterprises to attain SDGs? Combining these two questions gives us a “messy”, complex, problematical real-world situation: How does the enterprises maturity to

use open data impact the attainment of sustainable development goals? To this research question one simple solution cannot be given but a learning process is needed to gain insight into different situations addressing different stakeholders needs. Therefore, the optimal methodology for addressing our problem is the SSM by Peter Checkland (1989).

The soft system methodology learning cycle follows a sequence of seven stages, shown on figure 1.



**Figure 1: The learning cycle of SSM**

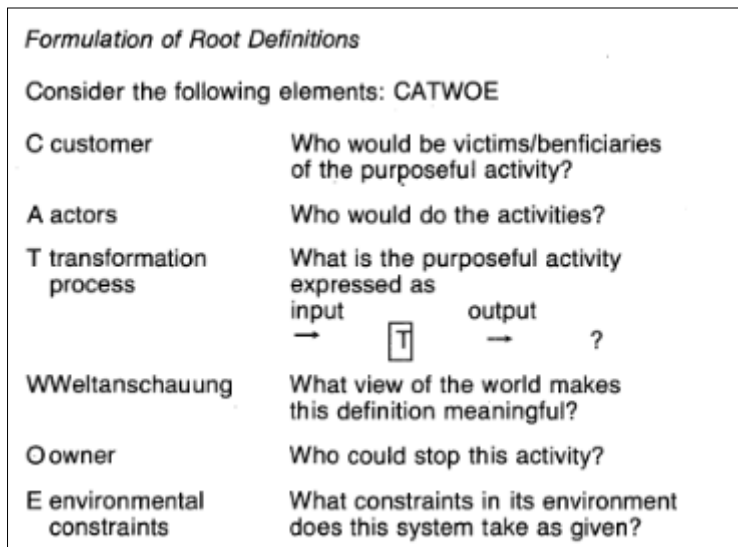
Source: P. B. Checkland, P. 281, 1989

The first two stages present the phase of *finding out*. In this phase pictures of the situation in question are assembled by recording elements of *structure* and *processes* and forming a view of how the two relate to each other in creating the *climate* of the situation (P. B. Checkland, p. 281, 1989). An abstraction of the situation can be shown on a “rich picture”, that represents the climate of the problematical situation. For this phase more elaborate guidelines include three analyses:

- the first analysis identifies the clients and problem-solver(s). The problem-solver lists potential “problem owners” including the clients and others affected by the situation

- the second analysis examines the situation as a social system and though highlights the cultural context of the problem,
- the third analysis examines the situation politically, analysing the distribution of power in the situation (P. B. Checkland, 1989).

The answers to these three analyses provide us the elements Customers, Actors, Transformation, Weltanschauung, Owners and the Environment, shortly named the CATWOE elements, which are explained in figure 2.



**Figure 2: Formulation of Root Definitions**

Source: P. B. Checkland, p. 283, 1989

During stage three so called Root definitions are established. Root definition represents the name of the system and is supposed to be constructed by consciously considering the elements of the CATWOE (P. B. Checkland, 1989). The core of the Root definition represents the T – transformation process which changes input into output.

Stage four of the methodology focuses on constructing conceptual models. In this phase, all the activities within the system are identified and clearly verbalised. These activities are then assembled into a system structure and hierarchically organized.

The completed assembly describes the transformational process named in the Root definitions. This is followed by stage five, which includes comparing the created model with real-world situation. This comparison serves as a basis for discussions aimed at improving the problem situation. Often, this stage prompts the problem-solvers to repeat earlier stages in the methodology. The learning process – the main objective of the methodology – is achieved through the comparisons of the models and the actual situation. In the next stage the participants focus on identifying the most suitable changes to address the problem situation. The evaluation of possible improvements has to satisfy two distinct criteria. Firstly, the comparison of desired reality to identified models will generate ideas for change. However, this logic is not enough, because people are not always motivated to implement changes even though these are systematically justified. Therefore, the second criteria includes identifying ideas that are also culturally acceptable. That is also the reason why it is important to carefully consider the *W* (*weltanschauung*) of the CATWOE for each model. The last, seventh, stage proposes acting. Once desirable and feasible changes have been identified, this stage involves implementing those changes and completing the SSM process (P. B. Checkland, 1989).

The scope of this paper includes the first three stages of the methodology: the identification of the problem, and formulation of root definitions to enable purposeful further activities. This will provide a foundation for understanding the problem and its complexity.

### 3 Results

Following the soft system methodology enables us to structure the complex problem within its environment and present it in a way that will be understood by everyone involved as coherent as possible. The problem that we identified is that we do not know how the maturity level of an enterprise to use open data impacts its possibility to attain sustainable development goals. From that a root definition is derived: **Large enterprises use open data to enhance their sustainability practices.** The input of the system are therefore the open data, that enterprises can use, and the output is the enhancement of an enterprises sustainable practices. In our study we argue that higher levels of maturity make it easier for enterprises to achieve higher levels of sustainability.

The third phase includes three analyses, the first one being the identification of all the actors in the process, from problem owners to problem solvers and everyone in between. In the CATWOE analysis these would represent the C – Clients, A – Actors, and O – Owners of the problem.

- The clients in our transformation are the organizations that conduct their business in Slovenia and have a legal obligation to attain some aspects of the SDGs and report about its achievement through CSRD reporting. In the scope of our study, we will focus on large enterprises.
- The problem owner is the Slovenian government that has the obligation to implement international law and EU directives in the national legislation. On the one side it is obliged by the EU directive 2019/1024 (European Commission, 2019) to open its data to the public for any purpose and monitor its use. And on the other side it enforces large and listed organizations to report about their sustainability practices. This reporting must include information on environmental, social and governance (ESG) impacts, risks, opportunities and strategies aligning with EU sustainability standards (European Commission, 2022).
- The actors in this transformation is a vast multitude of organizations, ranging from supra governmental like the United Nations Organization and the European Union; to governmental organizations like the legislative body and public sector organizations that have the obligation to publish their data according to open standards; as well as the non-governmental organizations, the media and the civil society that conduct the monitoring of the realisation of the directives and the veracity of corporate reports.

The second analysis includes the identification of the cultural surroundings of the problem and the definition of what the process under consideration represents to each of the participating entities. With that the W (weltanschauung) of the CATWOE analysis is identified. In the process of using open data in large organizations to enhance its corporate sustainability practices there are many stakeholders. The first to mention is the United Nations Organization (UN) which includes 193 states around the world. Their mission is to preserve international peace and security, protect human rights, deliver humanitarian aid, promote sustainable development, and uphold international law (United Nations, 2025). To achieve this the 17 Sustainable Development Goals have been introduced that represents a global

call to action to promote prosperity while protecting the planet. They recognize that ending poverty must go hand-in-hand with strategies that build economic growth and address a range of social needs including education, health, social protection, and job opportunities, while tackling climate change and environmental protection (United Nations, 2025).

The European Union as a leading global partner for the SDGs has committed to implement them into all the policies and encourage EU member states to the same (European Commission, 2025). To encourage large and listed enterprises to consider its impact in their immediate and far-reaching communities it presented the Corporate Sustainability reporting directive (CSRD) (European Commission, 2022). Along with that the EU has another agenda relevant to our problem. It introduced the Open data directive (European Commission, 2003, 2019) that mandates the public sector information to be published in an open and machine readable format for everyone to use for any purpose, including its use for profit. The Directive obliges public sector organizations to publish the data and encourages private sector enterprises to do the same. The use of open data for enterprises is optional, however it is promoted in numerous ways. Open data has the potential to be used for various purposes, in our study we only intend to explore its use to attain the SDGs.

Next stakeholders in the process of enterprises use of open data to attain the SDGs are member state governments. The governments are responsible for incorporating EU directives into national legislation. With that it must provide financial, human, and other resources to enable its implementation and monitor its application. Furthermore, it must empower them to introduce changes in the event of deviations from the expected outcomes.

Supranational and governmental stakeholders are followed by non-governmental organizations, who have a wide range of responsibilities to fulfill. They have to function as an intermediary balancing multiple responsibilities. On one side, they oversee the use of public funds. On another, they monitor the actions of enterprises and the veracity of their reporting. Finally, they are responsible to the public and their wellbeing as one of their main objectives. To achieve their function non-governmental organizations to the greatest extent possible they cooperate with the media to disseminate their findings. In the studied process the media serves as a

bridge between the enterprises and their environment. It has an obligation to objectively report on the enterprises' efforts to attain SDGs as well as their failures.

The owner of the process is the government. It has an obligation to adopt EU directives into national legislation and allocate resources for its implementation. Furthermore, it has the potential to promote the use of technologies, such as open data, and facilitate conditions for large enterprises to evolve to higher levels of maturity to use open data and to use those data to enhance its sustainable practices. The government is also responsible for the monitoring of implementation of legislation. In the studied process this means that the government plays a crucial role in promoting the use of open data to enhance corporate sustainability practices.

The minimum requirements to which the clients in the defined process – large enterprises – must conform are set in legislation. However, they have the possibility to exceed legal requirements. This gives them a unique opportunity to create economic profit through using open data, create jobs and provide innovative services that increase their beneficiaries' quality of life (Attard et al., 2016). In future studies, the answer to our research question – How enterprises maturity to use open data impacts the attainment of SDGs? – will represent the enterprises with an easy-to-understand answer to:

- why investments in increasing the maturity level to use open data are reasonable, and
- how the use of open data may help them to achieve higher levels of sustainability.

The last stakeholders involved in the process is the civic society, that possesses the fundamental right to live in peace and prosperity in an environment with no political or physical deprivations and provides conditions that improve health and education, reduces inequalities and spurs economic growth (United Nations, 2025). This gives the civic society the right to be informed of enterprises sustainable practices and empowers them to hold them accountable for their environmental and social impact. It also gives them the responsibility to demand a healthy environment for their well-being as well as for the benefit of future generations. With ensuring transparency and public inclusion enterprises can promote themselves as responsible and long-term sustainable partners in the environment in which they operate.

**Table 1: Defining the CATWOE elements**

CATWOE	Participants	Elements in defined problem
<b>Clients</b>		Organizations that are at different levels of maturity to use open data and have to comply with legislation regarding corporate sustainable reporting
<b>Actors</b>		A multitude of organizations from non-governmental, governmental and private to civic society
<b>Transformation</b>		Use of open data to attain sustainable development goals
<b>Weltanschauung</b>	United nations	Wishes to enable a future for all living things on our planet. Therefore, it presented the 17 SDGs that tackle different aspects of life.
	European commission	To enforce the implementation of SDGs into enterprises the EU has introduced the CSR directive, that mandates reporting of enterprises sustainable practices. Through the open data directive mandates that all the data, produced by the public sector has to be openly available for any purpose.
	Government	The national governments of the EU states, including Slovenia, have to introduce the EU mandated directives into their legislation and monitor its performance.
	Public sector organizations	Public sector organizations have to publish their data according to the open data legislation in non-proprietary, non-discriminatory, machine-readable formats, with corresponding open licences.
	Non-governmental organizations	Non-governmental organizations oversee the sustainable practices of enterprises and compare the reports with actual situation. They have the power (and often state provided means) to disclose good practices or non-compliances.
	Private sector large enterprises	Have the obligation to comply with the legislation. While the legislation for open data use is not binding for them, it is assumed that they may benefit from it. The legislation regarding CSR reporting is binding and they have to report of their actions and future plans to meet the SDGs.
	The media	Act as a link between the enterprises and their environment. The media has the obligation to objectively report of the enterprises efforts to attain SDGs as well as its failures.
	Civic society	Has the fundamental right to live in a healthy environment and demand the enterprises to act in a sustainable manner, so that the planet will be able to support future generations.
<b>Owners</b>		Government
<b>Environment</b>		European Union legislation, United nations recommendations, Slovenian legislation, European social security legacy – civic pressure

Source: Own



In the third analysis the environment of the transformation is determined. In our study we will focus on enterprises that conduct their business in Slovenia and the EU. The EU is historically prone to protect social security systems including comprehensive, adequate protection against common life cycle and labour market risks. The protection of individuals over the life course enables social security systems to play a key role in ensuring economic and social stability (International Social Security Association, 2024). The directives of the EU mandate the states to adapt their legislation to meet the requirements on open data and corporate sustainability reporting. Not only the EU, also the civil society is more and more aware and conscious of the sustainable practices of organizations.

Figure 3 presents a rich picture of interconnections between the CATWOE analysis elements. The W is not included in the picture to maintain clarity of links between the elements.

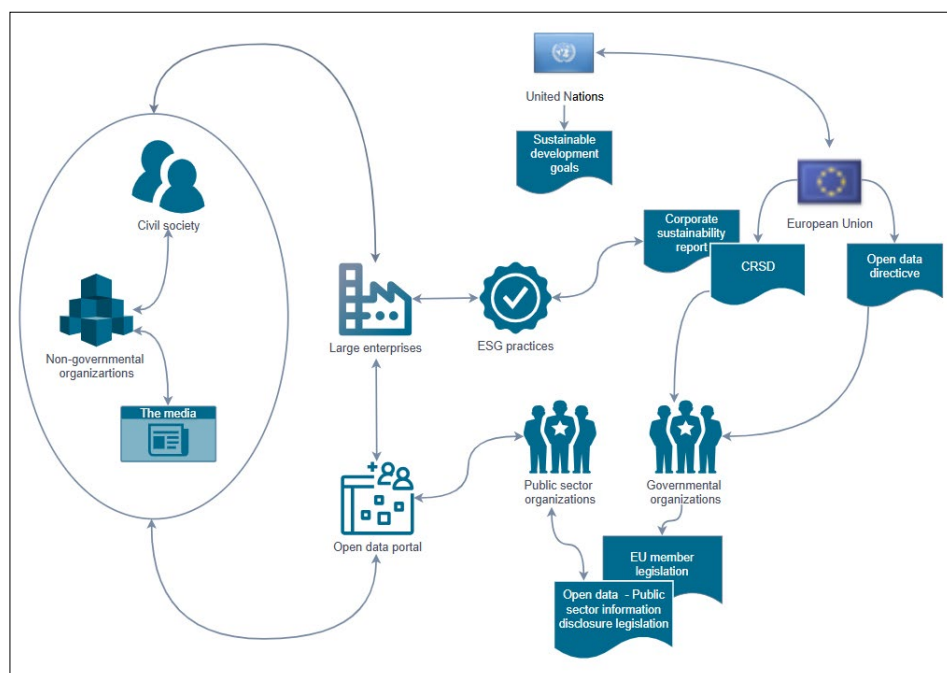


Figure 3: Using open data in enterprises to attain SDGs

Source: Own

## 4 Discussion

The Soft Systems Methodology (SSM) provides a structured approach to analysing the complex relationship between the maturity of an enterprise to use open data and its ability to attain SDGs. Using this methodology, we comprehensively defined the problem within its environment, identified the stakeholders involved, and assessed their role in it.

In our study we identified the problem that we don't know how the maturity level of an enterprise to use open data impacts its possibility to attain SDGs. The inputs of this system are the open data and the outputs: the enhancement of enterprises sustainability practices. From this a root definition was formulated as: large enterprises use open data to enhance their sustainability practices. After that the actors in the process were identified, that being: large enterprises as the clients of the system, the government as the owner, and other participants in the process: the UN, the EU, the public sector organizations, the non-governmental organizations, the media and the civic society. Each of the participants plays an important role in the system from providing quality material – the open data, through the process of its use to enable large enterprises to provide the wanted output – enhanced sustainable practices.

Enterprises in the EU function in a specific environment, where the rights of citizens that guarantee a high quality of life and social security, are at the top of the agenda of institutions such as the European Commission (von der Leyen, 2024). The enterprises must comply with restrictive legislation to ensure that the high standards are met. On the other hand, the institutions that restrict the un-sustainable practices are also the institutions that through its directives facilitate conditions for enterprises to move to a new, sustainable way of conducting business. One of the ways to achieve that is by requiring of the publication of high-quality open data.

By applying soft system methodology, we have identified the process and its key actors, the environment, and systemic interactions between them that impact enterprises use of open data to attain sustainable development goals. Future research should focus on measuring the actual maturity of enterprises to use open data and assess the impact of that to their ability to attain sustainable development goals.

## Acknowledgment

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# TUTORSTVO KOT PODPORNİ STEBER PRI IZBOLJŠANJU ŠTUDIJSKE USPEŠNOSTI ŠTUDENTOV

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Ustrezno vzpostavljen tutorski sistem je ključnega pomena, saj predstavlja učinkovito obliko podpore, ki temelji na sodelovanju med tutorji in študenti. Pri tem je glavni poudarek na ustvarjanju sodelovalnega, sproščenega in prijaznega okolja, ki prispeva k boljši povezanosti študentov, boljšim medosebnim odnosom in večjim občutkom pripadnosti, posledično pa tudi k večji stopnji motivacije in zadovoljstva. V prispevku opisujemo raziskavo, s pomočjo katere smo proučevali vpliv tutorstva na študijsko uspešnost študentov, iskali razloge za koriščenje oziroma nekoriščenje tutorske pomoči ter ugotavljali mnenja študentov o tutorstvu in njihove izkušnje z njim. Rezultati so pokazali, da tutorstvo pozitivno vpliva na uspeh pri študiju, saj so študenti, ki so koristili tutorsko pomoč, dosegali za povprečno eno oceno višje rezultate v primerjavi s tistimi, ki tutorske pomoči niso koristili. Ugotovili smo tudi, da ima večina študentov o tutorstvu pozitivno mnenje, kar poudarja njegov pomen pri akademskem in osebnem razvoju študentov.

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# TUTORING AS A SUPPORTIVE PILLAR FOR IMPROVING STUDENT ACADEMIC PERFORMANCE

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A properly established tutoring system is crucial, as it is an effective form of support based on collaboration between tutors and students. The main focus is on creating a collaborative, relaxed and friendly environment, which contributes to better student cohesion, better interpersonal relationships and a greater sense of belonging, resulting in higher levels of motivation and satisfaction. In this paper, we describe a study that explored the impact of tutoring on students' academic performance, the reasons for using or not using tutoring, and students' opinions and experiences of tutoring. The results showed that tutoring has a positive impact on academic performance, with students who benefited from tutoring achieving on average one grade higher than those who did not. We also found that the majority of students have a positive opinion of tutoring, underlining its importance in students' academic and personal development.



## 1 Uvod

V sodobnem času je vse bolj izrazita potreba po strokovnjakih z visokim nivojem znanja in veščin, ki so sposobni obvladovati izzive ter zadovoljevati kompleksne zahteve hitro spreminjajočega trga dela. Pri tem osrednjo vlogo igrajo fakultete, katerih cilj je opremiti študente z znanji, veščinami in kompetencami, ki jih delodajalci danes vse bolj iščejo. Zaradi tega se vse več dijakov odloča za nadaljevanje izobraževanja na visokošolskih ustanovah, vendar pa se mnogi med njimi soočajo z omejenim akademskim predznanjem in pomanjkanjem ključnih veščin za uspešno soočanje s študijskimi izzivi. Razkorak med predhodnimi izkušnjami in zahtevami visokošolskega izobraževanja pogosto privede do težav, kot so na primer nizka uspešnost, izguba motivacije in v najslabšem primeru celo opustitev študija. Vse naštetu lahko dolgoročno vpliva tudi na zaposlitvene možnosti posameznika in nenazadnje tudi na njegovo splošno kakovost življenja. Raziskave (Reinheimer & McKenzie, 2014; Stuart, Willocks & Browning, 2019; Yale, 2017) poudarjajo, da tutorstvo igra ključno vlogo pri premagovanju tovrstnih izzivov študentov, saj s svojimi pozitivnimi učinki predstavlja ključni podporni steber na vsaki fakulteti.

Čeprav številni avtorji (Najabat, Anwer & Abbas, 2015; Rheinheimer, Grace-Odeley, Francois & Kusorgbor, 2010; Schleyer, Langdon & James, 2005) dokazujejo, da tutorstvo pomembno prispeva k izboljšanju študijske uspešnosti študentov, pa obstajajo tudi izjeme. To je pogosto povezano z dejstvom, da se študenti izogibajo koriščenju pomoči tutorjev zaradi različnih razlogov, kot so pomanjkanje samozavesti, čustvene stiske, strah ali neustrezna obveščenaost. V nasprotju s tem pa se lahko pojavijo tudi primeri, ko imajo študentje previsoka pričakovanja od tutorjev, pri čemer se njihove zahteve ne navezujejo na naloge tutorja, temveč vključujejo prošnje po inštruiranju ali celo po prevzemanju njihovih študijskih obveznostih.

Omenjena problematika nas je spodbudila k raziskovanju tutorstva na Fakulteti za organizacijske vede Univerze v Mariboru (v nadaljevanju FOV). Glavni namen raziskave je bil ugotoviti, kako koriščenje tutorske pomoči vpliva na študijski uspeh študentov in zaradi katerih razlogov se študentje sploh odločajo za pomoč tutorjev.

## 2 Tutorstvo

### 2.1 Opredelitev tutorstva

Začetki tutorstva segajo že v čas antičnega Rima, ko so tutorji igrali pomembno vlogo pri skrbi za svoje varovance. Izraz »tutor« tako izvira iz latinske besede in pomeni varuh oziroma skrbnik (Maretič-Požarnik, Mihevc in sodelavci, 1997). Danes tutorstvo razumemo na različne načine, pri čemer pa ga lahko na splošno opišemo kot proces podpore, pri katerem izkušenejši študenti ali profesorji pomagajo mlajšim študentom pri soočanju z akademskimi in osebnimi izzivi. Takšna oblika pomoči ne vključuje samo prenosa znanja, temveč hkrati spodbuja tudi samostojnost in razvijanje kritičnih veščin.

Schleyer et al. (2005) poudarjajo, da je temeljni namen tutorstva olajšati proces učenja študentom. Pri tem je zelo pomembno, da študentje aktivno sodelujejo pri iskanju rešitev za svoje izzive, medtem ko jih tutorji motivirajo in usmerjajo. Vloga tutorjev tako ni omejena zgolj na akademsko podporo, temveč vključuje tudi ustvarjanje spodbudnega okolja, v katerem lahko študenti pridobijo samozavest in razvijajo ključne veščine, kot so komunikacija, reševanje problemov in timsko delo. Takšno okolje prispeva k večji uspešnosti in zadovoljstvu študentov, nenazadnje pa spodbuja tudi njihov celostni razvoj.

V literaturi lahko najdemo opisane različne oblike tutorstva, ki se razlikujejo glede na način izvajanja, vlogo tutorja in odnos med tutorjem ter udeleženci. Na splošno pa tutorstvo lahko delimo na učiteljsko ter študentsko tutorstvo. V prispevku se bomo osredotočili predvsem na študentsko tutorstvo. Po navedbah Najabat et al. (2015) lahko študentsko tutorstvo razvrstimo glede na naslednje vidike:

- Število udeležencev: individualno ali skupinsko tutorstvo;
- Starostno razmerje med tutorjem in študentom: medgeneracijsko ali vrstniško tutorstvo;
- Vloga udeležencev: fiksna vloga udeleženca in tutorja ali recipročna – izmenjujoča vloga.



Poleg že omenjenih delitev lahko tutorstvo razvrstimo tudi glede na obseg njihovih nalog in področja, na katerih delujejo. Med te oblike spadajo: strokovno oziroma predmetno tutorstvo, uvajalno tutorstvo, tutorstvo za študente s posebnimi potrebami ter tutorstvo za tuje študente (Tutorski sistem Univerze v Mariboru, 2011).

## **2.2 Tutorstvo na FOV**

Tutorstvo na FOV se izvaja že več kot desetletje in je razdeljeno na učiteljsko in študentsko tutorstvo. Študentsko tutorstvo je zasnovano tako, da študentje – tutorji delujejo po posameznih letnih študija, kar pomeni, da vsak tutor pokriva specifičen letnik, ki ga je sam že opravil. Naloge tutorja vključujejo pomoč študentom pri premagovanju akademskih izzivov, usmerjanje skozi študijski proces ter svetovanje o različnih študijskih in drugih pomembnih temah. Prav tako tutorji študente seznanjajo z njihovimi pravicami in dolžnostmi ter s pravili in postopki, povezanih z delovanjem fakultete, hkrati pa tudi spodbujajo študente k vključevanju v mednarodne izmenjave, nudijo podporo tujim študentom pri prilagajanju na novo okolje ter pomagajo študentom s posebnimi potrebami pri premagovanju specifičnih izzivov (Tutorstvo na FOV, 2023). Na FOV si prizadevajo, da bi bili tutorji čim bolj dostopni za vse študente, zato redno organizirajo tutorske ure, kjer imajo študentje priložnost pridobiti nasvete in podporo pri reševanju izzivov, s katerimi se soočajo med študijskim procesom.

## **3 Raziskava**

Namen raziskave je bil preučiti, kako delovanje tutorstva vpliva na študijski uspeh študentov in na njihovo splošno izkušnjo. Zaradi omejenosti dolžine prispevka so predstavljeni le najpomembnejši rezultati raziskave, izvedene med študenti prve in druge stopnje študija na FOV v mesecu marcu 2023, kot del zaključnega dela (Božnar, 2023). V tem prispevku smo se osredotočili na dve ključni raziskovalni vprašanji:

- RV1: Kateri so razlogi, zaradi katerih se študentje odločajo za koriščenje tutorske pomoči?
- RV2: Ali obstajajo razlike v študijski uspešnosti med študenti, ki koristijo tutorsko pomoč in tistimi, ki je ne?

Raziskavo o vplivu tutorstva smo izvedli s pomočjo anketnega vprašalnika, ki je vseboval deset glavnih vprašanj in dve dodatni podvprašanji, ki sta se nanašali na odgovor glavnega vprašanja. Eno vprašanje je bilo odprtega tipa, šest jih je bilo zaprtega, medtem ko sta bili obe podvprašanji kombiniranega tipa. Pri dveh vprašanjih smo uporabili 5-stopenjsko lestvico strinjanja. Prvi sklop vprašanj se je nanašal na poznavanje sistema tutorstva ter na razloge za koriščenje oziroma ne koriščenje tutorske pomoči. Drugi sklop se je navezoval na študijsko uspešnost in je vključeval vprašanja o povprečni oceni na izpitih v tekočem študijskem letu ter o povprečnim časom, ki so ga študentje porabili za študij. V tretjem sklopu vprašanj pa smo s pomočjo 5-stopenjske lestvice strinjanja ugotavljali vplive tutorstva, medtem ko je bil zadnji sklop vprašanj namenjen demografskim podatkom.

Anketni vprašalnik smo objavili na družbenem omrežju Facebook med obstoječe skupine študentov prve in druge stopnje študija na FOV (192 študentov). Skupaj smo prejeli 52 ustrezno izpolnjenih anket, od tega je bilo 40 % anketirancev in 60 % anketirank. Med anketiranci je bila večina vpisanih v dodiplomski študij (92 %).

## 4 Rezultati raziskave

### 4.1 Koriščenje tutorske pomoči

Najprej smo študente vprašali, ali so že kdaj iskali pomoč pri tutorjih. Kot je prikazano v spodnji tabeli 1, se je 46 % anketirancev po pomoč k tutorjem že obrnilo, medtem ko 54 % anketiranih študentov tega še ni storilo.

**Tabela 1: Iskanje pomoči pri tutorjih**

Ali ste se že kdaj obrnili na tutorje po pomoč?	
DA	46 %
NE	54 %

Vir: Lasten

Na vprašanje o razlogih za iskanje pomoči pri tutorjih so odgovarjali samo tisti anketirani študentje, ki so že koristili tutorsko pomoč. Anketiranci so lahko zbrali več odgovorov hkrati. Iz tabele 2 je razvidno, da so anketiranci najpogosteje prosili za zapiske (79 %), medtem ko so najmanj pogosto prosili za pogovor o osebnih temah (29 %).

Tabela 2: Glavni razlogi iskanja pomoči pri tutorjih

Razlogi za iskanje pomoči	
Potreba po zapiskih	79 %
Potreba po dodatni razlagi težje razumljive snovi	46 %
Potreba po nasvetu glede študijskih problemov	46 %
Potreba po konkretnih informacijah v zvezi s študijem	46 %
Pogovor o osebnih temah	29 %
Potreba po motivaciji in podpori	46 %
Drugi razlogi	0 %

Vir: Lasten.

Študente, ki še niso iskali pomoč pri tutorjih, smo povprašali, zakaj se za pomoč še niso odločili. Možnih je bilo več odgovorov. Kot prikazuje tabela 3, je bil najpogostejši razlog, da pomoči niso potrebovali (50 %), medtem ko je en anketiranec pod možnost »drugi razlogi« navedel, da raje pomoč poišče drugje (npr. pri sošolcih).

Tabela 3: Glavni razlogi za neiskanje pomoči pri tutorjih

Razlogi za neiskanje pomoči	
Pomoč ni bila potrebna	50 %
Nepoznavanje možnosti tutorstva	14 %
Dvom v učinkovitost tutorske pomoči	11 %
Strah pred iskanjem pomoči pri tutorjih	14 %
Težave pri vzpostavljanju stika s tutorjem	36 %
Drugi razlogi	4 %

Vir: Lasten.

#### 4.2 Razlike med študenti, ki koristijo tutorsko pomoč in tistimi, ki je ne

Najprej smo analizirali razlike med študenti, ki so koristili pomoč pri tutorjih in med tistimi, ki jo niso, na podlagi povprečne ocene anketiranih študentov (tabela 4).

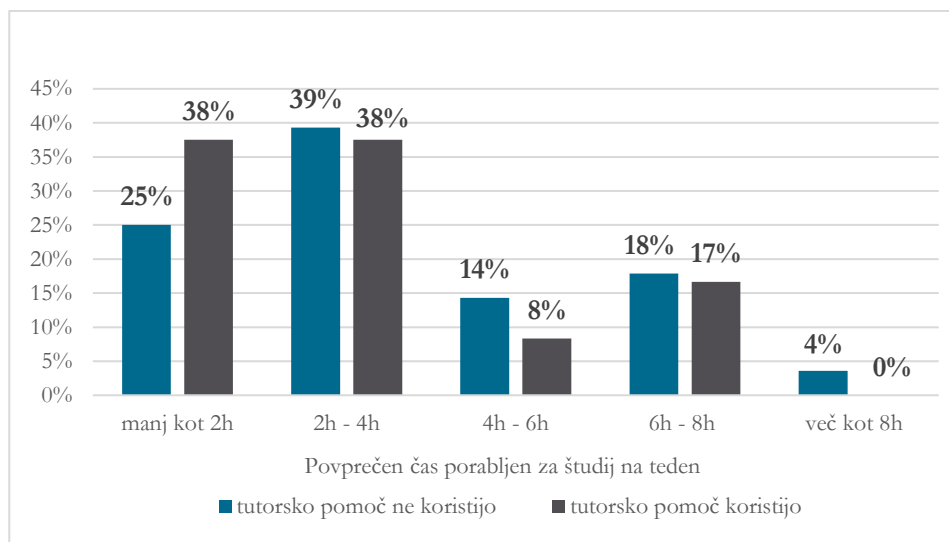
Tabela 4: Razlike v povprečni oceni

	Povprečna ocena
Tutorstva niso koristili	8,0
Tutorstvo so koristili	8,9

Vir: Lasten

Razvidno je, da je povprečna ocena tistih, ki so tutorsko pomoč koristili višja.

V nadaljevanju smo študente vprašali, koliko časa na teden v povprečju porabijo za študij. Analizirali smo razlike med anketiranimi študenti, ki so že koristili pomoč pri tutorjih in med tistimi, ki je še niso, na podlagi povprečnega časa, ki ga anketirani študenti porabijo za študij (slika 1). Odstotek študentov, ki tutorstva ne koristijo je večji v vseh časovnih intervalih časa, ki ga porabijo za študij, razen v primeru, da za študij porabijo manj kot dve uri na teden.



**Slika 1: Razlike v povprečnem času, porabljenem za študij, med študenti, ki tutorsko pomoč koristijo, ter med tistimi, ki je ne**

Vir: Lasten

Analizirali smo tudi razlike med anketiranimi študenti glede na čas, namenjen študiju in glede na njihove povprečne ocene. Kot prikazuje tabela 5, imajo študenti, ki koristijo tutorsko pomoč, višje povprečne ocene v primerjavi s tistimi, ki tutorske pomoči ne koristijo, ne glede na čas, ki ga posvetijo študiju.

**Tabela 5: Razlike med študenti v povprečnih ocenah in v času, porabljenem za študij**

Čas porabljen za študij	Povprečna ocena študentov, ki koristijo tutorsko pomoč	Povprečna ocena študentov, ki tutorske pomoči ne koristijo
do 4 ure	9,1	8,1
4 ure in več	8,3	7,7

Vir: Lasten

## 5 Diskusija

### 5.1 Razlogi za (ne)koriščenje tutorske pomoči

Eden od ciljev raziskave je bil raziskati, zakaj študentje koristijo ali ne koristijo tutorsko pomoč. Ugotovili smo, da je 46 % vprašanih že poiskalo pomoč pri tutorjih, medtem ko se 54 % vprašanih za tutorsko pomoč še ni odločilo. Poleg tega so rezultati pokazali, da študentje najpogosteje iščejo pomoč zaradi zapiskov (79 %), manj pogosto (46 %) pa zaradi specifičnih informacij o študiju, nasvetov pri študijskih težavah, dodatne razlage bolj zahtevne snovi ali zaradi potrebe po podpori in motivaciji.

Schleyer et al. (2005) izpostavljajo, da je eden izmed glavnih ciljev tutorstva podpora študentom pri učenju, s posebnim poudarkom na spodbujanju njihovega aktivnega sodelovanja pri reševanju težav. Tutorji imajo pri tem ključno vlogo, saj študente spodbujajo k prevzemanju odgovornosti za lastno učenje. Vendar pa se ugotavlja tudi, da zaradi pomanjkanja jasnih smernic pogosto prihaja do neskladij med pričakovanji študentov in dejansko vlogo tutorjev, kar pa lahko povzroči dodatne težave. Stuart, Willocks in Browning (2019) opozarjajo na dve pogosti skrajnosti: previsoka pričakovanja študentov na eni strani in zavračanje pomoči tutorjev na drugi. Colvin (2007) dodaja, da previsoka pričakovanja pogosto vodijo v neustrezno izkoriščanje tutorske pomoči, saj študentje iščejo hitre rešitve, kot so na primer zapiski ali odgovori na vprašanja, kar pa je v nasprotju s prvotnim namenom tutorstva.

Dognanja drugih avtorjev se skladajo z rezultati naše raziskave, saj smo ugotovili, da študentje najpogosteje iščejo pomoč tutorjev predvsem za pridobivanje zapiskov ali specifičnih informacij, kar pa oslabi osnovni namen tutorstva. Tutorstvo lahko v takšnih primerih postane celo ovira pri samostojnem učenju, saj študentje raje pridobijo zapiske pri tutorjih, namesto da bi si jih ustvarili sami. V primerjavi z našimi ugotovitvami pa je praksa delovanja tutorstva ponekod v tujini nekoliko drugačna. Schleyer et al. (2005) poudarjajo, da je tutorstvo najučinkovitejše, ko študentje sami pripravijo zapiske in se s tem poglobijo v študijsko snov, nakar pa imajo še vedno možnost, da se v primeru nejasnosti obrnejo na tutorje. Menimo, da bi bila uvedba podobne prakse smiselna tudi pri nas, pri čemer bi lahko tutorji še dodatno motivirali študente in sicer z organizacijo tematskih srečanj in diskusij. S

tem bi bili študentje primorani poglobljeno obravnavali študijske vsebine, saj bi le na ta način lahko aktivno sodelovali v razpravi.

Preučevali smo tudi razloge, zakaj študentje ne koristijo tutorske pomoči. Ugotovili smo, da polovica (50 %) anketiranih meni, da tutorske pomoči sploh ne potrebuje. Presenetljivo je, da je kar 36 % vprašanih izrazilo težave pri vzpostavljanju stika s tutorji, medtem ko 14 % anketirancev navaja, da o tutorskem sistemu niso dovolj informirani ali pa jih je preveč strah, da bi zaprosili za pomoč. Manjši delež anketirancev (11 %) dvomi o koristnosti tutorstva oziroma v to, da bi tutorji lahko rešili njihove težave.

Študentje različno pristopajo k koriščenju tutorstva – nekateri od tutorjev pričakujejo preveč, kot je njihova dejanska vloga, medtem ko drugi tutorsko pomoč zavračajo ali ji ne pripisujejo pomembnosti. Yale (2017) ugotavlja, da je pomanjkljivo poznavanje tutorskega sistema eden glavnih razlogov za njegovo nekorističenost. Čeprav so študenti pogosto seznanjeni z njegovim obstojem, pa niso prepričani o njegovem namenu in načinu delovanja. Colin (2007) izpostavlja dodatne vzroke, kot so na primer težave pri vzpostavljanju stikov s tutorji, strah pred postavljanjem vprašanj, dvom v učinkovitost tutorstva ali celo nezaupanje v iskrene namene tutorjev.

Do podobnih ugotovitev smo prišli tudi s pomočjo naše raziskave. Ugotovili smo, da mnogi anketirani študentje ne vedo, kako vzpostaviti stik s tutorji ali pa jih je strah prositi za pomoč. Ti strahovi in negotovost so pogosto povezani z občutkom razlik med tutorji in študenti, saj tutorji zaradi svoje vloge pogosto pridobijo določeno avtoriteto. To lahko v nekaterih primerih ustvari oviro v komunikaciji, hkrati pa se študenti lahko počutijo podrejene, kar pa vodi v negotovost pri navezovanju stikov ali postavljanju vprašanj. S pomočjo raziskave smo ugotovili tudi, da se nekateri študentje na tutorje ne obračajo zaradi pomanjkljivega poznavanja tutorskega sistema. Menimo, da bi bilo za izboljšanje celotne situacije ključnega pomena, da tutorji izboljšajo svojo dostopnost, odprtost in pripravljenost za pomoč, hkrati pa jasno predstavijo namen in možnosti tutorstva. Tak pristop bi ne le zmanjšal morebitno negotovost študentov, temveč bi spodbujal tudi večje zaupanje in pogum pri iskanju pomoči.

## **5.2 Razlike v uspešnosti pri študiju glede na (ne)koriščenje tutorske pomoči**

Drug cilj naše raziskave je bil preučiti, ali obstajajo razlike v uspešnosti študija med študenti, ki koristijo tutorsko pomoč in med tistimi, ki je ne. Razlike v študijski uspešnosti smo analizirali na podlagi časa, ki ga študentje tedensko namenijo študiju in na podlagi povprečne ocene v tekočem študijskem letu.

Rezultati nekaterih tujih raziskav (Schleyer et al., 2005; Seo in Ji Kim, 2019) kažejo, da tutorstvo pozitivno vpliva na akademske dosežke študentov. Podobne ugotovitve smo zaznali tudi v naši raziskavi, saj je bila povprečna ocena anketirancev, ki so koristili tutorsko pomoč, višja v primerjavi s tistimi, ki je niso koristili. Povprečna ocena anketiranih študentov s tutorsko podporo je znašala 8,9, medtem ko so študenti brez nje dosegali povprečno oceno 8.

V nadaljevanju smo raziskovali, ali obstajajo razlike med študenti glede na koriščenje tutorstva v času, ki ga tedensko namenijo študiju, pri čemer pa smo izključili čas, ki ga študentje namenijo predavanjem in vajam. Colvin (2007) poudarja, da je ena ključnih prednosti tutorstva ustvarjanje sproščene, prijazne in sodelovalnega okolja, ki študentom pomaga zmanjšati stres pri učenju in pri reševanju težav. Srivastava in Rashif (2018) prav tako ugotavljata, da tutorji zaradi svojih lastnih izkušenj pogosto ponujajo bolj prilagojeno podporo, ki omogoča bolj učinkovito učenje. Posledično postane učenje bolj zanimivo, študentom pa lažje in bolj razumljivo, kar pomeni, da potrebujejo manj časa za študij doma. Podobne ugotovitve so bile potrjene tudi v naši raziskavi.

Ugotovili smo, da med anketiranimi študenti, ki koristijo tutorsko pomoč in med tistimi, ki je ne, obstajajo razlike v času, ki ga tedensko namenijo študiju. Največja razlika je v skupini študentov, ki v povprečju za študij porabijo manj kot dve uri tedensko, in sicer je 38 % tistih, ki koristijo tutorsko pomoč in 25 % tistih, ki je ne. Razlike so opazne tudi v skupini, ki za študij porabi od 4 do 6 ur tedensko, pri čemer je v tej skupini 8 % koristnikov tutorstva in 14 % tistih, ki tutorstva ne koristijo. Najmanjše razlike med študenti glede na porabljen čas za študij, je v skupinah, od 2 do 4 ure ter od 6 do 8 ur. Pri tem sicer študentje, ki koristijo pomoč tutorstva, porabijo nekoliko manj časa, vendar pa so razlike zelo majhne. Zanimiv podatek se nanaša tudi na skupino študentov, ki študiju namenijo več kot 8 ur tedensko, pri

čemer so bili v tej skupini samo študentje, ki tutorske pomoči niso koristili. Skupno rezultati kažejo, da študenti, ki koristijo tutorsko pomoč, povprečno namenijo manj časa študiju v primerjavi s tistimi, ki je ne. Pri tem je treba upoštevati tudi individualne značilnosti vsakega posameznika, saj se študentje učijo na različne načine in z različno hitrostjo. Zato posledično težko trdimo, da so opažene razlike med študenti neposredna posledica korištenja oziroma nekoriščenja tutorske pomoči.

V raziskavi smo preučevali tudi povezanost časa, ki ga študenti namenijo študiju, s študijsko uspešnostjo. Ugotovili smo, da imajo anketirani študentje, ki porabijo manj kot štiri ure tedensko za študij, višjo povprečno oceno v primerjavi s tistimi, ki za študij porabijo več časa. To lahko nakazuje na to, da študentje, ki porabijo manj časa za učenje, učinkoviteje usvajajo znanje, redno obiskujejo predavanja in so bolj osredotočeni na ključne študijske vsebine. Prav tako smo ugotovili, da v obeh primerih anketirani študenti, ki koristijo tutorsko pomoč, dosegajo nekoliko višje povprečne ocene v primerjavi s tistimi, ki je ne. Izhajajoč iz tega lahko sklepamo, da tutorska pomoč nekaterim študentom koristi, predvsem pri doseganju boljših ocen na izpitih, vendar pa pri tem ni nujno, da jim koristi tudi v smislu pridobivanja globljega razumevanja snovi ali širših akademskih veščin, ki bi prispevale k dolgoročni uspešnosti.

V prejšnjem poglavju smo ugotovili, da se študenti najpogosteje obračajo na tutorje zaradi zapiskov, ki jih nato uporabljajo za pripravo na izpite. Na podlagi vsega ugotovljenega lahko sklepamo, da se študentje, ki že imajo na voljo zapiske ali celo odgovore na izpitna vprašanja, hitreje pripravijo na izpit, posledično pa se manj poglobijo v študijsko snov oziroma se pri učenju osredotočajo zgolj na učenje odgovorov izpitnih vprašanj. S tem se kaže negativen vidik tutorstva, saj tak sistem potem podpira površno razumevanje snovi, neresen pristop k študiju, lenobo in neaktivnost študentov pri samostojnem študiju. Posledično študentje ne razvijejo dovolj globokega razumevanja in širšega znanja, ki ga delodajalci pričakujejo, kar pa dolgoročno omejuje njihovo uspešnost. V tem primeru je tudi višja ocena na izpitu nekoliko zavajajoča, saj ni nujno, da odraža dejansko znanje in spretnosti.

Menimo, da bi bilo smiselno razmisliti o spremembah v organizaciji tutorstva na splošno. Naloge tutorjev so jasne, študenti pa so z njimi seznanjeni ob vsakoletni predstavitvi tutorskega sistema. Poseben poudarek je prav na dejstvu, da tutorji ne



ne zagotavljajo že pripravljenih zapiskov, temveč študente usmerjajo, spodbujajo in motivirajo, da zapiske pripravijo sami in na ta način pridobijo dragoceno znanje. Tak pristop od tutorjev zahteva več truda, potrpežljivosti in časa, vendar verjamemo, da bi bil koristen tako za študente, ki bi pridobili bolj dragoceno znanje, kot za tutorje, ki bi s tem razvili dodatne kompetence.

## **6 Zaključek**

Tutorstvo je eden izmed ključnih sistemov na fakultetah, saj ima dokazano številne pozitivne učinke, kar potrjujejo tudi rezultati naše raziskave. Ugotovili smo, da študenti, ki koristijo tutorsko pomoč, dosegajo višje povprečne ocene in porabijo manj časa za študij v primerjavi s tistimi, ki možnosti tutorstva ne koristijo. Ob tem je treba upoštevati, da ta ugotovitev lahko kaže na dejstvo, da se študenti po pomoč k tutorjem obračajo predvsem z željo po že narejenih zapiskih, odgovorih na izpitna vprašanja ali celo po starih izpiti, s katerimi si potem pomagajo pri pripravi na izpit. Taki študenti tako pri pripravi in učenju vložijo bistveno manj truda in časa, kljub temu pa imajo možnost, da na koncu pridobijo višjo oceno na izpitu. Po drugi strani pa lahko študenti, ki sicer ne koristijo pomoči tutorjev, vendar si ustvarjajo lastne zapiske in vlagajo veliko svojega truda in časa poglobljenemu študiju, kljub širini in globini pridobljenega znanja pridobijo nekoliko nižjo oceno pri izpitu, saj pri učenju niso osredotočeni zgolj na specifična vprašanja in odgovore. Pri tem sicer predvidevamo, da bodo taki študenti ob koncu študija imeli veliko več znanja v primerjavi s študenti, ki so se med študijem opirali na že narejene zapiske. Menimo, da način delovanja tutorstva s posredovanjem zapiskov sicer prinaša kratkoročne koristi študentom, dolgoročno pa lahko študentom celo škoduje. Zato bi bilo treba v prihodnje posredovanje zapiskov povsem nadomestiti s spodbujanjem študentov k čim bolj samostojnemu študiju, saj bodo tako osvojili znanje v širšem smislu, kar prinaša dolgoročne koristi tako njim kot celotni družbi.

Dobljeni rezultati naše raziskave so lahko dobra podlaga za nadaljnje raziskave na tem področju, npr. v poglobljeni raziskavi vpliva tutorstva na medosebne odnose in komunikacijo, pri čemer bi se lahko bolj osredotočili na socialni vidik. Prav tako bi lahko raziskali, kako različne oblike tutorstva vplivajo na študijski uspeh študentov, ter katera oblika tutorstva je pri tem najbolj učinkovita. Smiselno bi bilo raziskati tudi, kako tutorstvo vpliva na študente – tutorje, in sicer, katere kompetence in veščine pridobijo tutorji, kako to vpliva na njihovo samopodobo, kakšno je njihovo

dojemanje tutorstva, kateri problemi se pojavljajo z vidika tutorjev in nenazadnje bi lahko raziskali tudi vpliv tutorstva na študijsko uspešnost tutorjev.

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# RAZVOJ TRGOVALNEGA AGENTA Z JEZIKOM MQL4

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Diplomsko delo obravnava razvoj trgovalnega agenta z uporabo jezika MQL4, specifičnega za trgovanje na platformi MetaTrader 4. Naš cilj je bil ustvariti prototip agenta, ki bi samostojno analiziral gibanje cen med najpomembnejšimi valutnimi pari in izvajal trgovanje na podlagi določene strategije. Implementirali smo funkcije v MQL4, ki omogočajo agentu sprejemanje odločitev o nakupu in prodaji valutnih parov na podlagi različnih indikatorjev in analiz gibanja cen. Raziskava je vključevala tudi testiranje in optimizacijo uspešnosti v simuliranih trgovanjih. Obstoječa literatura se večinoma osredotoča na teoretične vidike algoritmičnega trgovanja, vendar pogosto primanjkuje konkretnih študij primerov in praktičnih implementacij v MQL4. Prav tako so številne raziskave usmerjene v splošne trgovalne strategije in funkcije, medtem ko je manj poudarka na prilagodljivosti algoritmov za specifične tržne pogoje in vplivu različnih optimizacijskih tehnik na njihovo dolgoročno uspešnost.

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# DEVELOPMENT OF TRADING AGENT USING MQL4 LANGUAGE

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The thesis deals with the development of a trading agent using the MQL4 language, specific for trading on the MetaTrader 4 platform. Our goal was to create a prototype of an agent that would independently analyze price movements among the most important currency pairs and execute trades based on a specific strategy. We implemented functions in MQL4 that allow the agent to make decisions about buying and selling currency pairs based on various indicators and price movement analyses. The research also included testing and optimizing performance in simulated trades. The existing literature mainly focuses on theoretical aspects of algorithmic trading, but there is often a lack of concrete case studies and practical implementations in MQL4. Also, many studies are focused on general trading strategies and functions, while there is less emphasis on the adaptability of algorithms to specific market conditions and the impact of various optimization techniques on their long-term performance.



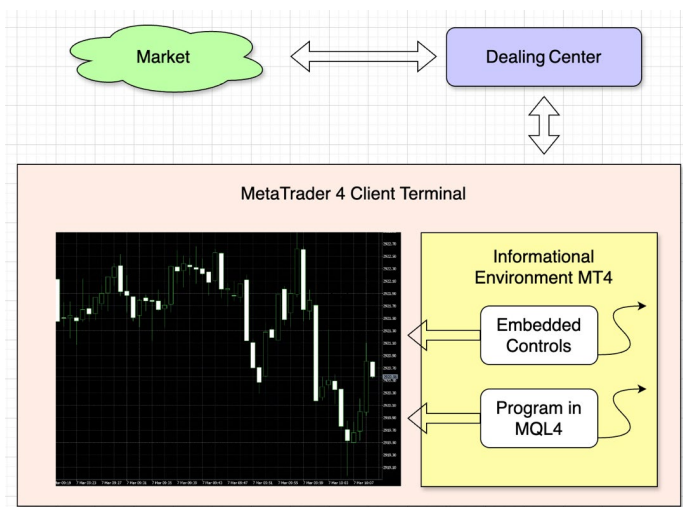
## 1 Algoritmsko trgovanje

Trgovalni agent predstavlja napredno programsko rešitev, ki z uporabo sofisticiranih algoritmov in funkcij avtomatizira trgovalne procese. Ti agenti temeljito analizirajo tržne podatke, prepoznavajo ključne vzorce in izvajajo transakcije z izjemno hitrostjo in natančnostjo. S tem omogočajo optimizacijo trgovalnih strategij, zmanjšanje tveganj ter povečanje dobičkonosnosti, kar jih postavlja v ospredje kot nepogrešljivo orodje za sodobne investitorje, ki si prizadevajo za učinkovitost in uspeh na finančnih trgih.

To delo je osredotočeno na razvoj trgovalnega agenta z uporabo programskega jezika MQL4 (MetaQuotes Language 4). MQL4 je specializiran programski jezik, namenjen razvoju trgovalnih sistemov, indikatorjev in skript za platformo MetaTrader 4 (v daljem tekstu MT4), eno izmed najbolj priljubljenih in razširjenih trgovalnih platform na svetu. Z njegovo pomočjo lahko ustvarimo zmogljive in prilagodljive trgovalne algoritme, ki so sposobni delovati v realnem času ter prilagajati se dinamičnim tržnim razmeram.

Algoritmsko trgovanje je tehnika trgovanja na finančnih trgih, ki za sprejemanje trgovalnih odločitev uporablja računalniške algoritme. V tem procesu računalniški programi analizirajo obsežno količino tržnih podatkov, vključno s preteklimi cenami, cenovnimi trendi, kazalniki tehnične analize, novicami in drugimi pomembnimi informacijami. Na podlagi teh podatkov in vnaprej določenih funkcijah algoritmi ustvarijo trgovalne signale in samodejno izvajajo trgovalne naloge. Glavna prednost algoritmskega trgovanja je njegova hitrost in sposobnost hitrega odzivanja na spremembe v tržnem okolju. Algoritmi lahko spremljajo in analizirajo gibanje cen v realnem času ter izvajajo transakcije brez odlašanja. Poleg tega so algoritmi programirani na podlagi posebnih pravil in strategij, kar zmanjšuje vpliv človeških čustev in subjektivnih odločitev pri trgovanju (Okonkwo, 2016).

Trgovalni agenti so lahko napisani v Pythonu, MQL4, Javi, MATLAB, R ali C++. To so najpogostejši jeziki. Algoritmsko trgovanje je način izvajanja 92 % uspešnih transakcij na borznem trgu (The Foreign Exchange Committee, 2016).



**Slika 1: Shema delovanja Metatrader4 platforme**

Vir: Lasten

MQL4, programska platforma v MT4, predstavlja ključno orodje za sodelovanje na trgu valut. Programski jezik, zasnovan za platformo MetaTrader 4, omogoča trgovcem razvijanje in implementacijo avtomatiziranih trgovalnih strategij, imenovanih "Expert Advisors" (EA), ali trgovalnih robotov.

MT4 ponuja obsežno funkcionalnost, vključno z dostopom do trgov valut, podporo, varnostnimi mehanizmi in možnostjo demo trgovanja. Demo računi omogočajo trgovcem preizkušanje strategij brez tveganja finančnih izgub, kar je ključno za razvoj in testiranje strategij z uporabo zgodovinskih podatkov (Linton M., 2012).

Programski jezik MQL4 omogoča razvoj avtomatiziranih trgovalnih strategij, ki temeljijo na tehnični analizi, indikatorjih in zgodovinskih podatkih. S tem lahko trgovalni agenti samodejno analizirajo tržne pogoje in izvajajo transakcije brez človeškega posredovanja, kar zagotavlja hitrejše odzivanje na tržne spremembe in boljši nadzor (Rechetin, 2014).

Spletna stran [book.mql4.com](http://book.mql4.com) je izčrpen vir za razvoj trgovalnih agentov, saj ponuja primere, vzorce, forume za izmenjavo znanja ter možnost najemanja freelancerjev za pomoč pri programiranju. Kljub temu je odgovornost za razvoj strategij na samih trgovcih, ki morajo imeti jasno predstavo o svojih ciljih in načrtih (Rechetin, 2014).

## 2 Razvoj agenta

Devizni trg vključuje več udeležencev, vključno z bankami, investicijskimi skladi, multinacionalkami, samostojnimi podjetniki in drugimi institucijami. Glavni cilj trgovanja na deviznem trgu je pridobiti dobiček z izkoriščanjem gibanj vrednosti valute. Imenovanje valutnih parov na trgu stranih valut sledi določenemu vzorcu, ki omogoča jasno identifikacijo obeh valut, vključenih v par.

**Tabela 1: Glavni valutni pari v borznem trgu**

EUR/USD	EUR/AUD
AUD/USD	EUR/NZD
NZD/USD	GBP/AUD
GBP/USD	GBP/CAD
USD/JPY	GBP/CHF
USD/CHF	GBP/NZD
USD/CAD	AUD/JPY
EUR/JPY	AUD/NZD
GBP/JPY	AUD/CAD
EUR/CHF	AUD/CHF
EUR/CAD	NZD/JPY
EUR/GBP	NZD/CAD
	NZD/CHF
	CHF/JPY
	CHF/CAD
	CAD/JPY

Vir: Lasten

Ko ustvarjamo trgovalnega agenta, je ključnega pomena, da se osredotočimo na funkcije, ki jih ustvarimo sami na podlagi našega poznavanja sveta borznega trgovanja. Medtem, ko ima vsak program nekaj standardnih funkcij, jih moramo pravilno uporabiti v naših lastnih funkcijah, da bodo smiselne. Uporabniško določene funkcije so bistvenega pomena, ko je treba strategijo trgovanja natančno definirati. Strategija trgovanja je načrt, ki ga trgovci uporabljajo za doseganje določenih ciljev trgovanja na Trgu stranih valut, uporabljajo pa različne strategije glede na njihov slog, cilje in toleranco do tveganja. Ko je strategija določena, je naslednji korak programiranje in prevajanje v algoritemski jezik, kot je MQL4.

```

bool IsTimeTrue() {
    datetime currentTime = TimeCurrent(); //trenuten čas programa (1 ura razlike od CET)
    int hour = TimeHour(currentTime);
    int minute = TimeMinute(currentTime);

    bool range1 = (hour == 3 && minute <= 60) || (hour == 4 && minute <= 37);

    bool range2 = ((hour == 9 || hour == 10) && minute <= 60) || (hour == 11 && minute <= 37);

    bool range3 = (hour == 15 && minute >= 30 && minute <= 60) || (hour == 16 && minute >= 0 && minute <= 60) ||
        (hour == 17 && minute >= 0 && minute <= 37);

    bool result = false;

    if ( range1 || range2 || range3) {
        result = true;
    }
    return result;
}

```

**Slika 2: Prikaz funkcije za preverjanje trenutnega časa, IsTimeTrue**

Vir: Lasten

Slika 2 prikazuje eno ključnih funkcij pri delovanju agenta. Ko ta funkcija vrne 'true', agent prejme signal, da lahko začne z delovanjem.

Trgovalni agent uporablja izjemno napreden algoritem, ki vključuje 223 funkcij, ki delujejo hkrati v zgolj 500 milisekundah. Ta kompleksnost omogoča izredno natančen in strog menedžment tveganj, kar posledično vodi v velike dobičke, ki presežejo morebitne izgube. Z optimalno razmerje med tveganjem in dobičkom, ki se giblje od 6 do 23, si lahko privoščimo tudi do pet neuspešnih transakcij zapored, saj bomo z vsakim naslednjim uspešnim poslom dosegli minimalen dobiček, ki nas bo v končni bilanci ohranil v plusu. Povprečna uspešnost transakcij v obdobju od oktobra 2022 do marca 2024 znaša 8.17, kar nakazuje stabilnost in učinkovitost strategije na dolgi rok. Ta visoka stopnja uspešnosti je rezultat temeljite analize tržnih podatkov in hitrega prilagajanja algoritma na spremembe v tržnih pogojih, kar omogoča ohranjanje stabilnosti in rasti v različnih tržnih scenarijih.

**Tabela 2: Parametri delovanja**

Parameter	Opis
Čas delovanja	Vnaprej določen
Odnos med tveganjem in dobičkom	Vsaj 1:6 za vsako uspešno transakcijo
Čas odločitve	10-500 milisekund

Vir: Lasten



### 3 Rezultati in SWOT analiza

Rezultati temeljijo na analizi zgodovinskih tržnih podatkov, ki so bili izbrani za valutni par zlato-ameriški dolar (XAUUSD). Za testiranje trgovalnega agenta smo določili ključne parametre, kot so časovni okvir trgovanja, obdobje optimizacije in uporabljeni indikatorji tehnične analize. Interpretacijo podatkov smo izvedli s pomočjo platforme TradingView, medtem ko načrtujemo uporabo knjižnice Backtrader v Pythonu za podrobnejšo analizo in natančnejši prikaz rezultatov. Uspešnost trgovalnega agenta smo ocenili na podlagi meritev, kot so donosnost strategije (ang. profit factor), maksimalna izguba (ang. Drawdown), razmerje med tveganjem in nagrado (ang. risk-reward ratio ali sharp ratio) ter odstotek uspešnih transakcij.

Meseca novembra 2023 je bilo izvedeno testiranje prototipa trgovalnega agenta na dokazano uspešni strategiji. Testiranje je potekalo na valutnem paru XAUUSD, kar pomeni, da je bila analiza usmerjena v ceno zlata v dolarjih. Rezultati analize prikazujejo, kako bi agent deloval, ko so vse funkcije agenta v celoti aktivirane in ko je agent povezan na virtualni računalnik preko Remote Desktop. Testiranje je omogočilo preverjanje delovanja agenta v realnih tržnih pogojih ter oceno njegovih sposobnosti za optimizacijo trgovinskih odločitev.



Slika 3: Prikaz rezultatov za mesec november v TradingView okolju

Vir: Lasten

Rezultati za prvi teden novembra so pokazali razmerje 8 : 33, kar pomeni, da je bilo 19 % uspešnih in 81 % neuspešnih transakcij. V tem tednu smo imeli 41 transakcij, od tega 8 uspešnih, s povprečnim dobičkom 9,375 tveganih enot, ter 33 neuspešnih, kar pomeni skupno 33 tveganih enot. Seštevek dobička in izgube je pokazal 42 tveganih enot dobička. Če je tvegana enota velikosti 0,2 % kapitala, to pomeni 8,4 % dobička v tem tednu.

V našem primeru SWOT analiza pokaže, da so moči trgovalnega agenta v avtonomiji, hitrosti in natančnosti, kar omogoča optimizacijo strategij in hitrejšo izkoriščanje tržnih priložnosti brez človeških napak. Šibkosti pa so povezane z omejenostjo strategij, potrebnim naprednim tehničnim znanjem ter tveganjem tehničnih napak, ki lahko vplivajo na uspešnost. Priložnosti vključujejo povečano učinkovitost trgovanja in dostopnost trga 24/7, medtem ko so nevarnosti predvsem sistemska tveganja, regulativne omejitve in konkurenca, ki lahko ogrozijo donosnost in varnost agenta.

**Tabela 3: SWOT analiza**

SWOT Analiza:	
MOČI	ŠIBKOSTI
Hitro delovanje	Omejen na MataTrader4
Brez emocionalnih ovir	Odvisen od podatkov
PRILOŽNOSTI	NEVARNOSTI
Integracija podatkov v strojno učenje	Volatilnost trga
Podpora večih platform	Restrikcije brokerjev

Vir: Lasten

## 4 Zaključek

Naša naloga potrjuje predpostavko, da uporaba trgovalnih algoritmov pripomore k večji natančnosti in hitrosti v primerjavi z ročnim trgovanjem, kar na koncu prinese večji dobiček. Osredotočili smo se na programsko okolje MQL4 in opisali postopek izgradnje ključnih funkcij, ki omogočajo delovanje trgovalnega agenta. Z uporabo uporabniško definiranih funkcij v programih MQL4 ali MQL5 lahko trgovalne strategije delujejo samodejno brez potrebe po stalnem nadzoru trga.

Pomembna ovira, ki smo se ji uspešno izognili, je vloga čustev pri trgovanju. Čustva lahko vplivajo na naše odločitve, kar je še posebej tvegano na finančnih trgih, kjer lahko celo najmanjše skrbi ali vznemirjenost vodijo do napak. Z uporabo algoritmov se lahko izognemo vplivu čustev in tako dosežemo bolj stabilne ter uspešne rezultate pri trgovanju.

Z analizo SWOT smo dokazali, da je uporaba trgovalnega agenta z uporabo jezika MQL4 lahko izjemno koristna za trgovce. S poudarkom na močeh, kot so avtonomija, hitrost, natančnost in optimizacija, ter priložnostih, kot so povečana učinkovitost, razvoj in prilagajanje ter dostopnost trgovine, smo pokazali, da lahko trgovalni agenti nudijo konkurenčno prednost v dinamičnem okolju finančnih trgov. Hkrati pa smo prepoznali tudi šibkosti, kot so omejenost strategij in tehnično znanje, ter nevarnosti, kot so sistemska tveganja in tveganje kraje intelektualne lastnine, ki zahtevajo ustrezno upravljanje in nadzor.

Kljub potrditvi prednosti uporabe trgovalnih algoritmov na podlagi MQL4 je treba upoštevati nekatere omejitve naše raziskave. Prvič, analiza temelji na določenem programskem okolju in specifičnih strategijah, kar omejuje njeno posplošitev na širši nabor trgovalnih pristopov ali platform. Drugič, naša raziskava ne upošteva vpliva zunanjih dejavnikov, kot so nenadne spremembe tržnih pogojev ali tehnične omejitve platforme, ki lahko vplivajo na delovanje algoritmov v realnih razmerah.

Za prihodnje raziskave bi bilo smiselno prevesti trgovalne strategije iz MQL4 v Python ter uporabiti knjižnico Backtrader za poglobljeno analizo in interpretacijo rezultatov. S tem bi omogočili večjo fleksibilnost pri razvoju strategij, boljšo vizualizacijo podatkov ter lažjo integracijo z naprednimi metodami strojnega učenja kar posledično poveča odnos med številom pozitivnih in negativnih transakcij.

## Opombe

Trgovalni agenti se soočajo s številnimi šibkosti, kot so omejitve strategij, ki jih lahko prilagodijo le z napredno programiranjem, in tehničnimi napakami, ki lahko povzročijo nepričakovane izgube. Poleg tega so izpostavljeni nevarnostim, kot so napake v sistemih, regulativne omejitve ter naraščajoča konkurenca na trgu, kar lahko vpliva na njihovo donosnost. Prav tako obstaja tveganje kraje intelektualne lastnine, kar lahko ogrozi konkurenčno prednost in poslovno varnost trgovcev.

Avtor tega besedila ni finančni svetovalec, zato informacije v tem članku ne smejo biti razumete kot finančni nasveti. Pred vsako odločitvijo glede trgovanja ali investiranja se posvetujte s strokovnjakom.

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# NEIZKORIŠČEN POTENCIAL SHRANJEVANJA ENERGIJE V GOSPODINJSKIH NAPRAVAH ZA STABILIZACIJO ELEKTRIČNEGA OMREŽJA

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Trenutne strategije za shranjevanje energije v energetskih sistemih se večinoma opirajo na baterijske tehnologije. Kljub temu obstaja velik, še neizkoriščen potencial shranjevanja energije v obliki toplote ali mraza, ki ga lahko zagotavljajo gospodinjske naprave, kot so hladilniki, zamrzovalniki in bojlerji. V tej raziskavi smo proučevali, kako prilagoditev delovanja teh naprav prispeva k stabilizaciji električnega omrežja ter podpira integracijo nestanovitnih obnovljivih virov energije. Predstavljamo analizo tehničnih možnosti in energetskega potenciala teh naprav ter njihov vpliv na učinkovitost in trajnostno delovanje omrežja. Rezultati raziskave kažejo, da lahko optimalno upravljanje teh naprav zmanjša obremenitve omrežja ter poveča njegovo prilagodljivost, kar je ključno za prihodnost energetske trajnostnih sistemov.

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# UNEXPLORED ENERGY STORAGE POTENTIAL IN HOUSEHOLD APPLIANCES FOR ELECTRIC GRID STABILIZATION

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Current strategies for energy storage in energy systems primarily rely on battery technologies. However, there is significant untapped potential for energy storage in the form of heat or cold, which can be provided by household appliances such as refrigerators, freezers, and water heaters. In this study, we examined how adjusting the operation of these devices contributes to stabilizing the electricity grid and supports the integration of intermittent renewable energy sources. We present an analysis of the technical capabilities and energy potential of these devices, as well as their impact on the efficiency and sustainability of the grid's operation. The results of the study indicate that optimal management of these devices can reduce grid loads and enhance its flexibility, which is crucial for the future of sustainable energy systems.



## 1 Uvod

Z naraščanjem uporabe obnovljivih virov energije, kot sta sončna in vetrna energija, se povečuje potreba po stabilizaciji elektroenergetskih omrežij. Obnovljivi viri energije so namreč nestalni, kar povzroča nihanja v proizvodnji, ki lahko presegajo trenutno porabo ali pa ne zadostujejo za pokritje potreb. Ta nihanja še povečujejo obremenitve na elektroenergetsko omrežje in ustvarjajo potrebo po razvoju sistemov za hranjenje energije. Tradicionalni sistemi za hranjenje energije, kot so baterije, imajo omejitve, predvsem zaradi visokih stroškov in vpliva na okolje (IEA, 2024). Zato postaja ključno raziskati nove pristope k hranjenju energije.

Raziskave na področju shranjevanja energije so v zadnjih letih doživele izjemen porast, kar je posledica prehoda na obnovljive vire energije in potrebe po stabilnosti energetskega omrežja. Natančno število trenutnih raziskav je težko določiti zaradi njihovega nenehnega naraščanja in širokega spektra področij, ki jih pokrivajo (ECA, 2022; Jadek & Pensa, 2023).

Evropska unija je v obdobju od leta 2014 do oktobra 2018 v okviru programa Obzorje 2020 namenila 1,34 milijarde evrov za projekte, povezane s shranjevanjem energije za omrežje ali nizkoogljeno mobilnost. Ta sredstva so bila usmerjena v razvoj in inovacije na področju shranjevanja energije, kar kaže na pomembnost tega sektorja za prihodnost evropske energetike (ERS, 2019).

Poleg tega je Evropska komisija objavila vrsto priporočil o shranjevanju energije s konkretnimi ukrepi, ki jih lahko sprejmejo države članice EU, da zagotovijo večjo izrabo obnovljivih virov. Analiza je namreč pokazala, da je shranjevanje energije ključno za razogljičenje energetskega sistema EU (Evropska komisija, 2023).

V Sloveniji je Kemijski inštitut organiziral kolokvij, posvečen prihodnosti raziskav na področju baterij, kar kaže na nacionalna prizadevanja za napredek na tem področju (Kemijski inštitut, 2024a). Poleg tega je konzorcij projekta Muspell, v katerem sodeluje tudi Kemijski inštitut, prejel nepovratna evropska sredstva v višini 3,5 milijona evrov za razvoj sistema za shranjevanje toplotne energije naslednje generacije (Kemijski inštitut, 2024b).

Globalno gledano, Bloomberg New Energy Finance navaja, da bo trg shranjevanja energije do leta 2030 dosegel 100 milijard dolarjev, kar kaže na ogromne naložbe in pričakovano rast v tem sektorju (BloombergNEF, 2024).

Gospodinjske naprave, kot so bojlerji, hladilniki in zamrzovalniki, predstavljajo neizkoriščen potencial za ustvarjanje prožnosti v omrežju. Te naprave lahko shranjujejo energijo v obliki toplote ali hladu in tako prispevajo k zmanjšanju obremenitev v času visoke porabe ter omogočajo boljše izkoriščanje obnovljivih virov energije. Po podatkih Eurostata gospodinjstva porabijo 25,8 % vse električne energije v Evropski uniji (Eurostat, 2024). Cilj tega članka je preučiti, kako lahko optimalno upravljanje delovanja teh naprav pomaga stabilizirati elektroenergetsko omrežje in podpre integracijo obnovljivih virov energije.

## 2 Povprečna poraba električne energije v gospodinjstvih

Povprečna dnevna poraba električne energije 4-članske družine je odvisna od vrste gospodinjskih aparatov, navad družine in energetske učinkovitosti naprav. V Sloveniji znaša povprečna **letna poraba električne energije** za gospodinjstvo približno **3500–4500 kWh**, kar omogoča ocenitev povprečne **dnevne porabe (SURS, 2021)**.

**Letna poraba:** 3500–4500 kWh

**Dnevna poraba:** 9,6-12,3 Wh

### 2.1 Razčlenitev porabe

**Tipična poraba po kategorijah:**

**Hladilnik/zamrzovalnik:**

**Dnevno:** 1–2 kWh

Deluje 24 ur na dan, energijsko učinkoviti modeli porabijo manj.



### **Pranje in sušenje:**

**Pralni stroj:** 0,5–1 kWh na pranje

**Sušilni stroj:** 2–3 kWh na sušenje

Možno nastavljanje zakasnjenege vklopa.

### **Razsvetljava:**

LED-sijalke za celo gospodinjstvo: **1–2 kWh dnevno.**

### **Kuhinja:**

Električni štedilnik/pečica: **1–2 kWh dnevno** (odvisno od uporabe).

Pomivalni stroj: 1–1,5 kWh na pomivanje - možno nastavljanje zakasnjenege vklopa.

### **Gretje vode (bojler):**

električni bojler: **5–7 kWh dnevno** za 4-člansko družino.

### **Elektronske naprave (TV, računalniki, polnilci):**

Skupaj: **1–2 kWh dnevno.**

## **2.2 Dejavniki, ki vplivajo na porabo**

Na porabo električne energije v gospodinjstvu vpliva več različnih dejavnikov. Ti dejavniki so povezani tako s tehničnimi lastnostmi naprav kot tudi z uporabniškimi navadami in sezonskimi spremembami. Ključni med njimi so:

**Vrsta ogrevanja:** Električno ogrevanje prostorov (npr. IR-paneli ali toplotna črpalka) lahko znatno poveča porabo.

**Energijska učinkovitost:** Sodobni aparati z višjim energijskim razredom (A+++)  
porabijo manj elektrike.

**Navade družine:** Prihranek pri razsvetljavi, izklop naprav v stanju pripravljenosti  
in optimizacija uporabe gospodinjskih aparatov lahko zmanjša porabo.

**Sezonska nihanja:** Pozimi se zaradi krajših dni in ogrevanja poraba poveča.

Iz podatkov je razvidno, da je največji porabnik električne energije v gospodinjstvu  
bojler (za pripravo tople vode po raziskavi Statističnega urada RS uporablja 20%  
gospodinjstev) na drugem mestu pa hladilnik oziroma zamrzovalnik, ki je običajen  
za gospodinjstvo.

### 3 Potencial bojlerjev in hladilnikov kot termičnih hranilnikov

Za analizo potenciala shranjevanja energije v gospodinjskih napravah so bile  
uporabljene simulacijske metode, podprte s podatki o povprečni porabi energije za  
ogrevanje vode, hlajenje in zamrzovanje. Poseben poudarek je bil na:

- Bojlerjih kot termičnih hranilnikih energije.
- Hladilnikih in zamrzovalnikih kot hlajenih hranilnikih energije.

Analizirani so bili različni scenariji:

- Klasična poraba električne energije brez prilagoditev.
- Poraba, prilagojena časovnim intervalom nizke obremenitve omrežja.

Izračuni za bojlerje so temeljili na povprečnem grelcu moči 2 kW in prostornini 100  
litrov. Za hladilnike in zamrzovalnike pa je bila povprečna poraba ocenjena na 1,5  
kWh dnevno.

Dodatno so bili izvedeni izračuni ekonomskih prihrankov, ki jih omogoča premik  
porabe energije v časovne bloke z nižjimi tarifami. Primerjava teh scenarijev je  
omogočila oceno potenciala teh naprav za stabilizacijo omrežja.

### 3.1 Bojler kot hranilnik energije

#### 3.1.1 Povprečna dnevna potreba po topli vodi

Povprečna oseba porabi približno **30–50 litrov tople vode na dan** (pri temperaturi 40–50 °C).

Za 4-člansko družino to pomeni:

**120–200 litrov tople vode na dan.**

#### 3.1.2 Energija za segrevanje vode

Energija za segrevanje vode je odvisna od količine vode, temperature vode iz vodovoda in želene temperature. Za izračun uporabimo formulo:

$$E = m \cdot c \cdot \Delta T$$

Kjer:

E = potrebna energija (v kWh),

m = masa vode (v kg; 1 liter vode = 1 kg),

c = specifična toplota vode (4,186 kJ/kg°C, kar je približno 0,00116 kWh/kg°C),

$\Delta T$  = razlika med začetno in končno temperaturo vode.

Primer izračuna:

Količina vode: 150 litrov (za 4 člane).

Začetna temperatura vode: 10 °C.

Želena temperatura: 50 °C.

Razlika v temperaturi:  $\Delta T = 50 - 10 = 40 \text{ }^\circ\text{C}$ .

$$E = 150 \cdot 0,00116 \cdot 40 = 6,96 \text{ kWh}$$

### 3.1.3 Prožnost bojlerjev in njihov prispevek k stabilizaciji omrežja

Bojlerji zaradi svoje sposobnosti shranjevanja toplote ponujajo znatno prilagodljivost pri porabi energije. Povprečen **bojler s kapaciteto 100 litrov**, nastavljen na temperaturo  $60 \text{ }^\circ\text{C}$ , lahko zagotovi približno **1,3 kWh prožnosti dnevno**. To omogoča prilagoditev porabe glede na razpoložljivost energije iz obnovljivih virov in nizke obremenitve omrežja. Ta prilagodljivost je še posebej pomembna za zmanjšanje koničnih obremenitev in povečanje stabilnosti elektroenergetskega sistema.

Prožnost bi bilo možno še dodatno povečati, če bi bojlerje segrevali na višjo temperaturo, na primer  $70$  ali  $80 \text{ }^\circ\text{C}$ , saj bi to omogočilo večje shranjevanje energije v obliki tople vode. Da bi to bilo izvedljivo brez negativnih učinkov, je ključno uporabljati bojlerje, ki preprečujejo nabiranje vodnega kamna, kar je pogosta težava pri višjih temperaturah vode in vodi do zmanjšanja učinkovitosti in večjih izgub energije (Smith et al., 2020). Takšni sistemi bi omogočili boljše izkoriščanje obdobj visoke proizvodnje iz obnovljivih virov, zlasti iz sončnih elektrarn, ki največ energije proizvedejo poleti.

### 3.1.4 Ekonomični prihranki zaradi premika porabe

Uporaba bojlerjev za ogrevanje vode v časovnih blokih z nižjimi tarifami lahko prinese znatne prihranke. Na primer:

Povprečen **100-litrski bojler** porabi približno **4–5 kWh energije dnevno** za ogrevanje vode.

Če je cena električne energije v času visoke tarife (VT) **0,20 €/kWh** in v času nizke tarife (NT) **0,15 €/kWh**, bi premik celotnega segrevanja vode iz VT v NT prinesel naslednje prihranke:

Tedenska poraba bojlerja:

$$5 \text{ kWh/dan} \cdot 7 \text{ dni} = 35 \text{ kWh/teden.}$$

Razporeditev porabe glede na tarife:

$$\text{VT (80 ur/teden): } 80/168 \cdot 35 \text{ kWh} \approx 16,67 \text{ kWh.}$$

$$\text{NT (88 ur/teden): } 88/168 \cdot 35 \text{ kWh} \approx 18,33 \text{ kWh.}$$

Strošek brez premika (VT + NT):

$$16,67 \cdot 0,20 + 18,33 \cdot 0,15 = 3,33 \text{ €} + 2,75 \text{ €} = 6,08 \text{ €/teden.}$$

Strošek ob popolnem premiku (samo NT):

$$35 \text{ kWh/teden} \cdot 0,15 = 5,25 \text{ €/teden.}$$

Teoretični tedenski prihranek (če bi premaknili celotno porabo):

$$6,08 \text{ €} - 5,25 \text{ €} = 0,83 \text{ €/teden.}$$

Dejanski prihranek:

V realnosti celotne porabe ne moremo premakniti v NT, saj bojler mora segreti vodo tudi v času VT, da zadosti potrebam (npr. zaporedno tuširanje). Da bi zagotovili, da tople vode ne zmanjka, hkrati pa kar največjo porabo premaknili v čas nizke tarife, je smiselno uporabiti **umetno inteligenco (UI)** za prilagoditev delovanja bojlerja. Tak sistem bi lahko:

- **Ugotavljal navade uporabnikov:** UI bi analizirala urnik uporabe tople vode (npr. kdaj se družinski člani tuširajo ali uporabljajo gospodinjstvene naprave) in na podlagi teh podatkov prilagodila delovanje bojlerja.
- **Optimizirala segrevanje vode:** Bojler bi predčasno segrel vodo v času nizke tarife, pri čemer bi upošteval, kdaj bo potreba po topli vodi najvišja.

- **Preprečevala izpraznitev bojlerja:** Sistem bi zagotavljal, da so rezerve tople vode vedno dovolj visoke, da zadostijo potrebam gospodinjstva, tudi če je trenutna tarifa visoka.
- **Zmanjšala porabo v VT:** Preostala poraba energije bi bila zmanjšana na minimum, pri čemer bi se večina segrevanja vode izvajala med NT.

Uporaba pametnega sistema za upravljanje lahko optimizira delovanje bojlerja in premakne 75–85 % porabe v NT.

Realni prihranek (85 % porabe v NT):

$$0,85 \cdot 35 \cdot 0,15 + 0,15 \cdot 35 \cdot 0,20 = 4,46 \text{ € (NT)} + 1,05 \text{ € (VT)} = 5,51 \text{ €/teden.}$$

$$\text{Prihranek} = 6,08 \text{ €} - 5,51 \text{ €} = 0,57 \text{ €/teden.}$$

### 3.1.5 Prihranek zaradi zmanjšane potrebe po baterijah

Ker bojlerji učinkovito shranjujejo energijo v obliki toplote, zmanjšujejo potrebo po dragih hranilnikih električne energije, kot so baterije. Na primer, tipična hranilna baterija za gospodinjstvo s kapaciteto 10 kWh stane približno **10.000 €**. Če bi bojler zagotavljal vsaj **1,3 kWh prožnosti dnevno**, bi to pomenilo prihranek vsaj **13 % investicije** v baterijo, kar znaša približno **1300 €** na gospodinjstvo. Poleg tega bojlerji ne potrebujejo dodatne infrastrukture ali stroškov vzdrževanja, kar še dodatno povečuje njihovo ekonomsko in okoljsko privlačnost.

### 3.1.6 Sezonske razlike in izzivi

Prožnost bojlerjev se sezonsko spreminja. Pozimi, ko so potrebe po topli vodi večje, lahko bojlerji zagotavljajo večji potencial za prilagoditev. Poleti, ko so potrebe po topli vodi manjše, se prožnost zmanjša, kar ustvarja izziv, saj se največ energije iz sončnih elektrarn proizvede ravno v poletnih mesecih (Mills et al., 2015; IEA, 2019). Pametno upravljanje bojlerjev s pomočjo UI bi lahko reševalo ta neskladja in maksimiralo prihranke v vseh letnih časih.

Bojlerji v povprečnem gospodinjstvu predstavljajo enega največjih porabnikov električne energije, pri čemer njihova kapaciteta za shranjevanje toplote omogoča zamik porabe energije. Simulacija je pokazala, da bi lahko bojlerji z optimalnim upravljanjem prispevali do 15 % k zmanjšanju koničnih obremenitev omrežja. Izračunano je bilo, da lahko 50.000 bojlerjev prispeva 100 MWh prožnosti dnevno, kar bistveno zmanjša potrebo po dodatnih zmogljivostih za regulacijo.

## 3.2 Hladilnikih in zamrzovalnikih kot hranilnikih energije

### 3.2.1 Princip delovanja hladilnikov in zamrzovalnikov

Hladilniki in zamrzovalniki delujejo na osnovi kroženja hladilnega sredstva, ki v procesu izhlapevanja odvaja toploto iz notranjosti naprave. Ta proces omogoča kompresor, ki je eden največjih porabnikov električne energije v hladilniku. Osnovni koraki delovanja so:

- **Kompresija:** Kompresor stisne hladilno sredstvo, ki s tem postane vroče in pod visokim tlakom.
- **Kondenzacija:** V kondenzatorju se hladilno sredstvo ohladi in spremeni v tekočino.
- **Ekspanzija:** Tekoče hladilno sredstvo se sprosti skozi ekspanzijski ventil, kar povzroči padec tlaka in temperature.
- **Izhlapevanje:** Hladilno sredstvo v uparjalniku izhlapi in odvzame toploto iz notranjosti hladilnika, s čimer se prostor ohladi.

Trenutni sistemi za optimizacijo porabe električne energije pogosto uporabljajo preprosto logiko, ki izklaplja celoten aparat v času visoke tarife in ga vklaplja v času nizke tarife. Ta pristop je pri hladilnikih problematičen, saj ne moremo prekiniti hlajenja za daljše časovno obdobje, ne da bi s tem ogrozili shranjevanje živil.

Pametnejši pristopi bi morali optimizirati delovanje **samo kompresorja**, ki je največji porabnik energije. To je možno doseči z natančnim upravljanjem njegovega delovanja.

### 3.2.2 Sodobni hladilniki in prednosti variabilnega ekspanzijskega ventila

Sodobni hladilniki so opremljeni z **variabilnim ekspanzijskim ventilom**, ki omogoča bolj učinkovito delovanje. Ta tehnologija omogoča:

- **Manj pogoste vklopitve kompresorja:** Variabilni ekspanzijski ventil natančneje regulira količino hladilnega sredstva, kar omogoča manj pogosto delovanje kompresorja.
- **Zmanjšanje nihanj temperature:** Bolj enakomerna regulacija preprečuje nihanja temperature v notranjosti hladilnika.
- **Energetska učinkovitost:** Redkejši vklopi kompresorja zmanjšujejo konične obremenitve in porabo električne energije.

To je pomembna izboljšava v primerjavi s starejšimi sistemi, kjer se je kompresor pogosto vklapljal in izklapljal, kar je povzročalo višje stroške in večjo obrabo komponent.

### 3.2.3 Prožnost hladilnikov in zamrzovalnikov ter njihov prispevek k stabilizaciji omrežja

Hladilniki in zamrzovalniki zaradi svoje konstantne potrebe po energiji ponujajo možnost mikro prilagoditev za zmanjšanje obremenitev elektroenergetskega omrežja. Povprečen **hladilnik z zamrzovalnikom kapacitete 200 litrov** lahko omogoči prilagodljivost porabe v višini približno **0,5 kWh dnevno**, če se čas delovanja kompresorja prilagodi glede na trenutne obremenitve omrežja in razpoložljivost energije iz obnovljivih virov. Ta prilagodljivost omogoča majhne, a številčne prihranke, še posebej v gospodinjstvih, ki uporabljajo več naprav hkrati.

Prilagodljivost bi bilo možno še dodatno izboljšati z uporabo sodobnih tehnologij, ki omogočajo natančno upravljanje delovanja kompresorja glede na temperaturo v hladilnem prostoru in okolici. Uporaba pametnih sistemov za nadzor bi tako omogočila boljše izkoriščanje obdobj z nizko tarifo ali visoko proizvodnjo iz obnovljivih virov, ne da bi pri tem vplivala na kakovost shranjevanja živil.



### 3.2.4 Ekonomični prihranki zaradi optimizacije porabe

Uporaba hladilnikov in zamrzovalnikov s prilagodljivim delovanjem lahko zmanjša stroške porabe električne energije. Na primer:

Povprečen hladilnik porabi približno **1–2 kWh energije dnevno**.

Če se čas delovanja kompresorja optimizira za delovanje v času nizke tarife (NT), se lahko prihranijo stroški, povezani z visoko tarifo (VT).

#### Izračun prihranjenega stroška:

Tedenska poraba hladilnika:

$$1,5 \text{ kWh/dan} \cdot 7 \text{ dni} = 10,5 \text{ kWh/teden.}$$

Razporeditev porabe glede na tarife:

$$\text{VT (80 ur/teden): } 80/168 \cdot 10,5 \text{ kWh} \approx 5 \text{ kWh.}$$

$$\text{NT (88 ur/teden): } 88/168 \cdot 10,5 \text{ kWh} \approx 5,5 \text{ kWh.}$$

Strošek brez optimizacije (VT + NT):

$$5 \cdot 0,20 + 5,5 \cdot 0,15 = 1,00 \text{ €} + 0,83 \text{ €} = 1,83 \text{ €/teden.}$$

Strošek z optimizacijo (večina porabe v NT):

$$8,5 \cdot 0,15 + 2 \cdot 0,20 = 1,28 \text{ €} + 0,40 \text{ €} = 1,68 \text{ €/teden.}$$

Tedenski prihranek:

$$1,83 \text{ €} - 1,68 \text{ €} = 0,15 \text{ €/teden.}$$

Letni prihranek:

0,15 €/teden · 52 tednov = 7,80 €.

Čeprav so prihranki na posamezno napravo relativno majhni, se lahko z množično uporabo optimiziranih hladilnikov dosežejo pomembni prihranki na ravni celotnega omrežja.

### 3.2.5 Prihranek zaradi zmanjšane potrebe po baterijah

Ker hladilniki zagotavljajo mikro prilagodljivost z možnostjo začasnega zamika delovanja kompresorja, lahko prav tako prispevajo k zmanjšanju potrebe po dragih hranilnikih električne energije, kot so baterije. Če bi hladilnik zagotavljal vsaj **0,5 kWh prožnosti dnevno**, bi to pomenilo prihranek približno **5 % investicije** v baterijo, kar znaša približno **500 €** na gospodinjstvo.

Poleg tega sodobni hladilniki z variabilnim ekspanzijskim ventilom in bolj učinkovitim upravljanjem kompresorja ne potrebujejo dodatne infrastrukture ali visokih stroškov vzdrževanja, kar še dodatno povečuje njihovo ekonomsko in okoljsko privlačnost. Ta prilagodljivost omogoča gospodinjstvom, da izboljšajo svoje energetske rešitve brez večjih začetnih investicij.

### 3.2.6 Sezonske razlike in izzivi

Hladilniki delujejo enakomerno skozi vse leto, vendar se njihova poraba lahko poveča v poletnih mesecih zaradi višjih temperatur okolja. To predstavlja dodaten izziv pri optimizaciji porabe, **a hkrati poleti sončne elektrarne proizvedejo največ energije**. Pametno upravljanje hladilnikov s pomočjo UI lahko izkoristi to sezonsko usklajenost in dodatno zmanjša obremenitev omrežja.

## 4 Zaključek

Predstavljene rešitve kažejo velik potencial za prispevek gospodinjskih naprav k stabilizaciji elektroenergetskega omrežja. Vendar pa obstajajo izzivi, vključno s potrebo po standardizaciji komunikacijskih protokolov, izboljšanju algoritmov za optimizacijo in zagotavljanju ekonomskih spodbud za končne uporabnike.

Zmanjšanje koničnih obremenitev bi imelo tudi pomembne ekonomske koristi, saj bi zmanjšalo stroške za operaterje omrežja in omogočilo učinkovitejše izkoriščanje obstoječe infrastrukture. Hkrati bi zmanjšanje nihanj proizvodnje in porabe energije prispevalo k trajnostnemu razvoju energetskega sistema.

Z uporabo **100-litrskega bojlerja** za shranjevanje energije v obliki toplote in z uporabo umetne inteligence za optimizacijo njegovega delovanja lahko gospodinjstva letno prihranijo na stroških električne energije, zmanjšajo potrebo po baterijah in hkrati prispevajo k stabilizaciji elektroenergetskega omrežja. Takšni pristopi ne le zmanjšujejo stroške za uporabnike, temveč tudi povečujejo učinkovitost porabe energije in spodbujajo prehod na trajnostne energetske rešitve.

Z uporabo pametnih hladilnikov in zamrzovalnikov, ki omogočajo prilagodljivo delovanje in vključujejo tehnologijo variabilnega ekspanzijskega ventila, lahko gospodinjstva letno prihranijo stroške električne energije, zmanjšajo potrebo po baterijah in hkrati prispevajo k stabilizaciji elektroenergetskega omrežja. Takšni pristopi so še posebej učinkoviti, če se uporabljajo v velikem obsegu, saj spodbujajo trajnostno porabo energije.

Uporaba bojlerjev, hladilnikov in zamrzovalnikov za shranjevanje energije predstavlja praktičen in učinkovit način za izboljšanje stabilnosti elektroenergetskega omrežja. Optimizirano upravljanje teh naprav bi lahko prispevalo k večji integraciji obnovljivih virov energije, zmanjšalo obremenitve omrežja in izboljšalo trajnost celotnega sistema. Nadaljnje raziskave na tem področju bi morale vključevati razvoj pametnih tehnologij predvsem s strani proizvajalcev tovrstnih aparatov.

Združevanje teh naprav v sistem pametnega upravljanja je pokazalo možnost zmanjšanja dnevnih obremenitvenih špic za do 20 %. To bi omogočilo boljše izkoriščanje obnovljivih virov energije in zmanjšalo potrebo po dodatni regulaciji iz strani operaterjev omrežja in zmanjšanje potreb po vgrajevanju baterijskih sistemov.

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# POZITIVNO MODELIRANJE IN OPOLNOMOČENJE KOT OSREDNJA DEJAVNIKA USPEŠNEGA AKADEMSKEGA MENTORSTVA

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Mentorstvo v zadnjem času pridobiva na pomenu, saj igra ključno vlogo pri uresničevanju kariernih ciljev, zlasti v akademskem okolju. Skozi različne oblike mentoriranja v akademskem okolju tako mentor kot mentoriranec pridobivata dragocene izkušnje, ki lahko pomembno vplivajo na njuno profesionalno vlogo na določenem področju. Pri mentoriranju pa se lahko pojavijo številni izzivi, ki se razlikuje glede na vpliv prepletenih dejavnikov, kot so spol, empatija, komuniciranje in drugo. Pogosto zanemarimo, da je načrtovanje temelj vsakega uspešnega procesa, pri čemer je potrebno izpostaviti vse značajne ovire, ki bi se lahko pojavile, ter predlagati načine za njihovo razrešitev. V sodobni literaturi je vse bolj prisotno povezovanje mentorstva s pozitivnim modeliranjem in opolnomočenjem. V prispevku želimo raziskati, s katerimi ovirami se soočajo mentorji in mentoriranci v akademskem okolju, kako lahko pozitivno modeliranje prispeva k uspešnejšemu mentorskemu odnosu ter kakšno vlogo ima opolnomočenje pri tovrstnem sodelovanju. V poglavju Rezultati in diskusija bomo na podlagi ugotovitev različnih avtorjev podali predloge ukrepov za reševanje izzivov, ki lahko na podlagi pozitivnega modeliranja in opolnomočenja učinkovito pripomorejo k uspešnejšemu mentorskemu odnosu.

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# POSITIVE MODELING AND EMPOWERMENT AS A CENTRAL FACTOR OF SUCCESSFUL ACADEMIC MENTORSHIP

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Mentorship has been gaining importance lately, as it plays a key role in achieving career goals, especially in academia. Through various forms of mentoring in the academic environment, both the mentor and the mentee gain valuable experience that can have a significant impact on their professional role in a particular field. However, there can be a number of challenges in mentoring, which vary depending on the impact of intertwined factors such as gender, empathy, communication, and more. We often neglect that planning is the foundation of any successful process, and it is necessary to highlight any significant obstacles that might arise and suggest ways to resolve them. In contemporary literature, there is a growing emphasis on linking mentoring with positive modeling and empowerment. In this paper, we aim to explore the barriers faced by mentors and mentees in the academic environment, how positive modeling can contribute to a more successful mentoring relationship, and the role of empowerment in such collaboration. In the chapter Results and discussion, based on the findings of various authors, we will provide proposals for measures to solve challenges that can effectively contribute to a more successful mentoring relationship based on positive modeling and empowerment.



## **1 Uvod**

Mentorstvo je oblika sodelovanja, v kateri mentoriranec od mentorja pridobiva nova znanja in veščine, na podlagi katerih lahko večji del obveznosti opravlja samostojno (Kostelec in Markič, 2024). Med sestavne dele strokovnega razvoja, poleg mentorstva, uvrščamo tudi coaching in različne oblike svetovanja (Nykiel – Bailey et al., 2025). Mentorski odnos nenazadnje vpliva tudi na organizacijsko klimo, kjer vsi stremimo k pozitivnem okolju zaradi učinkovitejšega sodelovanja (Filej et al., 2025).

Lastnosti, ki jih ima mentor, so za sodelovanje v akademskem okolju izjemno pomembne (Wang et al., 2025). Mentor mora nenehno izpopolnjevati svoje znanje in biti v stiku z novimi trendi na področju raziskovanja mentoriranca. Še posebej je mentorski odnos ključen pri praktičnem usposabljanju študentov, kot to lahko zasledimo v medicinskih strokah (Babuder, 2017).

Literatura prav tako kaže, da mentorstvo pri mladih izboljšuje vedenjske in psihosocialne vzorce ter uspešno prispeva k akademskim uspehom (Brookes et al., 2025). Mentorstvo lahko razumemo tudi kot temeljni steber čustvene podpore in ustvarjanja trajnega odnosa med mentorjem in mentorirancem. Ljudje smo vodena bitja, zato takšni programi pomagajo ohranjati raven zbranosti in dobrega počutja v boju proti slabemu počutju (Gaeta et al., 2024), kar lahko dolgoročno pripomore tudi k pojavi izgorelosti (Cavanaugh et al. (2022) in Menzin et al. (2020).

Namen prispevka je na podlagi pregleda literature identificirati ključne ovire v mentorskem odnosu. Iz teh ovir bodo oblikovane podskupine, ki so bistvene za nadaljnje raziskovanje obravnavane problematike. Nadalje bomo skozi ozaveščanje pomena pozitivnega modeliranja in opolnomočenja predstavili ukrepe, ki lahko prispevajo k izbolšanju mentorskih izkušenj v akademskem okolju.

## **2 Metodologija**

Podlaga za raziskovanje so bile številne težave, ki so negativno vplivale na dokončanje študija v časovno sprejemljivem roku. Nekateri študenti so zaradi teh težav celo zapustili študij in se osredotočili na poslovne priložnosti v delovnem okolju, kar lahko posledično vpliva tudi na število diplomantov.

Kljub pomembnosti teme akademskega mentoriranja pa v praksi še vedno ne vidimo očitnih implementacij pozitivnega modeliranja in opolnomočenja v delovno okolje v okviru razmerja med mentorjem in mentorirancem. Čeprav temeljne raziskave že obstajajo, pa dejavniki, ki natančno ločujejo koristi in slabosti, še niso povsem določeni.

Osrednji cilj raziskovanja je usmerjen v iskanje izzivov, s katerimi se soočajo mentorji in mentoriranci v akademskem okolju, ter v raziskovanje, kako lahko pozitivno modeliranje prispeva k uspešnejšemu mentorskem odnosu, in kakšno vlogo ima opolnomočenje pri tovrstnem sodelovanju.

Na podlagi zaznane problematike smo v nadaljevanju v spletnih bazah ScienceDirect, ProQuest in Google Scholar, s pomočjo kombinacij ključnih besed z veznikom »and« (mentorship, academic environment, positive modeling, empowerment), iskali primerne članke, na podlagi katerih bi lahko sestavili predlog ukrepov za učinkovito akademsko mentorstvo skozi pozitivno modeliranje in opolnomočenje.

Kriteriji, na podlagi katerih smo iz širokega spektra člankov izločili najpomembnejše, so bili odprta dostopnost in jezik (slovenščina ali angleščina). Skupno smo analizirali 30 virov, pridobljenih iz različnih uglednih znanstvenih baz podatkov in knjižničnih virov. Med njimi smo 10 virov identificirali preko Google Scholar, 1 vir v zbirki ProQuest, 14 virov v bazi ScienceDirect, 1 vir v knjižnici Fakultete za organizacijske vede v Kranju, ter 4 vire dostopne prek sistema Cobiss+.

Na podlagi pregledanih člankov, prispevkov in gradiva smo oblikovali temelj, na podlagi katerega je sledilo poglavje rezultatov in diskusije, v katerem smo ugotovitve primerjali z lastnimi videnji in razmišljanji. Na tej osnovi smo oblikovali predloge ukrepov za učinkovito akademsko mentoriranje, ki vključujejo dejavnike pozitivnega modeliranja in opolnomočenja.

### 3 Teoretična izhodišča

Izurjeni strokovnjaki na svojem področju skozi vlogo mentorstva, s pomočjo uporabe svoje moči in statusa, podpirajo razvoj nastajajočih kadrov, kar lahko izboljša zaposlitvene možnosti ter nenazadnje vpliva tudi na razvoj nacionalnih



kontekstov. Različni izzivi v delovnem okolju se lahko pojavijo pri komunikaciji, kjer je prisotnih več akterjev. Težavam v komunikaciji v mentorskem odnosu se lahko izognemo, če obe strani poskušata razumeti in spoštovati mnenja in raznolike poglede glede na določeno tematiko (Khatun et al., 2022).

Velika večina medicinskega akademskega mentoriranja je osredotočena na usposabljanje tehničnih in strokovnih veščin. Mentorstvo lahko vpliva tudi na zaposlovanje in zadrževanje kadrov v določeni organizaciji. Pomembnost komunikacije je razvidna iz ugotovitev, da lahko zaradi nje pride do velikih ovir, ki privedejo do neuspeha (Elce, 2021).

Naloga mentorja v akademskem okolju je lahko podvojena, saj ima poleg vloge poučevanja, ki je primarna, tudi vlogo mentoriranja (Jaspers et al., 2014). V praksi je pogosto opaziti obremenjenost študentov zaradi načina dela in usmerjanja s strani mentorja (Gray in Downer, 2021). Raziskave kažejo, da spol pomembno vpliva na mentorski odnos, pri čemer se pojavlja opazka, da ženske mentorke nudijo več psihosocialne podpore (Allen in Eby, 2004, povzeto po Ensher in Murphy, 2011).

V praksi je vse pogostejše prisotno e-mentorstvo, ki prinaša dodatne izzive pri vzpostavljanju komunikacijskih kanalov ter pri predhodnem znanju o informacijsko-komunikacijske tehnologije (v nadaljevanju IKT). Ena od ovir, ki se lahko pojavi pri mentoriranju, je lahko zavzetost mentorja, saj to lahko vpliva na uspeh kandidata pri zaključnem delu (Lach et al., 2025).

Interaktivno sodelovanje in poslušanje med predavanji izboljšujeta konceptualno učenje. V praksi smo zasledili, da je modeliranje del prizadevanja za oblikovanje akademskih in raziskovalnih mrež (Brewer et al., 2009). Mentor nam ponuja širino, ki jo z svojim znanjem in izkušnjami morda ne bi mogli zaznati, kar posledično vpliva na fokus in dinamiko pozitivnega mentorstva (Clark, 2015).

Učinkovito modeliranje poteka predvsem skozi različne dejavnike, ki so vključeni v modele in se implementirajo v okolje s pomočjo različnih čustev. Mentor v tem procesu lahko uporabi tudi subjektivne občutke, ki olajšajo usmerjanje in obvladovanje potenciala mentoriranja (Borod, 2000).

Pri upostavljanju učinkovitega mentorstva lahko naletimo na številne ovire, ki jih je za uspešno sodelovanje potrebno čim prej odpraviti. Pokazatelj, kako uspešno je bilo mentorstvo, lahko izvemo tudi iz evalvacije ali usmerjenega ocenjevanja (Filej et al., 2025). Mentor je ključni element mentorskega odnosa, saj mentoriranca vodi in usmerja k učinkovitim metodam, na podlagi katerih bo mentoriranec lahko v zastavljenem časovnem roku opravil svoje obveznosti (Kostelec in Markič, 2024).

V kontekstu mentorsko-izobraževalnega odnosa je opolnomočenje dinamičen proces, s katerim mentor omogoča mentorirancu progresivno večjo stopnjo neodvisnosti in kompetenčne samozavesti (Evans et al., 2024). V akademskih diskusijah je pogosto izpostavljen tudi termin »opolnomočenje prihodnosti«, ki poudarja, da lahko kontinuirano mentorsko vodenje spodbuja dolgoročno zavzetost za izobraževanje ter optimizira karierno odločanje (Allahwasaya et al., 2025).

Pri vse večjem raziskovanju področja mentorstva v akademskem okolju bi bistveno poudarili prvini pozitivnega modeliranja in opolnomočenja. Prakse modeliranja bi v prihodnosti lahko pomembno pripomogle k prepoznavanju okvirjev mentorirancev v izobraževanju in nenazadnje tudi v vsakdanjem življenju. Čeprav pozitivno modeliranje nudi številne prednosti, Ageitost et al. (2023) pojasnjujejo, da je premalo dokazov, na podlagi katerih bi lahko trdili, da s pomočjo njega lahko spodbudimo obravnavanje znanja na napredni ravni ali t. i. epistemološko zrelost.

V času delovanja v akademskem okolju mentoriranec skozi proces opolnomočenje z mentorjeve strani razvija različne kompetence in nivo zaupanja v svoje znanje ter pridobljene izkušnje skozi izobraževanje. Načelo opolnomočenja v povezavi s svetovanjem in avtonomijo lahko zasledimo pri svetovalnem delu, vendar tovrstna načela lahko posplošimo tudi na mentorski odnos v akademskem okolju (Rupar et al., 2024).

#### 4 Rezultati in diskusija

Definicije mentorstva lahko nekoliko razlikujejo, vendar imajo skupno značilnost, da gre za proces, v katerem mentor in mentoriranec vzpostavita delovni odnos, ki lahko pomembno vpliva na dosego zastavljenih ciljev v predvidenem času (Kostelec in Markič (2024) in Gaeta et al. (2024). Mentorstvo ni le praksa v akademskem

okolju, temveč se pogosto uporablja tudi za usposabljanje novih zaposlenih ali za različne prekvalifikacije (Bakhtiar et al., 2022).

Osnovna človeška sposobnost je, da se sporazumevamo, zato je ključno začeti pri komunikaciji. Tako v teoriji kot v praksi lahko zasledimo, da mora učinkovita komunikacija temeljiti na medsebojnem spoštovanju in priznavanju kompetenc posameznika. Mentorji so bogat vir znanja, zato je ključno, da spoštujemo njihova navodila in napotke (Khatun et al., 2022).

Pogosto se pojavi vprašanje o ustreznosti mentorstva, saj je težko natančno ločiti med mentorjevim strokovnim znanjem, področjem proučevanja in kariernimi cilji mentoriranca. Spodbudna komunikacija lahko pomembno vpliva na ohranjanje stikov, pravočasno reševanje težav in povečanje zavzetosti mentorja ter mentoriranca pri delu (Lach et al., 2025).

S pojavom Covid-19 se je velika večina mentorskih programov preselila na splet, kar je postalo pomembna komponentna, ki jo je treba vključiti v model učinkovite komunikacije v akademskem okolju (Boštjančič in Lep (2022) in Williams et al. (2012)). Z napredkom tehnologije se razvijajo tudi nove mreže in kanali, ki so lahko kljub številnim oviram, povezanim s pristranskostjo, uspešna alternativa tradicionalnim oblikam mentoriranja.

Ker sta mentor in mentoriranec v strokovnem odnosu, mentor ne sme pričakovati nobenega podkupovanja, saj to lahko vključuje kazenske elemente. Vendar je pojem opolnomočenja in nesebičnega ravnanja »pomagati nekomu brez pričakovanja dodatne koristi« še posebej pomemben (Appiah et al., 2025).

Veliko težav lahko hitro rešimo, če imamo zaupanja v dano avtoriteto, v tem primeru mentorja. Glede na mentorjeve kompetence, praktična in teoretična znanja ter druge dejavnike lahko jasno ločimo med laičnim in profesionalnim pristopom k obravnavani problematiki. Mentoriranci so raziskovalci, ki potrebujejo vodenje, zato je kompatibilnost ključni dejavnik, ki lahko gradi pot do zaupanja (Maloch et al., 2025).

Raziskave potrjujejo, da vrstniško mentorstvo ne vodi le do opolnomočenja mentorirancev, temveč ima tudi širše pozitivne učinke, kot so izboljšanje komunikacijskih kompetenc, večja samozavest ter krepitev zaznanega občutka podpore in povezanosti z akademsko skupnostjo (Oliver et al., 2022). Mentorja lahko obravnavamo tudi kot vzornika, ki nosi vlogo osebe nekoga, ki daje pohvale in kritike (Clark, 2015).

**Tabela 1: Ovire v mentorskem odnosu**

Zaznane ovire pri teoretičnem pregledu literature	Podskupine
Komunikacija (Elce, 2021).	<ul style="list-style-type: none"> <li>– Neuskklajenost komunikacijskih poti</li> <li>– Raznolikost kulturnih paradig</li> <li>– Pomanjkanje kulturne in družbene občutljivosti</li> </ul>
Ustreznost mentorstva (Lach et al., 2025).	<ul style="list-style-type: none"> <li>– Neuskklajeni časovni okvirji zaradi osebnih prioritet</li> <li>– Visoka stopnja obremenjenosti mentorja</li> <li>– Omejeno poznavanje raziskovalne tematike</li> </ul>
Tehnologija (Boštjančič in Lep (2022) in Williams et al. (2012).	<ul style="list-style-type: none"> <li>– Nezagodna tehnična podpora</li> <li>– Težave pri interpretaciji sporočil sogovornika</li> <li>– Preobremenitev e-naslova</li> </ul>
Zaupanje (Rupar et al., 2024).	<ul style="list-style-type: none"> <li>– Predhodno neuspešno mentorsko sodelovanje</li> <li>– Omejena transparentnost v mentorskem odnosu</li> <li>– Preveč strukturiran mentorski odnos</li> </ul>
Avtoriteta (Maloch et al., 2025).	<ul style="list-style-type: none"> <li>– Dvom o lastni presoji</li> <li>– Neenakost v statusu znotraj mentorskega odnosa</li> <li>– Omejena svoboda pri raziskovanju</li> </ul>

Na podlagi pregledanih člankov ugotavljamo, da so največje ovire, s katerimi se soočajo mentorji in mentoriranci v mentorskem odnosu : komunikacija, ustreznost mentorstva, tehnologija, zaupanje in avtoriteta. Ovire so številne, prav tako pa lahko zgoraj navedene ovire razdelimo na podskupine, ki jih navajamo v Tabeli 1. Tovrstne podskupine bi omogočile boljšo opredelitev obstoječih ovir in posledično povečale zavedanje o širši obravnavi problematike, ki jo obravnavamo bolj splošno.

Čprav sta prvini pozitivnega modeliranja (Borod, 2000) in opolnomočenja (Evans et al., 2024), ključni za izboljšanje mentorskega odnosa, v praksi še vedno primanjkuje poglobljenih raziskav na obravnavano tematiko v akademskem okolju. Mentor, kot glavni vir znanja nudi mentorirancu podporo, ki predstavlja dobro podlago za postavljanje jasnih in definiranih ciljev. Pozitivno modeliranje omogoča mentorirancu, da razume situacijo, ki od njega zahteva soočanje z različnimi ovirami (Ageitost et al., 2023).

Mentorji imajo tudi vlogo svetovalcev v primeru težav, saj s svojim dolgoletnim znanjem znajo predvideti in razrešiti določene problematike (Cencič, 2020). Pri pozitivnem modeliranju mentor ni le oseba, ki poučuje temveč tudi vodi in usmerja mentoriranca skozi sam proces dela (Borod, 2000). V akademskem okolju je mentorstvo najpogosteje prisotno pri pisanju zaključnih del poleg tega pa tudi pri različnih sodelovanjih v okviru znanstveno-raziskovalna dela (Krmac, 2022).

Opolnomočenje temelji na krepitvi dejavnikov, ki mentoriranca na koncu osamosvojijo in mu dodelijo določeno odgovornost (Evans et al., 2024). Mentorji morajo v določenem obdobju raziskovanja mentorirancu omogočiti večjo avtonomijo, saj jim to omogoča razvijanje kreativnosti in inovativnosti, kar lahko pozitivno vpliva na končni izdelek.

**Tabela 2: Ukrepi pozitivnega modeliranja in opolnomočenja v akademskem mentorstvu**

Zaznane ovire pri teoretičnem pregledu	Ukrepi skozi pozitivno modeliranje	Ukrepi skozi opolnomočenje
Komunikacija (Elce, 2021).	<ul style="list-style-type: none"> <li>– Beleženje ključnih točk pogovorov</li> <li>– Prilagajanje komunikacije glede na sogovornika</li> <li>– Praktična uporaba teoretičnih spoznanj</li> </ul>	<ul style="list-style-type: none"> <li>– Pomoč pri neodvisnem izražanju idej</li> <li>– Spodbujanje k odprti komunikaciji</li> <li>– Usmerjanje k natančnemu izražanju</li> </ul>
Ustreznost mentorstva (Lach et al., 2025).	<ul style="list-style-type: none"> <li>– Usklajevanje zahtev glede na tematiko</li> <li>– Razvoj prilagojenih načinov vodenja</li> <li>– Vključevanje mentoriranca v skupne raziskovalne projekte</li> </ul>	<ul style="list-style-type: none"> <li>– Pomoč pri razvijanju metod za ohranjanje samostojnosti</li> <li>– Spodbujanje k oblikovanju unikatnega raziskovalnega sloga</li> </ul>

Zaznane ovire pri teoretičnem pregledu	Ukrepi skozi pozitivno modeliranje	Ukrepi skozi opolnomočenje
		<ul style="list-style-type: none"> <li>– Usmerjanje mentoriranja pri iskanju gradiva ali mreženja</li> </ul>
Tehnologija (Boštjančič in Lep (2022) in Williams et al. (2012).	<ul style="list-style-type: none"> <li>– Uporaba različnih komunikacijskih kanalov</li> <li>– Implementacija sistema za spremljanje napredka</li> <li>– Uporaba orodij za shranjevanje podatkov ali raziskovalnega gradiva</li> </ul>	<ul style="list-style-type: none"> <li>– Implementacija novih tehnologij za pomoč pri raziskovanju</li> <li>– Podpora pri reševanju težav nastalih zaradi tehnologije</li> <li>– Učenje o IKT rešitvah, ki lahko olajšajo delo</li> </ul>
Zaupanje (Rupar et al., 2024).	<ul style="list-style-type: none"> <li>– Spodbujanje k zaupanju vrednemu odnosu</li> <li>– Pomoč pri krepitvi zaupanja v sposobnosti mentoriranja</li> <li>– Učenje mentoriranja o jasnem izražanju pomislekov</li> </ul>	<ul style="list-style-type: none"> <li>– Avtonomno usmerjanje poteka dela</li> <li>– Samostojno odločanje</li> <li>– Proste roke pri prevzemanju vodilne vloge v zrelem obdobju raziskovanja</li> </ul>
Avtoriteta (Maloch et al., 2025).	<ul style="list-style-type: none"> <li>– Razvijanje komunikacije v kateri se spoštujejo vloge</li> <li>– Podpiranje izvirnosti pri raziskovanju</li> <li>– Spodbujanje k izvajanju lastne avtoritete pri delu</li> </ul>	<ul style="list-style-type: none"> <li>– Urjenje k prevzemanju odgovornosti za opravljeno individualno delo</li> <li>– Spodbujanje mentoriranja, da zaupa svojim raziskovalnim odločitvam</li> <li>– Krepitev motivacije za samostojno delovanje</li> </ul>

Obe komponenti, pozitivno modeliranje in opolnomočenje, tvorita izvrstno celoto, ki pripomore k napredku v mentorskem odnosu v akademskem okolju. Na podlagi pridobljenega znanja, ki izvira iz elektronskih in fizičnih virov, predlagamo primer ukrepov za implementacijo v prakso, ki je prikazan v Tabeli 2.

## 5 Zaključki

Sodobne paradigme mentorstva so podvržene številnim oviram, kar nakazuje potrebo po temeljiti znanstvenih analizah. Prenos znanja preko mentorstva se izvaja tako v akademskem okolju (Case et al., 2024) kot tudi v delovnem svetu (Bakhtiar et al., 2022). Pozitivno modeliranje in opolnomočenje prinašata številne prednosti, zato je njihova implementacija v prakso značajnega pomena.

Za nadaljnje raziskovanje priporočamo pregled večjega števila člankov, na kar smo bili omejeni zaradi časovnih okvirjev. Na podlagi prepoznanih ovir priporočamo oblikovanje podskupin (Tabela 4.1), ki pomembno vplivajo na njihov pojav ali pa so že opazne v praksi. Nato je potrebno izvesti podrobno kvantitativno analizo s pomočjo vprašalnikov, ki jih je potrebno razdeliti med mentorje in mentorirance.

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# SIDE EFFECTS OF USING VIRTUAL REALITY TOOLS AND THEIR MEASUREMENT

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Virtual reality (VR) is becoming increasingly important in education, offering immersive learning experiences. However, head-mounted displays (HMDs) often cause side effects such as cybersickness and discomfort, which can affect learning outcomes. The study of side effects using validated tools is becoming increasingly important as it can influence the perceived quality of education. An overview of virtual reality and tools for measuring side effects can be a starting point for future research and suggests that the prevalence of VR sickness is still problematic and little is known about side effects, also making these issues a primary aim of future studies and considering not only students but also professionals involved in Virtual Reality Education.

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## 1 Introduction

In recent years, Virtual Reality (VR) has played an increasingly important role in education, providing opportunities for learning through simulations that safely and effectively replicate real-world environments and situations. VR allows students and professionals to practice in highly immersive virtual environments; however, the use of immersive VR devices, such as head-mounted displays (HMDs), during or after VR immersion can cause certain side effects known as cybersickness (e.g., nausea, headache, dizziness, disorientation) or discomfort (e.g., thermal discomfort, weight discomfort), which can negatively affect the user experience. This review will provide a starting point for future research into virtual reality and adverse effects.

## 2 Virtual Reality in Education

VR is an advanced technology that allows users to immerse themselves in digitally simulated environments and interact in a multi-sensory way through devices such as headsets, hand controllers and sensors to simulate realistic experiences (Elmqaddem, 2019). In fully immersive VR, users are completely immersed in a virtual environment, creating a highly realistic and interactive experience. This technology relies on VR headsets, glasses, hand controllers and various sensor devices to closely simulate real-life situations. Immersive VR, as described by Freina and Ott (2015), aligns with the concept of HMD and motion tracking to achieve a sense of complete 'presence' in an artificial environment. This technology allows the user to engage and practice with realistic scenes and objects, creating a multi-sensory dynamic experience that evokes the feeling of being in a real environment, all within a virtual environment (Simón-Vicente et al., 2024).

VR for the consumer market is currently mostly used for gaming and entertainment (viewing 360 videos and live events), but the scope is very broad and suitable for use in industrial and business environments (Somrak et al., 2019). In the following years, numerous competitors entered the market and launched their own HMDs, making this innovative technology accessible to a wider audience, including for research and educational purposes (Jensen and Konradsen, 2018).

Their immersive nature is not always an advantage, and in some cases the immersive experience can even hinder learning, as it can distract from the task at hand (Jensen and Konradsen, 2018).

In educational contexts, the effectiveness of VR use has been extensively investigated, with several reviews supporting its use. However, these reviews have tended to focus either on the causes of cybersickness in different contexts (Chang, Kim, & Yoo, 2020; Saredakis et al., 2020; Caserman et al., 2021) or on the acceptability and feasibility of VR (Bazavan et al., 2021; Renganayagalu et al., 2021; Tang et al., 2022; Bicalho et al., 2023; Simón-Vicente et al., 2024). Although numerous studies reported cases of cybersickness and discomfort (Renganayagalu et al., 2021), these issues were often addressed as secondary outcomes. While HMDs have shown promise in many settings, they have been documented to produce worse cybersickness outcomes than traditional desktop displays (Yildirim, 2019). These symptoms can occur during or after HMD use and can impair user performance and force sensitive users to terminate VR use prematurely, even in controlled experimental settings (Mittelstaedt et al., 2018).

### **3 Side Effects Of Virtual Reality**

Side effects of using virtual environments have been referred to by many terms, including simulator sickness (Kennedy et al., 1993), motion sickness (Kennedy et al., 2010), cybersickness (LaViola, 2000), and VR sickness (Kim et al., 2018).

The term simulator sickness originated from the early use of flight simulators in the military (Kennedy et al., 1993) and is still used in research using modern HMD technology (Tyrrell et al., 2018).

The term motion sickness refers to a range of symptoms experienced in moving environments, such as air, land or sea travel, and is not specific to HMDs. Symptoms can vary significantly depending on the context; for example, nausea tends to be more intense in seasickness than in simulator use (Kennedy et al., 2010). In addition, the symptomatology associated with sickness differs between technologies. Research has shown that HMDs often produce severe symptoms related to nausea, dizziness and blurred vision (Kennedy et al., 2003).

The term cybersickness was coined to describe adverse effects resulting from the use of virtual environments (McCauley and Sharkey, 1992); it encompasses a range of symptoms similar to motion sickness, particularly associated with the use of VR technology, such as nausea, dizziness, disorientation and eye strain (LaViola, 2000). Currently, cybersickness is not formally recognised as a health condition (Keshavarz et al., 2019). This problem is compounded by a lack of understanding of the underlying causes of cybersickness and the existence of competing theories to explain its occurrence (Chang, Kim and Yoo, 2020). It is likely to be caused by a mismatch between the physical properties of the screen ('accommodation') and the focal point of the virtual environment that the user is observing ('vergence'). This mismatch between the optical information received through the HMD and other sensory inputs, such as spatial perception, can lead to symptoms such as nausea, headaches and general discomfort (Davis et al., 2014; Rupp, 2024). Several potential solutions to the 'vergence-accommodation conflict' are being explored, which may have implications for the wider use of VR in medical education (Kramida, 2016; Vovk et al., 2018). In the meantime, technical advances such as improved HMD resolution and reduced latency are being implemented to mitigate these symptoms.

Discomfort refers to a range of physical and psychological symptoms that users may experience when using VR headsets (Chen, Wang and Xu, 2021). Ergonomic problems such as excessive weight, uneven distribution of gravity, localised pressure, restricted head mobility and inadequate thermal regulation can result from the weight, fit and prolonged wear of HMDs, especially if the device is poorly adjusted. The weight of the device can influence the duration and impact of user discomfort. In particular, when experiencing VR with an HMD, wearing a heavy object on the head for long periods of time may cause discomfort to the user, regardless of the VR content (Chang, Kim and Yoo, 2020). Comfort therefore relates to the personal experience of wearing the headset (Rupp, 2024). These ergonomic challenges not only negatively impact the physical and mental well-being of users, but also limit the potential applications of VR technology in various fields (Chen, Wang and Xu, 2021). Advances in graphics, sensors and battery technology can increase the weight and thermal profile of the headset, so VR headset designers must balance immersion and comfort to optimise the user experience (Rupp, 2024).

### **3.1 Tools for the evaluation of cybersickness and discomfort**

Measuring VR sickness is a fundamental part of determining prevalence and symptomatology in virtual environments. There are objective and subjective methods of assessing the severity of simulator sickness. The Simulator Sickness Questionnaire (SSQ) (Kennedy et al., 1993) is the most commonly used validated sickness scale (Rebenitsch and Owen, 2016), but dedicated Likert scales asking study participants to rate individual symptoms are also used (Keshavarz and Hecht, 2011). Very few studies report the use of objective physiological measures (e.g. heart rate, skin conductance, electroencephalograms, eye blink rate, and electrogastrogram) that do not rely on individual self-report data (Kim et al., 2005).

#### **3.1.1 Simulator Sickness Questionnaire (SSQ)**

The SSQ was developed by Kennedy, Lane, Berbaum and Lilienthal in 1993. The scale contains 16 items grouped into three non-exclusive categories that assess disorientation (difficulty concentrating, nausea, head fullness, blurred vision, dizziness with eyes open, dizziness with eyes closed, dizziness), nausea (general discomfort, sweating, nausea, vomiting), and oculomotor disturbance (difficulty concentrating, fatigue, abdominal awareness, burping), nausea, difficulty concentrating, abdominal awareness, burping) and oculomotor disturbance (general discomfort, fatigue, headache, eye pain, difficulty focusing, difficulty concentrating, blurred vision) on a 4-point Likert scale (0 none, 1 mild, 2 moderate, 3 severe). The score for each category is defined as the sum of its symptom scores. These subscales are weighted differently, multiplied by a constant scaling factor and summed to give the SSQ total score. The SSQ total score ranges from 0 to 235.62 (Simón-Vicente et al., 2024); total scores are obtained using a conversion formula in which the highest scores indicate the most severe disorders and, for each domain, a score between 5 and 10 is considered as minimal symptoms, between 10 and 15 significant symptoms, between 15 and 20 significant symptoms and more than 20 severe symptoms. A total score above 20 was considered 'poor' (Stanney et al., 1997). The questionnaire has good internal consistency (Cronbach's alpha of 0.87). The scale was originally developed to assess simulator sickness in flight simulators (Kennedy et al., 1993); however, it has also been used in VR, although there is ongoing debate about the relationship between cybersickness and simulator sickness (Stanney et al., 1997; Bos, Diels, and Souman, 2022).

### **3.1.2 Simulator Sickness Questionnaire - French (SSQ-F)**

The French adaptation of the SSQ was validated by Bouchard et al (2007), who criticised the SSQ for its complicated factor structure and for having been developed on a dataset of military personnel; the factors were revised on the basis of a population of adults from the general public and different HMDs were evaluated. The SSQ-F contains 16 items grouped into two categories: nausea (general discomfort, increased salivation, sweating, nausea, headache, dizziness with eyes open, dizziness with eyes closed, vertigo, abdominal awareness, burping) and oculomotor (fatigue, headache, eye strain, difficulty focusing, difficulty concentrating, head fullness, blurred vision), rated on a 4-point Likert scale from 0 (not at all) to 3 (very much). Bouchard et al (2007) reported their results as means for the nausea (from 0 to 27) and oculomotor (from 0 to 21) factors and the total score as the sum of these means (from 0 to 48).

### **3.1.3 Virtual Reality Sickness Questionnaire (VRSQ)**

The VRSQ is an extended iteration of the SSQ. Kim et al. (2018) used nine symptoms from the original SSQ to represent oculomotor and disorientation constructs. Its items were derived from the SSQ and tailored to assess symptoms experienced in a virtual reality environment (Josupeit, 2023). The scale consists of nine items divided into two categories: disorientation (including headache, feeling full, blurred vision, dizziness with eyes closed and vertigo) and oculomotor (including general discomfort, fatigue, headache, eye strain and difficulty focusing). Responses are measured on a 4-point Likert scale (0 none, 1 mild, 2 moderate, 3 very severe). The total VRSQ score is calculated by averaging the scores from the oculomotor and disorientation categories, but the scale does not provide a specific total score.

Sevinc & Ilker (2020) found in their study that the VRSQ is more specifically designed to measure cybersickness and has better psychometric properties for assessing HMD VR applications when compared to the SSQ and SSQ-F, which are instruments designed to measure simulator sickness. They provided evidence for the validity of the VRSQ as a measure of cybersickness, whereas the SSQ and SSQ-F could not be psychometrically validated. Their results provided evidence for the reliability of all measures. The VRSQ was highly sensitive to differences between the



application aspects of the VEs evaluated, although they investigated fewer symptoms than the simulator sickness scales.

### **3.1.4 Motion Sickness Assessment Questionnaire (MSAQ)**

The MSAQ is a validated instrument for the assessment of motion sickness; it was developed by Gianaros et al. (2001) and is used to assess motion sickness as a multidimensional construct. It was developed to measure motion sickness in general, without a specific focus on VR and simulators. These distinct dimensions may respond differently to different types of real or apparent motion. Furthermore, individuals may experience different degrees of activation along each of these dimensions in the same type of motion environment. The MSAQ scale contains 16 items grouped into four categories: gastrointestinal (nausea, vomiting), central (lightheadedness, dizziness, vertigo), peripheral (sweating, feeling warm) and somatosensory (irritability, drowsiness, fatigue) on a 9-point Likert scale from 0 (none) to 8 (severe).

### **3.1.5 Fast Motion Sickness Scale (FMS)**

The FMS (Keshavarz and Hecht, 2011) is considered to be a brief assessment method to assess motion sickness as a unidimensional construct. FMS uses a rating scale from 0 (no sickness at all) to 20 (overt sickness) focusing on nausea, general discomfort, and stomach problems, which can be used to quickly capture sickness scores during exposure. Results show that scores obtained using this measure are highly correlated with SSQ dimensions and total severity scores (Keshavarz and Hecht, 2011, 2014). Several studies have also used similar single-item assessment methods to measure simulator sickness (e.g., McCauley et al., 1990), but these methods have not been psychometrically evaluated.

## **4 Implications for future research**

Despite the improvements in HMD technology, Rebenitsch and Owen (2016) suggested that the prevalence of VR sickness is still problematic, and little is known about the side effects. The varying quality and lack of robustness in the existing research underscore the need for further, more rigorous investigations to explore the most promising applications of HMDs in educational environments. In practice,

the use of full-immersive virtual reality holds great potential across all educational contexts. However, research underscores the need for further investigation into cybersickness and discomfort, treating these issues as primary objectives for future studies and considering not only students but also professionals. It is crucial to account for the technological advancements of head-mounted displays (HMDs) and the specific purposes for which they are employed. Furthermore, a thorough evaluation of adverse effects using tools tailored to educational settings could yield more accurate and comparable results. The increased use of virtual reality and HMDs may stimulate research to investigate more common side effects and to explore the correlation between side effects and time of use the HMDs and the characteristics of participants to find the most suitable way to implement the virtual reality in educational context and training contexts. Also, bio signals response (e.g. galvanic skin) will be investigated to predict and detect side effects in real-time. In this field locomotion techniques will be analyse to explore the relation between movement and side effects.

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# GREEN EDUCATION IN HEALTHCARE: WHAT DOES IT MEAN? FINDINGS FROM A LITERATURE REVIEW

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Sustainability is an emerging issue in many contexts, including education: the targets of the World Health Organization's Agenda 2030 have pushed for sustainable development of health systems, including training and digitalization. The aim of the study was to identify green and sustainable strategies in different health education settings, in particular in the digital field, through a literature review. Sustainable healthcare was defined as the evaluation of resources, recycling strategies and taking care of nature, while green education focuses on the skills needed to carry out consciously sustainable actions. Some identified digital strategies were simulations, online lectures and tests. There is an urgent need to address the effects of the climate crisis and promote a sustainable health model starting from professionals who have a crucial role.

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## 1 Introduction

Healthcare professionals are pivotal in each country and setting, having several contacts with citizens and providing health promotion strategies. Awareness and skills about sustainability and green are crucial in this field, not only because of the potential benefit to healthcare facilities, but also because patients may achieve better outcomes.

Several international position statements, such as United Nations Organization's (UN) 2030 Agenda in its 17 goals, have recommended to include green education in the undergraduate and postgraduate programs, including recycling and reuse strategies, knowledge about the impact on health and how to manage it (United Nations General Assembly, 2015). As a global emergency in the last decades, there is an urgent need to prepare healthcare professionals to deal with the concepts of sustainability and green health care, and to prepare educators to shape appropriate programs by embodying these concepts.

Sustainability affects many interconnected fields such as environmental, economic, social, ethics, normative; the UN Commission, though, defined it as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development [WCED], 1987). Green education is also applicable to different sectors and stages of education. The Council of the European Union in 2022 adopted a Recommendation on learning for the green transition and sustainable development: green education is about learning and teaching for personal, societal and environmental well-being starting from now to the future, where all subjects and disciplines contribute (Council of the European Union, 2022). This achievement requires interventions as hands-on and action-based learning fostering knowledge, practical skills, critical thinking, and empathy.

### 1.1 Sustainability in healthcare systems and education

Healthcare systems worldwide are under pressure to adapt to rapidly changing conditions, such as overpopulation, increasing chronic diseases and diseases linked to climate change and pollution, new technologies, staff shortages and unequal

distribution of health resources, patients' role in the care process (Directorate-General for Health and Food Safety, 2021).

Identifying the skills and competencies that healthcare professionals need to recognize these concerns in the long term includes an effective approach to new technologies and digital transformation, which make healthcare systems more accessible and functional through the redefinition of the relationship between service providers and citizens to create a system that provides high-quality care. A standardized protocol for health professionals training has not yet been defined, nor are there shared digital infrastructures or outcome-based guidelines that encourage the effective use of digital and technological tools. Although, they already play an important role in care continuity (for example telemedicine) requiring professionals to be adequately prepared to use them. Investing in digitalization (from electronic health records to artificial intelligence applications) results in better quality of care and should be a guaranteed process without exclusions: robotic surgery, for example, is already performed worldwide and not only reduces the variation in outcomes, but also limits blood losses, decrementing post-surgery pain and shortening the hospitalization stays (Directorate-General for Health and Food Safety, 2021).

Special attention should be paid to increasing patients' confidence in these new tools, providing sufficient and understandable information for independent reflection and informed decision making: the European Society of Radiology believes that quality indicators related to continuing education and the university syllabuses need to include knowledge about artificial intelligence and skills in digital communication (Directorate-General for Health and Food Safety, 2021). A teaching-mediated digitalization strategy is important in developing curricula for medical and health professions students, especially because at present healthcare systems' reorganization is based on primary care and the family and community nurse, who needs essential knowledge, skills and attitudes for practice transcending the limits of the professional figure, in particular: adaptability to different settings and models of care; person-centered communication and empathy; digital skills; basic understanding and analysis of clinical data health; managerial and administrative skills; and ability to work in multidisciplinary teams (Directorate-General for Health and Food Safety, 2021).

The aim of the study was to summarize evidence regarding the sustainable and green education strategies documented in healthcare education settings, in particular the ones based on digital development.

## **2 Methods**

A literature review was conducted, which included qualitative and quantitative primary studies concerning students in the first, second and third degree of health education and describing strategies to implement and promote sustainable and green education and its impact on patients. No limits on publication year or language were set.

The research was conducted in 2024, in three databases: PubMed, Scopus and Cumulative Index to Nursing and Allied Health Literature. The keywords have been used in combination with the boolean operators.

The synthesis of the extracted data was narrative and summarized the definitions of sustainability and green education reported in the selected studies, and the digital strategies described to implement green education and green learning.

The studies selection was conducted according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses guidelines by two independent reviewers (MC and RM) and a supervisor (SC) for conflict resolution.

From 9,820 results, all the duplicates were removed, and the remaining documents were screened. Of 52 eligible studies, 20 were included in the review. The software supporting this phase was Rayyan.

## **3 Results**

The included studies were published in English [n=18] and Spanish [n=2] between 2016 and 2024; they were mostly qualitative [n=6] and reviews [n=6] in the design. Cross-sectional [n=4] and mixed methods [n=4] studies were also represented.

The authors' affiliations were mainly linked to universities, hospitals and research institutes.



Based on the aim of the studies included, the following areas for the synthesis of results were identified:

- Definitions of sustainability and green education in the studies.
- Digital strategies identified and implemented to integrate sustainability and green education in health curricula.

### 3.1 Definitions of sustainability and green education in healthcare

Most of the included studies [n=11/20, 55%] did not report any definition of sustainability nor green education, some [n=9/20, 45%] reported a definition: [n=6/10, 60%] only defined green education, [n=2/10, 20%] only defined sustainability and [n=1/10, 10%] reported both definitions (see Table 1).

**Table 1: Summary of definitions of sustainability and green education**

Definition	
Green Education	Skills and abilities for sustainable actions ( <i>Chinene et al., 2024; Mohamed et al., 2024</i> ) Pedagogical approaches to understand the ecosystem - people's health link ( <i>Teberani et al., 2023</i> ) Green healthcare: anticipate and manage health effects of climate change and share preventive interventions ( <i>Cogen et al., 2024</i> ) Sustainable healthcare education: approaches to teach knowledge and skills based on the ecosystem – health link ( <i>Brand et al., 2021</i> ); education on the impact of climate change on health and of the healthcare industry on ecosystem ( <i>Bray et al., 2023; Gupta et al., 2022 both citing Teberani, 2017</i> )
Sustainability in education	Environmental care ( <i>Chinene et al., 2024</i> ) Resource use and anti-waste strategies in healthcare ( <i>Marsden et al., 2021</i> ) Holistic knowledge to maintain health for present and future generations ( <i>Aronsson et al., 2023</i> )

The Sustainable Development Unit of the British National Health System defines sustainable health as "the work of the entire health system and partners to provide health care that delivers financial, social and environmental performance outcomes": this involves investing in sustainable care models, promoting health and prevention, and adopting corporate social responsibility (Marsden et al., 2021).

The definitions of sustainability and green education are still heterogeneous and focused on different aspects, which represents a barrier to keeping up with an extremely fast digital and technological evolution. The need is therefore to identify multi-dimensional sustainability indicators that assess the sustainability of hospitals, including strategic, economic, social, environmental and technical aspects, combining resource optimization with environmental impact monitoring and mitigation (Galvão et al., 2023). All these aspects need to be transferred into the healthcare professionals' education.

### 3.2 Digital strategies to integrate sustainability and green education in health curricula

The identified digital strategies have been collocated into 4 macro areas, covering respectively: strategies applied in the academic or institutional field; strategies concerning teaching and learning methods; clinical strategies and other, where strategies not belonging to the other categories have been included (see Table 2).

**Table 2: Digital strategies identified and implemented to integrate sustainability and green education in health curricula**

Macro area	Strategies
Academic / institutional	Networking/multidisciplinary Enhancing the training/leadership of educators Lectures from environmental experts Fostering international partnerships
Teaching / learning methods	Projects that provide extra credits Case studies Simulations Innovative teaching/learning methods Tests on learned content Peer education
Training / clinical practice	Clinical skills/ skills training Sustainable evidence-based clinical practice
Other	Taking action to mitigate climate change Green campuses

The included literature analyzed the relevance of sustainability and green education in health curricula, identifying the most suitable strategies for their inclusion in health education through a structured educational action to train health professionals to contribute to a more sustainable health system.

The main challenge is to overcome existing barriers and develop effective teaching methods. For example, an interdisciplinary and collaborative approach is essential to achieve this goal, possibly involving environmental experts in lectures (Chinene et al., 2024; Véliz-Rojas et al., 2023). Moreover, comprehensive training is needed for educators, who often rely on social media for information on sustainability (Mohamed et al., 2024). Tools such as archives of updated content (Cogen et al., 2024) and continuing education projects (Teherani et al., 2023) may support them. The introduction of sustainability into existing programs through case studies and research projects may also be relevant (Brennan & Madden, 2023). Finally, an online curriculum and a partnership with different faculties and universities may facilitate interprofessional education (Véliz-Rojas et al., 2023). It is therefore relevant for the integration of sustainability principles, to create greener learning environments by adopting eco-friendly practices in campuses and classrooms (Álvarez-Nieto et al., 2017).

Despite the importance of innovative healthcare education, there does not seem to be a clear consensus on how to best integrate sustainable healthcare into health professions curricula (Gupta et al., 2022). This underlines the need to develop shared guidelines and methodologies to teach sustainability.

Despite the rapid technological development, which is increasingly attentive to green practices, there does not seem to be emerging strategies specifically focused on the digital and technological field. This is a gap that should be developed more in depth in the future.

## **4 Conclusions**

Sustainable health issues are complex: understanding the link between environment and health and the impact of health systems on climate issues is essential and make digital transformation a necessity.

There are many options to include sustainability in health care workers' education; however, none of them has been identified as more used or effective, as they often result from poor adoption and integration of digital tools by institutional organizations.

Healthcare students show a growing interest in sustainability and want to acquire skills to promote sustainable health practices; however, they face several barriers, as for example overloaded curricula lacking in multidisciplinary contents and inadequate verification of the learned issues.

However, there are other opportunities to attain sustainability by developing new technologies and sustainable healthcare models, which are still lacking or not adequately applied.

In conclusion, this study highlights the urgent need for collective action to promote a sustainable health model through innovation: health professionals play a crucial role, and their training is essential to make them change agents.

#### **4.1 Study limits and implications for research and education**

This review has some limitations. First, only three databases were screened, so it may have limited the research. Second, the studies included were not evaluated qualitatively, thus it could have led to an incorrect evaluation of the included results. Furthermore, comparisons were not available within health systems where sustainability has already been integrated and health systems where this transition has not yet taken place.

To implement clinical practice results, specific tools for the health field need to be developed and integrated into accreditation standards assessing the quality of care to analyze their impact on both health system and patients' health.

Similarly, research and innovation should be promoted to explore new technologies for more sustainable health: this would provide an overview of existing programs through which identify and develop good sustainable practices.

In the education field, a standard curriculum on sustainability would identify the most effective teaching and learning strategies through the regulated assessment of skills and attitudes acquired by health students. Similarly, homogeneous training for educators and clinical supervisors would provide tools to integrate sustainability into educational practice.

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# UPORABA SPLETNE UČILNICE IN UMETNE INTELIGENCE ZA NAMENE IZOBRAŽEVANJA ZDRAVSTVENIH DISPEČERJEV

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Uporaba spletnih učilnic in umetne inteligence (UI) za izobraževanje zdravstvenih dispečerjev predstavlja pomembno inovacijo v izobraževalnem procesu. Vključevanje UI v spletne učilnice omogoča personalizacijo učnih poti, prilagoditev vsebine potrebam posameznikov ter analizo uspešnosti, kar prispeva k boljši usposobljenosti zdravstvenih dispečerjev. V članku so predstavljene možnosti spletnih učilnic v procesu usposabljanja zdravstvenih dispečerjev. Prednosti, kot sta prilagodljivost in stroškovna učinkovitost, so poudarjene poleg izzivov kot so tehnološke ovire in omejena praktična uporaba. V članku so prav tako predstavljene preverjene metode za uspešno izvajanje učnega procesa, vključno z usklajevanjem učnega načrta, interaktivnim učnim načrtom in stalno podporo uporabnikom.

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# USING AN ONLINE CLASSROOM AND ARTIFICIAL INTELLIGENCE FOR THE EDUCATION OF MEDICAL DISPATCHERS

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The use of online classrooms and artificial intelligence (AI) for the education of medical dispatchers represents a major innovation in the educational process. The integration of AI in online classrooms offers the possibility to personalise learning pathways, tailor content to the needs of individuals and analyse performance, which contributes to better training of medical dispatchers. The article presents the possibilities of online classrooms in the process of training medical dispatchers. Advantages such as flexibility and cost-effectiveness are highlighted alongside challenges such as technological barriers and limited practical application. The article also presents proven methods for successful implementation of the learning process, including curriculum coordination, interactive curriculum, and ongoing user support.





## **1 Uvod**

Zdravstveni dispečerji so skriti junaki sistema za odzivanje na nujne primere, ki klicateljem v primerih zdravstveno ogrožajočih stanj nudijo pomembna navodila glede pred bolnišnične oskrbe. Njihova vloga je bistvena pri zagotavljanju pravočasne razporeditve virov in omogočanju učinkovite oskrbe pacientov, preden reševalci prispejo na kraj dogodka.

Tradicionalno usposabljanje zdravstvenih dispečerjev se pogosto opira na metode, ki temeljijo na klasičnih učilnicah, kar je lahko zamudno, drago in geografsko omejujoče tako za udeležence izobraževanj kot za inštruktorje. Pojav platform spletnih učilnic predstavlja transformativno priložnost za revolucijo izobraževanja zdravstvenih dispečerjev, saj ponuja večjo prilagodljivost, dostopnost in stroškovno učinkovitost. Ta članek obravnava prednosti in izzive uporabe spletne učilnice za usposabljanje zdravstvenih dispečerjev. Članek temelji na nedavnih raziskavah in najboljših praksah za prikaz možnih poti do bolj inovativne in učinkovite paradigme usposabljanja.

## **2 Prednosti spletnega usposabljanja za zdravstvene dispečerje**

Poznamo več prednosti spletnega usposabljanja, mednje spadajo prilagodljivost in dostopnost, stroškovna učinkovitost, privlačne učne izkušnje ter povratne informacije in podpora v realnem času.

### **2.1 Prilagodljivost in dostopnost**

Spletne učne platforme opolnomočijo tečajnike, da dostopajo do gradiva tečaja in dokončanja modulov v svojem tempu po svoji želji ter se osvobodijo togih urnikov in geografskih omejitev. Asinhroni učni model je še posebej koristen za posameznike, ki usklajujejo zahtevne urnike doma in v službi ter tiste, ki živijo na oddaljenih območjih.

## 2.2 Stroškovna učinkovitost

Spletno usposabljanje bistveno zmanjša finančno breme, povezano s tradicionalnimi učilnicami. Odprava stroškov, povezanih s stroški prizorišča, potovanjem inštruktorjev, tiskanimi materiali in ponudbo prigrizkov in pijač lahko privede do znatnih prihrankov, ki jih je mogoče preusmeriti v druge ključne vidike usposabljanja in razvoja zdravstvenih dispečerjev.

## 2.3 Privlačne učne izkušnje

Spletne učilnice ponujajo široko paleto interaktivnih učnih orodij, ki povečujejo sodelovanje v učnem procesu in ohranjanje znanja. Simulacije, ki posnemajo scenarije pošiljanja v resničnem svetu, elementi igrifikacije, ki spodbujajo učenje, večpredstavnostne vsebine, kot so videoposnetki in podcasti ter sodelovalni projekti spodbujajo aktivno udeležbo kakor tudi globlje razumevanje.

Igrifikacijo (angl. gamification) lahko opredelimo kot uporabo elementov igralniške zasnove v ne-igralniških kontekstih, v tem primeru v izobraževanju. Kot taka želi razširiti interaktivni pristop teorije izobraževanja, ki spodbuja stalno motivacijo in vključenost (DiCesare et al., 2025).

## 2.4 Povratne informacije in podpora v realnem času

Sistemi za upravljanje spletnega učenja (angl. Learning Management System – LMS) pogosto vključujejo funkcije za zagotavljanje takojšnje povratne informacije o kvizih in nalogah, kar omogoča neprekinjen cikel učenja. Virtualni forumi za razprave in seje klepeta v živo omogočajo udeležencem, da se povežejo z inštruktorji in vrstniki za podporo, razjasnitev in izmenjavo znanja ter spodbujajo občutek skupnosti in sodelovanja.

## 3 Izzivi izvajanja spletnega usposabljanja za zdravstvene dispečerje

Med izzive izvajanja spletnega usposabljanja štejemo tehnološke ovire, omejeno praktično prakso in ohranjanje motivacije učencev.

### **3.1 Tehnološke ovire**

Dostop do zanesljive internetne povezave in ustreznih naprav lahko za nekatere posameznike predstavlja oviro. Premostitev digitalnega razkoraka je ključnega pomena za zagotovitev pravičnega dostopa do možnosti spletnega usposabljanja. Organizacije bi se morale bolj posvetiti razmisleku o zagotavljanju tehnične podpore, naprav za izposojajo ali alternativnih načinov učenja za odpravljanje teh razlik.

### **3.2 Omejena praktična praksa**

Čeprav simulacije ponujajo dragoceno izkušnjo, morda ne bodo v celoti posnemale zapletenosti in odtenkov scenarijev odpreme v resničnem svetu. Vključitev tehnologij navidezne resničnosti (angl. Virtual Reality – VR) ali razširjene resničnosti (angl. Augmented Reality – AR) bi lahko pomagala premostiti to vrzel z zagotavljanjem bolj poglobljenih in realističnih izkušenj usposabljanja.

### **3.3 Ohranjanje motivacije učencev**

Spletno učenje zahteva samodisciplino in motivacijo. Strategije, kot je vključevanje elementov igrifikacije, postavljanje jasnih učnih ciljev, zagotavljanje rednih povratnih informacij in spodbujanje občutka skupnosti lahko pomaga ohranjati sodelovanje in napredek učencev.

## **4 Najboljše prakse za uspešno spletno usposabljanje zdravstvenih dispečerjev**

Za spletno usposabljanje so potrebne najboljše prakse, katere pripomorejo k samemu doseganju uspešnosti spletnega usposabljanja.

### **4.1 Uskladitev učnega načrta**

Spletni učni načrt usposabljanja mora biti natančno usklajen s standardi in najboljšimi praksami za zdravstvenega dispečerja. Vključuje študije primerov iz resničnega sveta, vaje, ki temeljijo na scenarijih, in dejavnosti praktične uporabe, ki bodo povečale ustreznost in praktičnost učne izkušnje.

## 4.2 Interaktivno oblikovanje učenja

Spletni tečaji naj bodo oblikovani tako, da povečajo sodelovanje udeležencev z interaktivnimi elementi, kot so simulacije, dejavnosti igranja vlog, sodelovalni projekti in multimedijske vsebine. Spletni tečaji naj vzpodbujajo aktivno sodelovanje in izgradnjo znanja namesto pasivnega poslušanja informacij.

## 4.3 Nenehna podpora in povratne informacije

Za spletne učilnice je potrebno zagotoviti stalno podporo udeležencem izobraževani preko komunikacije po e-pošti, namenskih forumov ali drugih načinov prijav težav z delovanjem sistema, vpisom uporabnikov in podobnim. Ponuditi je potrebno konstruktivne povratne informacije o nalogah in ocenjevanju za olajšanje izboljšav in reševanje morebitnih učnih izzivov.

## 5 Možne nadgradnje spletnega usposabljanja zdravstvenih dispečerjev s pomočjo UI

Obstaja veliko možnosti za nadgradnjo spletnega usposabljanja ob pomoči UI. Med pomembnejše nadgradnje spletnega usposabljanja štejemo prilagojeno učenje in prilagodljivo vsebino, izboljšano simulacijo scenarijev in vadbo s scenariji z uporabo UI, povratne informacije in oceno, nenehno učenje in upravljanje znanja ter prilagojena priporočila za nadaljnje izobraževanje.

### 5.1 Prilagojeno učenje in prilagodljiva vsebina

Za prilagojeno učenje se uporabijo učni sistemi, ki jih poganja UI. Z uvedbo virtualnega pomočnika zagotovimo, da udeleženci dobijo odgovore na vprašanja, ki se jim zastavljajo v realnem času. Virtualni pomočnik nudi osebno usmerjanje glede na prednosti in slabosti udeležencev izobraževanja ter predlaga dodatne učne vire, prilagojene njihovim potrebam. S tem bi lahko bistveno izboljšali učno izkušnjo in odpravili razlike v znanju posameznikov.

Z uvedbo UI lahko zagotovimo prilagodljive učne poti. Algoritmi UI lahko analizirajo podatke o uspešnosti udeležencev izobraževanja za zdravstvenega dispečerja, da ustvarijo individualizirane učne poti. Če se udeleženec izobraževanja

za zdravstvenega dispečerja spopada z določenim konceptom, lahko UI prilagodi težavnostno stopnjo ali jim priporoči dodatna gradiva, da zagotovi, da prejmejo in razumejo bistvene informacije.

## **5.2 Izboljššana simulacija scenarijev in vadba s scenariji z uporabo UI**

Uporabimo lahko scenarije sprejema klicev, ki jih poganja UI. Nadgradnjo v postopku izobraževanja predstavlja tudi razvoj realistične simulacije klicev, ki jih poganja UI. Ti scenariji se lahko dinamično prilagajajo dejanjem in odločitvam udeležencev. UI bi lahko ustvaril različne scenarije, od rutinskih klicev do nujnih primerov z nepričakovanimi preobrti, preizkušal kritično mišljenje, komunikacijo in sposobnosti odločanja udeležencev na varnem učnem okolju.

## **5.3 Povratne informacije in ocena**

Z uporabo UI se lahko zagotovi analiza glasu za komunikacijske veščine: UI lahko analizira posnetke glasovnih interakcij udeležencev med simulacijami, pri čemer ocenjuje dejavnike, kot so ton, tempo, empatija in jasnost pri posredovanju informacije. Te informacije zagotavljajo dragocen vpogled v komunikacijsko učinkovitost in področja za izboljšave udeležencev izobraževanja.

## **5.4 Nenehno učenje in upravljanje znanja**

Z UI lahko opolnomočimo platformo vprašanj in odgovorov. Za namene izobraževanja se izdelata spletno bazo znanja, kjer lahko udeleženci izobraževanja dostopajo do obsežnega skladišča medicinske terminologije, postopkov v nujnih primerih in najboljših praks. Iskalnik, ki ga poganja UI jim lahko pomaga hitro najti ustrezne informacije in odgovoriti na njihova vprašanja.

## **5.5 Prilagojena priporočila za nadaljnje izobraževanje**

Na podlagi podatkov o uspešnosti udeležencev izobraževanja in interesnih področjih lahko UI priporoči ustrezne tečaje nadaljnjega izobraževanja ali vire, ki bodo pomagali udeležencem izobraževanja posodobiti znanje na zahtevan nivo.

Sodobne spletne učilnice, kot je Moodle, omogočajo vključevanje UI, ki odpira nove možnosti za bolj prilagojeno, interaktivno in učinkovito izobraževanje zdravstvenih dispečterjev. UI predstavlja ključni tehnološki napredek, ki omogoča avtomatizacijo določenih procesov, prilagajanje vsebine posameznim učencem ter izboljšanje dostopnosti in učinkovitosti učenja.

## 6 Prilagoditev učnega procesa z UI

UI omogoča personalizacijo učenja glede na posameznikove potrebe, predhodno znanje in učni napredek. V Moodleu se to lahko doseže z uporabo prilagodljivih učnih poti (adaptive learning pathways), ki jih podpirajo UI algoritmi. Ti algoritmi analizirajo uspešnost dispečterjev na interaktivnih kvizih, testih in vajah ter na podlagi teh podatkov avtomatsko prilagodijo naslednje učne korake.

Na primer:

- če zdravstveni dispečter izkaže šibko razumevanje osnovnih protokolov za nujne primere, mu sistem ponudi dodatna gradiva in simulacije;
- če je zdravstveni dispečter pri določenih tematikah že uspešen, mu sistem omogoči preskok na zahtevnejše teme, kar preprečuje izgubo časa z obravnavo že osvojenega znanja.

## 7 UI za analizo podatkov in zagotavljanje povratnih informacij

Sistem Moodle, obogaten z UI, omogoča napredno analizo podatkov o učenju, ki voditeljem usposabljanj pomaga prepoznati šibke točke učencev. Na primer, UI lahko analizira, katere naloge zdravstveni dispečterji najpogosteje rešujejo napačno, in pripravi poročila, ki inštruktorjem omogočajo, da se osredotočijo na problematične vsebine.

Poleg tega UI omogoča avtomatsko ocenjevanje nalog, kar je še posebej koristno pri velikem številu udeležencev. Moodle, opremljen z UI, lahko:

- analizira eseje in zagotovi povratne informacije o skladnosti, koherentnosti in pravilnosti odgovorov;
- ocenjuje kvize in simulacijske vaje, pri čemer natančno prikaže, kje je učenec naredil napako in kako jo popraviti.

## 8 Simulacije in scenariji podprti z UI

Zdravstveni dispečerji pogosto potrebujejo izobraževanje v simulacijskem okolju, kjer lahko vadijo reševanje kompleksnih situacij, kot so množične nesreče ali zahtevni nujni primeri. UI omogoča ustvarjanje dinamičnih in realističnih simulacij, kjer lahko zdravstveni dispečerji vadijo svoje odzive v realnem času.

V Moodleu lahko UI generira:

- scenarije klicev v sili: simulacije klicev, kjer UI posnema obnašanje klicateljev, ki so lahko prestrašeni, nejasni ali jezni. To zdravstvene dispečerje pripravi na stresne situacije in jim omogoči vadbo komunikacijskih veščin;
- analizo odzivov: po simulaciji UI oceni odzive zdravstvenega dispečerja, identificira pomanjkljivosti in ponudi priporočila za izboljšave.

## 9 Chatboti za podporo učencem

V spletnih učilnicah kot je Moodle, je uporaba UI chatbotov vedno bolj razširjena. Chatboti lahko pomagajo zdravstvenim dispečerjem pri:

- dostopu do učnih gradiv z odgovori na pogosto zastavljena vprašanja;
- pomoči pri navigaciji po učilnici in tehničnih težavah;
- omogočanju sprotne komunikacije, kjer UI zagotavlja podporo pri razumevanju učnih vsebin.

Takšni chatboti ne razbremenijo le učiteljev in mentorjev, temveč učencem omogočajo tudi dostop do podpore kadar koli v dnevu.

## 10 Predikcija uspešnosti in preprečevanje osipa

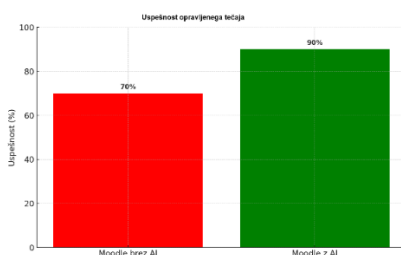
UI omogoča napovedovanje uspešnosti učencev na podlagi podatkov o njihovem delu v spletni učilnici. Moodle lahko s pomočjo UI analizira:

- pogostost dostopa do učnih vsebin;
- čas, porabljen za posamezne naloge;
- rezultate na kvizih in testih.

Na podlagi teh analiz lahko sistem prepozna učence, ki bi lahko zaostali, in jim ponudi dodatno podporo, preden pride do osipa. Ta proaktivni pristop je še posebej pomemben pri izobraževanju zdravstvenih dispečerjev, kjer je stalno izboljševanje znanja ključno.

## 11 UI za prevajanje in dostopnost

Med zdravstvenimi dispečerji so pogosto tudi udeleženci, ki govorijo različne jezike ali imajo posebne potrebe. UI omogoča avtomatsko prevajanje učnih vsebin in transkripcijo videoposnetkov, kar povečuje dostopnost učilnice Moodle za vse udeležence.



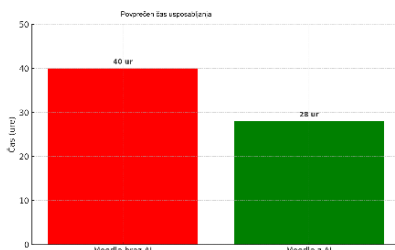
Slika 1: Uspešnost opravljenega tečaja

Vir: Lasten

UI v spletnih učilnicah, kot je Moodle, ponuja inovativne rešitve za izobraževanje zdravstvenih dispečerjev. Z uporabo UI lahko izobraževalni proces postane bolj prilagodljiv, interaktiven in učinkovit, kar izboljšuje tako uspešnost zdravstvenih dispečerjev kot tudi kakovost oskrbe pacientov v kritičnih situacijah. Integracija UI

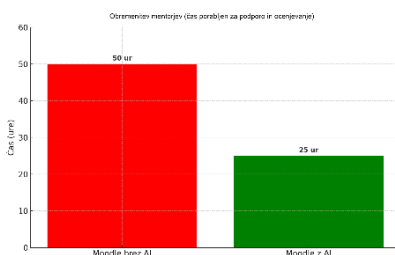


tehnologij v izobraževanje predstavlja ključen korak k modernizaciji usposabljanj v zdravstvenih ustanovah.



Slika 2: Povprečen čas usposabljanja

Vir: Lasten



Slika 3: Obremenitev mentorjev (porabljen čas za podporo in ocenjevanje)

Vir: Lasten

## 12 Pomembni premisleki

Potrebno je zagotoviti človeški nadzor. Čeprav je UI lahko močno orodje, so človeški inštruktorji še vedno bistveni za zagotavljanje smernic, mentorstva in obravnavanje zapletenih učnih potreb.

## 13 Zaključek

Spletne učilnice predstavljajo transformativno priložnost za usposabljanje zdravstvenih dispečerjev, saj ponujajo bolj prilagodljiv, dostopen, privlačen in stroškovno učinkovit pristop v primerjavi s tradicionalnimi metodami. Če skrbno

obravnavajo izzive in izvajajo najboljše prakse, opisane v tem članku, lahko organizacije izkoristijo spletne platforme, da svoje zdravstvene dispečerje opremijo z znanjem, veščinami in samozavestjo, potrebno za odličnost v tej ključni vlogi. Ker se tehnologija še naprej razvija, lahko pričakujemo še več inovativnih aplikacij spletnega učenja pri usposabljanju zdravstvenih dispečerjev, kar lahko še dodatno izboljša kakovost zagotavljanja nujne medicinske oskrbe in pripomore k izboljšanju pomoči za paciente. S premišljeno integracijo UI v spletne učilnice lahko ustvarimo bolj prilagojene, privlačne in učinkovite izkušnje usposabljanja za zdravstvene dispečerje, s čimer na koncu izboljšamo njihove zmogljivosti in izboljšamo oskrbo pacientov.

Da bi raziskali dolgoročni vpliv usposabljanja s pomočjo spletnih učilnic in UI na rezultate dela zdravstvenih dispečerjev v delovnem procesu, varnost pacientov in zadovoljstvo zdravstvenih dispečerjev pri delu so potrebne nadaljnje raziskave. Študije, ki jih predlagamo bi morale raziskati učinkovitost različnih strategij spletnega učenja, integracija tehnologij UI in VR/AR v dispečersko usposabljanje ter razvoj najboljših praks za ocenjevanje in izboljšanje programov spletnega usposabljanja.

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# FROM REGULATION TO IMPLEMENTATION: CHALLENGES IN THE EUROPEAN DATA ECONOMY

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Over the past two decades, open data sharing, reuse and data-driven innovation have become essential components of the digital economy in Slovenia and across Europe. The European Strategy for Data and the Data Act aim to create a single data market and promote common European data spaces that support data accessibility, interoperability, and sovereignty. Despite regulatory progress, challenges remain in terms of companies' ability to implement data sharing regulations, integrate into data ecosystems, and develop sustainable business models. For this purpose, we conducted a systematic literature review to identify research gaps in the field of data economy integration, using the PRISMA model. Preliminary findings indicate a lack of practical implementations and maturity of data spaces, highlighting the need for further research on regulatory compliance, technology readiness and value creation strategies. The findings contribute to a deeper understanding of how enterprises can effectively navigate the evolving data economy and leverage data sharing frameworks for innovation and growth.

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## 1 Introduction

Over the past two decades, the sharing of open data, its reuse, and the new possibilities for product development have become a commonplace concept in Slovenia and more broadly across Europe and broader, worldwide. In Slovenia, the initiative was taken over by the Ministry of Public Administration and in recent years by the Ministry of Digital Transformation which, since 2012 through the NIO portal and since 2015 with the Open Data Slovenia (OPSI) portal, has set standards for data collection through a single access point, data sharing, and the publication of reuse examples. According to the Open Data Maturity Report, Slovenia has ranked above the European average in recent years, indicating a high level of engagement from both the public sector and private stakeholders who use the data. Both Slovenia and Europe recognize the importance of data reuse and, based on the types of impact (e.g., economic, social, environmental), the influence of conditions (e.g., policies, data quality), and the cause-and-effect relationships between data use and outcomes, they analyze the data and adopt new data sharing policies.

In 2020, the European Commission introduced the European Strategy for Data, aimed at establishing a single data market to strengthen Europe's global competitiveness and data sovereignty. The strategy emphasizes the development of Common European Data Spaces which facilitate the availability of data from diverse sources across the economy and society while ensuring that data providers (such as hospitals and researchers) retain control over data access (A European Strategy for Data, 2020).

As a natural continuation of data sharing in recent years the European Union has focused its attention on user-generated data—data that users consciously or unconsciously share with service providers, typically through cloud services. This may occur within the infrastructure of a provider of a physical product that generates data or within the framework of a software service.

With the new Data Act, the European Commission aims to standardize the regulation of the relationship between users and service providers while introducing new guidelines for data processing and, most importantly, data sharing with third parties. Consequently, the nature of regulation also addresses the creation of new value, innovation, and business models with a particular emphasis on data with a

high impact on the development of new products. In a press release, the Commission estimates that approximately 80% of European industrial data remains unused and that the regulation will generate an additional €270 billion in GDP by 2028.

It is particularly important to mention that the Data Act establishes an environment for the operation of data spaces, thereby fostering the further development of the data economy by establishing clear rules for data access, sharing and portability. By ensuring fairer data sharing between businesses, consumers and public institutions, it promotes interoperability and trust in data ecosystems. The regulation lowers the barriers for companies to access and use data, thereby promoting innovation, competition and new business models. By supporting sector-specific data spaces, e.g., in health, energy and manufacturing, the Data Act also promotes cross-industry collaboration, unlocking the potential of data-driven growth and strengthening Europe's position in the global data economy.

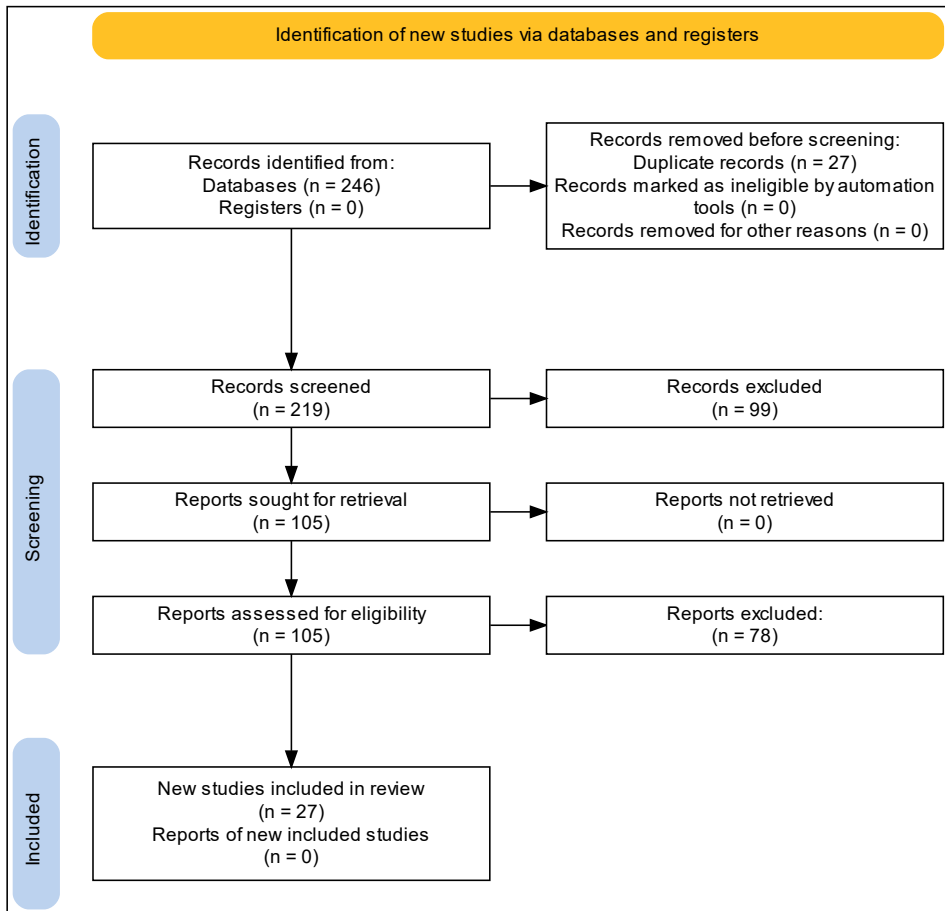
Despite the established regulations and high expectations for the data economy, its actual development depends on how effectively companies can implement existing regulations into their operations. Several studies have been conducted in the broader field of data-driven business, data economy, and inter-organizational data sharing. However, the field remains underresearched, particularly in terms of companies' ability to implement regulations, integrate into data ecosystems, and develop business models, value creation strategies, and innovations based on data sharing.

To address this problem, we will conduct a literature review to identify research gaps, theoretical foundations, and key factors influencing enterprises' integration in data economy.

## **2 Methodology**

The research question addressed in this study is:

"What are the key research gaps in existing literature regarding companies' ability to implement data-sharing regulations, integrate into data ecosystems, and develop business models and value creation strategies within the evolving data economy?"



**Figure 1: Identification of studies (Diagram made with PRISMA Flow Diagram tool (Haddaway et al., 2022))**

Source: Own

We followed the PRISMA (Page et al., 2021) model guidelines which involve a systematic search for relevant sources in bibliographic databases and other sources through the following steps: 1) Identification, 2) Screening, 3) Inclusion.

Figure 1 presents a schematic overview of the source identification process in the Web of Science and Scopus databases based on the specified keywords, as well as the procedure for including or excluding specific sources and the final set of sources selected for analysis.

We have searched for the keywords and phrases: "data space" OR "data spaces" and "International Data Space" OR "European data space" OR "Dataspace Protocol", limiting the search to document types »article«, »paper« and »conference paper«, omitting the texts that were not in English. The search yielded a total of 227 results (Scopus and Web of Science), which we further analyzed by scanning titles and abstracts. The search for keywords "data space" and "data act" yielded 19 additional results (Scopus and Web of Science).

We applied the following **exclusion criteria**:

- Removed duplicate sources.
- Removed the workshop proceedings.
- Does not relate to the Data Act.
- Does not relate to data spaces.
- Does not focus on European studies.

The final set of sources selected for further analysis consists of 27 sources that we have read and synthesized in the results section.

### 3 Results

In the bibliographic databases examined, we identified 246 articles, from which we selected 27 articles for further analysis. As expected, there were fewer contributions on the topic of legislation, particularly the Data Act (19 articles), while significantly more were found on the topic of data spaces (227 articles).

In the following sections, we first present the Data Act, its importance, and its role in the data economy, specifically in interorganizational data sharing. We then introduce the concept of data spaces and related terms, such as data economy, data ecosystem, and interorganizational data sharing, along with the opportunities they create for the economy.

### 3.1 Data Act

Regulation (EU) 2023/2854 on harmonised rules on fair access to and use of data and amending Regulation (EU) 2017/2394 and Directive (EU) 2020/1828 ((EU) 2023/2854 - Data Act), which aims to facilitate and promote the exchange and use of data within the European Economic Area Data Act, 2023).

The regulation focuses on machine-generated "data" which is intentionally or unintentionally collected by a "connected product" (often referred to as an Internet of Things (IoT) device) or "connected services" following a user's action. Under the regulation, users have the right to access their own data, such as the data generated by their car during operation. Additionally, data holders must establish a contractual agreement with users for the use of non-personal data, such as environmental temperature data. If a user decides to share personal data with a third party, the data holder is obligated to provide access to the data under predefined conditions. All participants must ensure appropriate technical protection measures and in cases of detected misuse, data holders or users can demand that recipients delete the data or cease its use.

While previous regulations have already enabled the voluntary exchange of data with public institutions, the Data Act mandates that data holders provide necessary data to authorities in exceptional situations, such as responding to public emergencies, mitigating their impact or facilitating recovery. If data is required to respond to a general hazard, access must be provided free of charge. However, under certain conditions, the public sector may also request data to fulfill a legally mandated public interest task, such as statistical reporting. In such cases, data holders are entitled to compensation.

In addition to defining data-sharing processes, the legislation will also impact data processing service providers, such as cloud service providers, as it outlines contractual and technical aspects for switching between providers. This ensures greater flexibility for customers but presents challenges for existing providers, as it prohibits practices that create obstacles preventing customers from migrating to competitors. The regulation promotes a more competitive market with lower entry barriers for new providers.



Such an approach reduces vendor lock-in, a situation where businesses become dependent on a specific service provider. Additionally, data service providers are also affected by the data protection mechanisms introduced by the regulation. Providers must implement measures to prevent access to and the transfer of non-personal data stored in the EU to third-country authorities.

Data service providers are also affected by the data protection mechanisms introduced by the regulation. They must implement measures to prevent access to and the transfer of non-personal data stored in the EU to third-country authorities.

An important innovation introduced by the regulation is the establishment of formal frameworks for the operation of the so-called data spaces.

Although the specific market implications of the new regulation have been discussed in numerous articles and online publications, scientific literature and practice have yet to introduce methodologies and models that comprehensively assess the maturity of companies for implementing the Data Act, as it is a novelty in the field of regulation.

Therefore, the development of a new model will need to leverage existing systems and approaches to regulatory compliance verification.

### **3.2 Data Spaces**

The concept of data spaces first emerged in 2005 (Franklin et al., 2005), predating its inclusion in the Data Act, which provides it with a legal framework for operation—ensuring secure and trusted data sharing among stakeholders. To further clarify, the needs of emerging data spaces played a key role in shaping the development of legislation (Otero, 2019). One of the fundamental definitions of a data space is provided by Hutterer et al. (2023, pp. 6): “A data space is a system of physical and/or logical nature consisting of elements and functions for providing a certain utility while at the same time relying on appropriate governance.”

Data spaces are a technical solution that enables data sharing between two organizations. They provide the capability to publish data catalogues, which contain metadata about datasets (data) that an organization wishes to share with others. Data

spaces address technical challenges, such as access control and monitoring, establishing agreements for data sharing (or access), and facilitating data discovery.

The data space, as defined by the Data Act, provides both a technical and legal framework for data sharing among stakeholders (e.g., data ownership and rights). It ensures data ownership, thereby creating opportunities for cross-organizational collaboration (Beverungen et al., 2022). Additionally, the regulation is expected to boost the data economy and data-driven innovation by enhancing trust among stakeholders and increasing legal certainty within data spaces (Hutterer & Krumay, 2024; Erion, 2024).

Stakeholders within data spaces operate through the so-called connectors (IDS Connector), which offer a set of technical solutions for functioning within a data space, similar to how a web browser facilitates internet access (Möller et al., 2024; Otto & Jarke, 2019; Noardo et al., 2024). Searching through data catalogues partially replaces the role of data intermediaries and portals, as users can search for specific data within a data space and receive multiple providers, enabling automated data integration and redundancy.

There is no universally accepted definition of a data space as various overlapping terms are used, which can lead to confusion. Authors agree that data plays a vital role in the data economy, becoming a strategic asset for business operations and value creation (Otto & Jarke, 2019; Hutterer et al., 2023). Data also plays a crucial role in the digital transformation of companies (Beverungen et al., 2022; Hupperz & Gieß, 2024). However, the role of data in interorganizational digital transformation remains less explored, particularly in the context of co-innovation, the development of sustainable solutions, and addressing complex societal challenges (Beverungen et al., 2022). This represents a transformation of the business ecosystem, extending beyond the boundaries of a single organization or company. As a result, it introduces additional challenges, as it falls outside the control of any single actor (Beverungen et al., 2022). In the context of data spaces, the term data ecosystem emerges, which differs from a business ecosystem. While a business ecosystem refers to stakeholders within a specific business environment (e.g., a company with its suppliers, subcontractors, customers, banks, and competitors), a data ecosystem involves stakeholders whose shared interest is data (Gelhaar & Otto, 2020). There is no universally accepted definition of data ecosystem either. Some define data ecosystem

as network of actors that use, create, and provide data to generate added value (Gelhaar & Otto, 2020) while others (Möller et al., 2024) define data ecosystem as network of organizations (actors) that share data based on dataspace technology.

In any case, data has become an asset with intrinsic value. Data sharing between businesses (B2B) and between businesses and the public sector (B2G) is driven by legislative requirements (e.g., PSI directive, open data, COVID-19), supply chain management (Steiner & Münch, 2024), industry needs (Möller et al., 2024), and the need for competitiveness. In recent years, various initiatives have led to the establishment of the Common European Data Space, along with 14 sector-specific data spaces and related standards.

Data spaces are already being used, but only to a limited extent. There are use cases from the automobile industry such as Catena-X (Catena-X Your Automotive Network | Catena-X, n.d.), mostly including large organizations. Adoption challenges and sector-specific issues hinder their adoption in many industries and for SME. In healthcare, for example, problems arise considering personal data (e.g., GDPR restricts data sharing) and there is a lack of data interoperability between institutions (Yousefi, 2022; Terzis & Santamaria Echeverria, 2023; Hajduk, 2024). In the field of agriculture, Atik (2022) highlights the need for additional or separate legislation on data as large agricultural conglomerates hold advantage over farmers (vendor lock-in) and farmers show distrust in big companies and government in context of data sharing.

Hutterer & Krumay (2024) identified 12 factors that influence the adoption of data spaces among organizations, namely: Complexity of using data spaces; Clarity of initial (entry) costs for using data spaces; Data sovereignty (self-management of own data); Control over ecosystems; Ecosystem readiness; Data interoperability; Technology maturity; Clarity regarding legal regulations; Security; Technological maturity of the organization; Technology transparency; Trust among stakeholders.

The novelty of the technology, the complexity of implementation, and the technological maturity of organizations create significant barriers for small and medium-sized enterprises (SMEs) (Hutterer & Krumay, 2024; Olmedo-Peralta, 2024; Jurmu et al., 2023) leveraging data sharing for value creation. The Data Act aims to provide additional protection and support to SMEs. To further assist SMEs,

the EU plans to establish European Digital Innovation Hubs (EDIHs) (EU Commission, 2024). These hubs will serve as local systems, providing infrastructure and digital services to ease SMEs' integration into data spaces. Additionally, EDIHs will act as data intermediaries, facilitating access and use of data for SMEs.

### 3.3 Research gap

**Table 1: Research gap by categories and sub-categories**

Dimension	Sub-dimensions	Reference
Organizational & Management Aspects	Governance	(Stienmetz & Kolomojets, 2024; Ordóñez-Martínez et al., 2024; Falcão et al., 2023; Schleimer et al., 2023; Otto & Jarke, 2019)
	Business models	(Stienmetz & Kolomojets, 2024; Falcão et al., 2023; Klug & Prinz, 2023; Gieß et al., 2025)
	Value creation	(Jurmu et al., 2023; Ordóñez-Martínez et al., 2024; Hutterer, 2023; Gieß et al., 2025)
	Innovation	(Jurmu et al., 2023; Ordóñez-Martínez et al., 2024; Hutterer, 2023; Gieß et al., 2025)
	Sustainability governance	(Schleimer et al., 2023; Möller et al., 2024)
Methods	Quantitative methods/testing/experiments	(Steiner & Münch, 2024; Noardo et al., 2024; Steinert & Altendeitering, 2024)
	Qualitative (in depth case studies, multiple case studies)	(Gelhaar & Otto, 2020; Gieß et al., 2025; Steinert & Altendeitering, 2024)
Maturity	Implementations	(Klug & Prinz, 2023; Möller et al., 2024; Noardo et al., 2024; Otto & Jarke, 2019; Hutterer et al., 2023), (Gieß et al., 2025)
	Capabilities	(Steiner & Münch, 2024; Hupperz & Gieß, 2024)
	Business models	(Hupperz & Gieß, 2024; Klug & Prinz, 2023)
Ecosystems – holistic approach	Public authorities' role/actors' roles	(Falcão et al., 2023; Beverungen et al., 2022)
	technology, organizations, people, legal	(Möller et al., 2024; Hutterer & Krumay, 2024; Atik, 2022; Otto & Jarke, 2019; Schleimer et al., 2023),
	Sustainable development /green deal	(Lush et al., 2024; Otsu & Maso, 2024)

Source: Own

Areas: organizational and management aspects, methodological approaches, data space maturity, and a holistic or ecosystem-based perspective. Table 1 outlines these research gaps, highlighting key areas in the literature that require further exploration and offering opportunities for future research.

Existing research primarily focuses on the development and analysis of legislation that facilitates efficient data sharing, as well as on technical and conceptual studies of data space implementations. However, a notable gap remains in the practical application of these frameworks, particularly regarding the maturity of implemented data spaces and their long-term value creation for all stakeholders. Most studies emphasize the lack of real-world implementations, highlighting the need for deeper insights into how data spaces evolve and generate sustainable value over time.

Given that the new regulatory framework aims to empower small and medium-sized enterprises (SMEs) in their transition into the data economy, there is a critical need for research that identifies key factors influencing companies' readiness to implement the Data Act. Furthermore, future studies should explore how these maturity factors can be systematically assessed using existing regulatory compliance methodologies, ensuring a structured approach to evaluating and enhancing companies' data-sharing capabilities.

## **4 Conclusion**

This study addresses the challenges of Data Act implementation, emphasizing the role of data sharing, reuse, and data-driven innovation in shaping the digital economy, particularly within data spaces. While the European Strategy for Data and the Data Act establish a regulatory framework for common European data spaces, SMEs face significant barriers to effective implementation.

Using a systematic literature review (PRISMA model), we identified key research gaps in organizational and management aspects, methodological approaches, data space maturity, and a holistic ecosystem perspective. Existing studies focus primarily on technical and regulatory dimensions, yet there is a lack of practical implementations, particularly regarding data space maturity and long-term value creation.

Future research should prioritize identifying key factors influencing companies' readiness to implement the Data Act and explore assessment methodologies based on regulatory compliance frameworks. While market implications have been widely discussed, scientific literature still lacks comprehensive models for evaluating companies' maturity for Data Act implementation. Developing such a model will require leveraging existing compliance verification approaches to support a structured transition into the data economy.

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# GRAPH NEURAL NETWORKS AND DEEP REINFORCEMENT LEARNING IN WAREHOUSE ORDER PICKING AND BATCHING - LITERATURE REVIEW

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This paper is a systematic literature review on use of the Deep Reinforcement Learning (DRL) and Graph Neural Networks (GNN) in warehouse. We first explore the use of DRL and GNN for optimization of order picking and batching in warehouse. Because of very little results on use of GNNs in optimization of order picking and batching we extended our search to general use of GNNs in warehouse environment. We identified different topics of research using Latent Dirichlet Allocation (LDA) and identified main problems in use of DRL and GNNs in warehouse environment.

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## 1 Introduction

The order picking process is one of the most labor-intensive processes in warehouses and has been for a long time cited to consist of 55% of all warehouse operating costs and is one of the most researched topic of warehouse research to this day (Bock et al., 2025). Significant research has been done on optimization of order picking paths and batching of orders to minimize path traveled by pickers. Finding shortest order picking path is variation of Traveling Salesman Problem (TSP) which is NP-hard (Bock et al., 2025). In recent years new methods of solving large optimization problems with Deep Reinforcement Learning (DRL) (Arulkumaran et al., 2017; Bello et al., 2017) and with Graph Neural Networks (GNN) (J. Zhou et al., 2020) and combination of both (Munikoti et al., 2022) emerged. In this paper we explore the use of DRL in optimization of order batching and picking tasks. We further explore the use of GNNs in a general warehouse context. We follow PRISMA methodology (Page et al., 2021) for systematic literature Review.

## 2 Methodology

PRISMA methodology (Page et al., 2021) describes how methods and results in systematic reviews should be reported. We searched 3 different scientific papers databases for papers on topic of use of DRL and GNNs and combination of both in warehouse setting. Databases used were Scopus, Web of Science and ProQuest. We search for the occurrence of certain words in the paper titles and abstracts. Those words include words like “warehouse”, “reinforcement learning”, “order picking”, “order batching” and “graph neural networks”. We then excluded duplicate records and non-related papers.

Our goal was to find how GNNs and DRL are used in warehouse settings. We were mainly interested in the topic of order picking and batching optimization. We searched for any papers that included GNNs or DRL for use in order picking and batching. We found only 1 article containing both GNNs and DRL (Begnardi et al., 2024) for order picking or batching problem. So, we extended our search on general use of GNNs in warehouse setting. We were interested in what GNNs were used for and how they were modeled.

To find general topics in research we used Latent Dirichlet Allocation (LDA) (Blei et al., 2003) on papers texts. Our text analysis pipeline (Figure 1) started with extraction of texts from pdf files and cleaning those texts by removing chapters like literature, notes, acknowledgement and all text before the start of abstract. We then used scikit-learn (Pedregosa et al., 2011) implementation of LDA to identify different topics of research. When using LDA we iteratively added new stop words and word replacements and tested them with different numbers of topics to find the most distinguishable topics. In choosing the best number of topics, we used perplexity score of LDA model. With those topics we aimed to find general topics on research in use of GNNs and DRL in warehouse settings.

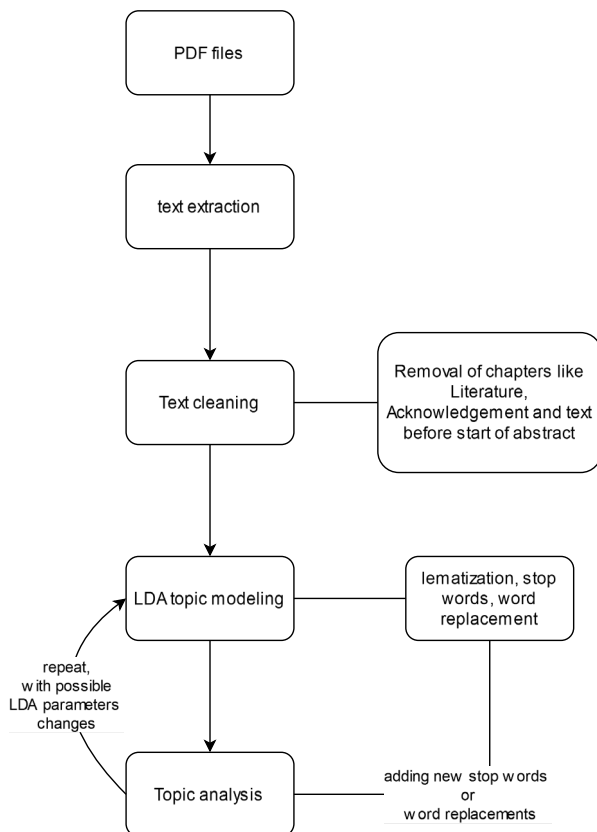


Figure 1: Scientific papers' text analysis pipeline

Source: Own

## 2 Results

With queries in Table 1 we identified 85 papers. Figure 2 shows identification of new studies via databases and registers. In the process, 31 of papers were excluded as duplicates and we excluded 4 full conference proceedings where combination of words was in full conference abstract. We then screened 50 papers and removed 11 of them as unrelated. Between unrelated papers there were mostly papers that included word warehouse as in context of data-warehouses and some computer vision papers focused on object detection in warehouse settings. We retrieved and analyzed the rest of the papers (31 papers). All but 2 of the included papers were published between the years 2021 and 2025.

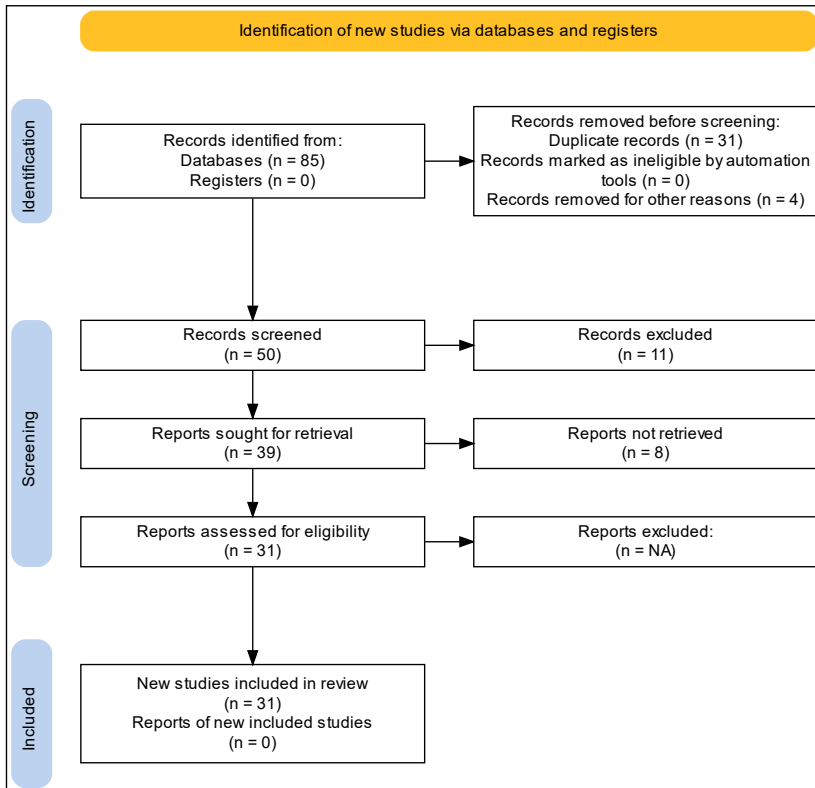


Figure 2: Identification of new studies via databases and registers (Made with PRISMA Flow Diagram app (Haddaway et al., 2022))

Source: Own

**Table 1: Queries**

Topic	query	Database	results
DRL	TITLE-ABS-KEY (( warehouse* ) AND ( "order picking" OR "order batching" ) AND ( "reinforcement learning" ))	Scopus	21
DRL	TS=((warehouse* AND ("order picking" OR "order batching") AND ("reinforcement learning"))	WOS	17
DRL	ab(warehouse* AND ("order picking" OR "order batching") AND ("reinforcement learning"))	ProQuest	7
DRL	Left after leaving non accessible, duplicates and unrelated		23
GNN	TITLE-ABS-KEY (warehouse* AND ("Graph Neural Networks" OR gnn* ) )	Scopus	23
GNN	TS=(warehouse* AND ("Graph Neural Networks" OR gnn* ))	WOS	11
GNN	ab((warehouse* AND ("Graph Neural Networks" OR gnn*)))	ProQuest	6
GNN	Left after leaving non accessible, duplicates and unrelated		9
Combined	Both topics after removing duplicates		31

We analyzed both topics (DRL and GNN) separately. First, we analyzed papers on DRL. Research highlights the growing role of Deep Reinforcement Learning (DRL) in warehouse logistics and order fulfillment. Several studies demonstrate the superior performance of DRL-based methods compared to traditional heuristics (Begnardi et al., 2024; D. Wang et al., 2022; X. Wang et al., 2025). However, challenges remain, including the difficulty of modeling DRL agents effectively (Cals et al., 2021), the need for more realistic problem formulations (Dehghan et al., 2023; Neves-Moreira & Amorim, 2024), and issues related to data collection and model complexity (Cheng, Wang, et al., 2024). Several studies emphasize the importance of incorporating additional constraints and real-world factors such as worker ergonomics (Niu et al., 2021), congestion, and system breakdowns (Perumaal Subramanian & Kumar Chandrasekar, 2024).

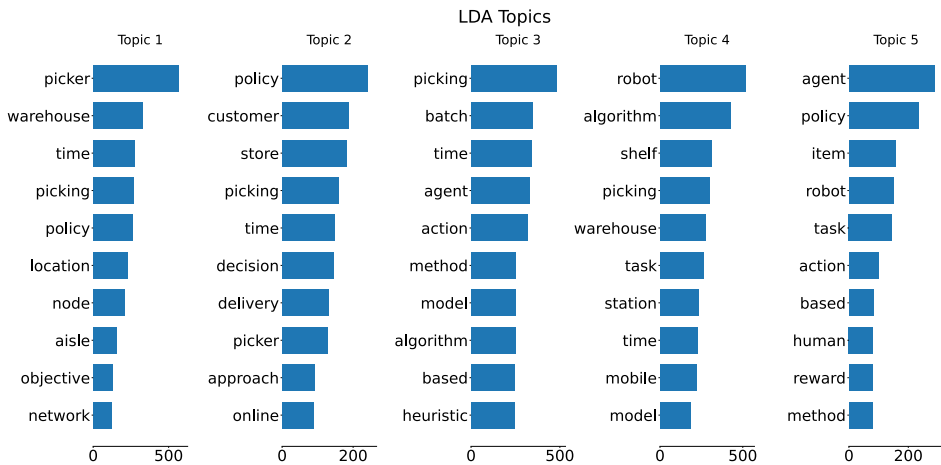
Use of DRL for optimization of order batching and picking can be separated into five topics by using LDA (Table 2). In all topics use of DRL is often leveraged to offer way of joint optimization for multiple goals in real time (dynamic decision making). The first topic explores the use of DRL for optimization with focus on picking task. The second topic is more focused on external logistics (customers and delivery). The third topic adds more focus on order batching. The fourth topic is addressing problems with the use of automated guided vehicles (AGV). And the last

fifth topic has more human centric focus (ergonomic, human-robot cooperation and transition to automation).

**Table 2: DRL papers**

Reference	Lda Topic
(Begnardi et al., 2024) (X. Wang et al., 2025) (Mahmoudinazlou et al., 2024) (Smit et al., 2024)	1
(Dehghan et al., 2023) (Kamoshida & Kazama, 2017) (Neves-Moreira & Amorim, 2024)	2
(D. Wang et al., 2022) (Cals et al., 2021) (H. Li et al., 2022) (L. Zhou et al., 2022) (Drakaki & Tzionas, 2017) (Cheng, Wang, et al., 2024)	3
(Kaiser et al., 2023) (K. Li et al., 2024) (Cheng, Xie, et al., 2024) (Tang et al., 2021) (Perumaal Subramanian & Kumar Chandrasekar, 2024) (Chen et al., 2024) (Wu et al., 2024)	4
(Krnjaic et al., 2024) (Yoshitake & Abbeel, 2023) (Niu et al., 2021)	5

Figure 3 shows LDA Topics recommendation for selected papers.



**Figure 3: LDA Topics recommendation**

Source: Own

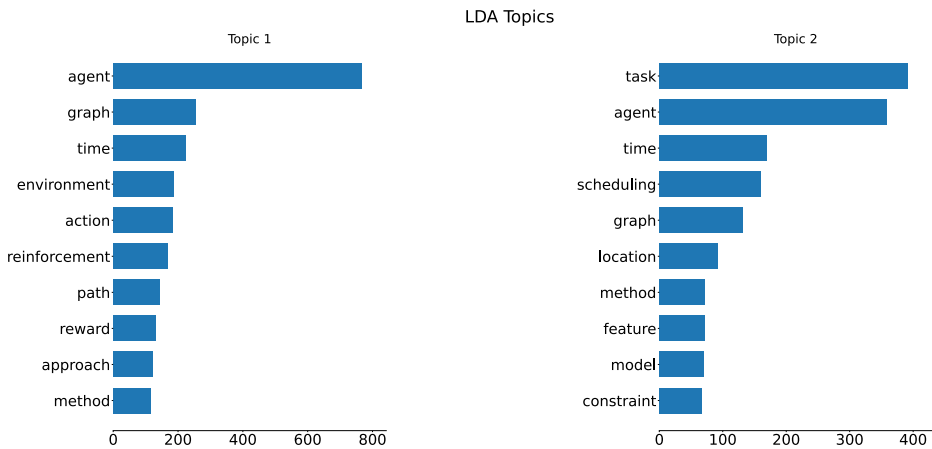
The biggest problem highlighted in papers was need for adding more optimization constraints and difficulty of modeling problems for DRL (Cals et al., 2021; Cheng, Wang, et al., 2024; Dehghan et al., 2023; Krnjaic et al., 2024; K. Li et al., 2024; Neves-Moreira & Amorim, 2024; Tang et al., 2021; Wu et al., 2024; Yoshitake & Abbeel, 2023).

Use of GNNs in warehouse settings can be separated into two topics by using LDA. The first topic explores finding the best action for agent (AGV, human worker) with emphasis on RL and the second topic explores scheduling and allocation/assignment of tasks between agents. Table 3 shows the set of GNN papers.

**Table 3: GNN papers**

Citation	LDA Topic
(Begnardi et al., 2024) (Knippenberg et al., 2021) (X. Li et al., 2023) (Xiao et al., 2024) (Pham & Bera, 2024) (Shelke et al., 2023)	1
(Paul et al., 2023) (Cho et al., 2024) (Z. Wang et al., 2022)	2

Figure 4 shows LDA Topics recommendation for selected papers.



**Figure 4: LDA Topics**

Source: Own

Analyzing the papers we find that there is no clear and unified way to model warehouses as graphs for GNN. Every paper has different hand-picked nodes, edges and features of graphs with while many papers highlight problem of not considering enough constraints and factors to generalize well to real-word environments (Begnardi et al., 2024; Paul et al., 2023; Pham & Bera, 2024; Z. Wang et al., 2022; Xiao et al., 2024). There is an idea of foundation models (like for large language models) for DRL-GNN paradigm (Munikoti et al., 2022). Such model in warehouse

setting (foundational warehouse DRL-GNN model) would greatly decrease the both computational and modeling difficulty of training DRL-GNN models for any optimization or decision-making task in warehouse environment while possibly having more wholistic view on warehouse environment which could in term give better performance in real word applications.

### 3 Discussion

In this paper we identified general research topics in use of GNNs and DRL in warehouse settings. We found a lack of research on the use of GNN in warehouse settings which implies possibilities for future research on modeling warehouse as graphs for use on any downstream optimization task or decision making. Use of GNNs with combination with DRL provide promising results compared to other optimization methods. The use of both GNNs and DRL together for optimizing order picking paths is only explored in one conference paper. Further research is needed to explore the use of GNNs and DRL in optimization of warehouse processes such as optimizing order picking paths.

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### Notes

This systematic literature review follows the PRISMA methodology (Page et al., 2021) to ensure transparency in selecting and analyzing studies on DRL and GNN for warehouse optimization. The findings highlight a research gap in applying GNNs to order picking and batching, with only one study integrating both approaches (Begnardi et al., 2024). DRL is commonly used for real-time joint optimization in areas like order batching, AGV routing, and human-robot collaboration. However, the lack of a standardized warehouse graph model limits the applicability of GNNs. Future research should focus on developing a foundational DRL-GNN model to enhance computational efficiency and real-world adoption.

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# MASSIVE OPEN ONLINE COURSES (MOOCs) FOR HEALTH PROFESSIONALS: WHAT WE CAN FIND IN THE LITERATURE

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**Background.** Massive Open Online Courses (MOOCs) provide distance learning opportunities for healthcare professionals on different topics. However, an overview on this topic is not available to date in the literature. **Aims.** To summarize the available literature on MOOCs dedicated to healthcare students and professionals. **Methods.** A review was conducted following the PRISMA guidelines in PubMed, CINAHL, Cochrane, Scopus, PsycInfo, and MEDLINE databases. Primary and secondary studies published between 2020, and July 2024 were included. The quality of the studies was assessed using the Joanna Briggs Institute tools. **Results:** Forty-three studies were included. The development of MOOCs is a worldwide phenomenon. MOOCs are attractive due to their many topics, flexibility, ability to be customized to learners' needs, and frequently free nature. Nevertheless, just few MOOCs have focused on topics related to vulnerable populations. **Conclusion:** Research on MOOCs has significantly increased during and after the pandemic. This educational format is effective, although there are some barriers to overcome. There is an urgent need to implement MOOCs that focus on all populations, particularly the vulnerable ones, to educate health professionals about challenges and disparities.

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## 1 Background

### 1.1 Massive Open Online Courses

Massive Open Online Courses (MOOCs) are training courses defined as 'Massive' because they can enroll thousands of participants; 'Open' because they are free, open to all, and require no prerequisites; 'Online' because they are accessible 24/7 via the web; and 'Courses' because they are based on specific learning objectives (Hendriks et al., 2020). MOOCs are online training courses characterized by free accessibility, flexibility, and the absence of prerequisites. They represent an important innovation for learning and improving continuing education and professional development, especially in healthcare (Yilmaz et al., 2021). MOOCs offer health professionals, especially nurses, an effective solution for continuing education to acquire knowledge and skills that will enable them to respond effectively to the health needs of the population (Bendezu-Quispe et al., 2020). During the COVID-19 pandemic and subsequent lockdown, the use of MOOCs demonstrated their potential to ensure access to training for health professionals (Paules et al., 2020). Therefore, distance learning through MOOCs has proven to be an effective learning strategy in this new healthcare context (Nieder et al., 2022). Massive Open Online Courses (MOOCs) provide distance learning opportunities for healthcare professionals on different topics. For this reason, it is interesting to give an overview of this phenomenon to understand its evolution and importance.

### 1.2 Aim

The aim of this study was to summarize studies on MOOCs dedicated to healthcare students and professionals. In addition, the aims were to explore the facilitators and barriers to participation in MOOCs.

The following research questions were set: a) 'What is the status of research from 2020 to 2024 in the literature regarding MOOCs dedicated to students and health professionals?'; b) 'What are the facilitating factors and the barriers to participation in MOOCs?'

## 2 Methods

A review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021), in PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane, Scopus, PsycInfo, and MEDLINE. Primary and secondary studies published between 2020, and July 2024 were included. Studies on MOOCs dedicated to students or health professionals whose content focused on facilitating factors and the barriers to participation were included. Comments, letters, books, Delphi studies and articles without the full text were excluded. The following keywords were adopted: 'Massive online open course', 'MOOC', 'online course', 'healthcare professional', 'nurs\*', 'education', combined with the Boolean operators AND or OR. The Rayyan platform was adopted to organize the retrieved sources and allowing efficiency to the screening process (Ouzzani et al., 2016). A total of 3061 studies were identified, which was reduced to 2071 after duplicates was removed. The potentially eligible studies were first screened based on their title and abstract: 1959 studies were excluded as not satisfying the inclusion criteria. Therefore, 43 article were included. Two researchers independently screened the studies; in case of disagreements a third researcher was consulted to reach consensus. Then, an extraction grid was created, including: author(s), year of publication, journal, country; purpose(s) of the study; study design; data specific to the MOOC, including (a) platform, (b) developers, providers, (c) language(s), (d) students enrolled, (e) teaching methods, (f) pedagogical foundations, if described; evaluation method(s) and tools used; facilitators and barriers to MOOC effectiveness; whether the MOOC included or targeted vulnerable populations.

## 3 Results

The studies publication were mainly from Australia, Brazil and Canada, and some did not specify the country of origin. MOOCs were mainly developed by universities, and the main objectives were to assess their impact and effectiveness on learners (Eglseer, 2023; Floss et al., 2021), to identify barriers and facilitators in continuing education (Khin et al., 2022; Longhini et al., 2021a), and to map the characteristics of the content provided (Bendezu-Quispe et al., 2020; Nieder et al., 2022). MOOCs addressed a range of topics, including infectious diseases such as COVID-19 and associated management strategies (Floss et al., 2021; Jones et al., 2024; Leathwick et

al., 2023) the prevention and treatment of chronic illnesses (Longhini et al., 2021a; Nieder et al., 2022; Reparaz et al., 2020, Yilmaz et al., 2021), and effective communication techniques with patients (Bendezu-Quispe et al., 2020; De Castro et al., 2020). The most represented teaching methods were videos, discussion forums, lectures, text and article readings, case presentations and assignment of exercises and tasks. MOOCs are attractive due to their many topics, flexibility, ability to be customized to learners' needs, and frequently free nature (Bendezu-Quispe et al., 2020; Longhini et al., 2021a). Nevertheless, just few MOOCs have focused on topics related to vulnerable populations such as the LGBT population, the prison population, pregnant women (Caitano et al., 2022), pregnant adolescent girls (De Castro et al., 2020), adolescents and minors (Ibrahim et al., 2021) and vulnerable people with diabetes (Mackenzie et al., 2024), according to Gordon et al. (2020) classification. Moreover, several barriers have been identified, including the need of having access to the Internet and advanced technological skills (Leathwick et al., 2023), the low quality of the design, the limited or too difficult content, the use of reading material, the lack of selective blocks for enrolment, the unspecific subject matter, the lack of experts to supervise the courses and MOOCs that are too long (Longhini et al., 2021a). Other barriers that emerged were the lack of formal accreditation (Mackenzie et al., 2024), the voluntary nature of the course (Nieder et al., 2022), a single trainer teaching thousands of students making meaningful interaction difficult (Schettino et al., 2024), and finally scheduling problems (Wang et al., 2023) and lack of time (Longhini et al., 2021a; Mackenzie et al., 2024; Nieder et al., 2022; Schettino and Capone, 2022). A significant dropout rate attributed to insufficient motivation or social support was also observed (Nieder et al., 2022).

#### **4 Discussion and conclusion**

This review highlights a strong expansion of MOOCs for healthcare professionals, showing a significant increase in studies from 2020, in line with the increase in the offer of these courses. The results highlight how MOOCs offer a unique educational opportunity due to their flexibility and affordability. As in the review by Longhini et al. (2021b), numerous factors have been identified that facilitate or hinder the effectiveness of MOOCs. In the present study, the factors seem to be oriented towards the dimensions of the MOOC itself and its educational content, the characteristics of the participants, the socialization aspect and the organizational context. This suggests the need to design MOOCs in multidisciplinary teams, taking



all these aspects into account, especially to address critical issues such as high dropout rates (Bendezu-Quispe et al., 2020; Leathwick et al., 2023; Longhini et al., 2021a; Nieder et al., 2022). Universities continue to be the main developers of MOOCs, due to their ability to ensure high quality content and inclusivity (Eglseer, 2023; Floss et al., 2021). The results indicate that MOOCs are a valuable resource for the continuing education of healthcare professionals, but further studies are needed to improve their effectiveness and assess their impact on clinical practice. Moreover, there is an urgent need to implement MOOCs that focus on vulnerable populations to educate health professionals and address challenges and disparities.

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# IMPROVING PROCUREMENT PROCESS MANAGEMENT BY APPLICATION OF KPIs IN THE COMPANY FROM METAL INDUSTRY

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The procurement process is one of the most critical processes for any company, as it ensures the provision of all necessary material resources. Improving the procurement process can contribute to reducing procurement costs by acquiring higher-quality raw materials, shortening delivery time, producing higher-quality products, and enhancing business relationships with suppliers. The subject of this paper is the improvement of the procurement process management, based on Key Performance Indicators (KPIs). The paper presents a set of five KPIs defined and implemented in the procurement process management on a case study of a real company from the metal industry. The result of the application of selected KPIs is improved procurement process that observed company use for monitoring supplier performance and the procurement department's efficiency. It also led to the applications of corrective measures, such as contract revision and modification, or termination of partnerships in favor of more reliable suppliers, as well as enhanced efficiency in the operations of the procurement department.

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## 1 Introduction

In recent decades, the procurement process in every modern company has become increasingly significant, both administratively and strategically. The growing role of the procurement process has been influenced by numerous factors (rising energy prices, inflationary trends, raw material price increases, economic crises and others). Procurement refers to all activities through which a company acquires the necessary material resources required to ensure the smooth and continuous operation of the production function at the lowest possible cost impacted by many factors, both objective (market conditions) and subjective (procurement policies, organization of procurement departments, employees involved in procurement and others) (Kakwezi & Nyeko, 2019). Considering that procurement costs accounted for 40 [%] of total costs by the end of the 20<sup>th</sup> century and that today they present almost 60 [%] of total company costs (Đukić Vujanović, 2021), it can be concluded that in today's global, dynamic and increasingly competitive market, the importance of the procurement process, in terms of managing overall business costs, has never been more important. For this reason, companies that manage to achieve a higher degree of differentiation from competitors pay significant attention to controlling procurement costs. A basic prerequisite for effective procurement process management is the availability of all necessary data related to procurement, starting with the current state. This means it is essential to have access to a full range of procurement performance indicators, based on which a strategic procurement plan will be done, and the success of its implementation could be continuously monitored. One approach that can improve procurement process management is the use of Key Performance Indicators (KPIs). These KPIs help achieve objectives, enhance strategies, improve and optimize the implementation of all procurement-related activities, aligned with the core production goals (Parmenter, 2020).

The subject of this paper is the improvement of procurement process management through the application of KPIs in the company Vendom, a company from the metal industry that exports most of its products to foreign markets. The paper presents a set of six KPIs, defined and implemented to improve the management of the procurement process. The defined set of KPIs was applied in a case study of the company Vendom, to improve procurement process management in this renowned company. The paper consists of six chapters. After the introductory considerations, the second chapter provides theoretical insights into the procurement process in the

company. The third chapter presents the basic concepts related to KPIs, while the fourth chapter emphasizes the set of KPIs defined for improving the procurement process management. The fifth chapter shows the application of the defined set of KPIs in the case of the company Vendom. The sixth chapter presents concluding remarks.

## **2 Procurement Process**

The procurement process refers to a series of steps necessary to obtain raw materials, products or services, while the three most important ones are (Baily et al., 2008): ordering goods, receiving goods and paying for goods/services. The main objective of this process is to reduce costs, decrease procurement time for materials and build strong business relationships with suppliers. In a manufacturing company, procurement presents a set of activities, measures and tasks carried out to purchase materials for reproduction, machines, equipment, accessories and tools, ensuring the smooth operation of the work function (Vasiljević et al., 2024). The procurement process can be viewed in both a narrow and broad sense. These tasks can include those performed daily and frequently, related to procurement and categorized as operational tasks, as well as tasks that are performed occasionally and categorized as strategic tasks. Procurement includes the following operational functional tasks (Ferišak & Stihović, 1989): receiving, examining, and consolidating procurement requests; requests to suppliers; receiving and analyzing offers; selecting suppliers; ordering products; monitoring delivery deadlines; receiving and inspecting ordered products and documents; handling complaints with suppliers; keeping procurement records; inventory control; collaborating with other business systems; reporting; selling surpluses and waste. On the other hand, procurement in the broader sense involves operational, tactical and strategic activities over a longer period (from one to 10 years), while, from a company's perspective, it includes procurement of materials and services, rights (licenses, rentals, leases), energy and resources, such as equipment and investment goods (Žilbert, 2007). Companies operating in larger markets are expected to have a dedicated unit responsible for procurement tasks. The responsibilities of this department, among other things, include: ensuring a continuous supply of raw materials, consumables and services required for the company's operations, minimizing investment and losses related to inventory, maintaining high-quality standards for raw materials, forming and developing supplier networks, procuring standardized products whenever possible, sourcing

raw materials at the lowest possible price, improving the company's competitiveness, coordinating with other departments and achieving procurement objectives with the lowest possible administrative costs (Bloomberg, 2006).

### 3 Key Performance Indicators

Procurement process management is just one part of production management. To fully understand all aspects of procurement management, it is necessary to consider which elements of the procurement function have the potential for performance identification and performance management. Performance encompasses the quantification of the effectiveness and efficiency of events that have occurred in the past and the comparison of results with selected reference indicators (Neely, 2004). A performance indicator is a set of data collected through regular monitoring of the performance of specific activities, processes or systems (Atanasov, 2016). It presents a crucial tool for tracking the functioning, monitoring and controlling or overall management of activities, processes and systems (Fitz-Gibbon, 1990). KPIs are metrics used in business to plan and monitor the outcomes achieved by a company. They focus on organizational aspects that are most critical to the current and future success of the business (Parmenter, 2020). A broader definition of KPIs is provided by (Belić, 2019), who states that "key performance indicators are metrics that, when considered together, provide a meaningful, concise and general picture of the performance of a company and its processes, reflecting the critical success factors". The concept of KPIs has become increasingly popular in recent business practices, indicating that companies recognize the need to measure and track their performance to make informed decisions and improve their operations. The popularity of these indicators is supported by certain studies that show that over 90 [%] of the most successful companies worldwide apply some form of KPIs (BCG, 2024). By using KPIs, companies can assess their progress in achieving strategic and operational goals within the framework provided by the performance indicators. These indicators also offer valuable insights into various aspects of business operations, allowing managers and stakeholders to track progress and make decisions based on the obtained information. The selection of criteria for the selection of performance indicators is a crucial step in measuring performance. KPIs help to assess and monitor outcomes, as well as the achievement of set objectives and their deviations from the company's strategies. Recent approaches to performance measurement emphasize measuring a smaller number of KPIs,

focusing on the connection between the measured data and critical success factors, as well as alignment with the company's strategy (Kojić, Dajić & Vučković, 2017).

#### **4 Key Performance Indicators for the Improvement of the Procurement Process Management**

In this chapter, a set of six KPIs for improving the procurement process management is presented.

##### **KPI 1. $NDCR_i$ – Non-delivery compliance rate by the supplier**

Failure to comply with the agreed delivery time by the supplier is a crucial indicator for the company. Specifically, in cases where the supplier exceeds the delivery time, serious consequences for production may occur, leading to delays in the delivery of products, unforeseen costs and damage to the company's reputation. The calculation of KPI 1.  $NDCR_i$ , for each supplier individually, is presented with a formula (1).

$$NDCR_i = \left( \frac{CNDD_i}{CN_i} \right) * 100 \text{ [%]} \quad (1)$$

where:

- $NDCR_i$  – Non-delivery compliance rate by the supplier  $i$  [%];
- $CNDD_i$  – The total number of contracts with a supplier  $i$  that had a delivery delay [1];
- $CN_i$  – The total number of contracts with the supplier  $i$  [1];
- $i$  – supplier, where  $i = 1, \dots, n$  ( $n$  – total number of suppliers).

The aimed value of KPI  $NDCR_i$  should be as low as possible.

##### **KPI 2. $PNCQ_i$ – The percentage of non-compliance with the delivery of the contracted quantity of goods by the supplier**

The percentage of non-compliance with the delivered contracted quantity of goods by the supplier is also an important indicator for the company, as it can lead to the company being unable to deliver the ordered quantity of products to its customers,

thereby incurring compensation (penalties) stipulated by the contract. The calculation of KPI 2.  $PNCQ_i$ , for each supplier individually, is presented with a formula (2).

$$PNCQ_i = \left( \frac{TCQ_i - TDQ_i}{TCQ_i} \right) * 100 [\%] \quad (2)$$

where:

- $PNCQ_i$  – The percentage of non-compliance with the delivery of the contracted quantity of goods by the supplier  $i$  [%];
- $TDQ_i$  – Total delivered quantity from supplier  $i$  [t];
- $TCQ_i$  – The total contracted quantity from the supplier  $i$  [t];
- $i$  – supplier, where  $i = 1, \dots, n$  ( $n$  – total number of suppliers).

The aimed value of KPI 2.  $PNCQ_i$  should be as low as possible.

### **KPI 3. $PPQD_i$ – The percentage of goods delivered by the supplier that did not match the quality standards**

The problem arises when suppliers deliver the ordered quantity of goods within the agreed timeframe, but those goods or their quantity, do not meet the required quality standards and cannot be used in production or can only be used with certain limitations. The calculation of KPI 3.  $PPQD_i$ , each supplier individually, is presented with a formula (3).

$$PPQD_i = \left( \frac{OPQ_i}{TQD_i} \right) * 100 [\%] \quad (3)$$

where:

- $PPQD_i$  – The percentage of goods delivered by the supplier  $i$  that did not match the quality standards [%];
- $OPQ_i$  – The total quantity of goods delivered by the supplier  $i$  that did not match the quality standards [t];
- $TQD_i$  – The total quantity of goods delivered by supplier  $i$  [t];
- $i$  – supplier, where  $i = 1, \dots, n$  ( $n$  – total number of suppliers).



The aimed value of KPI 3.  $PPQD_i$  should be as low as possible.

#### **KPI 4. $PDGS_i$ – The percentage of delivered goods per supplier**

The purpose of KPI 4.  $PDGS_i$  is to calculate the supplier participation rate, thereby avoiding the risk of over-reliance on a single supplier or, if possible, reallocating deliveries from a supplier with a minimal impact on procurement to another supplier. This reallocation aims to achieve better procurement conditions by increasing the purchasing volume. The calculation of KPI 4.  $PDGS_i$  for each supplier individually, is presented with a formula (4).

$$PDGS_i = \left( \frac{TDS_i}{TDG} \right) * 100 [\%] \quad (4)$$

where:

- $PDGS_i$  – The percentage of delivered goods by the  $i$  supplier [%];
- $TDS_i$  – Total quantity of delivered goods of the  $i$  supplier [t];
- $TDG$  – Total quantity of delivered goods from all suppliers [t];
- $i$  – supplier, where  $i = 1, \dots, n$  ( $n$  – total number of suppliers).

The aimed value of KPI 4.  $PDGS_i$  is to be as high as possible.

#### **KPI 5. $PGDP$ – The percentage of goods purchased directly from the plant**

Direct procurement of goods from the plant is, when possible, the best solution for any manufacturer, as it eliminates the profit margin of intermediaries (suppliers). The calculation of KPI 5.  $PGDP$  is presented with a formula (5).

$$PGDP = \left( \frac{TPP}{TPG} \right) * 100 [\%] \quad (5)$$

where:

- $PGDP$  – The percentage of goods purchased directly from the plant [%];
- $TPP$  – The total quantity of goods purchased from the plant [t];
- $TPG$  – The total quantity of purchased goods [t].

The aimed value of KPI 5. *PGDP* is to be as high as possible.

**KPI 6. *PIPG*– The percentage of internal requests for the goods procurement with a delivery time of less than seven days**

Respecting the wishes of customers who require shorter delivery times for final products, it is necessary to procure all the required goods within a very short timeframe (up to seven days) to meet these demands. Procurement costs in such tight deadlines are significantly higher and this approach is not commonly used. However, it does happen because the company cannot disregard customer requests. The calculation of KPI 6. *PIPG* is presented with formula (6).

$$PIPG = \left( \frac{NIRG}{NTR} \right) * 100 [\%] \quad (6)$$

where:

- *PIPG* – The percentage of internal requests for the procurement of goods with a delivery time of less than seven days [%];
- *NIRG* – The number of internal requests for goods procurement with a delivery time of less than seven days [1];
- *NTR* – The total number of requests for the goods purchased [1].

The aimed value of KPI 6. *PIPG* should be as low as possible.

**5 Improvement of procurement process management using Key Performance Indicators in the company Vendom**

A defined set of six KPIs for improving procurement process management was applied in the case of the company Vendom that is engaged in manufacturing and service provision in the metal industry. It has various product ranges, including industrial and residential fences, small steel structures up to 100 [t] and demanding structures for industrial purposes up to and over 1,000 [t]. The company also produces underground and above-ground waste disposal systems, as well as cranes for container unloading. Structures, fences, steel moulds, underground and above-ground waste containers, cranes, steel constructions for buildings and others are

manufactured from various types of steel based on customer requirements or designs by the company's engineers (Vendom, 2025). Vendom procures all raw materials (goods) needed for production from suppliers, so, the procurement department was established to manage this process. The study used real data from this company for the year 2024. Special attention was given to suppliers (16 of them) who predominantly (over 99 [%]) supply the company with necessary goods (sheets, pipes, profiles, bolts, etc.). The implementation of KPIs in the company's procurement sector was carried out in 2024 to optimize procurement through monitoring and measuring the performances of the procurement department. The designed set of KPIs enables management to assess the efficiency of procurement processes and, based on the obtained KPI values, identify areas for improvement and make important decisions to enhance the procurement process.

### KPI 1. $NDCR_i$ – Non-delivery compliance rate by the supplier

Table 1 presents the obtained values for KPI 1.  $NDCR_i$  from which it can be concluded that most suppliers complied with the agreed delivery times, while suppliers 4, 8, and 14 did not, because their delay exceeds 5 [%]. If the same suppliers delay deliveries in the future, proposals for improvement are modification of contracts or terminations of partnerships. Given that the total number of contracts ( $CN_i$ ) is 196 [1] and the total number of contracts with delayed deliveries ( $CNDD_i$ ) is 6 [1], the KPI 1.  $NDCR_i$  is 3.06 [%]. The company believes that the value of this KPI can be reduced to below 2 [%] as the aimed value, through specific actions and agreements with suppliers.

**Table 1: Values of KPI 1.  $NDCR_i$**

Supplier	1	2	3	4	5	6	7	8	
$CN_i$ [1]	53	34	24	17	15	9	8	11	
$CNDD_i$ [1]	1	0	1	2	0	0	0	1	
KPI 1. $NDCR_i$ [%]	1,89	0,00	4,17	11,76	0,00	0,00	0,00	9,09	
Supplier	9	10	11	12	13	14	15	16	Sum
$CN_i$ [1]	4	3	5	4	1	4	3	1	196
$CNDD_i$ [1]	0	0	0	0	0	1	0	0	6
KPI 1. $NDCR_i$ [%]	0,00	0,00	0,00	0,00	0,00	25,00	0,00	0,00	3,06%

Source: Own

### KPI 2. $PNCQ_i$ – The percentage of non-compliance with the delivery of the contracted quantity of goods by the supplier

The calculated values for KPI 2.  $PNCQ_i$  are presented in Table 2.

Table 2. Values of KPI 2.  $PNCQ_i$

Supplier	1	2	3	4	5	6	7	8	
$TCQ_i$ [t]	2180	840	565	207	178	96	64	93	
$TDQ_i$ [t]	2138	822	553	196	168	96	62	87	
KPI 2. $PNCQ_i$ [%]	1,93	2,14	2,12	5,31	5,62	0,00	3,13	6,45	
Supplier	9	10	11	12	13	14	15	16	Sum
$TCQ_i$ [t]	35	25	46	18	7	23	18	5	4400
$TDQ_i$ [t]	33	25	40	18	7	22	18	5	4290
KPI 2. $PNCQ_i$ [%]	5,71	0,00	13,04	0,00	0,00	4,35	0,00	0,00	2,50

Source: Own

It can be concluded that there are issues with suppliers 11, 8, 4 and 5, whose percentage of undelivered goods exceeds 5 [%], considering that the company's aimed value is below 1.6 [%]. If these suppliers continue to fail to deliver the contracted quantity of goods, the proposal for improvement is to modify contracts or even terminate partnerships. The procurement department should consider forming reserves for certain critical raw materials. Given that the total contracted quantity ( $TCQ_i$ ) is 4,400 [t] and the total delivered quantity ( $TDQ_i$ ) is 4,290 [t], the average KPI 2.  $PNCQ_i$  is 2.5 [%]. The company believes that this KPI value can be reduced up to 1.6 [%] through specific actions and agreements with suppliers.

### KPI 3. $PPQD_i$ – The percentage of goods delivered by the supplier that did not match the quality standards

From Table 3, that presents the calculated values for KPI 3.  $PPQD_i$ , can be observed that most suppliers delivered goods that met quality standards. However, during the analyzed period, issues were identified with suppliers 7, 9, 12 and 15, whose percentage of goods with poor quality exceeded 5 [%]. If these suppliers continue to deliver substandard goods, certain measures should be taken to establish partnerships with more reliable suppliers. The value of KPI 3.  $PPQD_i$  should be as low as possible. The company's objective is to be no more than 1 [%]. Given the total quantity of goods delivered by the supplier ( $TQD_i$ ) is 4,400 [t] and the total

quantity of goods delivered by the supplier that did not match the quality standards ( $OPQ_i$ ) is 70 [t], the average KPI 3.  $PPQD_i$  is 1.59 [%]. This value indicates that certain corrective actions need to be implemented to reduce this KPI value to the desired value.

**Table 3. Values of KPI 3.  $PPQD_i$**

Supplier	1	2	3	4	5	6	7	8	
$TQD_i$ [t]	2180	840	565	207	178	96	64	93	
$OPQ_i$ [t]	34	11	9	2	0	0	5	3	
KPI 3. $PPQD_i$ [%]	1,56	1,31	1,59	0,97	0,00	0,00	7,81	3,23	
Supplier	9	10	11	12	13	14	15	16	Sum
$TQD_i$ [t]	35	25	46	18	7	23	18	5	4400
$OPQ_i$ [t]	2	0	2	1	0	0	1	0	70
KPI 3. $PPQD_i$ [%]	5,71	0,00	4,35	5,56	0,00	0,00	5,56	0,00	1,59

Source: Own

#### **KPI 4. $PDGS_i$ – The percentage of delivered goods per supplier**

From Table 4, that shows the calculated values for KPI 4.  $PDGS_i$ , it can be observed that only three suppliers 1, 2 and 3 participate in a total of 81.89 [%] of the total delivered goods. This indicates that the company Vendom mostly depends on the deliveries from these three suppliers, highlighting the issue of their share. Eight suppliers contribute less than 1 [%] of the total delivered goods. Based on the value of this KPI, it can be concluded that the number of suppliers providing exceptionally small quantities of goods should be reduced to enable better contract terms for suppliers with a higher participation rate.

**Table 4: Values of KPI 4.  $PDGS_i$**

Supplier	1	2	3	4	5	6	7	8
$TDS_i$ [t]	2138	822	553	196	168	96	62	87
KPI 4. $PDGS_i$ [%]	49,84	19,16	12,89	4,57	3,92	2,24	1,45	2,03
Supplier	9	10	11	12	13	14	15	16
$TDS_i$ [t]	33	25	40	18	7	22	18	5
KPI 4. $PDGS_i$ [%]	0,77	0,58	0,93	0,42	0,16	0,51	0,42	0,12

Source: Own

**KPI 5. *PGDP*– The percentage of goods purchased directly from the plant**

Considering that out of the total quantity of purchased goods (*TPG*) is 4,400 [t] and the total quantity of goods purchased from the plant (*TPP*) is 3.98 [t], the value of KPI 5. *PGDP* is 0.09 [%]. The company believes that this KPI is at a very low level and should be increased to at least 0.5 [%] in the future, that would lead to a reduction in procurement costs.

**KPI 6. *PIPG*– The percentage of internal requests for the goods procurement with a delivery time of less than seven days**

Considering the total number of requests for the goods purchase (*NTR*) is 196 [1] and the number of internal requests for goods procurement with a delivery time of less than seven days (*NIRG*) is 5 [1], the value of KPI 6. *PIPG* in the company Vendom for the observed year is 2.55 [%]. This is within the desired value range defined by the company Vendom, as it slightly exceeds the aimed value of 2.5 [%].

## 6 Conclusion

This paper presents the application of a selected set of KPIs that can improve procurement process management. The chosen and defined set of KPIs focused on monitoring supplier performance in terms of compliance with agreed quantities, qualities, delivery times and supplier participation. This set of KPIs was applied to a case of the company Vendom from the metal industry. The results showed that there is potential for improvement in the procurement process management in the observed company by implementing certain corrective measures, such as revision and modification of contracts or terminating partnerships in favour of more reliable supplier. Some of the identified shortcomings can also be addressed by improving the efficiency of the procurement department, particularly in creating stockpiles of goods supplied by suppliers who have delays in deliveries, fail to meet agreed quantities or provide substandard raw materials. Additionally, the company should focus on procuring raw materials directly from plants whenever possible. Future research directions of the authors of this paper aim at identifying another set of KPIs to further enhance procurement process management from additional perspectives.

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# REDUCING PRODUCTION COSTS BY MINIMIZING ERRORS IN THE OPERATIONAL PRODUCTION: A CASE STUDY OF COMPANY VENDOM

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Errors in operational production cannot be entirely eliminated, but they can be minimized to reduce their impact on production costs. These errors can affect several aspects, including increased material costs, waste generation, product quality, delivery delays, company reputation, and customer dissatisfaction. By identifying the root causes and applying various methods and techniques, it is possible to determine the most critical and frequent errors in operational production and develop effective corrective measures. The purpose of this study is to illustrate, through the example of the company Vendom, how to minimize costs arising from errors in the operational production, using the FMEA method for error identification. The results of the study is a proposed set of measures to reduce errors in operational production. These measures have a direct impact on reducing production costs.

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## 1 Introduction

Product quality is one of the main conditions for a company to participate in local, regional or global markets since a high-quality product can provide a company with a competitive advantage. Product quality refers to the specificity of a product or service that impacts its ability to meet customers' specific needs (Sun, 2011). According to (Kotler & Armstrong, 2010), product quality is the ability of a product to perform its functions, including overall durability, reliability, accuracy, ease of operation and repair, as well as other product attributes. The good or poor quality of a product depends on the company's ability and standards to continuously meet consumer perceptions. For consumers, quality depends on their expectations of how the product will behave during its use.

Given the greater availability of choices, customer expectations of the products that they purchase grow over time and lead to decreasing tolerance for any type of error. Even minor or seemingly negligible errors become increasingly unacceptable. Customers are not concerned with why a product is defective, they only care that it is defective (Vasiljević et al., 2024). For this reason, modern companies pay special attention to improving operational production processes and internal control of their products, aiming to produce the highest possible quality. Lazibat and Baković (2020) argue that quality control, as a key factor in a company's production results, can be simply defined as the process of ensuring compliance with standards by involving observing current performances, comparing them with the standards and taking appropriate actions if significant deviations are detected.

For a company striving to be competitive in the market, increasing demands are placed not only on the quality of products or services but also on the quality of production and business processes, as well as the reliability of the entire quality system (Kumar, Maiti & Gunasekaran, 2018). This is because achieving functional product quality contributes to increased sales (realization) due to customer satisfaction (user), cost reduction, increased production and the coordinated actions of all participants in a business system (Lazibat, 2003). Errors in operational production cannot be completely eliminated, but they can be minimized in a way that reduces their impact on increasing production costs. These errors can impact material costs, waste generation, product quality, delivery delays, company reputation and customer dissatisfaction. By identifying the root causes and applying

various methods and techniques, it is possible to determine the most critical and frequent errors in operational production, as well as to design effective corrective measures. The first step in reducing production errors is identifying their root causes. Various methods are used for this purpose, such as Pareto Charts, 5 Whys, FMEA (Failure Mode and Effects Analysis), Six Sigma, Fishbone Diagrams and others. By identifying the root causes of errors, priorities can be set for addressing the most critical and frequent problems, that lead to the implementation of efficient corrective actions.

On the example of the Vendom company, this paper presents how minimization of errors in the operational production process, through the application of the FMEA method, can contribute to the reduction of production costs. The paper consists of four chapters. The first chapter provides introductory considerations related to the topic. The second chapter presents the theoretical concepts of the FMEA method, while the third chapter presents a case study of the company Vendom. The fourth chapter presents concluding remarks.

## **2 Failure Mode and Effects Analysis method**

Errors made by humans are one of the main sources of failures in production operations and can arise due to various factors, such as lack of training, tiredness, distractions, stress, lack of concentration, poor communication and others. This type of error can impact the quality, reliability, safety and efficiency of products and processes, leading to customer dissatisfaction, increased waste, additional rework and even product recalls. To prevent or minimize human errors, manufacturers can use various methods, such as one of the most commonly applied, the systematic FMEA method, or analysis of operation modes and effects of failure/breakdown. FMEA is a proactive tool that identifies potential failures, their causes and consequences and prioritizes actions to reduce risks. By using the FMEA method, manufacturers can identify potential human errors that may occur in production operations and assess their impact and likelihood of occurrence (Demirkaya, 2022). The FMEA method can also help determine the root causes of human errors and suggest preventive or corrective measures to eliminate or reduce them.

In the manufacturing sector, FMEA has a crucial role in improving product quality and reliability, reducing waste and inefficiencies and ensuring customer satisfaction (Dobrović, Tadić, & Stanko, 2008). According to the same authors, by identifying potential failure modes and proactively implementing corrective measures, production facilities can prevent costly downtimes, rework and product recalls. The use of FMEA in the production process allows manufacturers to (Demirkaya, 2022):

- Identify and prioritize potential failures and their causes;
- Assess the effects of these failures on the overall production process;
- Develop and implement strategies to mitigate or eliminate these risks;
- Improve process control and product quality.

FMEA is a method that emerged in the 1950s, initially based on safety assessments of military systems in the United States. Due to its reliability, the use of this method quickly expanded not only within the US but also in France, where it was used to assess the safety of air traffic systems. Starting in the early 1960s, NASA adopted an updated version of the FMEA method due to the importance of safety and prevention of accidents in space projects (Stamatis, 2003). Later, in the 1980s, Germany implemented this method in its chemical and nuclear industries. In the second half of the 1980s, Ford's automotive manufacturing introduced the ISO 9000 quality standard to the US automotive industry by using this method, that has been applied worldwide in the automotive sector (Stamatis, 2003). The effectiveness of the FMEA method has also led to its adoption in healthcare centres to improve patient safety and emergency medical systems. Moreover, FMEA is widely used in electronics, chemicals and other manufacturing sectors to identify, prioritize, and address failures, deficiencies, and potential issues (Alizadeh, 2015).

The FMEA method is defined as a tool that prioritizes types of errors with the greatest impact on the entire system, rather than as a method for planning the identification of a large number of errors (Bahadır Ünal & Acar, 2016). The primary objectives of this method are to predict potential errors that may occur in a product or process, take preventive measures to avoid them and determine the degree of impact or criticality of individual types of errors.

In the literature (Mazlan, Yassin, & Kamaruddin, 2023), three types of FMEA are identified: DFMEA (Design FMEA), PFMEA (Process FMEA) and SFMEA (System FMEA). DFMEA primarily focuses on analyzing failure types related to design, helping companies identify and resolve design faults or weaknesses before the product enters production. PFMEA analyzes potential types of failures within the production or assembly process, aiming to prevent or reduce the likelihood of errors occurring during manufacturing. Finally, SFMEA evaluates potential types of failures in a system or subsystem, addressing issues related to component or subsystem integration and their overall functionality. Authors (Dobrović, Tadić, & Stanko, 2008) also mention a Service FMEA model, applying it to service analysis. Considering that the characteristics of services include intangibility, inseparability and the inability to store services, they are crucial in conducting this analysis before the requested service is provided to the user, ensuring the quality of the service and meeting end-user requirements (Dobrović, Tadic, & Stanko, 2008).

The implementation of FMEA in manufacturing involves several steps, where the first is identifying potential failure causes. This step includes identifying all potential factors that could lead to production process delays or defective products. These factors may include equipment failures, process disruptions, human errors and various other issues that can impact product quality. The outcome of FMEA analysis is the Risk Priority Number (RPN), a number calculated as the mathematical product of the values assigned to the Severity (S) of the consequences of a failure, the Probability of Occurrence (O) of the failure and the Detectability (D) of the failure. This calculation is presented by the following formula (1).

$$RPN = S \times O \times D \tag{1}$$

**Table 1: Scale for Determining the Parameter S (Severity of Consequences)**

Grade	Severity of Error Consequences
1-2	Can be neglected
3-4	Minor
5-6	Marginal
7-8	Major
9-10	Extremely significant

Source: Stamatis, 2003

For evaluating the parameters S, O and D are used scales, as shown in Tables 1–3. These scales may include descriptions for each score, depending on the author.

**Table 2: Scale for Determining the Parameter O (Probability of Occurrence)**

Grade	Probability of Occurrence
1-2	Very low
3-4	Minor
5-6	Medium
7-8	Major
9-10	Extremely significant

Source: Stamatis, 2003

**Table 3: Scale for Determining the Parameter D (Detectability)**

Grade	Detection Ability
1-2	Very Easy
3-4	Easy
5-6	Medium
7-8	Difficult
9-10	Very Difficult

Source: Stamatis, 2003

Taking into account the three given scales, the value of the RPN number is obtained, indicating the level of risk, whether is it necessary to respond and recommendations, as presented in Table 4.

**Table 4: RPN Value and Corrective Actions**

RPN Value	Reaction to RPN Value (Corrective Actions):
RPN < 10	No need for action
10 < RPN < 100	Greater adherence to prescribed procedures
100 < RPN < 250	Enhanced monitoring of the production process and introduction of certain corrections
250 < RPN < 400	Significant changes in the production process
RPN > 400	Excessive risk – termination of unprofitable production

Source: Stamatis, 2003

RPN values are listed from highest to lowest, according to the selected criteria. Higher RPN values have greater priority compared to lower to improve the production process, increase product quality and require faster and more efficient responses.

### **3 Case Study of the Company Vendom**

This paper presents cost reduction in the production process through minimizing errors in operational production by applying the FMEA method, using the example of the company Vendom. Company Vendom produces a wide range of products in the metal industry. Real data from this company, collected during 2023, was used for the analysis.

#### **3.1 Company Vendom**

The company Vendom, Limited Liability Company (LLC), Laktasi was founded in 2003. It specializes in manufacturing metal products for both domestic and international markets, with a focus on the international market, primarily various types of waste disposal containers for the EU and South America. The company currently employs 200 workers and has an annual revenue exceeding 10 million euros. Vendom LLC, Laktasi is one of the largest exporters in the metal sector in Bosnia and Herzegovina. The most significant competitive advantages of the company are short delivery times, reliability and quality. The products of Vendom are distinguished by their design, innovation, and quality. The benefits of collaborating with this company for customers include responses to specific client requests and the uniqueness of the company's products, as well as product assembly, servicing and maintenance.

The product range of this renowned company includes industrial and residential fences, smaller steel structures up to 100 tons and demanding structures for industrial needs up to 1,000 tons. Within the Vendom product range, special emphasis is placed on underground and above-ground waste management systems, as well as cranes for container emptying. In addition, the company offers constructions, fences, steel moulds, underground and above-ground waste containers, cranes, steel structures for building construction and various products made of all types of steel manufactured according to customer requirements or solutions designed by the company's engineers.

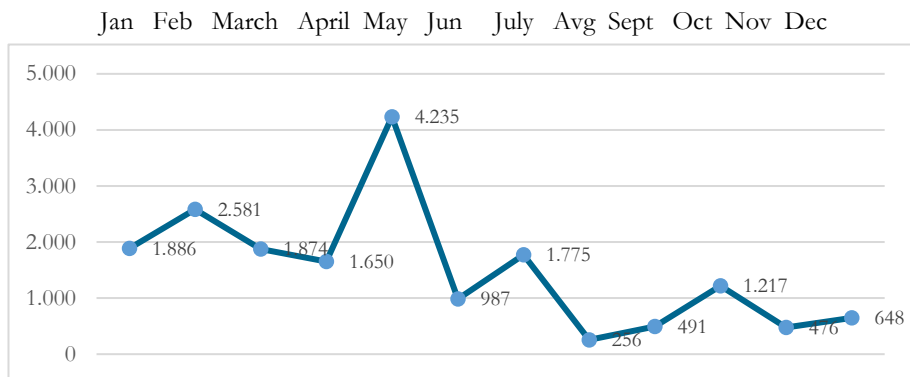
In addition to its products, the company offers services to both domestic and international markets, including laser, plasma and gas sheet metal cutting, sheet metal bending, punching, welding, sandblasting, powder coating, assembly, repair,

reconstruction, concept design, product design and development according to customer requirements or its conceptual solutions. The company annually produces over 2,500 above-ground and underground waste containers, 50 cranes, 100,000 various metal products and more than 30 steel structures (Vendom, 2025).

### 3.2 Identified Issues in the Production of Vendom Company

The company has a reputation as a responsible company delivering proven and recognizable product and service quality. Most errors in the production process that impacted product quality have been identified through internal controls, ensuring that customers, except in exceptionally rare cases, have not received products with quality defects.

In 2023, Vendom incurred total costs of 16,189 [€] due to operational production errors, specifically for repairing or replacing defective products. These costs are shown in Figure 1, with details about monthly expenses related to production errors.



**Figure 1: Vendom company's costs in 2023, due to operational production errors (in [€])**

Source: (Vendom, 2025)

As shown in Figure 1, the highest costs for Vendom due to operational production errors occurred in May 2023. This was triggered by a customer complaint regarding poor joining of mouldings on platforms, resulting in a portion of the delivered platforms being returned for additional welding, leading to extra expenses. In this case, aside from the poorly executed welding operation, internal quality control of finished products also failed, as it did not detect the errors in question. In such cases,



the role of internal quality control is particularly crucial, as it is far more important for the company to identify defects before delivery to the customer. Furthermore, delivered products with legitimate complaints negatively impact the company's positive reputation.

In February 2023, there was also a significant increase in costs due to operational production errors when approximately 200 components were mistakenly sent for galvanizing before welding operations for steel flats had been completed. This indicates a disruption in the sequence of production procedures. The internal quality control detected the error, which was eliminated by first removing the zinc layer through grinding, after which the welding operations were completed and the components were re-galvanized. Additionally, during that month, costs increased due to two platforms being damaged (warped) during transport, necessitating subsequent straightening.

A detailed analysis of production operations, conducted in 2023 using the FMEA method, determined that all operational production errors at the Vendom company, mostly attributed to human resources, could be categorized into five groups (with associated costs for 2023 shown in parentheses):

1. Errors during internal transport (4,582 [€]);
2. Errors in bending (3,968 [€]);
3. Errors in welding (3,192 [€]);
4. Errors in preparation: laser cutting, plasma cutting and others (2,326 [€]);
5. Errors in preparation: saw cutting, eccentric press (2,121 [€]).

Table 5 shows the most common errors, i.e., errors that contributed the most to the costs of the Vendom company, along with the RPN value for each error.

### **3.3 Discussion**

Observing the obtained RPN values presented in Table 5, it can be concluded that for each error, the values range from 12 to 126. By applying the corrective actions recommended by the FMEA method, that correspond to the measured RPN parameter values, as shown in Table 4, the main recommendations for Vendom company to reduce errors in operational production, thereby reducing overall

production costs, are to ensure greater adherence to prescribed procedures and intensify monitoring of the production process, introducing certain corrections.

**Table 5: The most common errors and RPN values for each error**

<b>Internal transport errors</b>	<b>S</b>	<b>O</b>	<b>D</b>	<b>RPN</b>
Warping and deformation of platforms during internal transport	3	4	1	12
Damage during internal transport	4	3	3	36
<b>Errors during bending</b>				
Reverse bending	4	2	5	40
Incorrect countersinking	4	3	7	84
Extremely poor bending leads to scrapping of materials	9	2	3	54
<b>Welding errors</b>				
Incomplete welding	4	4	7	112
Incorrect welding	5	3	6	90
Deformation during welding	5	3	3	45
Poor-quality welding	5	3	6	90
Corrosion due to poor welding	5	3	8	120
Welding instead of assembly	6	2	6	72
<b>Errors in preparation: laser cutting, plasma cutting, etc.</b>				
Warping of components during laser cutting	5	3	3	45
Incorrect countersinking	6	3	4	72
<b>Errors in preparation: saw cutting, eccentric press</b>				
Poorly cut pipes	8	3	2	48
Poorly finished container cladding	6	2	3	36
Incorrectly installed screws	6	3	7	126

To implement these FMEA recommendations and corrective measures, Vendom company introduced certain improvements to its operations. In its production cycle, the company uses state-of-the-art machines and tools, that were in the early stages of operation in 2023. However, the human factor was predominantly responsible for the errors and associated costs. To minimize such errors, the company conducted additional employee training on the operation of these machines and tools. There is a clear issue with internal transport, that significantly contributes to overall costs. During 2023, in the course of transporting finished products, not only the platforms were distorted and deformed, but the products also suffered significant damage. To address this issue and reduce these costs, the company has organized further training for employees responsible for transportation tasks and has invested in acquiring more suitable transport machinery for such products.

The most frequent bending errors arise from the human factor, such as reverse bending of components, incorrect countersinking and extremely poor bending, that rendered the product irreparable and needed to be scrapped. All these errors occurred due to non-compliance with clearly prescribed procedures, unskilled machine handling and a lack of concentration among employees. The recommendation is to further clarify each procedure to employees performing bending tasks to minimize these errors.

The majority of errors in the company occur during welding, typically involving incomplete, incorrect or poor-quality welding. Some errors result from failing to follow prescribed procedures, such as performing welding instead of assembly. The most easily noticeable errors of this type are deformations that occur during welding, while the most problematic are instances of corrosion caused by poor welding. Corrosion often becomes evident only after the product has been delivered, leading to higher costs. To address this, it is necessary to improve the skills of employees involved in welding to minimize such errors and to strengthen internal quality control to prevent the delivery of defective products.

Some errors occurred during the preparation phase, various types of cutting using lasers, plasma cutters, saws and eccentric press which latter being used for the quick forging of small-dimension objects. In these cases, common issues include warping of components during laser cutting, poorly cut pipes, poorly finished container cladding or the installation of incorrect screws. Errors that involve incorrect screws are the hardest to detect and are often only noticed when the product is already in use. In this situation, it is essential to frequently monitor compliance with prescribed procedures to reduce such occurrences to a minimum.

#### **4 Conclusion**

This paper presents the potential for reducing production costs by minimizing errors in the operational production process using the FMEA method in the company Vendom. Based on the obtained results and qualitative analysis of the RPN values for each error, it can be concluded that the company should implement stricter adherence to prescribed procedures, enhanced monitoring of the production process and introduce certain corrections, with internal quality control. The measures implemented based on the application of the FMEA method yielded

results as early as the second half of 2023. This is evident shows a decrease in the company's average monthly costs related to product quality, i.e. costs fell below 1,000 [€].

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# PREDICTION OF STUDENT PERFORMANCE IN A SERIES OF RELATED COURSES OF THE UNDERGRADUATE PROGRAM OF THE DEPARTMENT OF COMPUTER, INFORMATICS AND TELECOMMUNICATIONS ENGINEERING – INTERNATIONAL HELLENIC UNIVERSITY

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It is a fact that educational institutions at all levels are now focusing their attention on analyzing the behavior and performance of their students. The main objective of this study is to examine whether it is possible to predict the grades of students in the Department of Computer, Informatics and Telecommunications Engineering (ICT) at the International Hellenic University (IHU), in a course, based on their performance in previous related courses within real error margins, as well as the optimization of the prediction error. Different models were used for prediction in order to evaluate the performance and impact of each model separately. The goal of this work is to provide significant results regarding the long-term performance of the students. The models used were capable of predicting the performance within the defined absolute error margin.

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## 1 Introduction

Undoubtedly, prediction models are powerful tools for understanding, examining, and interpreting complex phenomena and data for every aspect, as well as academic institutions. For all levels of education, it is a growing tension, to analyze and attempt to predict the students' performance [Devasia, Vinushree, & Hegde, 2016] [Verma, Srivastava, & Singh, 2021] and even inform students for the possible outcome [Dias, Hadjileontiadou, Diniz, J., & Hadjileontiadis, 2020].

In the context of this study, the aim is to explore trends, student profiles, academic outcomes, and to examine whether key prediction models can estimate student grades through a series of related academic courses following the previous statistical research for the bachelors' program [Angeioplastis, Panagis, Tsakiridis, Tsimpiris, Varsamis, 2024]. The main features and data related to the undergraduate program of the Department of Computer, Informatics and Telecommunications Engineering at the International Hellenic University were analyzed.

In this research, the grades of 6 related courses are used to predict the grade in the 7th course in terms of time. This study has been contacted by the open software «*Orange Data Mining*» [Demsar, Curk, Erjavec, Gorup, Hocevar, Milutinovic, Mozina, Polajnar, Toplak, Staric, Stajdohar, Umek, Zagar, Zbontar, Zitnik, Zupan, 2013] to apply the prediction models of Regression, Random Forest, Decision Trees and Neural Networks. Success is defined as the mean absolute error being smaller than one unit for the predictions of students' grades.

## 2 Dataset

The dataset used concerns the set of grades for the 6 selected and related courses: Programming I, Programming II, Object-Oriented Programming, Software Development Environments, Programming Methodology, and Software Technology, which are offered in the undergraduate program of the Department of Computer Engineering, Computers, and Telecommunications at the University of Applied Sciences of Serres. This is under the condition that students have passed the course exam on their first attempt. The data was processed anonymously, respecting the privacy of all students.

### 3 Orange Data Mining

The software chosen for the implementation of these models is the open-source software Orange Data Mining [Scarselli, Gori, Hagenbuchner, & Monfardini, 2008] [Kaur, Stoltzfus, & Yellapu]. Orange Data Mining is an open-source platform for visual data analysis, machine learning, and data mining. It is designed for data analysis and model creation with a user-friendly, visually oriented environment. One of the main features of Orange Data Mining is that it enables visual programming analysis, as it allows users to create data analysis workflows using a graphical interface. Widgets are used to perform various tasks, such as loading data, cleaning data, analysis, and visualization. Additionally, it is a suitable tool for data mining, as it includes a variety of machine learning and data mining algorithms for classification, regression, clustering, and association rule analysis.

### 4 Methodology

The methodology followed as:

1. **Data Extraction:** Data related to students' successful examination attempts on their first try for all courses in the faculty were extracted. The data collection was performed using SQL queries within the database environment, and the final file was converted into a CSV format for easier processing in the Orange Data Mining environment.
2. **Selection of Relevant Course Sequence:** The courses of interest were selected. These include the programming courses: Programming I, Programming II, Object-Oriented Programming, Software Development Environments, Programming Methodology, and Software Technology. The courses were chosen in increasing order of the semester of study.
3. **Importing the CSV File:** The CSV file containing the data was imported into the Open-Source software Orange Data Mining for processing.
4. **Application of Prediction Models:** Prediction models were applied within the Orange Data Mining environment. The prediction models chosen and applied were Multiple Linear Regression, Decision Tree, Random Forest, and Neural Network models.

5. **Evaluation of Results:** The results of the prediction models were evaluated.

## 5 Results

### 5.1 Multiple Linear Regression

The first attempt at prediction was made using Multiple Linear Regression [Montgomery, Peck & Vining, 2021] without normalization, employing the Cross Validation method with various Number of Folds to obtain better results.

**Table 1: Results of Multiple Linear Regression for Each Number of Folds**

Multiple Linear Regression – Cross validation				
Number of folds	MSE	RMSE	MAE	MAPE
2	1.481	1.217	<b>0.875</b>	0.163
3	1.424	1.203	<b>0.855</b>	0.162
5	1.543	1.242	<b>0.881</b>	0.166
10	1.582	1.258	<b>0.910</b>	0.171
20	1.601	1.275	<b>0.933</b>	0.175

It was observed that the model can generate predictions within the target of one unit that was set. The best prediction was with 3 Number of Folds, resulting in a Mean Absolute Error (MAE) of 0.855 and a Mean Squared Error (MSE) of 1.424, while the worst prediction was with 20 Number of Folds, with an MAE of 0.933 and an MSE of 1.601. It is worth noting that the error results remain consistent regardless of how many times the experiment is repeated.

The reason the best predictions come with smaller folds is that this is a relatively small dataset, and using more folds can lead to smaller training and test subsets. With 3 folds, each fold contains a larger percentage of data, which can improve model performance as the model is trained on more representative samples of the data. The dataset is split into three equal parts, and the model is trained on two of them and tested on the third. This process is repeated three times, with each fold being used once for testing.



Additionally, using fewer folds reduces the complexity of the training and testing process, potentially reducing the relative errors. In any case, the target of one unit was achieved for the Multiple Linear Regression model.

## 5.2 Neural Networks

A particularly interesting aspect that we wanted to examine is whether the individual Neural Networks [Agatonovic-Kustrin, 2000] [Rasamoelina, Adjailia & Sinčák, 2020] that we can develop through Orange Data Mining provide results within the target range. After experimenting with various combinations, we settled on the SGD – ReLU neural network model, with 20 neurons, 300 iterations, and 10 folds.

**Table 2: Neural Network with SGD Solver and ReLU Activation Function**

Neural Network SGD – ReLU 20 neurons, 300 iteration				
Number of folds	MSE	RMSE	MAE	MAPE
10	1.440	1.200	<b>0.954</b>	0.176

The forecasting experiments were conducted multiple times to ensure that the results were not due to random chance. The optimal Mean Absolute Error (MAE) value achieved was 0.954.

## 5.3 Decision Tree Algorithm

The next model used to predict the students' grades in the course Software Technology was the Decision Tree algorithm (Suthaharan, 2016) (Priyam, 2013). The choice to create a binary tree result in a simpler and clearer model, where each node has only two branches. This facilitates the interpretation and analysis of the decisions made by the model, as it helps avoid excessive overfitting compared to trees with multiple branches. By setting the condition that no subset should be smaller than 20 observations (Do Not Split Subset Smaller Than: 20), it ensures that the tree does not split into subsets that are too small to provide reliable predictions.

The maximum depth limit (Limit Max Tree Depth) ensures that the tree does not become overly complex for the given range of values.

**Table 3: Decision Tree with Minimum Number of Observations in the Leaves 2 and 10 Folds**

Decision Binary Tree				
Number of folds	MSE	RMSE	MAE	MAPE
10	1.383	1.176	<b>0.806</b>	0.159

As shown, the Mean Absolute Error (MAE) for the model is 0.806, making this decision tree the most reliable model, especially due to the use of 10 folds for cross-validation.

#### 5.4 Random Forest

The last prediction algorithm evaluated is the Random Forest algorithm. For the evaluation of the results of a Random Forest model [Breiman, 2001], it is crucial to ensure that the results are stable and reliable. To achieve this, we applied 10-fold cross-validation, which is common in most machine learning applications. We ran each model with the respective settings 30 times, aiming to ensure that no extreme values outside the target range of one unit occurred.

**Table 4: Largest Value of Mean Absolute Error (MAE) for 200 Trees**

Random Forest				
Number of folds	MSE	RMSE	MAE	MAPE
10	1.477	1.215	0.905	0.175

After several trials, we settled on the choice of 200 trees and an average execution time of the algorithm of 5 seconds across the 30 runs. As shown, there was a significant reduction in the difference between the two extremes, with the Mean Absolute Error (MAE) ranging from 0.870 to 0.905. This indicates that the model is producing reliable and consistent results, with a minimal variance between the runs. The lower bound of the range is 0.870, while the upper bound is 0.905.

## 6 Model’s Comparison

We investigated whether there are statistically significant differences between the predictive models using ANOVA Bonferroni’s test [Judd, McClelland, & Ryan, 2017]. We chose to analyze the results of the algorithms by applying 10-fold cross-validation, which ensures that the model is evaluated on different subsets of the data, providing a reliable estimate of model performance while reducing the impact of randomness. For this reason, the models were selected for which there is evidence that they perform better with this number of folds.

**Table 5:Combination of Models with 10-Folds and Statistical Results**

ANOVA test between the models				
	Random Forest	Multiple Linear Regression	Neural Network	Decision Tree
Random Forest		0.356	0.402	0.575
Multiple Linear Regression	0.644		0.576	0.636
Neural Network	0.598	0.424		0.623
Decision Tree	0.425	0.364	0.377	

The results show that all models achieve the target of the Mean Absolute Error (MAE) being less than one unit. From the statistical analysis of the algorithms and the comparisons between them, p-values greater than 0.05 were obtained, which was set as the significance level of the test. This indicates that there are no statistically significant differences between the models in terms of predicting the grades for the course Software Technology.

## 7 Conclusion

For the sequence of 6 courses followed, the models of **Multiple Linear Regression, Decision Tree, Random Forest, and Neural Networks** were able to provide predictions within the target of one unit for the **Mean Absolute Error (MAE)**. The **Decision Tree algorithm** was the most capable, presenting the smallest error values, while the **Neural Network algorithm** showed the largest error values. After the statistical analysis, it was concluded that there are no statistically significant differences between the models in terms of predicting the grades for the course **Software Technology**. This scientific field remains open for future research, with the application of predictive models to other sequences of

courses. Additionally, the optimization of the model errors for more reliable predictions is left open for further exploration.

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# (UN)SECURE BOOKING: SECURITY RISKS WITHIN FACEBOOK GROUPS ACCOMMODATION RESERVATIONS

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The tourism industry has significantly reshaped with the development of ICT and the Internet. In the contemporary digital world, most tourists utilise Smart Tourism Technologies services to search and book their travels, pay for services, and discover attractions at destinations. The level of security is a significant factor affecting the tourist experience since tourists employ technology to obtain information in all stages of their travel, especially in the first phases, and trust that it is reliable and truthful. Among the most known threats are fake profiles, identity theft, personal data theft, AI fraud, and others. Facebook, a pioneer in social media, hosts various groups related to promoting tourism (advertisements, tourist communities, reviews) or tourism offers (transportation, accommodation, guided tours, equipment sales). There are increasing cases of Facebook booking scams, where users are paying money for tourism services but ending up without paid service. Therefore, this paper focuses on the booking phase by analysing providers' actions within Facebook groups regarding popular tourist destinations such as Amsterdam, Milan, Prague, Istanbul, London, and Dublin. By analysing written and visual content and carefully reviewing group posts and requests, we identified signs of potential security risks that users should be aware of when searching for providers.

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## 1 Introduction

The tourism sector has widely welcomed the new digital era. The use of websites, social media and smartphones is on the rise and pervasive. Tourism today heavily relies on digital platforms, with consumers increasingly inclined to use various applications and websites (Kapera, 2022). We can describe digitalisation as “the integration of digital technologies into everyday life” (Kuhn & Margellos, 2022, pp. 93). Smart Tourism Technologies (STT) are, therefore everyday life of tourists and their travel. Crucial elements of STT services are personalisation, accessibility, an abundance of information, and interactivity; nevertheless, we emphasise another important element, and that is security. The level of security is a significant factor affecting the tourist experience since tourists employ technology to obtain information in all stages of their travel and trust that it is reliable and truthful. Recent trends show that researchers of digital in tourism are focused on malware detection, data mining and support vector machine when working within the cyber community (Sharma et al., 2023). These trends support the statement that cybersecurity is of the utmost importance.

With the increasing reliance on social media for travel-related arrangements, addressing the concerns associated with booking accommodation is essential. Fraudulent listings on such platforms pose a significant risk to travellers, especially those unfamiliar with digital security practices. To examine this issue, our study investigates deceptive accommodation scams by engaging students in a practical experiment and conducting a content analysis of scam-related discussions.

As a notable example of a security vulnerability, we emphasize the risks of booking accommodation via social media, particularly within Facebook groups. The primary objective is to identify potential cybersecurity threats that users should be aware of when searching for accommodation providers, along with suspicious behaviours or indicators that could compromise profile security.

Following an extensive literature review, this work presents examples of counterfeit profiles and deceptive accommodation offers identified across major European cities, including Amsterdam, Milan, Prague, Istanbul, London, and Dublin. Through content analysis, we extracted key indicators of fraudulent listings that could serve as valuable references for future accommodation searches. Grounded in the

Protection Motivation Theory, these findings aim to enhance tourists' cybersecurity awareness and provide them with practical tools to assess the credibility of social media profiles, ultimately enabling safer and more reliable booking decisions.

## **2 Literature review**

Cybersecurity (also called information technology security) is defined as a set of mechanisms for ensuring security for different types of information technology systems, processes, data and information, software, computers, virtual resources, electronic devices, physical infrastructures and people in order to reduce unauthorised access or usage (Villalón-Fonseca, 2022; Kovačić, Čičin-Šain, & Milojica, 2022). This includes online platforms, payment processing systems, customer databases, and communication channels. All of these are widely used by tourists, travel agencies, hotels, airlines, private tourism providers and others. Therefore, the tourism and hospitality sector is not immune to fraud and scams and is facing an extensive increase in cybercrime (Waller & Bartlett, 2022). Studies show that tourists and tourism providers have encountered cyber-attacks, side jacking, point-of-sale attacks, insecure transactions, personal data breaches, and phishing (Ghaderi, Beal & Houanti, 2024). If we focus on scams, “a scam is a form of fraud that is achieved through trickery that results in financial gain for the perpetrator and financial loss for the victim. Scams have proliferated on online sharing-economy platforms, with such scams typically relying on varying degrees of misrepresentation for their success.” (Reid, 2024, pp. 3).

The consequences of listed malpractice can be substantial financial loss, damaged reputation, and broken trust (Ghaderi, Beal & Houanti, 2024). Besides, customers' and employees' personal information (personal identity and contacts) can be compromised (Chen & Fiscus, 2018). Other consequences may be the influence on mental illness symptoms, a feeling of humiliation and worsening of personal relationships (Parsons, Pantridge & Flaherty, 2021). These are the reasons why the tourism sector has to perform cybersecurity risk assessment. Within this process, they identify the critical assets they need to protect, determine the possibility of risk realisation, recognise possible attackers, their motivation and mode of operation, and evaluate the impact of the attack on the organisation (Chen & Fiscus, 2018; Paraskevas, 2020).

All tourism sectors are prone to cybercrime. Several experts have researched tourism providers and their practices with cybersecurity. Florido-Benítez (2024) and El-Maksoud (2024) examined travel agencies and recommended more education on cybersecurity for employees and taking procedures to secure tourism networks to achieve the digital trust of customers. Berezina et al. (2012) focused on the hotel sector and confirmed that guests' credit card information breaches result in lower satisfaction and no revisiting intentions.

In tourism, booking accommodation through online platforms and social media is not a new phenomenon; it is a part of the sharing economy (Pouri & Hilty, 2021) and has been noticed for several years. More specifically, we can refer to it as peer-to-peer (P2P) accommodation, which works through online networking platforms where people rent out available space (a whole property or just a part of it) for a short period of time (Farmaki & Christou, 2019). The market leader is Airbnb, also known is couch surfing and similar organised providers. However, some individuals rent their property through social media.

As known, Facebook is a pioneer in social media. On its sites, there are various groups related to promoting tourism (advertisements, marketing, tourist communities, reviews) or tourism offers (transportation, accommodation, guided tours, equipment sales). There are also different types of scams on Facebook. Joy and Leroux (2024) list 15 types: Defective or counterfeit gadgets and electronic items; Bait and switch; Fake payment receipts; Mouth-watering giveaways; Overpayment by a buyer; Moving conversations out of Facebook; Fake rental posting; Advance payment requests; Asking for confirmation codes; Asking for car deposits; Requesting unnecessary charges; Mailing items; Fake claims of lost packages; Counterfeit money; Clicking a link to fill out more information. Relevant to our study is bait and switch, when tourists rent attractive-looking accommodation, which is later switched with an inferior one. Also important is fake rental posting, which is when scammers post fake rental properties (they do not own them or are not authorized to post them). They request an advance payment as deposits or background check fees from tourists or other interested people for renting the place. However, if a tourist visits the property, it is not available or does not even exist (Joy & Leroux, 2024).



The presented cases can be referred to as “phishing,” a technique used in attacks to steal money, identity, and sensitive data, such as bank account information and passwords (Aleroud & Zhou, 2018). Through Facebook booking scams, the goal is to trick the victim into believing they are communicating with a trusted organisation. There are also scams, where customers believe they are interacting with services such as banks, online stores, or platforms like Booking or Airbnb. Van Der Zee, Clayton & Anderson (2019) call them “rental scammers”, which are described as individuals who engage in advance fee fraud by pretending to be landlords and attempting to deceive victims into paying a deposit for an apartment that is not actually available for rent. These individuals use fake ads and information to create the illusion of offering actual apartments, misleading victims in order to take their money upfront, often before the apartment can even be seen or verified.

As mentioned, there are other social networks and alternative online booking methods. Reid (2024) focused on Airbnb and discovered that the development of Generative artificial intelligence (GenAI) might increase the misconduct behaviour of scammers on sharing-economy platforms. Using GenAI, inauthentic content can be produced quickly and cheaply (for example, aliases, fake profile images, fake property images, and fake property descriptions).

The online environment is highly liable to cybersecurity threats. Taylor, McDougall, Ollis & Alford (2019) examined several websites and analysed the viewers' trust in the website content. The conclusion was that websites can be designed to encourage more or less perceived trust. Therefore, viewers should be aware of the threats and verify “too good to be true” deals. Trust in the host has become a crucial element of online commerce since customers have to feel safe and believe that the purchase will fulfil their expectations without any harm (Nisar et al., 2020).

This statement is supported by the Protection Motivation Theory (PMT). It is defined as a pre-eminent health behaviour theory that emphasises behaviours which protect one's health, reduce risks or increase benefits for a person's well-being (Balla & Hagger, 2024). The concept of health-protective behaviour is also used in other fields, for example, cybersecurity and tourism. Here, PMT helps tourists gain insight into the risks that arise from the digital world. Tourists can identify their vulnerable points by rational thinking about the possibility of harmful events and can prepare to react or respond in appropriate, recommended ways (Ghaderi, Beal & Houanti,

2024). This includes protective measures such as using secure payment methods, caution about sharing personal data online, and checking websites and social media for security indicators. Especially the latter is the focus of this research. Examining different fake Facebook profiles, we tried to identify key security indicators that signal a clear security threat while booking accommodation on social media.

### **3 Method**

After conducting a literature review, empirical data was collected through a practical experiment. Later, a content analysis of written and visual material was conducted to analyse the data. The practical experiment was done with the help of tourism students from the University of Maribor, Slovenia. Within their class about safety and security in tourism, one of the topics was current travelling problems, especially connected with cybersecurity and social media. There, the students were introduced to common fraudulent tactics used in online accommodation scams. That provided them with foundational knowledge on identifying potential threats when searching for rentals on social media platforms, which was their study task. Students focused on “rental scammers” on Facebook.

#### **3.1 Guided Student Task**

The research focused on Facebook groups dedicated to renting apartments in different cities across Europe (Amsterdam, Milano, Prague, Istanbul, London, Vienna, Berlin and Dublin). Firstly, students connected with Facebook accommodation rental groups/individuals and created a post using combinations of words that indicate travellers searching for accommodation rentals. Therefore, they described that they needed an apartment for themselves and their friends; they wrote how long they would stay; and what their budget was. Next, students engaged with responses received, documenting their interactions, observations, and key indicators of fraudulent behaviour. Screenshots of conversations enabled further content analysis and interpretations.

To ensure ethical compliance, all students voluntarily participated in the task and, after completing the exercise, deleted their posts and profiles. The collected data included screenshots of conversations, personal reflections, and comparative

assessments of legitimate versus fraudulent listings. All data is stored with the researchers.

### **3.2 Content Analysis of Scam-Related Posts**

The second phase of the study consisted of an in-depth content analysis of scams identified in open Facebook groups for accommodation search. To detect fraudulent activity, we searched for key terms such as "phishing," "scam," "fake," and "fraud" using a personal account. Materials were mostly URLs of discussions, screenshots, conversations and descriptions of how tourists have been scammed.

We focused on posts from Europe and countries that are popular for their seasonal tourism (Italy, Austria, Croatia, Greece and others). We also searched for the reviews of the tourists who had bad experiences and have been scammed already including discussions on Reddit and Facebook. Reviews from scammed tourists were analysed and helped us to identify recurring patterns, emerging scam tactics, and common characteristics of deceptive listings.

## **4 Results**

Based on our content analysis and discussions, we developed two tables to summarize our findings: (1) key fraud indicators - the most common warning signs of fraudulent listings and (2) recommended best practices for avoiding scams - recommended actions to mitigate risks, which are explained in following chapters.

### **4.1 Scam indicators**

To better understand how rental scammers attempt to deceive their victims, we analysed their posts, comments, and messages. Indicators through which we can conclude that it is a scam are described in Table 1.

**Table 1: How to recognise a rental scam?**

Indicator	Explanation	Example
<b>Fake rental listing</b>	Scammers often create listings for properties that do not exist or are not available for rent. They may use photos and descriptions stolen from legitimate rental websites or hotels.	<ul style="list-style-type: none"> <li>- The accommodation location is in town, but in the pictures, there is a sea.</li> <li>- A listing for a beachfront villa uses photos copied from a luxury resort's website.</li> <li>- The provider sends different (not matching) pictures of the apartment (for example, different styles of one bathroom on more pictures).</li> <li>- The provider says that it is a one-room apartment, but they sent a picture of a studio without the rooms.</li> </ul>
<b>Unusually low prices</b>	Tourist accommodations in popular destinations often come at a premium price. Listings with prices significantly lower than the market average are a red flag for scams. Also, there is something unusual if the rent price is significantly lower than the market value per night/person.	<ul style="list-style-type: none"> <li>- A luxury apartment in a prime tourist area is listed at half the price of similar properties.</li> <li>- Offering a discount/one more night when tourist moves to a private chat with providers.</li> </ul>
<b>Pressure to pay quickly</b>	Scammers create a sense of urgency to pressure travellers into making hasty decisions, often claiming that the property is in high demand.	<ul style="list-style-type: none"> <li>- The provider says that someone cancelled the booking, so they want to give a lower price and mention other tourists are waiting.</li> <li>- The lower price stands only within the next hour.</li> </ul>
<b>Request to pay in advance</b>	Legitimate hosts typically do not ask for full payment or large deposits before the guest has seen the property or signed a rental agreement. Scammers have typical patterns that you need to send them a deposit. They often promise to secure your booking and may provide bank account details that do not match the name of the supposed host or property owner. They frequently request payment through fast transfer services, as these methods allow them to receive funds quickly and make it difficult to trace or recover the money.	<ul style="list-style-type: none"> <li>- After a few exchanged messages, the provider mentions that the guest would need to pay 200 € in advance.</li> </ul>
<b>Moving the conversation or payment to another platform</b>	Scammers may try to move communication or transactions off the original platform to avoid detection and make it harder for victims to report them.	<ul style="list-style-type: none"> <li>- Providers often comment on the post "dm me".</li> <li>- Providers start the chat with the victim on Messenger.</li> <li>- "Let's discuss the details and payment on WhatsApp or email instead of here".</li> </ul>

Indicator	Explanation	Example
<b>Non-verified sender</b>	<p>There are profiles which are untrustworthy. Often, there is a lack of personal details, friends, posts and engagement in general. Scammers often use fake or newly created profiles with no information or activity history. These profiles are designed to disappear after the scam is complete.</p>	<ul style="list-style-type: none"> <li>- A profile with no photos, no friends, and only one post advertising a rental.</li> <li>- The provider is blocked by Facebook, and tourists are notified that he/she was a scammer. FB advised to block them everywhere and not to provide any personal or banking information.</li> <li>- A provider with a profile picture of a little girl who was presenting herself as a middle-aged man.</li> <li>- The profile contains no information, only a profile picture.</li> </ul>
<b>Poor English proficiency and generic responses</b>	<p>Usually, the messages that scammers send are poor in grammar, unity, coherence, presentation, and vocabulary. Messages are usually riddled with errors, incomplete sentences, or overly generic responses. Also, it is hard for them to chat like native speakers, especially in some less-known languages. They may struggle to answer specific questions about the property. They strive for the conversation to keep on going.</p>	<ul style="list-style-type: none"> <li>- The provider does not carefully read tourists' posts since they ask for already communicated information.</li> <li>- The provider posted a generic response: "Hello dear, the apartment is very nice and available. Send payment now to book."</li> </ul>
<b>Inconsistent or mismatched details</b>	<p>Discrepancies between the listing description, information, their role, and location.</p>	<ul style="list-style-type: none"> <li>- Sending an address of the accommodation of another accommodation (for example a rental in Amsterdam that is promoted on other platforms).</li> <li>- The provider represents his/herself as a help in search (not an owner).</li> </ul>
<b>Fake exclusivity or Commitment</b>	<p>Claims that the property is in high demand or requires an immediate commitment to pressure the victim. They use a "limited edition" type of persuasion, which is popular when you want to rush someone to buy something and decide on it. People often don't want to miss the chance.</p>	<ul style="list-style-type: none"> <li>- Provider mentions that the tourist is not the only one and that other people are interested, so the tourist needs to decide very quickly.</li> </ul>
<b>Kindness or Sympathy</b>	<p>Scammers may use overly friendly or emotional language to gain trust.</p>	<ul style="list-style-type: none"> <li>- Almost every conversation starts with "dear".</li> <li>- The provider offers extensive help with the price and searching.</li> </ul>

Scams can be detected from various factors of the provider profile. One of the main factors is the age of the profile (a profile with no history) and profile pictures. Other factors include profiles, which send links to numerous non-credible websites (usually scam sites). Also, when providers are asked for a personal ID document, they send a fake document and immediately delete the conversation. The next factor is money since fake providers often ask for a 200-300 € payment upfront.

#### 4.2 Recommendations for verification

While some individuals may immediately recognise that the profile and post are fake, others may reach out and realise later that the listings and offers are fraudulent. Some users even share advice on how to verify the legitimacy of such offers. It is essential for tourists to ask for more information to avoid falling for phishing scams and fake content.

In accordance with the Protection Motivation Theory, developing a set of criteria is crucial for distinguishing between fake and legitimate profiles, posts, comments, and other related content. Guidelines for tourists are presented in Table 2. However, even if the criteria can be satisfied, it can still be a case of a rental scam because scammers are getting better with time and experience.

**Table 2: Guidelines on how to behave and respond to suspected scams**

Recommendation	Explanation
<b>Verify the identity/profile</b>	Carefully examine the landlord’s or host’s profile for authenticity. Look for signs of a genuine user, such as a history of activity, real photos, detailed information, and interactions with others. Be cautious of profiles that appear incomplete or newly created. A profile with generic stock photos and no friends or reviews is the first “red flag”.
<b>Ask for legal documentation</b>	Request official documents to confirm the legitimacy of the rental. This includes a rental agreement, proof of ownership, or a government-issued ID. Legitimate hosts will provide these without hesitation. Tourists can ask for a copy of the property deed or a utility bill in the host’s name or request a signed rental contract before making any payments.
<b>Use trusted platforms</b>	Book through reputable platforms that verify hosts and properties (for example Airbnb or Booking.com). They are not 100% safe, but they provide secure payment systems and customer support to resolve disputes. Avoid deals arranged solely through social media or messaging apps and avoid booking through unverified Facebook groups or Craigslist.

Recommendation	Explanation
<b>Search for reviews of accommodation</b>	Tourists can look for reviews from previous guests to confirm the legitimacy of the property and the host. Looking for reviews that mention specific details about the property or host can help to recognise whether it is generated or not. They should not forget to be cautious if there are no reviews or if they seem overly positive and generic.
<b>Search for an address in Google Maps</b>	Verify the property's location and existence using Google Maps or Street View. Scammers often list properties in prime locations that don't exist or use fake addresses. Even if the address exists on Maps, there can be many concerns, especially when the listing is in the city centre and when the address leads to other organisation property.
<b>Never share Personal Information</b>	Avoid sharing sensitive information like passport details, bank information, or social security numbers unless absolutely necessary and verified. Scammers can misuse this information for identity theft. They can use your ID, data and information to scam other people, which is a very complicated situation.
<b>Watch for unusual behaviour, inconsistencies</b>	Be cautious if the host avoids answering specific questions, provides inconsistent details, or behaves suspiciously. Scammers often struggle to maintain a consistent story. If something feels off or too good to be true, it probably is. Don't ignore red flags, even if the deal seems attractive.
<b>Search for the same pictures</b>	Use tools like Google Lens or similar to check if the property photos appear on other websites or listings. Scammers often reuse photos from other sources to create fake listings. Do the cross-check listings and search for the same property on multiple platforms to ensure consistency in detail, photos, and pricing. Scammers often create multiple listings with conflicting information.
<b>Consult Local Authorities</b>	Contact local tourism offices or housing authorities to verify the legitimacy of the property and the host. They can confirm if the property is registered or if there have been previous complaints.
<b>Avoid paying in advance</b>	Never pay the full amount or a large deposit before seeing the property or signing a contract. Scammers often disappear after receiving payment.
<b>Ask for the quote and invoice</b>	Request a formal quote or invoice and ensure you receive a receipt for any payments made. This provides proof of the transaction and can be used to resolve disputes. The host should provide a detailed invoice with their contact information.
<b>Make a video call</b>	Request a live video tour of the property or visit it in person before committing. Scammers often avoid showing the property or make excuses for why they can't. The host can also refuse to do a video call or show the property. They can say that accommodation is currently reserved or occupied.
<b>Ask others for opinion</b>	Like on Reddit, tourists can share the listing with friends, family, or online communities to get a second opinion. Others may spot red flags someone missed.
<b>Avoid Wire Transfers</b>	Avoid payment methods that are hard to trace, such as Western Union, cryptocurrencies, or direct bank transfers to unknown accounts. These methods offer little to no recourse if something goes wrong.

The guidelines can help travellers avoid rental scams when booking tourist accommodations online. Some key recommendations include verifying the host's identity, using trusted platforms, and avoiding untraceable payment methods. On the other hand, traditional reservation methods can offer a sense of safety and security. Visiting a local travel agency or directly calling a hotel reduces the risk of encountering fake listings or fraudulent hosts, as tourists are dealing with verified businesses or individuals.

## 5 Conclusion

As shown through the research, there is a need for caution when booking accommodation on social media platforms such as Facebook. While these platforms offer convenience, they also expose users to significant risks, particularly in the context of rental scams. Interestingly, these platforms sometimes have built-in systems to help detect fraudulent listings, and posts from other users who wish to alert others about scams. However, there are cases where users still become victims of fraudulent activities, demonstrating the need for enhanced awareness and vigilance.

Rental scams often involve fake listings, unusually low prices, and pressure tactics to exploit victims. Key red flags include mismatched details, requests for advance payments, generated messages and poor communication. To protect themselves, individuals should verify listings, avoid off-platform transactions, and remain cautious of overly friendly or urgent messages. Awareness of these indicators is crucial to avoiding financial losses and ensuring safe rental experiences.

The recommendations outlined in the paper serve as a practical guide for travellers to navigate the complexities of booking tourist accommodations in an era where scams are increasingly common. By verifying listings, using secure payment methods, and relying on trusted platforms, travellers can significantly reduce their risk of becoming victims of fraudulent schemes. However, it's equally important to recognise that not all listings are scams, and an overly cautious approach can sometimes lead to missed opportunities. The key is to remain vigilant, trust verified sources and seek external opinions when in doubt. Ultimately, a balanced approach will help travellers enjoy safe and hassle-free experiences while minimising the impact of scams on their trust in the booking process.



While this study covered only several scam cases from Facebook groups, further analysis of other platforms should be considered. There are also other aspects of online booking frauds. The role of Artificial Intelligence (AI) in facilitating scams has already been detected. With advanced AI tools, scammers can create more convincing fake profiles, advertisements, and even correspondence, making it even harder for users to detect fraudulent activities. Therefore, research on AI usage will certainly be the focus of future studies.

Based on the Protection Motivation Theory and this research, we can conclude that it is crucial for tourists to learn how to identify key indicators that signal untrustworthy profiles and listings. They should also be aware of how to protect their personal data to avoid falling victim to scams.

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# THE ROLE OF AI IN TRANSFORMING GLOBAL DEVELOPMENT AND SOCIETY

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Technological trends drive change and innovation, shaping how we live, work, and communicate. Artificial intelligence (AI) stands out by transforming society, enhancing work, learning, and daily life. Its adoption across sectors improves efficiency, personalizes processes, and expands resource access. While developed countries rapidly adopt AI technologies, less developed nations face challenges like infrastructure gaps, limited resources, and digital illiteracy, creating a significant development gap. This paper explores AI potential by comparing practices between developed and less developed countries, aiming to identify best practices for inclusive technology application. Special attention is given to the importance of understanding AI's impact on society's future. The paper emphasizes that AI integration is not just a technological challenge but a social responsibility, as it can reduce global inequalities and improve quality of life. Recommendations for strategic AI implementation are provided to minimize risks and negative consequences from improper application and regulation.

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## 1 Introduction

Artificial Intelligence (AI) represents one of the most revolutionary technologies of our time, with the capability to transform global social and economic dynamics. It is not limited to computer sciences but encompasses fields such as healthcare, security, education, arts, and business. Its exponential growth in interest has led to significant research into its impact on society, including technological, legal, and ethical aspects.

The rapid development of AI technologies and their integration into daily processes have transformed the ways we produce, communicate, and innovate. However, this transformation is neither universally accessible nor equally beneficial for all regions of the world. Thus, this paper focuses on the potential and importance of AI for the future of society.

Although there are fears about the societal impact of AI, these concerns should encourage the development of a systematic framework that supports sustainable AI growth rather than hinders it. It is crucial to distinguish science fiction from practical reality and ensure sustainable funding and responsible investment. In doing so, AI has the potential to transform the future of society, the economy, and daily life (Kayid, 2020).

## 2 Creation and evolution of AI

Over the past 20 years, AI has become a topic of global significance, with its applications increasingly surpassing expectations. In this context, various definitions and interpretations of the term exist. However, as Kayid (2020) states, Alan Turing is considered the pioneer of AI with his question, "Can machines think?" and the development of the Turing Test in 1950, which assesses a machine's ability to mimic human intelligence. The term "artificial intelligence" was first used by John McCarthy, associating it with "symbolic artificial intelligence," which remained dominant until the late 1980s (Kayid, 2020).

According to Kayid (2020), AI represents the science and engineering of developing intelligent machines capable of understanding and replicating intelligent behavior. Furthermore, Kayid notes that AI encompasses tools and techniques such as neural networks, genetic algorithms, symbolic intelligence, and deep learning, all of which

have seen exponential growth and impact fields such as healthcare, space exploration, robotics, and the military.

On the other hand, Lu (2019) emphasizes that AI includes methods enabling computers to analyze and simulate human thought processes, performing tasks previously reserved for humans. After 60 years of development, AI has evolved into a multidisciplinary science, now evident in its industrialization and commercialization through emerging trends (Lu, 2019):

- Deep learning and big data – Artificial neural networks enable robots to solve complex tasks;
- Industrial applications – AI is used in image recognition, speech recognition, NLP, and predictive analytics;
- Expanding applications – From services and commerce, AI is spreading to manufacturing and agriculture, standing out as a general and fundamental technology.

The next image shows the subfields of AI.

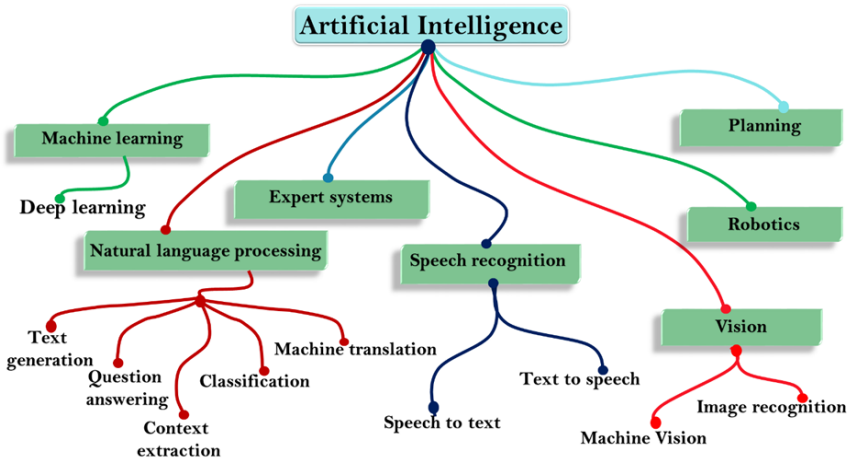


Figure 1: Subfields of Artificial intelligence

Source: Kayid, 2020

The development of AI did not occur in all subsectors at once, so if we look at its progression over time, it unfolded as follows (Lu, 2019):

- Initial Phase (1956–1980): AI was used to solve mathematical problems, prove theorems, and learn languages. A key event was the 1956 Dartmouth Conference, where scientists like McCarthy and Minsky laid the foundations for AI;
- Industrialization Phase (1980–2000): In this phase, the focus shifted to "knowledge processing." The Japanese government launched the Fifth Generation Computer Program, supported by other developed countries, with the goal of developing technologies like image recognition, translation, and human-machine dialogue;
- Explosion Phase (2000–present): This phase began with significant achievements, such as IBM's Deep Blue defeating Kasparov and Google's AlphaGo defeating Lee Sedol. The development of the internet, big data, and GPUs enabled the widespread application of AI in everyday life. The period from 2010 to 2012 was crucial for the development of deep learning, marked by exponential growth in computing power and advancements in distributed computing theory.

### **3 The Impact of AI on Business and Technological Advancement**

Many authors have explored the impact of AI on innovation. For example, Allam (2016) emphasizes that AI has enormous potential to transform innovation, particularly in situations where traditional innovation management methods are limited. AI allows for faster and more efficient data processing, uncovers new opportunities, and helps overcome innovation challenges. He recommends that organizations implement AI into their innovation strategies to gain competitive advantages, accelerate innovation processes, and improve customer experiences. Allam (2016) also discusses AI's significant potential to accelerate innovation and change the way products and services are designed, but notes that companies must radically alter their approach to innovation to fully leverage the benefits AI offers.

Bahoo et al. (2022) in their study highlight the crucial role of AI in corporate innovation. In their conclusion, they provide recommendations for companies on how to integrate AI into their business strategies, particularly in the context of

business models and production. They suggest that all companies, regardless of size, consider adopting AI, while advising industrial manufacturing companies to encourage the use of AI technologies to gain a competitive edge, including the establishment of a specialized department for AI management.

Gama & Magistretti (2023) explore the role of AI in innovation and its impact on organizations and industries. They note that AI is regarded as a key technology that not only enhances an organization's internal capabilities but also supports decision-making, product and service development, and innovation processes. They recognize AI as a crucial technology for innovation across various industries and applications but also highlight that its implementation requires new competencies and the ability to interpret data effectively.

While Lu (2019) points out that future artificial intelligence will have the ability to adapt to humans through language, gestures, and emotions, and that people will live simultaneously in both physical and digital spaces, Kayid (2020) underscores that the advancements in AI provoke both excitement and concern about its potential to surpass human abilities in many areas.

Heng et al. (2022) mention that, despite the different definitions, terminologies, and techniques, the contribution of AI to improving individual well-being is recognized. They also predict that AI-based technologies will drive economic stimulus in the world's largest industrialized economies in the foreseeable future.

#### **4 AI and global development**

Achievements in AI and the popularity of various tools are not equally distributed. They are particularly not accessible in developing countries, where limited access to cutting-edge technologies and inadequate infrastructure present significant challenges.

According to research by PwC, the potential of artificial intelligence could increase global GDP by \$15.7 trillion by 2030, highlighting its importance for global economic growth. However, the benefits of AI technologies are primarily concentrated in developed countries, while developing nations lag behind due to limited access to modern technologies and infrastructure. This creates a significant

gap in the ability to utilize AI tools and potential economic benefits (Mannuru et al., 2023).

The study by Mannuru et al. (2023) investigated the impact of generative AI technologies on developing countries, analyzing both the positive and negative effects across various domains. The aim was to identify the opportunities and challenges that generative AI brings to these nations, with a focus on employment and industrial growth, which will be discussed in the following section.

#### **4.1 Impact on Employment**

Speaking of the positive impacts, it is noted that generative AI has the potential to transform the labor market in developing countries through (Mannuru et al., 2023):

- Overcoming language barriers, which helps in translation and language education;
- Development of technological skills and improvement of employees' digital literacy;
- Increasing employer efficiency by automating routine tasks;
- Providing accessible training for skill development;
- Creating new job positions related to AI work, such as prompt engineering.

However, generative AI can also have negative impacts on employment, including (Mannuru et al., 2023):

- Automation of administrative tasks, such as data entry and customer support;
- Reduced demand for certain skilled jobs, such as programming;
- Loss of opportunities for artists and creative professionals due to automation.

#### **4.2 Impact on Industrial Growth**

Speaking of the positive effects of generative AI on industrial development, the following points are mentioned (Mannuru et al., 2023):



- Increased efficiency: Automation saves time and resources;
- Improved productivity: Employees can focus on more creative and complex tasks;
- Better decision-making: Analyzing large datasets enables more precise strategic decisions, especially in product development and marketing;
- Encouraging innovation: Enables the creation of new products and services that were previously not feasible;
- Enhanced customer experience: Personalized interactions with clients and the application of technologies like facial recognition and telemedicine.

However, generative AI also brings risks, which include (Mannuru et al., 2023):

- Overreliance on AI: This can weaken a company's ability to make decisions without the aid of technology;
- Bias and discrimination: AI models can reproduce existing biases from the data they were trained on;
- Security challenges: Vulnerabilities in AI systems can lead to the theft of sensitive data;
- Job loss: Automation may render certain professions obsolete;
- Ethical concerns: The generation of inappropriate content, such as fake news or deepfake materials, can negatively impact society.

The study concludes that developing countries have the opportunity to leverage the potential of generative AI, but careful consideration of the challenges is necessary to ensure balanced and sustainable growth.

## **5 Risk and the future of AI**

AI and discussions about its potential applications have become a topic of polarized debates about the future, encompassing a wide range of utopian and dystopian fantasies (Arora et al., 2023). In their paper, Arora and colleagues (2023) focus on the ambiguity of risks associated with the potential benefits and potential harms linked to the future of AI.

Bailey et al. (2022) argue that it is crucial to develop our understanding of AI as a new technology, whose uses and effects are still not clearly defined and are yet to stabilize into recognizable patterns.

Arora et al. (2023) place special emphasis on algorithmic bias, which is a direct function of the quality of the data used to train AI algorithms. This bias is effective only for those populations for which training data is available. They also introduce the concept of "data colonialism," linked to the term "Global South," where clean data and the development of algorithms are refined for the benefit of those in the Global North who use these algorithms.

Heng et al. (2022) define the Global South (GS) as "a group of countries that are rapidly adjusting to the industrialization of their economies". These are countries trying to leverage the growing demand for innovative products and services to negotiate the adoption of new technologies like AI, which can help them further stimulate economic growth and become influential in shaping policies that could improve global development. However, the same authors also point out that poorly directed AI adoption strategies pose the risk of neglecting the social, economic, and cultural needs of these countries, which could ultimately lead to the implementation of technologies that do not meet the needs of their users.

In this regard, Arora et al. (2023) propose a relational approach to risk, which should be useful for policymakers in developing new AI laws, taking into account technological changes and development in line with the digital maturity of each country and region. Policies should address the rights and ethics not only of AI users but also of those developing these technologies, particularly marginalized groups, since data colonialism contributes to inequalities. This approach would help in understanding the complex interdependencies between risks and policies, as well as differences in AI regulation across regions, which would enhance global cooperation. Furthermore, an effective approach to ethics requires multidisciplinary collaboration among all key stakeholders, including innovators, policymakers, and the public. It is also emphasized that it is important to prevent marginalized populations from being excluded from AI innovations, ensuring their inclusion in development, not just the distribution of technology (Arora et al., 2023).

In this context, Heng et al. (2022) conducted a study aimed at providing guidelines on how to conduct a comprehensive analysis of the AI ecosystem in Global South countries, to assess their readiness to adopt and effectively use these technologies. For this analysis, they conducted a qualitative case study of two Global South countries, Senegal and Cambodia.

The examination of the AI ecosystems in these countries revealed the need to stimulate their societies (e.g., through media exposure, education, etc.) to recognize the practical effects of AI. Additionally, they emphasized that successful AI implementation requires mutual fulfillment of the needs of the various stakeholders involved in the process. Aderibigbe et al. (2023) highlight that key actors, including governments, companies, and educational institutions, must work together to improve infrastructure, education, and skills, while public-private partnerships play a crucial role in creating a conducive ecosystem for AI implementation.

The authors Heng et al. (2022) provided specific recommendations at the level of academic, industrial, and government institutions in these countries, suggesting that they focus on better directing their resources to energize (and optimally allocate) their research and entrepreneurial capacities. These efforts could help identify ways in which AI solutions can add value within these countries. Aderibigbe et al. (2023) also emphasized that it is essential for actors to proactively leverage the opportunities that AI provides. This includes using AI for sustainable agriculture, improving healthcare accessibility, and encouraging innovative approaches to education. They also note that the challenges and opportunities of AI in developing countries transcend national borders and that global collaboration is crucial for sharing knowledge, best practices, and resources.

International organizations, technology companies, and research institutions can play a pivotal role in supporting developing countries on their AI implementation journey. Therefore, the integration of AI in developing countries is a dynamic process that requires joint efforts, strategic planning, and a commitment to inclusivity. The potential benefits are enormous, and by collectively addressing the challenges, key stakeholders can pave the way to a future where AI serves as a catalyst for sustainable development, leaving no one behind (Aderibigbe et al., 2023).

## 6 Conclusion

The ability of AI to automate processes, reduce costs, and increase efficiency brings significant changes and has become a key driver of innovation. In the healthcare sector, it enhances diagnostics, enables precision medicine, and optimizes healthcare services, particularly in rural and remote areas. Its application in sustainable development helps address global challenges such as climate change, agricultural production, and resource management. Smart cities utilize AI to optimize traffic, improve energy efficiency, and enhance the quality of life, demonstrating how technology can contribute to sustainable solutions. Simultaneously, AI enables personalized education and workforce reskilling, offering new opportunities for learning and professional development. In this regard, AI plays a crucial role in transforming global development and society, shaping the aforementioned and many other sectors.

However, the use of AI carries significant risks. Inadequate implementation can deepen social inequalities between wealthy and impoverished regions. While automation creates new jobs, it also threatens traditional industries, leading to economic insecurity and increased unemployment in certain sectors. Ethics and privacy emerge as critical challenges in the AI era, as it is essential to protect user data, prevent discrimination, and ensure the fair application of technology.

While developed countries rapidly adopt these technologies, less developed nations face challenges such as a lack of infrastructure, resources, and digital skills, exacerbating global inequalities.

Key challenges faced by AI communities in Serbia, Croatia, Montenegro, and North Macedonia in fostering collaboration often stem from differences in regulatory frameworks and approaches to innovation. Each of these countries has specific legal regulations regarding AI, data protection, and ethical standards, complicating the harmonization of legal aspects of cooperation. Additionally, the approach to innovation and the level of support provided by governments to AI sectors vary significantly, resulting in different paces of development and implementation of new technologies. The lack of uniform financial incentives and investment opportunities also represents a barrier to more effective regional collaboration. Despite these

challenges, there is strong motivation to strengthen joint initiatives, with a need to align legal norms and promote transnational AI projects<sup>1</sup>.

To overcome the challenges faced by less developed countries, Serbia is making significant efforts in the development of AI, as reflected in the adoption of the Artificial Intelligence Development Strategy for the period 2025–2030. With this strategy, Serbia became the first country in the Southeast European region to take a significant step in managing AI development, positioning itself as a regional leader. This achievement has also been recognized through Serbia's presidency of the Global Partnership on Artificial Intelligence (GPAD)<sup>2</sup>.

In the future, the focus must be on the sustainable and inclusive application of AI, as it can become a tool for societal progress only if developed in alignment with global standards and ethical guidelines. It is crucial to ensure equitable access to technologies and guarantee that all segments of the population benefit from their advantages. Global collaboration in the development and regulation of AI is essential for minimizing risks and negative consequences while maximizing its potential to improve quality of life and reduce social inequalities. AI is not merely a technological challenge but also an opportunity for social responsibility, capable of shaping a fairer and more prosperous future.

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<sup>1</sup> <https://web-mind.rs/vestacka-inteligencija/kako-funkcionise-ai-zajednica-u-zemljama-regiona/>

<sup>2</sup> <https://nitra.gov.rs/lat/ministarstvo/vesti/usvojena-strategija-za-razvoj-vestacke-inteligencije-u-republici-srbiji-za-period-od-2025-do-2030-godine>

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# KOMPETENCE TRENERJEV ALPSKEGA SMUČANJA

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Kompetence predstavljajo skupek znanj, spretnosti, izkušenj in stališč, potrebnih za učinkovito delovanje v vsakdanjem življenju, pa naj bo to na delovnem mestu, ali pa pri domačih opravilih. Na področju dela kompetence predstavljajo pomembno vlogo in nič drugače ni tudi v alpskem smučanju. Pri alpskem smučanju trenerji in vodje ekip potrebujejo specifične kompetence, da lahko uspešno vodijo športnike. Uporaba teh kompetenc v praksi je ključna za razvoj športnikov in doseganje vrhunskih rezultatov. Tehnične veščine so glavne, poleg tega pa ne smemo zanemariti sposobnost vodenja, motiviranja ter strateškega načrtovanja samih treningov in tekmovanj. Namen prispevka je ugotoviti ključne kompetence trenerjev alpskega smučanja, potrebnih za uspešno izvajanje trenerskih nalog. Ugotovljeno je bilo, da je za uspešnost trenerjev pomembno, da razpolagajo tako s tehničnimi kot z mehкими kompetencami, med katerimi izstopajo motivacija in prilagajanje treningov posameznikom.

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# COMPETENCIES OF ALPINE SKIING COACHES

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Competencies are the set of knowledge, skills, experiences and attitudes needed to function effectively in everyday life, whether at work or at home. Competencies play an important role in the world of work, and this is no different in Alpine skiing. In alpine skiing, coaches and team leaders need specific competencies to be able to lead athletes successfully. Putting these competencies into practice is crucial for the development of athletes and the achievement of top results. Technical skills are key, but the ability to lead, motivate and strategically plan the training and competitions themselves should not be neglected. The aim of this paper is to identify the core competencies of alpine ski coaches needed to successfully perform coaching tasks. It was found that it is important for coaches to possess both technical and soft competencies for their success, among which motivation and adapting training to individuals stand out.





## 1 Uvod

Uspešnost in učinkovitost pri delu povezujemo s kompetentnostjo posameznika. Brez ustreznih kompetenc posameznik težko kvalitetno opravlja svoje delo, pa naj si bo to neko enostavno delo ali pa zelo zahtevno delo. Kompetence so skupek spretnosti, znanj, izkušenj, veščin, ki jih posameznik implementira v prakso. V kolikor so posamezniku jasne njegove kompetence, si že v začetku lahko izbere delo, ki mu je pisano na kožo in ga veseli, s tem pa se tudi poveča njegova produktivnost in zadovoljstvo pri delu.

Alpsko smučanje je zelo priljubljen zimski šport, ki vključuje smučanje po strminah na označenih progah. Obstajajo različne discipline, kot so slalom, veleslalom in smuk. Njegovi začetki segajo daleč nazaj, ko so ljudje smuči uporabljali za lažje premikanje po snegu. Prvi zametki organiziranih smučarskih tekem so se pojavili v 19. stoletju v Alpah (Švica, Avstrija). Alpsko smučanje kot tekmovalni šport na mednarodni ravni pa so priznali leta 1924, ko je bilo prvič vključeno v olimpijske igre (FIS, 2025).

Kompetence igrajo veliko vlogo pri trenerjih alpskega smučanja. Poleg generičnih kompetenc so pri njih še posebej pomembne specifične kompetence, da lahko uspešno vodijo športnike oz. športno ekipo. Prenos teh spretnosti v prakso igra ključno vlogo pri razvoju in napredku športnikov. Trenerji morajo svoje metode in pristope prilagoditi vsakemu športniku posebej ali pa na dinamiko celotne ekipe. Trenerji tako poleg tehničnih veščin uporabljajo mehke veščine kot so komuniciranje, motiviranje, vodenje ter strateško načrtovanje tekmovanj in treningov. Sposobni morajo biti tudi komunicirati z drugim osebjem in delovati v timu.

V tem prispevku raziskujemo kompetence alpskih smučarskih trenerjev. Ugotovili smo, da je za uspešnost in učinkovitost trenerjev pomembno, da razpolagajo tako s tehničnimi kot z mehкими kompetencami (kot sta motivacija in prilagajanje treningov posameznikom).

## 2 Teoretične osnove

Koncept kompetenc je raznolik in širok, ker se prilagaja kontekstu in strokovnemu področju. V poslovnem svetu predstavljajo kombinacijo znanj, veščin, izkušenj in osebnih lastnosti, ki omogočajo, da posameznik uspešno opravi svoje delo. Na akademskem področju pa so vključena specifična področja znanja kot tudi širše sposobnosti (kritično razmišljanje, timsko delo, komunikacija). Teorije kompetenc poudarjajo različne vidike od sposobnosti vedenja in odnosov do merjenja rezultatov. Nekatere so osredotočene na cilje dela in specifične naloge, medtem ko druge obravnavajo širši kontekst kot sta družbena dinamika in organizacijska kultura. Kljub različnim definicijam in vidikom je pomembno, da tako podjetja kot posamezniki poznajo pomen razvoja in uporabe kompetenc. Kompetence so temelj za uspeh, napredek in prilagajanje v različnih okoljih.

Kompetence so celovita kombinacija znanj, veščin in stališč, ki omogočijo uspešno delovanje posameznika (EU, 2019). Znanje obsega dejstva, podatke, koncepte, ideje in teorije, ki so uveljavljene in pomagajo razumeti določeno področje ali temo. Veščine predstavljajo sposobnost izvajanja različnih procesov in samo uporabo znanja, da se dosežejo specifični rezultati. Stališča odražajo našo miselno naravnost, ki oblikuje naš način delovanja in odzivanja na ideje, ljudi in situacije.

Formalno in neformalno učenje ter praktične izkušnje pomagajo razvijati kompetence posameznika. Torej lahko rečemo, da so kompetence dinamične in prilagodljive glede na spremembe v delovnih okoljih. V današnje hitro spreminjajočem se okolju brez ustreznih kompetenc posameznik ne more delovati. Razvoj, identifikacija in upravljanje sami kompetenc so temelj za učinkovito upravljanje s človeškimi viri, omogočajo pa tudi upravljanje z novimi izzivi, izboljšajo konkurenčnosti in uspešnost organizacij (Hron, 2004).

Splošne kompetence človek razvija vse svoje življenje, pri čemer ima vsaka oblika učenja pomembno vlogo, naj si bo to formalno izobraževanje ali pa vsakodnevne izkušnje. Ta proces poteka v okoljih, kot so domače okolje, izobraževalne institucije, delovna mesta ali skupnosti. Kompetence niso ločene ena od druge, ampak se med seboj prepletajo in se krepijo.

Specifične kompetence vključujejo strokovna in tehnična znanja ter veščine, ki so ključne za uspešno izvajanje poklicnih nalog. Zahteve po kompetencah se razlikujejo glede na delovno okolje, poklic in industrijo. Pri poklicih (zdravnik, odvetnik) so nekatere kompetence nenadomestljive in zahtevajo točno določeno izobrazbo, medtem ko je v drugih poklicih (voznik, kadrovik) potrebna kombinacija znanj in izkušenj. Prenos teh kompetenc med poklici je lahko enostaven ali pa zahteven, vse je odvisno od narave dela (ZRSZ, 2024). Specifične kompetence so usmerjene v uspešno delovanje na določenem delovnem mestu, pogosto so vezane na specifično dejavnost (pek – mora točno vedeti, kdaj je kruh pečen). Specifične kompetence navadno niso uporabne v popolnoma drugih poklicih. Poleg tehničnih znanj vključujejo specifične kompetence tudi socialne in vedenjske veščine, ki pa omogočijo prilagoditev spreminjajočim se razmeram in ohranijo posameznika konkurenčnega. Dandanes diploma ni več zadosti, saj delodajalci iščejo posameznike z dodatnimi, prenosljivimi veščinami, ki povečujejo zaposlitvene možnosti in zagotovijo uspeh na delovnem mestu (Imam, Abas-Mastura, Imam, & Osman, 2018).

Za uspeh športnikov je pomembno, da ima njihov trener razvite prave kompetence. Na eni strani imamo tehnične kompetence na drugi pa so potem socialne kompetence. Prve so povezane s tehničnim vidikom poznavanja alpskega smučanja, kot na primer razumevanje tehnik alpskega smučanja, planiranje treningov, uporaba opreme, varnost itd. Socialne kompetence pa vključujejo komuniciranje, vodenje, motiviranje. Ker pa je to šport, ki se hitro razvija (predvsem v tehničnem smislu) je pomembno, da se trenerji nenehno izobražujejo in usposablajo, da so lahko prilagodijo novim izzivom in trendom alpskega smučanja.

## **2.1 Smučarska zveza Slovenije in Združenje učiteljev in trenerjev smučanja Slovenije**

Smučarska zveza Slovenije (v nadaljevanju SZS) je nacionalna panožna zveza, ki je včlanjena v Olimpijski komite Slovenije. Skupina smučarskih društev sestavlja SZS. Ta društva se ukvarjajo z različnimi disciplinami – alpsko smučanje, nordijska kombinacija, skoki, deskanje, biatlon itd. Društva so povsem avtonomna in se združujejo po panogah (SZS, 2024).

Zgodovina zveze sega v leto 1920, ko je v Bohinju potekalo neuradno državno prvenstvo v smučarskih tekih in skokih. Leta 1938 je skupina Gorenjskih športnih delavcev v okviru Jugoslovanske športne zveze predlagala ustanovitev zveze. Do leta 1948, ko je bila potem ustanovljena zveza, so se smučarski klubi zbirali v centrih na Jesenicah, Ravnah na Koroškem, Mariboru in Ljubljani. Slovenske tekmovalke in tekmovalci so predstavljali največji delež skupne federacije, zato je imela SZS najpomembnejšo vlogo. Po osamosvojitvi je Mednarodna smučarska zveza (FIS) sprejela SZS v svoje vrste in leta 1992 na olimpijskih igrah so tekmovalci že nastopali pod slovensko zastavo (SZS, 2024).

Zveza združuje preko 220 društev, znotraj katerih več kot 2300 tekmovalcev tekmuje v različnih disciplinah na vseh stopnjah. Zveza je pravna oseba zasebnega prava, ki ima svoj znak, žig in zastavo. Aktivno sodeluje z drugimi športnimi organizacijami ter se povezuje tako da državni kot na mednarodni ravni. Namen zveze je, da uresničuje skupne in nacionalne interese na področju smučanja, zagotavlja organizirano in skladno izvajanje smučarskih dejavnosti, krepi materialni položaj, s čimer se razvije množični šport ter zagotovi zastopanje in sodelovanje na mednarodni ravni (SZS-statut, 2022).

Združenje učiteljev in trenerjev smučanja Slovenije (ZUTS) je bilo ustanovljeno leto 1936. Trenutno obsega več kot 3300 aktivnih učiteljev in trenerjev smučanja. Delovanje ZUTS obsega sedem komisij, povezanih s športnimi panogami. Komisije so odgovorne za izobraževanje in usposabljanje strokovnih kadrov na vseh ravneh (ZUTS, 2024). Namen delovanja ZUTS je, da skrbi za strokovno usposobljenost trenerjev in učiteljev vseh disciplin, izvaja enotni program usposabljanja in program slovenske šole smučanja, uresničuje skupne interese, razvija vrhunski smučarski šport, zastopa in predstavlja slovenske šole smučanja, povezuje domače ter tuje institucije, zagotavlja strokovnost svojih kadrov, skrbi za enotnost in strokovnost učnega programa, podeli licence učiteljem in trenerjem ter vodi razvoj učiteljev in trenerjev smučanja in organizira družabne in športne prireditve za člane (ZUTS - Poslovnik, 2020).

Znotraj ZUTS se zavedajo, da je za doseganje visokih standardov na terenu potrebna kakovost učiteljev in trenerjev. To dosega z odlično izpeljanimi tečaji in seminarji, najnovejšo literaturo in zanesljivimi ter izkušenimi demonstratorji. Demonstratorji aktivno sodelujejo s tekmovalnimi selekcijami in klubi SZS, kjer pomagajo izboljšati

tehniko vrhunskih smučarjev. Največ časa se posveti usposabljanju novih učiteljev alpskega smučanja na različnih stopnjah, kjer svoje bogate izkušnje prenašajo na nove generacije in tako zagotavljajo odličnost slovenskega smučarskega znanja.

### 3 Raziskava in diskusija

#### RAZISKAVA

Namen raziskave je bilo dobiti vpogled v kompetence alpskih smučarskih trenerjev. Preverili smo ali se teorija in praska skladata ter kakšne so potrebne in kakšne so dejanske kompetence, ki jih potrebujejo trenerji alpskega smučanja. V raziskavi je sodeloval trener, ki je v svoji karieri sodeloval v ekipi za svetovni pokal, saj so v takih ekipah zaposleni le najboljši trenerji, poleg tega pa morajo imeti razvite odlične veščine za obvladovanje take ekipe. S tem trenerjem smo izvedli krajši pogovor z vnaprej sestavljenimi vprašanji (podkrepljenimi s teoretičnimi osnovami).

V raziskavi smo zasledovali dva ključna vprašanja:

1. Katere so potrebne in dejanske kompetence trenerjev alpskega smučanja?
2. Katere kompetence bo moral trener alpskega smučanja imeti v prihodnosti, da bo uspešno vodil ekipo?

Zanimalo nas je, katere kompetence so najpomembnejše pri opravljanju trenerskega posla v alpskem smučanju. Pomembno je, da trenerji obvladujejo širok spekter kompetenc. To vključuje tako tehnično znanje kot vodstvene sposobnosti, nadalje so pomembne tudi organizacijske spretnosti. Ker so trenerji tudi učitelji ne gre zanemariti pedagoške sposobnosti. Ker se spremembe dogajajo zelo hitro tudi v alpskem smučanju, je pomembno, da ima trener sposobnost prilagodljivosti na spremembe. Visoka stopnja tehničnega znanja in strokovnosti je danes ključnega pomena za uspešnost trenerjev. Trenerji morajo poznati tehniko smučanja in iz tega zgraditi taktiko, ki jo potem morajo znati prenesti na svoje tekmovalce. Ker so odgovorni za načrtovanje in organizacijo treningov, koordinacijo prevozov, rezervacijo opreme in prog ter logistiko tekmovanj, morajo imeti dobro razvite organizacijske spretnosti. Trenerji morajo znati oceniti pogoje na terenu, zato da lahko prilagodijo trening, poleg tega pa je pomembna tudi improvizacija, saj nikoli ne veš kakšne bodo razmere na prog. Podnebne spremembe in tehnološki napredki

v ospredje postavljajo prilagodljivost in spremembe k pristopu do treningov. Napredne analitične metode in digitalna orodja zahtevajo, da trenerji poznajo nove tehnologije. To pa jim omogoča vodenje treningov na vrhunski ravni kar pripomore k izboljšanju rezultatov tekmovalcev.

Trener mora učinkovito komunicirati s svojo ekipo, torej so veščine komuniciranja zanj zelo pomembne. Da pa trener motivira tekmovalce, vzpostavi pozitivno in zaupno delovno okolje, mora imeti dobro razvite vodstvene sposobnosti. Za uspešno vodenje ekipe je pomembno da poznajo psihologijo športa, saj le tako lahko prilagajajo pristop glede na osebne značilnosti vsakega člana ekipe.

Trenerji morajo skrbeti tudi za svojo kondicijsko pripravljenost in zdravje, saj jim to omogoča, da uspešno izvedejo naloge v zahtevnih pogojih alpskega smučanja.

V prihodnosti bodo zagotovo izstopale mehke veščine, med njimi čustvena inteligenca in empatija. Ne smemo zanemariti tudi sposobnost uporabe pravilnega komunikacijskega sloga, posebej pri mlajših generacijah, kjer bo zahtevan individualiziran pristop. Trenerji bodo morali z oprtimi rokami sprejeti nove pristope in metode tehnike, ki bodo temeljile na raziskavah in inovacijah. Pomembna bo širitev mreže stikov, saj jim bo to omogočalo dostop do vrhunskih pogojev za treninge in tekmovanja. Da pa bodo ostali konkurenčni, bodo morali slediti globalnim trendom in praksam.

Trenerji bodo morali pristopiti k svojemu delu zelo celostno. Prilagodljivost, digitalne spretnosti, tehnično znanje, pedagoška odličnost in vodenje so kompetence prihodnosti v alpskem smučanju, ki je zelo kompleksen in hitro se spreminjajoči svet.

## DISKUSIJA

Trenerji v alpskem smučanju nosijo težo odgovornosti, saj so tisti, ki usmerjajo, motivirajo in prenašajo svoje znanje na tekmovalce. Od trenerjev alpskega smučanja se zahteva mnogo več kot samo tehnično znanje. Trenerski poklic se razvija v smer, kjer kombinacija pedagoških, vodstvenih, tehničnih in organizacijskih kompetenc omogoča izgradnjo uspešnih ekip ter zagotavlja razvoj ekipe v dinamičnem okolju.

V prihodnosti pa bodo spremembe na področju tehnologije, logistike in športne psihologije dodatno preoblikovale profil uspešnega trenerja.

Raziskava nam je pokazala, da so za alpske smučarske trenerje pomembne tako trde kot mehke kompetence, ki so prikazane v tabeli 1. Mehkih kompetenc se je težko naučiti, zato mora trener biti prava oseba za ta poklic. Sposoben mora biti učinkovito komunicirati v timu, motivirati ekipo in sprejemati hitre in pravilne odločitve, še posebej v nepredvidljivih razmerah, ki so v alpskem smučanju pogost pojav.

Alpsko smučanje je šport, ki vključuje kompleksne logistične operacije (organizacija treningov, reševanje zapletenih potovalnih razporedov, pogoji na terenu). Dobro organiziran trener ne olajša življenja le tekmovalcem in celotni ekipi, ampak zagotovi večjo učinkovitost pri treningih in tekmovanjih.

Hiter tempo življenja in nenehne spremembe (podnebne spremembe, tehnološki napredek) diktirajo trenerjem, da se prilagodljivi. Trener mora hitro reagirati na vremenske pogoje, nepredvidene situacije na progi in spremembe v načrtih treningov.

Delo trenerja v alpskem smučanju zahteva veliko fizične kondicije in odpornosti, saj velikokrat delajo v zahtevnih vremenskih razmerah in terenskih pogojih. Po drugi strani pa mora biti trener tudi sposoben psihološko pristopiti k tekmovalcu. Tekmovalci se soočajo z visokimi pričakovanji in tukaj mora trener nastopiti kot mentor in podpora. Razumevanje individualnih potreb in značilnosti posameznikov je bistvenega pomena za grajenje zaupanja in spodbujanje razvoja potenciala.

Trde kompetence pa trenerjem zagotavljajo izvedbo kakovostnega treninga in pravilno pripravo tekmovalcev na tekmovanja. Trenerji morajo biti izkušeni, poleg tega pa nenehno izpopolnjevati svoje znanje, da lahko sledijo trendom in tehnologijam v športu. Tako ostajajo konkurenčni na mednarodni ravni.

Tehnologija je v alpskem smučanju postala nepogrešljiva. Napredna orodja za analizo smučarskih tehnik, GPS-sledenje, senzorji za merjenje biomehanike in programske opreme za taktično pripravo tekmovanj postavljajo trenerje pred izziv, da osvojijo vsa ta nova znanja. Uspešen trener ne le, da mora znati uporabiti ta orodja, znati mora tudi interpretirati podatke in jih potem uporabiti v praksi.

**Tabela 1: Mehke in trde kompetence trenerjev alpskega smučanja**

MEHKA KOMPETENCA	TRDA KOMPETENCA
Sposobnost komuniciranja	Poznavanje tehnike in metod smučanja
Motiviranje in motiviranost	Poznavanje metod postavitvev
Vodstvene sposobnosti	Primerna izobrazba
Sposobnosti odločanja	Usposobljenost
Iznajdljivost	Izkušenosť
Prilagodljivost	Znanje

Vir: Lasten

Prihodnost kompetenc trenerjev alpskega smučanja je tesno povezana z novimi trendi, razvojem tehnologije in spremembam v alpskem smučanju. Mehke veščine, kot so čustvena inteligenca in empatija posajajo ključnega pomena. Čutiti in razumeti posameznika, še posebej nove generacije, je osnova za učinkovito in prilagodljivo delo. Mladi so bodo vedno bolj primorani spopadati s psihološkimi pritiski, zato je pomembno, da trenerji razumejo športnika ne zgolj kot izvajalca tehnik, ampak tudi kot celovito osebnost. Dolgoročno bodo bolj kot tekmovalni uspehi pomembni odnosi med trenerjem in športnikom. Empatija lahko okrepi zaupanje in rast posameznika.

Generacijska raznolikost bo vedno bolj zahtevala inovativne pristope. Prilagodljivost trenerjev na nove tehnologije, raziskave in inovacije, ki se hitro razvijajo, bo ključnega pomena za njihovo konkurenčnost. Pomembno je, da trenerji niso zacementirani v starih metodah, ampak sprejemajo in uporabljajo nove tehnike, ki jih ponuja sodoben čas.

Globalizacija pomeni, da so informacije in prakse prosto dostopne. Vendar pa bo pomembno, da jih trenerji prenesejo tudi na lokalno raven. Torej bodo morali biti odprti za sodelovanje v širših omrežjih, kar pomeni izmenjevanje znanj, spretnosti in dobrih praks s tujimi trenerji ter sodelovanje z eksperti. Samo s širjenjem mrež stikov, tako lokalno kot globalno, si bodo zagotovili dostop do vrhunskih pogojev za treninge.

Trener prihodnosti ne bo le tehnični strokovnjak, ampak bo tudi odlični pedagog, inovator in ekspert za tehnologijo, vsestranski vodja, psiholog in mentor. Njegova vsestranskost bo v prihodnosti igrala ključno vlogo v uspehu alpskega smučanja na globalni ravni.



## 4 Zaključek

Vloga trenerjev v alpskem smučanju je izjemno kompleksna in ključna za razvoj in uspeh te športne discipline na nacionalne in globalnem nivoju. Od trenerjev ne pričakujemo le dobro tehnično znanje, ampak tudi vrsto mehkih in organizacijskih veščin, s katerimi lahko učinkovito vplivajo na razvoj svojih tekmovalcev. V hitro spreminjajočem se okolju alpskega smučanja so kompetence, kot so prilagodljivost, sposobnost motivacije športnikov, razumevanje psihologije, organizacijske spretnosti, sposobnost uporabe novih tehnologij in vodstvene sposobnosti, nepogrešljive za doseganje top rezultatov.

SZS kot organizacija prinaša pomembno podporo in strukturo za razvoj smučarskih disciplin. Pomemben je pomen nenehnega usposabljanja, izobraževanja in nadgrajevanje znanj trenerjev, ki morajo biti pripravljeni na prilagajanje metodologij na podlagi globalnih trendov, raziskav in inovacij. Slovenija lahko ohranja svojo konkurenčnost in uspešno vlogo na svetovni smučarski sceni le z vlaganjem v razvoj trenerjev, njihovih kompetenc in širjenjem strokovnih mrež. S tem se ne prispeva le k uspehu tekmovalcev, ampak k širjenju ugleda in razvoja alpskega smučanja ter športa v celoti.

Zanimivo bi bilo raziskati kako lahko smučarske zveze bolje podprejo trenerje pri razvoju vseh teh ključnih kompetenc. Raziskati bi bilo potrebno tudi kako naj trenerji uravnotežijo vsa ta raznolika pričakovanja brez izgube kakovosti na posameznih področjih. Spremljati bo potrebno tudi ali se bodo kompetence prihodnosti trenerjev alpskega smučanja res razvijale v tako smer kot je izpostavljeno v tem prispevku.

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# »SACRED HALLS VS PUBLIC MALLS?« THE PARADOX OF UNIVERSITY CULTURE IN A COMPETITIVE AGE

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This study examines the success factors of the Budapest University of Economics and Business (BGE/BUÉB), focusing on its organisational cultural development. We attempt to explore how organisational culture can improve the level of market-oriented behaviour and support success in higher education. Efforts before 2020 to capture the University's culture (Heidrich et al, 2022) laid the foundation for the ViVa (Vision and Values) Project, a unique initiative in Hungarian higher education aimed at cultural development. Between 2020 and 2024 ViVa involved all 800 full-time staff, with special roles for a dedicated organising team and 40 so-called 'culture ambassadors' i.e. non-managerial staff chosen by colleagues. Serving as an ambassador was regarded as a position of trust, with direct influence on ViVa's processes and outcomes at a university with a history of merging three, previously independent colleges in 2000. This paper reveals links between organisational strategy, culture and values tied to market-oriented behaviour. The authors argue that market-oriented culture is integral to how effectively a model-changing university can adapt within its competitive market space.

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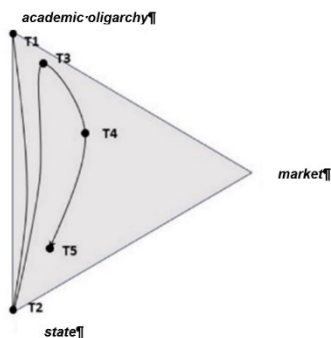
## 1 Introduction

At the end of the twentieth century, universities adopted expressions from the increasingly dominant economic and business sectors (e.g. ‘key performance indicator’, ‘quality assurance’, ‘return on investment’ etc.), which many researchers viewed as the definitive collapse of the classic concept of ‘*the*’ university (Scott, 1984), (Reeves, 1988), (Halsey, 1992). Gradually, these processes eroded the foundations of the university’s self-image rooted in the 19th century. Our study focuses on one of the most significant aspects of this change: the market orientation of higher education (particularly universities) and the internal cultural transformations that may influence its deepening.

The phenomena of the past two decades or more (such as the diversification of higher education structures, the Bologna Process, the chancellor system, some institutional restructuring, etc.) have clearly led Hungarian universities to respond to the increasingly diverse demands of a more heterogeneous cohorts of students (Hrubos, 1998), (Polónyi-Kozma, 2020). Until 2000, Hungary had been characterised by a large number of educational institutions and a relatively low rate of participation in higher education compared to the European average. However, following the launch of the Bologna Process, an unprecedented number of students were admitted, and the perspective that views higher education as a market service came to dominate even in Hungary (Lengyel, 2021). Our study – along with the academic-teaching profiles of its authors – pays particular attention to the business and economics disciplines, which are so closely aligned with this perspective.

### 1.1 The theoretical background of the topic in focus

One of the starting points of our thinking is Clark’s model (Clark, 1983), which assumes a three-actor structure: according to his findings, higher education can be interpreted within the ‘state-market-academic oligarchy’ triangle, where the relationship between these three segments defines the operational modes of a given higher education system. Hungarian higher education has undergone changes that have led nearly every higher education institution to place greater emphasis on market orientation today. This idea can be linked to Day’s (1994) general observation, which states that the atmosphere of market instability and increasing competition leads to a more intense market orientation in many organisations.



T1 = pre-communist era, T2 = soviet era, T3 = Humboldtian restoration,  
T4 = transition period, T5 = back to the future?

**Figure 1: The Development of Hungarian Higher Education Interpreted in Clark's Triangle**

Source: Kováts-Heidrich-Chandler, 2017

The trend analysis of the changes experienced by Hungarian higher education over the past three and a half decades (i.e. since the systemic change in 1990), along with the analytical review of higher education literature, has been receiving increasing attention (Polónyi-Kozma, 2020). From the literature review, it can be concluded that higher education – due to its strong social embedding – can and should be examined in conjunction with external factors (e.g., labour market, social mobility, economic efficiency, cultural values, etc.). As a result of all these factors, higher education expansion, institutional and training structures, as well as institutional management itself, have been shaped and developed (Temesi, 2016). The question that this study also seeks to answer is: how a changing organisational culture and subcultures of higher education institutions can support the much-needed market orientation?

By the early 2000s, clear signs of the 'entrepreneurial university' model emerged (Hrubos, 2004). Therefore, due to exogenous factors, the bureaucratic higher education system of the socialist era could transform into a system with economic and academic autonomy after the systemic change of 1990. Successive left-wing and conservative governments shared the stance that the university association model was being moved towards the corporate model. Looking outward, the corporate university model began to dominate the academic world in much of the developed

world, which is a form of this association-corporate model (Hrubos, 2017). Business and corporate terms, indicators, and correlations started to appear increasingly in higher education. This is confirmed by Freeman's (1992) assertion that twelve of the twenty chapters of the ISO9001 standard could be directly transferred to the higher education sector. Regarding the international environment of higher education, the European University Association (EUA), which was established in 2001 and functions as the European Rectors' Conference, previously held an unquestionable principle that higher education is a public good. However, this has shifted towards a market-oriented thinking that has been present to some extent in higher education for decades (Hrubos, 2017), (Kovats et al., 2017).

This paper puts its foundations on the Cameron-Quinn (1999) organisation model in which market orientation is introduced. Market orientation can vary to some extent from organisation to organisation: ranging from those that are truly market-oriented to those that are not market-oriented at all, there are all sorts of organisations (Kasper, 2005). In the same context, market orientation is defined as: 'the degree to which an organisation's ideas and actions are guided by the market behaviour of the organisation itself and its consumers (whether internal or external)' (Kasper, 2005 p. 6). Although market orientation is not the only factor through which a competitive advantage can be gained, according to Day (1994), information about market trends can also be obtained through the following: creating an environment that enables open information flow; analysing the actions of competitors; understanding the opinions of employees on the front line; uncovering latent needs; actively monitoring the market and supporting continuous experimentation. In order to gain adequate information on its presence in the academic scenario, researches focused on factors to be developed from the MARKOR scale, namely Student Orientation, Competition Orientation and Cooperation Orientation. (Heidrich et al., 2022)

## **1.2 Introducing Budapest University of Economics and Business**

The higher education institution featured in this case study is a player in the Hungarian business education market, and it has perhaps never before been in a situation where market orientation has come to the forefront so strongly. The strength of the Budapest University of Economics and Business (BGE in Hungarian) lies in being one of the most practice-oriented business universities on

the Hungarian market, with a dominant market share. At the strategic level, the institution's leadership has already accomplished the first steps, including enhancing the practice-oriented nature of education, strengthening corporate collaborations and projects, and increasing corporate scholarships for students, which had not previously existed.

The Budapest University of Economics and Business (BGE/BUEB) is Hungary's leading institution for business education, training more than 18,000 students in the field of economics, including programmes in tourism and hospitality, international business, commerce and marketing, finance and accounting, management and business, business informatics, and human resources. Its three faculties operate in Budapest: the Faculty of Commerce, Catering and Tourism (KVIK), the Faculty of International Business (KKK), and the Faculty of Finance and Accounting (PSZK). Since 2000, the three faculties have been operating under one institutional umbrella; however, due to their different traditions, profiles, and the fact that they are located on three separate campuses, they have effectively functioned as three independent organisations, each maintaining its own distinct identity. The BGE/BUEB employs approximately 800 full-time colleagues in teaching, research, or other professional-administrative roles.

In addition to the aforementioned characteristics, the situation was further complicated by the fact that, as a higher education institution, the organisational structure of BGE/BUEB is divided into academic (or directly academic-related) and non-academic (support) areas. Moreover, at the time of launching this project, a dual power structure (rector and chancellor) was in place. Due to the existence of this dual power base and concerns over the autonomy of the faculties, there was a long-standing lack of executive leadership to promote a unified identity for BGE/BUEB.

## **2 Change of culture: the ViVa project 2020-2024**

The development of culture was initiated by the university's rector, with preliminary discussions forecasting a three-year process. The primary objective of the project was to strengthen the BGE/BUEB identity and enhance collaboration between the faculties, as well as to establish the primacy of the university's identity over that of the individual faculties. The latter was particularly important because further centralisation and organisational restructuring were expected in the distant future.

The rector of the university asked Human Telex Consulting (HTC)<sup>1</sup> to provide professional direction for the project. Both parties were committed from the start to ensuring that as many elements of the project as possible would be realised using the university's own resources. A joint project steering committee was established, consisting of three consultants from HTC and three colleagues from BGE/BUEB, each active in different areas (referred to as the ViVa Organising Team). The committee's first step was to 'name the child' and it decided to call the culture development process ViVa, which was formed by combining the words 'vision' and 'values'.

ViVa is a multi-step, long-term initiative aimed at establishing a new, collaboratively developed and accepted set of values with everyone's active contribution. These values, along with their associated norms, guide the university's strategy, support daily collaboration, and positively shape the community by fostering an understandable, liveable, lovable, and strong organisational culture.

The ViVa initiative, which can be considered unique in Hungarian higher education, was based on inclusion: all full-time colleagues at BGE/BUEB (nearly 800 people) were involved, with the ViVa organising team and the current 35 ambassadors elected by colleagues playing a central role. It was a great honour and trust to be a culture ambassador, as they had a direct impact on the ViVa processes and the shaping of the university's culture. Developing an organisational culture of this nature is typically a multi-year process, with its results becoming truly evident in the long term. Below, we will analyse what had happened by 2024, what steps had been taken, and the outcomes of the project.

## **The ViVa Process Overview: year by year**

### **Year 2020**

The events of 2020 can be summarised as a period of 'postponement.' This delay was due to two main factors: the general disruption caused by the Covid-19 pandemic and tensions within the university's senior management (stemming from

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<sup>1</sup> On HTC: . <https://htconsulting.hu/en/>



the dual leadership structure). The postponement initially preserved hopes for in-person, large-group programmes to take place.

## **Year 2021**

To support cultural development internally, a group of ‘culture ambassadors’ was established. Uniquely for the university, their selection was based on departmental (organisational unit) voting, and to encourage broad participation, managerial staff were excluded from candidacy. This democratic process not only enhanced the ambassadors’ legitimacy but also ensured that diverse perspectives were represented. However, practically, around 75% coverage was achieved as many organisational units initially struggled to understand this novel initiative within the higher education context. By 2021, it became evident that the planned large-group, in-person events could not proceed. Both the consultants and the university had to adapt to the idea of delivering the programme through online events. Following the creation of the university’s vision (mission and strategy), it was necessary to agree on the values underpinning this vision. Thus, we focused on defining these values and any associated norms. This iterative process unfolded in the following steps:

1. Proposal of values (initiated by senior management, involving 10+ people).
2. Joint interpretation and validation by ambassadors (40+ people).
3. Large-group interpretation and validation through voting (600+ participants).
4. Finalisation by a panel of senior managers and ambassadors (10 people).

The same process was repeated for the development of behavioural expectations and norms associated with the values. This process took four months. The outcomes were continuously communicated through BGE/BUEBS’s various communication channels, embedding the ViVa values and norms into the university’s narrative. It was also clarified exactly what the organisation means by the given value (i.e., what it supports and what it does not support as a norm).



**Figure 2: The chosen and accepted five values**

Source: own

In the second semester, the large-scale programmes continued with initiatives tailored specifically to individual organisational units. These workshops were entirely facilitated by the ambassadorial team, whose preparation was carried out by the external consultant, HTC. The aim of these sessions was to address the question, “*Alright, we’ve got values and norms displayed on the wall, but what do they actually mean to us?*” The focus was on how to interpret the vision, values, and norms of BGE/BUEB at the organisational unit level and what actions each unit could take to strengthen BGE/BUEB as an institution. Additionally, the workshops explored how these norms could manifest in everyday work—how they could be implemented during an average workday. Units (i.e. departments) were invited to agree on initiatives aimed at improving team atmosphere and efficiency. Many units successfully did so, while several proposals were also submitted for leadership approval regarding actions that would impact the university as a whole.

One of the notable aspects of any project aimed at influencing soft factors is that disruptive elements inevitably emerge. The most significant of these were not the ones like ‘my internet/camera/microphone isn’t working’ or ‘our Zoom licence supports 100 participants, but 140 are trying to join’ or ‘what’s the point of all this?’ or varying abilities to interpret the content or ‘I’m a university professor, why should this matter to me?’ or the blurred line between ‘not mandatory but strongly recommended participation’ or the trade union’s unique interpretation of its role but the one that was the announcement of the university’s transition to a new operational model during the process.

**Table 1: Norms to support and not to support**

	COLLABORATION	EXPERTISE	COMMITMENT	DEVELOPMENT	TRUST
WE SUPPORT	each other	prudent, high-quality and accurate work	active actions to implement the objectives of the BGE/BUEB	continuous learning from our colleagues, students and the outside world	respectful and open communication
	listening to each other	exchange of professional ideas and sharing knowledge among ourselves	representation of organisational values in everyday life	sharing the best of our knowledge and experience	transparent operation
	team work, in which everybody participates according to their abilities and actively	working out, considering and implementing new ideas	the 'I work well even if they do not see me' approach	experimenting, attempting, learning from failures	acting according to the 'I do as I say' principle
	honest and positive feedbacks and constructive criticism	professional renewal, regular professional self-education	representation of BGE/BUEB identity	openness to change, development of adaptability	empowering, making decisions at the right levels
	efficient sharing of information in every direction	absorbed expert work	proactivity	continuous development of processes	good intentions, supporting expertise
	WE DO NOT SUPPORT	each other's humiliation	sloppy and superficial work	the 'who cares?' approach	lack of flexibility
negative labelling		the 'it's good enough, just tick it off' approach	speaking ill of the BGE/BUEB	pigeon-holing	distorting the truth
finding scapegoats, pointing fingers at each other		application and representation of outdated professional knowledge	stopping at the first difficulty	laziness	hiding and covering up errors
favouritism, violating the principle of equal treatment		the 'free rider' approach, when people do not take their shares of common work	violation of accepted norms and values	treating colleagues as unequal partners	prejudices

Source: own

This change fundamentally shook and disrupted the community's perception, daily routines, and, in some cases, even their sense of security. The previous state-maintained structure and its associated civil servant status were replaced by a foundation-led model governed by the Hungarian Labour Code, with a notable shift toward 'business thinking' ('market-orientation') within the university. This change and the accompanying uncertainty made it more difficult for staff to genuinely believe in the importance of culture. However, there's always a silver lining - the ViVa project provided a kind of anchor or a stepping stone for the shared future. It also served as the sole platform where colleagues could connect across campuses during an otherwise extremely isolating COVID-affected period. Meanwhile, in the continually transforming organisation, the ambassadorial team had to be repeatedly restructured.

## **Year 2022**

As a student-centred organisation, our original intention was to focus on the student experience, potentially involving BGE/BUEB's 18,000 students in the process in some way. However, the organisational reality required us to focus on more fundamental aspects due to general organisational inertia and the particularly taxing wave of organisational changes. This also necessitated a thorough rethinking of the planned steps. The revised concept was approved by the university's senior management at the beginning of 2022.

The primary focus was placed on the top-priority value: *COLLABORATION* - to be interpreted both within organisational units and between them. Meanwhile, the ViVa initiative began establishing its own cultural traditions: large-scale (60–120 participants) "community-wide" spring events, which took a lighter and more engaging approach, cutting across organisational units to introduce key themes. These were then made more tangible through autumn workshops held within individual units.

The general perceptions showed several things:

- 1) Since culture development was essentially a soft process, from the beginning, we aimed to produce as many tangible and perceptible results for the participants as possible. In addition to their own actions, the teams also made numerous requests

to the management which the management responded to slowly, but in bundles. For example, organised leadership training started under the coordination of HR.

2) As a new element, a one-day culture development programme for the entire senior and middle management of BGE/BUEB was also announced, focusing on the collaboration between leaders and their role in promoting cooperation within their teams. A total of 59 leaders gave an average score of 9.56 (on a 10-point scale) in a satisfaction sheet, showing that the management team was beginning to appreciate the process.

3) In May and June, it was finally made possible to work with large groups in person during the so-called Culture Days (8 sessions, with 610 participants, which means about 76% of BGE/BUEB's staff). The focus was on sharing experiences of existing collaboration excellence (using our own appreciative inquiry method), and we also provided our own collaboration experiences (in an environment where this was not at all obvious). By this time, more than half of the university population was already aligned with the ViVa process, and despite a relatively small minority (6-8%) showing strong resistance, the biggest achievement was turning around the initially hesitant or even sceptical third of the staff. A small but culturally shaping element was the introduction of informal addressing one another, which was not common at the university.

4) In the second half of the year, the gradually 'battle-hardened' ambassador team invited organisational units to local workshops once again. A completely new element was that the individual units gave their leaders a mandate to negotiate with two other leaders from different units to discuss and develop cooperation between them. The participants left the workshops enriched with direct feedback, which is common in the training profession but not typical in university life.

5) The ViVa's 'citizenship' was demonstrated by the fact that in 2022, the university's performance evaluation system introduced the ViVa work, i.e., the work done to develop the university culture, as a separate category, even though it was recognized to a small extent.

## Year 2023

During the spring semester, the entire BGE/BUEB staff community participated in half-day workshops centred around the value of *DEVELOPMENT*. These sessions aimed to align the organisation on the importance of personal and professional development. The ViVa organisational culture development project gained national recognition. It received the prestigious *Imre Lövey Award* (named after the respected organisation developer, thinker, writer)<sup>2</sup> to for the best organisation development project of the year. The award was presented by the Hungarian Society for Organisation Development. This milestone highlighted BGE/BUEB's commitment to cultivating a forward-thinking workplace culture. In the autumn, over 50 workshops were organised across various units within the organisation. These small-group training sessions were facilitated by ambassadors to explore the value of growth. The initiative ensured that all employees had the opportunity to engage and contribute. The workshops promoted dialogue and shared understanding around growth-focused values. The programme's structured approach fostered collaboration and alignment across teams. By involving all units, the effort reinforced the importance of shared organisational values.

## Year 2024

During the spring semester, the first ViVa event conducted in English was launched to include the non-Hungarian-speaking staff. This marked a significant step in fostering inclusivity and a shared sense of belonging. Half-day workshops were again conducted for the entire BGE staff, this time focusing on the value of *EXPERTISE*. Separate programmes were tailored to meet the specific needs of academic and support staff. The workshops encouraged the exchange of best practices and expertise across teams. This season's initiatives emphasized BGE/BUEB's dedication to quality and professional growth.

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<sup>2</sup> <https://szmt-hu40.webnode.hu/lovey-imre-dij/>

### 3 Conclusion

What could be learned during the different phases reinforced the idea that such a project cannot be communicated enough. One of ViVa's great merits is that we communicated continuously about both the process and the results, initially in newsletters and later on the intranet. ViVa values became embedded in the university's narrative. Internal interviews about the ViVa process were also conducted with the initiating leader, the Rector, along with university milestones. Another great achievement was that since 2022, the ViVa process has been included in the university's onboarding process, and we have been trying to continuously involve new colleagues in ViVa.

ViVa as one might have expected served other goals beyond its original purpose. Having started in the crisis period of Covid times, this project remained the sole platform for all the colleagues to communicate and belong to the community. Furthermore, when it had turned into real presence events, people of the three distant campuses of the university began to know each other after working together formally for decades. The exposed values also became part of the individual performance evaluation system of the university.

At the same time, it must be admitted that – although organisational change was almost continuous – there is room for improvement e.g. in the field of communication by using channels more precisely and predictably; finding more creative solutions to engage the community more; highlighting more intensely the credibility of the ambassadors; and finally handling resistance well. Since results were constantly measured through surveys, it is evident that ViVa became an integral part of the university's normal organisational functioning and practically became the most comprehensive interdisciplinary 'movement' connecting faculties and units beyond their boundaries.

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# AFTER FOREVER – THE CONTINUITY MODEL OF FAMILY BUSINESS GOAL SETTING: A THEORETICAL FRAMEWORK AND PRACTICAL APPLICATIONS

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This study introduces a continuity model grounded in goal-setting theory to examine the formulation and influence of goals on the continuity of family businesses. Rooted in Tagiuri and Davis's (1996) three-circle framework, the model integrates the dimensions of family, business, and ownership, highlighting their individual and collective impact on goal-setting processes. Empirical findings emphasize the importance of explicit and latent goals within the family dimension, organizational objectives shaped by resource availability, and the critical role of leadership in aligning these goals. The research highlights the leader's personality values and entrepreneurial orientation—including risk-taking, innovation, and strategic vision—as central determinants in the establishment and execution of business strategies. Findings from the wine industry illustrate how leaders effectively reconcile personal, familial, and organizational goals while adapting to internal and external moderating factors, such as generational transitions and dynamic market environments. The model bridges theoretical insights and practical applications, offering a robust framework for academics and practitioners to enhance the continuity and sustainable growth of family enterprises.

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## 1 Introduction

The continuity and long-term viability of family businesses hold significant importance. While many of these businesses operate successfully for extended periods, most encounter considerable challenges and often fail to survive generational transitions. Ward's studies (1987) revealed that two-thirds of family businesses fail to survive their first generational transition, and only 10% reach the third generation.

In Hungary, owners of family businesses established during the post-political transition era have now reached an age where transferring leadership and ownership has become inevitable. Similar trends are observed in Central and Eastern European countries, where the challenges are comparable, yet examples of successful transitions and established models are scarce (Mosolygó et al., 2018). This underscores the need for a detailed examination of factors influencing continuity and the associated goal-setting processes.

*Continuity*, as conceptualized in this study, is a complex notion linking the past, present, and future. It is not merely an outcome but a process in which the goals of family businesses provide direction and define the mechanisms for continuity (Salvato et al., 2010). *Goals*, as fundamental determinants of organizational behaviour and performance, foster growth, sustain motivation, and aid in forming strategic directions (Calabrò et al., 2017; Basco, 2014).

Within family businesses, goals extend beyond organizational objectives to encompass those of individual family members. Alongside shared family goals, there are business-specific objectives. The founder's role is particularly pivotal: their understanding of and commitment to corporate goals can enhance the engagement of both family and non-family members. However, the founder's central role may also negatively affect goal realization if they fail to align family and business goals effectively.

The primary aim of this research was to explore the role of goals in sustaining the continuity of family businesses. The central research question was: *How do family businesses define and achieve their goals to ensure continuity?* To address this question, the

study examined: a) the goals of family-owned wineries, b) the influence of family relationships on goal setting, and c) the factors shaping the goal formulation process. The research resulted in the development of a model illustrating the goal systems of family businesses and their impact on continuity. This model offers valuable theoretical insights while providing practical applicability for family business leaders and consultants.

## **2 The role of the leader in the goal system of family businesses**

The literature widely recognizes that the personal attributes and characteristics of the leader are essential to the operation of family businesses (Chandler et al., 2021). In smaller family enterprises, the leader's values and goals are directly mirrored in the company's objectives, strategies, and daily activities. In family businesses, the goals of all individuals involved — both family members and non-family employees — affect the company's objectives. The founder, as the leader, holds a particularly critical role; their comprehension of and dedication to corporate goals can foster greater commitment among other participants (Kelly & Amburgey, 1991). However, if the leader assumes an overly dominant position, this may obstruct the achievement of these goals. On the other hand, with a balanced and consistent approach, the leader can effectively harmonize family and business objectives (Heidrich et al., 2016).

### **2.1 Entrepreneurial orientation in family businesses**

The concept of entrepreneurial orientation was introduced by Miller (1983), emphasizing the roles of innovation, proactiveness, and risk-taking in fostering renewal and market adaptation within businesses. The literature identifies five key dimensions in this context: innovativeness, risk-taking, proactiveness, autonomy, and competitive aggressiveness. Lumpkin and Dess (1996) expanded on the concept by adding autonomy and competitive aggressiveness as dimensions. Together, these dimensions define the leader's entrepreneurial orientation, which fundamentally influences the strategy and continuity of family businesses.

Zellweger et al. (2012) adapted the concept of entrepreneurial orientation to family businesses, introducing the term family entrepreneurial orientation. This framework defines families' attitudes and mindsets regarding the pursuit of entrepreneurial

activities. According to Zellweger and Sieger (2010), while risk-taking and competitive aggressiveness are less critical for family businesses, autonomy, innovativeness, and proactiveness emerge as more significant attributes.

## **2.2 Ambidexterity in family businesses**

According to March's (1991) theory, organizations must balance exploration (discovering new opportunities) and exploitation (efficiently utilizing existing resources) to achieve long-term success. Ambidexterity enables leaders to adapt flexibly to a changing market environment while maintaining the stability and growth of the business. Gibson and Birkinshaw (2004) describe contextual ambidexterity as the ability of an individual to reconcile and effectively perform two distinct activities simultaneously, a skill that is essential in the dynamic environment of family businesses. Smith and Tushman (2005) highlight that the integration of exploration and exploitation is embodied by top management. Leaders in these roles can develop balanced strategies, thereby overcoming strategic contradictions and ensuring the long-term success of the enterprise. This is particularly critical in family businesses, where leaders must consider family values and traditions while adapting to market changes and innovations.

Ambidexterity also encompasses the alignment of dualities within family businesses. It extends beyond the ability to manage present and future tasks simultaneously, incorporating the combination of emotional and rational approaches. Leaders not only direct the enterprise but also manage family relationships, maintaining family unity while safeguarding the business's interests. Ambidexterity related to family goals requires a distinct balance. Exploration includes developing family plans, succession planning, and formulating the mission. Leaders explore external training opportunities for family members and identify the family's needs. They place particular emphasis on involving and preparing successors. In this context, exploitation involves leveraging family resources and capabilities, preserving family values, and applying the family's knowledge and experience. It also includes nurturing family relationships, maintaining harmony, and utilizing the skills of successors. This synergy ensures the success and continuity of the family winery (Vajdovich, 2024).

### 3 Methodology

The first step in selecting the sample was to clarify the definition of a family business. The definition established by the Budapest LAB of the Budapest Business School served as the basis for identifying family firms (Kása et al., 2019).

In the first phase of the research, 28 semi-structured interviews were conducted with leaders of family businesses, continuing data collection until theoretical saturation was achieved, meaning no new information emerged from additional cases (Eisenhardt, 2021). During the analysis of the results, new questions and characteristics emerged, leading to a second phase of the research, which involved case studies of two wineries and an additional six semi-structured interviews with three members from each family-owned winery.

The first phase of the research was considered exploratory, serving as a preliminary investigation to address the research questions. This was followed by a conclusive phase (Malhotra, 2002), with the expectation that conclusions would emerge as a synergy of the findings.

**Table 1: Phases of the Empirical Research**

Research	Number of Interviews	Timeframe	Type
BBU-Research*	28	October 2020 – June 2021	Exploratory research
Case Study Interviews** (Winery 1,2)	6	February – June 2022	Conclusive research

Source: Own Compilation

To ensure diversity in the sample, family wineries were selected from each of Hungary's seven wine regions, without imposing restrictions on the size of the company or the number of generations involved in the business. The estate sizes ranged from 2.5 to 160 hectares, and both male and female winemakers were included among the interviewees. The interviewees were selected using snowball sampling method.

The Hungarian wine sector boasts a long-standing tradition, particularly in the Tokaj and Villány regions, renowned for producing world-famous wines. The combined market share of the five largest companies is only 8–9%, highlighting the market's diversity and the significant role of smaller players (Németh et al., 2022).

#### 4 Analysis and results

The research aimed to identify the leadership competencies necessary for effectively managing wineries, applying the three-circle model developed by Tagiuri and Davis (1996). Initially, the leaders' activities and responsibilities were categorized into three areas: business-oriented, family-oriented, and ownership-related tasks. At the intersection of these dimensions is the leader (owner), who integrates all three and is responsible for aligning their respective goals.

Based on the interviews, the tasks of leaders can be categorized as follows:

a, Business-oriented tasks: defining and achieving economic and non-economic goals, developing and implementing business plans and strategies, operational management, resource management, risk management, and ensuring ethical and transparent operations.

b, Family-oriented tasks: preserving family relationships and traditions, maintaining family unity and harmony, creating opportunities for future generations, transferring knowledge and values, and fostering and passing on family identity.

c, Ownership-oriented tasks: ensuring financial resources, demonstrating commitment to shared goals, planning generational transitions, and defining the roles and responsibilities of family members within the business.

The leader (owner) is positioned at the intersection of the three subsystems, tasked with aligning their goals and leveraging synergies between the business and the family. The case studies confirmed that leaders play a central role in managing the business and preserving family values. In Winery 1, the founder makes decisions independently while seeking input from family members, who support him with their expertise in various fields. In Winery 2, the leader separates family and business

by establishing a professional corporate structure, while the family remains integral to the transmission of values and knowledge.

The five key dimensions of entrepreneurial orientation in the examined winery businesses, autonomy plays a particularly significant role. The leaders' ability to guide the business according to their own vision, aspirations, and values was a decisive factor in establishing a unique identity. This autonomy allows leaders to prioritize continuity efforts while also enabling the introduction of new directions and innovations. In terms of willingness to innovate, Winery 1 demonstrates outstanding product and process innovation, particularly through the combination of three key resources of Tokaj winemaking: furmint, substrate (rock), and *aszú* technology. Winery 2 engages in extensive innovation activities, including technological advancements, product innovations, and the introduction of new services such as truffle-related concepts, cooling technology, drone usage, and offering new sports opportunities on the estate.

Their proactiveness is reflected in the active efforts of the second generation to explore new markets and develop marketing strategies. They also adapt to changing market demands and demographic trends, for example, by producing lighter wines aimed at younger consumers. In terms of risk-taking, the leaders demonstrate openness to innovation and a willingness to adopt new production technologies, such as organic winemaking. They also make long-term strategic decisions by planting new grape varieties, further underscoring their readiness to embrace calculated risks. Limited data is available regarding competitive aggressiveness, but in the case of Winery 2, an active effort to increase market share is observed. This is demonstrated through aggressive pricing strategies and intensive marketing campaigns.

Ambidexterity is critical for ensuring competitiveness and continuity (see Table 2). At the organizational level, exploration involves laying the foundation for future competitiveness by identifying business opportunities, acquiring new industry knowledge, and utilizing external financial resources, such as EU funding, to finance product and organizational innovations. In contrast, exploitation focuses on realizing immediate financial benefits and enhancing operational efficiency by leveraging existing knowledge and experience while preserving the values of the business.

**Table 2: Organizational and managerial ambidexterity in family wineries**

	Exploration	Exploitation
Organizational ambidexterity	Creating future competitiveness Recognizing business opportunities Acquiring new (industry) knowledge Utilizing external financial resources Product and organizational innovation Securing EU funding	Generating immediate profit Enhancing efficiency Leveraging knowledge and experience Ensuring patience capital Preserving values
Managerial ambidexterity	Flexibility Intuitive thinking Creativity Risk taking Renewing processes and product portfolios	Problem-solving Analytical thinking Persistence Managing existing resources Optimizing processes and product portfolios

Source: Own Compilation

At the leadership level, exploration requires flexibility, intuitive thinking, creativity, and risk-taking, enabling the development of a renewed product portfolio and adaptation to rapidly changing market conditions. Exploitation, on the other hand, emphasizes problem-solving skills, analytical thinking, persistence, and effective management of existing resources to optimize processes and the product portfolio.

The alignment of family and business dimensions is also essential, as integrating family relationships, values, and goals into the business operations contributes to the organization’s ambidexterity. The case studies highlight that the ambidexterity of leaders is pivotal, as their personality and competencies have a direct impact on the goals and orientation of the business.

Our empirical research revealed that latent, non-explicitly formulated goals play a significant role in the goal-setting processes of family businesses. These goals often stem from family values, traditions, and relationships among family members, influencing the business’s decision-making and strategy. An especially intriguing finding from the analysis of goals was that hidden (latent) goals play a decisive role in guiding the business’s operations from the background (see Table 3). This insight was unexpected, as our initial assumptions primarily focused on explicit, formally articulated goals.



**Table 3: Latent goals**

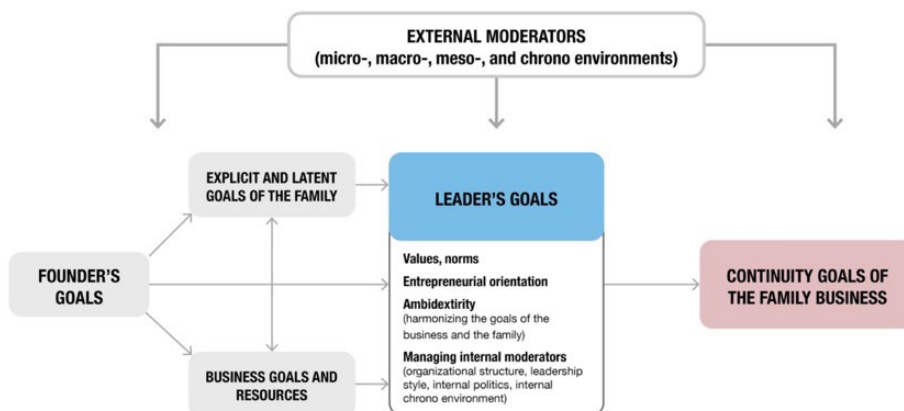
	Latent Goals	Potential Obstacles
Leader's latent goals	Preserving family heritage Ensuring continuity Maintaining family unity and harmony Creating jobs and supporting the family Balancing work and personal life Pursuing professional development Establishing a legacy and gaining recognition for personal name and achievements Minimizing business risks	Family hierarchy Generational differences Meeting family expectations
Family members' latent goals	Ensuring long-term financial security and increasing family wealth Fostering family collaboration Achieving professional development and recognition Attaining personal satisfaction Balancing leisure, personal life, and work Acquiring entrepreneurial knowledge and experience Pursuing entrepreneurial freedom	Meeting family expectations Diverging personal ambitions and life paths Lack of entrepreneurial skills Differences in professional and leadership approaches

Source: Own Compilation

Empirical data indicates that discrepancies between the goals of leaders and family members, as well as conflicts arising from generational differences, can hinder business continuity. Hidden goals, such as preserving family heritage, pursuing professional development, or achieving work-life balance, may not always surface explicitly but significantly influence decision-making and strategic directions.

## 5 Conclusions

Based on the research findings, we identified significant factors influencing the goal-setting processes of family wineries, which are also critical for ensuring business continuity. Drawing on the empirical research examining the goal-setting processes in family businesses and their impact on continuity, we developed a comprehensive model to better understand the formation and effects of these goals. This model analyses the internal dynamics of family businesses, with a particular focus on the role of goals and goal-setters in ensuring business continuity. The model is grounded in the three-circle model developed by Tagiuri and Davis (1996).



**Figure 2: Continuity Model of Family Businesses Based on Goal setting**

Source: Vajdovich, 2024

The model highlights three key dimensions:

*Family Dimension:* This encompasses both explicit and latent goals of the family, which reflect the values and objectives of the founders and directly influence the overarching goals of the business.

*Organizational Dimension:* The goals of the business are shaped by the available resources, determining how these resources are utilized in the operation of the enterprise.

*Leadership Dimension:* Positioned at the intersection of the three circles, this dimension underscores the pivotal role of the leader — who is often a family member and owner — in setting goals and managing the business.

The results highlight the importance of the family dimension: the explicit and latent goals of the family have a fundamental impact on the formation of the business's objectives. From a management perspective, this implies that latent goals must also be considered when defining the business's objectives, with efforts directed toward making them explicit. However, it is important to note that identifying and

addressing latent goals can be challenging, as they are often unconscious or difficult to articulate.

In most cases, the founder serves as both the leader of the family and the business, resulting in alignment between the business's goals and values and the founder's own objectives and values. In the examined family wineries, the goals typically reflect the leader's personality, aspirations, abilities, and entrepreneurial orientation, which influence the formation and achievement of goals and are directly linked to business continuity.

The available resources are crucial as they determine the goals a business can set and achieve, directly influencing its continuity.

Organizational ambidexterity serves distinct purposes. Exploration focuses on business growth, including identifying new markets and implementing innovative production techniques. Exploitation, on the other hand, relies on established practices and traditions, emphasizing the maintenance and optimization of well-developed products and conventional processes. Exploration emphasizes progress, succession planning, and the acquisition of new knowledge, while exploitation focuses on leveraging family resources and traditions.

Leaders' ability to align the goals of the business with those of the family, manage resources effectively, and navigate family dynamics fundamentally impacts continuity. This capability enables them to strategically integrate economic objectives with family values and interests, as well as align short-term goals with long-term aspirations.

Understanding and modelling the goal-setting process in family businesses is essential for their long-term survival and success. The definition of goals and the processes through which they are established directly influence the business's strategy, operations, and adaptability to a changing market environment. In family businesses, goals encompass not only economic factors but also socio-emotional elements, resulting in a complex and dynamic system of objectives.

## Notes

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The second set of three interviews was conducted as part of the Longitudinal Research Project of the Budapest Business University (2022). In addition to the predefined research questions, I had the opportunity to include questions relevant to my own research.

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# THE IMPACT OF WORK MODELS ON ORGANIZATIONAL COMMITMENT

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The aim of this study is to investigate the impact of work models on employees' organizational commitment. The data is collected from a sample of 71 participants across Kosovo regions, including respondents from other countries as well. The results of study's research is showing, that at least one of the Organizational Commitment (OC) items exhibits a significant difference across groups, with the empirical results supporting all four study hypotheses. Therefore, for H1, the study indicated a statistically significant difference in the second Item of OC which is emotional attachment to the organization, between On-Site and Hybrid groups. For H2, the study also indicated a significant difference in emotional attachment between Flexible and Pre-Determined groups. For H3, the hypothesis was confirmed with the finding that Age is the only demographic factor showing a significant difference in general OC among its groups. For the last hypothesis, H4, the study shows statistically significant differences in two demographic factors: 1. Gender: a significant difference was found in the item: "I don't feel connected to the team and leadership while working remotely" and 2. Civil Status: A significant difference was found in the item: "My hybrid work model has increased my engagement with organizational goals".

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## 1 Introduction

In recent decades, the world has undergone profound transformations, particularly in the realms of technology and globalization, both of which are experiencing relentless and exponential growth with rules and requirements that are changing every day. Within this context of change, organizations, recognized as essential components of society and integral to individuals' lives, must adapt and innovate to enhance their effectiveness and sustain their relevance.

Organizations must ensure that both employees and managers are equipped with the requisite skills and competencies to effectively leverage their knowledge and experience in pursuit of organizational goals and objectives. To achieve this, business organizations must cultivate teams that are deeply committed to their strategic imperatives, with a strong orientation toward organization and operational excellence. Human resource management, positioned as a core function within the organization, plays a pivotal role in fostering organizational commitment (Herrera and Heras-Rosas, 2021). This commitment emerges between the resources provided by the organization and the inputs of the employee, establishing a reciprocal relationship that is further strengthened by an emotional alignment between the organization's goals and values and those of its workforce (Buchanan, 1974).

Dedicated and responsible employees are thus regarded as critical drivers of organizational success (Jafari & Bidarian, 2012). On the other side, as of Covid19 Pandemics, employees' work environment has shifted from offices to homes and will likely persist, and home office will become an essential part of the working environment (Krajčik et al., 2023). Simultaneously, the integration of hybrid work models, combining remote and in-office work, offers mutual advantages for employees and employers. Thus, on one hand, the topic of this study is organizational commitment while on the other hand, it is the working models especially the hybrid work models and the impact of these on employee's organizational commitment, as one of the most important organizational behaviors. The organizational commitment is closely related to job satisfaction, which consists of an individual's relation, or attachment with an organization (Silverthorne, 2005). Though literature indicates different kinds of approaches regarding Organizational Commitment, studying it from the context of the employee's possibility to choose or to combine his/her work model (remote and in-office work) presents gaps that



have indicated the need for more and new research in this direction (Martins, Euzebio and Beuren, 2022).

The aim of this study is to investigate the impact of hybrid work on organizational commitment.

The dynamics of the work of employees is undergoing changes due to the new era of technology and working infrastructure possibilities. As a result, the findings of the given study will help organizations achieve a higher level of their staff commitment. In order to keep them in the company, the employers should invest in increasing their organizational commitment (Ahmed et al., 2011). It can also predict the turnover rate and staff replacement, with a higher level of organizational commitment leading to higher productivity and performance and lower levels of absenteeism (Brown et al., 2007).

In the following paragraphs, an overview of the existing literature and previous research on organizational commitment and its role within organization will be provided as well as the work models with a special focus of the impact of hybrid work models on organizational commitment.

## **2 Literature review**

### **Organizational Commitment**

Organizational Commitment has garnered significant attention from both employers of different organizations and researchers, particularly since the 1980s. Broadly defined, organizational commitment refers to the extent to which employees demonstrate loyalty and dedication to their employer and express a desire to remain part of the organization. Commitment encompasses the employees' feelings and behaviors toward their company (Jex, 2002).

Scholars have noted that individuals exhibit varying forms of commitment in the workplace, not only toward the organization itself but also toward subunits such as departments, teams, unions, or specific locations etc.

According to Mowday et al.'s definition (cited in Meyer and Allen, 1991: 64), organizational commitment represents "the relative strength of an individual's identification with and involvement in a particular organization". This conceptualization underscores three critical components: (1) a desire to maintain membership in the organization; (2) a belief in and alignment with the organization's values and objectives and (3) a willingness to exert effort on behalf of the organization (Arnold, 2005).

Among most important contributors in this subject that have significantly expanded its framework are Meyer and Allen who introduced it in another aspect by dividing the organizational commitment in three forms or components as in the following dimensions:

1. Affective (organizational) Commitment (Desire to Stay): This dimension reflects an employee's emotional attachment to the organization. According to Boselie (2010), this type of commitment is especially valued by employers as it reflects the employees "level of identification with the organization, its goals and values as well as their genuine sense of loyalty towards the company".
2. Continuance Commitment (Need to Stay): This dimension pertains to an employee's assessment of the costs and risks associated with leaving the organization. It reflects the connection with the organization due to the lack of other opportunities or alternatives. It arises from the perception of limited alternatives or substantial investments already made within the organization which it costs too much if leaving and joining another company. Hence, encompassing two kinds of variables: perceived personal investments and perceived availability of alternatives (Rogelberg, 2007).
3. Normative Commitment (Moral Obligation to Stay): This form of commitment stems from an individual's moral sense of obligation and responsibility towards the organization (Meyer et al., 1993). It reflects a belief that remaining with the organization is the right or expected course of action.

For employers, the concept of organizational commitment is particularly compelling due to its potential to foster a workforce that identifies with their organization and aligns with its mission and values while demonstrating a proactive willingness to contribute. Employees who demonstrate high levels of organizational commitment play a crucial role in the company as their loyalty and engagement facilitate the implementation of positive organizational changes and initiatives.

According to Suliman and Lles, 2012, positive relationships between organizational commitment and employee performance were found in earlier studies and as well as a meta-analysis of 51 empirical research undertaken by Jaramillo et al., 2014 indicated a favorable association between organizational commitment and job performance (Ying et al., 2024).

In the study of Alomran et al., 2024, it is found that according to Celep and Yilmazturk, organizational commitment (OC) and trust are crucial for maintaining high levels of performance within companies and achieving organization-specific goals. The achievement of organizational goals is strongly predicated on employee trust and organizational commitment. Also, according to Lewicka et al., building employee commitment is a necessity for human resources managers, as it leads to increased efficiency and the organization's success and organizational commitment has been extensively discussed as a crucial aspect of employee-organization relationships, with increased efficiency and production as possible outcomes. It is essential for organizations to determine what employees are faithful to and the level of their commitment, in addition to determining how effective they are perceived to be. In this context, Mayer et al. (1995) claim that by recognizing the importance of organizational construction, the organization will be able to adapt to changes in the surrounding environment. Commitment is critical for increased production and performance, as well as capacity optimization (Alomran et al., 2024).

### **On-Site, Remote and Hybrid work**

The idea of flexible work arrangements which are known as work from home (WFH), hybrid or remote setting are not new and the usage of these work settings were and are still practiced by the organizations nationwide (Selvaraju and Anuar, 2024).

On-site work involves performing work directly at employer's premises, typically within an office or designated workplace environment. This type of work requires active participation in in-person meetings, events and close collaboration with colleagues and clients, fostering direct, face-to-face interactions. However, COVID-19 pandemic has irreversibly changed the attitude towards office presence. According to Smite et al., 2024, companies indeed struggle with office presence and a large share of corporate space (35-67%) is underutilized whereas the main motivator for office presence is Connection and community, followed by Material offerings, Preference and Duty (Smite et al., 2024).

The concept of remote work was developed in the early 1970s and simply meant working remotely with the use of IT devices and office equipment. This type of work was commonly referred to as teleworking. Teleworking is a flexible work arrangement in which employees perform their duties remotely, outside the employer's premises, relying on information and communication technologies, particularly the internet, to deliver work outcomes and facilitate the transfer of data. In the era of general access to the internet and widespread computerization, the term "teleworking" has been replaced with the term "remote work" (Wontorczyk and Roznowski, 2022).

According to Hopkins and Bardoel, hybrid work is a relatively new term, gaining popularity during the pandemic to define a working arrangement where an employee divides their time between working at a traditional workplace and working remotely (typically at home, or from 'third places' such as a coworking space, library, or local café, etc.), which attempts to combine the best parts of both telework and office-based work (Hopkins and Bardoel, 2023).

### **The Relation between Organizational Commitment and Work models**

Scholars have conducted many studies on organizational commitment in relation to different factors and work attitudes for the success of the organization, as well as on work models as the most common work arrangements for them. However, little research has been conducted to identify the different hybrid work models that have been emerging rapidly (Hopkins and Bardoel, 2023) and their impact on the relationship with these factors including organizational commitment. Therefore, in

this context, there have been gaps that have indicated the need for more and new research in this direction (Martins, Euzebio and Beuren, 2022).

According to Tuzovic and Kabadavi (2021), working from home was, for many employees, required with short notice by the employer or the government in response to the need to keep social distance and not a voluntary action to balance work and family life (Innstrand et al. 2022). Employees reported feelings of social isolation and increased family-work conflict despite experiencing the newfound benefits of autonomy and self-leadership from remote working (Galanti et al., 2021). The combination of working at the office and work from home can benefit both employees and employers but may also lead to various issues arising from both work environments (Krajčik et al., 2023).

On the other hand, the performance of a company significantly depends on the effort that employees put into their work. Responsible employees, who are also committed, courageous, and smart, are considered one of the main factors for the success of an organization (Jafari & Bidarian, 2012).

The results of a study conducted within the IT departments in the Jordanian banking sector show that the commitment of the IT employees positively and significantly affected organizational performance and job satisfaction (Al-dalahmeh, et al., 2018). Another study, conducted in the branches of a Persian Bank in Tehran, Iran, show that organizational commitment and its components have a significant positive impact on market-orientation of Persian banks (Khoshnamnoghdam, 2017).

A study conducted in some selected IT companies with a stratified sampling method, collecting data from 210 employees observed two main factors, the effectiveness of the hybrid workplace and the second one was the determinants of organizational commitment. The SEM model was applied to examine the significant impact of the effectiveness of hybrid work on determinants of organizational commitment which its results showed that there is a significant impact. Thus, it was suggested that for better organizational commitment, companies should develop and propagate a hybrid work model (Vidya Sri and Vasantha, 2024).

### 3 Methodology

Since the aim of the study was to measure the impact of work models on employees' organizational commitment in general, as well as by placing a special emphasis on the hybrid work models, the study participants were divided into two groups. The first group consisted of participants from the on-site working model and the second one included those with different hybrid work models including the remote ones. Data was collected online from a total of 71 participants (N=71), out of which 34 were from the on-site category and 37 from hybrid and remote. Out of them, 37% of the participants were male and 63% female. A total of 51% of participants were 36 to 45 years old, 42% were under the age of 36 and 7% were over 45 years old. Other demographic information included the participants' marital status, place and their level of education and years of experience in the company, the number of employers they were working for until participating in this study. The research questions and hypothesis:

*R.Q.: 1. Is there a significant difference in OC across work model groups?*

H1: There is a significant difference at least in one of the four OC Items between 2 work models (On-Site vs. Hybrid).

H2: There is a significant difference at least in one of the four OC Items between 2 hybrid work models (Flexible vs. Pre-Determined).

*R.Q.: 2. Is there a significant difference in OC among the groups in the demographic data factors such as, age, civil status, academic level etc. in OC?*

H3: There is a significant difference in OC among the groups in at least one demographic data factor.

*R.Q.: 3. Is there a significant difference in OC related to the Hybrid Work Model across different groups in the demographic data factors such as age, civil status etc?*

H4: There is a significant difference in OC related to the Hybrid Work Model across the groups at least in 2 demographic data factors.

The measuring scale included the instrument for measuring the organizational commitment which was developed by Meyer, Allen & Smith (1991) and used by Ellemers et al. in 1998, (Boselie, 2010). The measurement scale consisted of four statements that were designed to measure the general organizational commitment. The respondents expressed how much they agreed with each statement on a five-point Likert scale, with values ranging from 1 (strongly disagree), to 5 (strongly agree).

#### 4 Data analysis and results

A total of 75 respondents were sent a questionnaire for fulfilment. However, 71 of them responded and filled the questionnaire online. 3 out of these 71 were removed from the analysis because they were left unanswered in several questions. After creation of new variable from the means of the items from the measuring scale of Organizational Commitment, the analysis for outliers was done (univariate and multivariate). It was verified that there was one outlier with a value smaller than  $|z| = -3.3$  which was removed from the sample. Therefore, the final sample number of this study was 67 which we did the analysis from.

Reliability of OC measurement scale, mean, standard deviation, minimum and maximum values are presented in Table 1.

**Table 1: Reliability of measuring scales**

Scale	No. of items	Cronbach alpha	Mean	SD	Min.	Max.
OC	4	0.85	3.69	2.97	3.28	3.97

The results show that the value of Cronbach’s Alpha is quite high, respectively (0.85) indicating a satisfactory level of construct validity. In general, it can be concluded that, on a five-point Likert scale, the mean value of participants’ organizational commitment is 3.69. This implies that research participants generally agree that they are committed to their company.

**Descriptive Data**

Descriptive Data was presented for the groups of work models, hybrid work models, as well as for the demographic data. After analysing carefully all the numbers achieved from the questionnaire for three main categories of work models (on-site, remote and hybrid) it was decided that these models will be rearranged only into two categories, on-site and hybrid+remote category due to having a very small number of participants who work fully remotely, respectively only 4 of them.

**Table 2: Work Model Groups and Hybrid Work Model Groups**

Category	Subcategory	Number of Participants	Notes
Work Models	On-Site	31	
	Hybrid + Remote	36	33 Hybrid + 4 fully remote.
<b>Total</b>		<b>67</b>	
Hybrid Work Models	Flexible	14	Flexible, Role-Based, and Team-Based categories.
	Pre-Determined	19	Fixed, Office-First, and Remote-First categories.
<b>Total</b>		<b>33</b>	

Therefore, as shown on the table 2 above, the final number of participants of this study who work fully on-site is 31 and 36 belong to the hybrid+remote category, respectively  $33+4=36$ . For these 33 participants from the category of Hybrid which itself has 6 different categories as hybrid work models (Flexible, Fixed, Office-first, Remote-first, Role-based and Team-specific), it was decided to apply the same rule for reducing them into 2 main categories due to having a very small number of participants to some of the categories. Therefore, it was decided that the first category will be the Flexible (which includes the Flexible, Role-Based and Team-Based) with a total number of 14 participants and the second category is the Pre-



Determined (including the Fixed, Office-First and Remote-First) with a total number of 19 participants

There were 43 females and 24 males who participated in the study. As per the age, the respondents had to choose one of the respective categories divided according to the age group provided for each. Categories varied from 20 – 25 years old, which there was only one respondent in this category; the second category was the age group from 26-35, which there participated 27 respondents, the other category was from 36 -45 years old which had the highest number of respondents with a total of 34, the next one was from 46 – 55 which had 4 respondents and the last one was Above 55 years old which had only 1 participant. On the other hand, regarding the Academic level of respondents, in the study there was only one participant that has finished only the High-School Degree, furthermore there were 16 participants who have finished Bachelor's Degree, whereas the highest number of participants of this study were with a Master's Degree with a total number of 44 and with a PhD Degree as the last category for the Academic level there were 6 participants. The civil status of participants was as following: 14 were single, 49 married and 4 Divorced. Lastly, the categories of the location or place where the participants come from were divided into three main ones. The first was the Local – Kosovo Category which represents the number of respondents who live and work in different cities from Kosovo which at the same has the largest number of the sample with a total of 38 participants. The second is International – Abroad Category which represents all the other participants who live outside Kosovo, spread everywhere around different countries of the world with a total number of 18 participants. The last category which is called Unspecified, represents a total of 10 participants who did not want to answer where they live and work, therefore they have left the question unanswered.

Most of the participants (49 of them) have more than 10 years of work experience in general, 14 of them have from 5-10 years of work experience and only 4 have 2-4 years of work experience, whereas no participant belongs to the category with 0-1 year of work experience in general. In the actual company where participants work, 10 of them belong to the category with 001 year of work experience earned there, 21 of them have 2-4 years of work experience there, 19 have 5-10 years and 17 participants have more than 10 years of work experience in the actual company they work in.

13 participants come from Public sector whereas the private sector leads with a number of 31 participants, the NGO sector with 20 and the last one as Other with only 3 participants. On the other hand, for the number of Employers it can be seen that 16 participants have declared to have had from 1-2 Employers until now, 23 have had 3-5 Employers, 13 participants have had 6-10 Employers whereas 15 respondents of this study sample have had more than 10 Employers to date.

### T-test and Anova

As per our Research Question 1 if there is a significant difference in Organizational Commitment across two groups of work models On-site vs. Hybrid+Remote, and in order to test our 1st Hypothesis that there is a significant difference at least in one of the four items of OC between On-Site and Hybrid+Remote, the T-Test was used for such comparison. As it can be seen in the table 3, in fact there is a significant difference between these two groups only in the second item of OC which is “I feel emotionally attached to this organization” with the respective values:  $t(67) = 2.049$ ;  $p < 0.05$ ; **Therefore, we can say that our 1st Hypothesis is accepted.**

**Table 3: Independent Samples T-Test across the Work Model groups (On-Site vs. Hybrid)**

		Levene's Test for Equality of variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
OC Item 2: I feel emotionally attached to this organization	Equal Variances assumed	3.646	.061	2.049	65	.044
	Equal Variances not assumed			2.068	64.938	.043

In order to test our second Hypothesis that there is a significant difference at least in one of the four items of OC between Hybrid work models (Flexible vs. Pre-Determined) the T-Test was used for this comparison as well. As it can be seen in the table 4, there is a significant difference between these two groups again in the same item of OC which is the second item “I feel emotionally attached to this

organization” with the respective values:  $t(33) = 2.317$ ;  $p < 0.05$ ; **Therefore, we can say that our 2nd Hypothesis is also accepted.**

**Table 4: Independent Samples T-Test across the Hybrid Model groups (Flexible vs. Pre-Determined)**

		Levene's Test for Equality of variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
OC Item 2: I feel emotionally attached to this organization	Equal Variances assumed	.660	.423	2.317	31	.027
	Equal Variances not assumed			2.381	30.419	.024

ANOVA was used for our research question no. 2 if there is a significant difference in OC among the groups in the demographic data factors such as age, civil status etc. and to test our 3rd Hypothesis that there is a significant difference of OC among the groups in at least one demographic data factor.

We conducted ANOVA analysis of the new common variable of OC which includes the Mean of the four OC Items (Table 5). This was analysed among the groups in different factors such as the different age groups, the groups of civil status (single, married, divorced and widowed), academic level (High School, Bachelor, MA and PhD) and all the other groups of the factors involved in our study. We found that significantly there is a difference between groups in only one factor which is Age. In the analysis of the means of each age group of participants we see that there is a significant difference among the five age groups respectively 20-25, 26-35, 36-45, 46-55 and the last one - Above 55 years old. **Therefore, we can say that our 3rd Hypothesis is also accepted.**

**Table 5: ANOVA Results at the comparison with the groups of Age**

		ANOVA				
		Sum of Squares	df	Mean Square	F	Sig.
OC	Between groups	7.153	4	1.788	3.615	.010
	Within Groups	30.669	62	.495		
	Total	37.823	66			

ANOVA was used also for our last research question if there is a significant difference in OC related to the Hybrid Work Model across different groups in the demographic data factors such as age, civil status etc. and to test our 4th and last Hypothesis that there is a significant difference at least in 1 of the five Items of OC related to the Hybrid Work Model across the groups in at least one of the demographic data factors.

Just like in the 3rd hypothesis above, we conducted ANOVA analysis among the groups in different factors such as the different age groups, the groups of civil status (single, married, divorced and widowed), academic level (High School, Bachelor, MA and PhD) and all the other groups of the factors involved in our study (Table 6).

**Table 6: ANOVA Results at the comparison with the groups of Gender and Civil Status**

		ANOVA				
		Sum of Squares	df	Mean Square	F	Sig.
OCHM-5th Item by Gender	Between groups	8.000	1	8.000	7.556	.010
	Within Groups	36.000	34	1.059		
	Total	44.000	35			
OCHM-2nd Item by C.S.	Between groups	5.567	2	2.783	4.983	.013
	Within Groups	18.433	33	.559		
	Total	24.000	35			

However, this time we did this with the other 5 Items of OC that were related specifically for the category of those with Hybrid Work Model and not with the general OC Scale. We found that significantly there is a difference between groups in two factors such as Gender and Civil Status. In the analysis of the means of each

group of participants from these two factors we see that there is a significant difference among Male and Female but only in the 5th item “I don’t feel connected to the team and leadership while working remotely” as well as among the four civil status groups (single, married, divorced and widowed) but only in the item “My hybrid work model has increased my engagement with organizational goals”. **Therefore, we can say that our 4th and last Hypothesis of our study is also accepted.**

### **Interpretation of Results**

This study highlights the nuanced impact of work models on organizational commitment. The t-test results for the 1st Hypothesis indicated a statistically significant difference in the second Item of OC which is emotional attachment to the organization, between On-Site and Hybrid groups and at the same time accepting the Hypothesis. This suggests that the way employees work (on-site or hybrid) influences their emotional attachment to the organization. The lack of significant differences in the other three items of the OC Scale indicates that emotional attachment is uniquely sensitive to the work models, while other aspects of commitment might remain consistent across groups.

In the examination of the mean scores for each group, we see that the On-Site group feels more emotionally attached to the organization (M=4.00, the 4th level of Likert scale, respectively the Agree answer level) than the Hybrid+Remote Group (M=3.58, between levels 3 to 4, respectively Neutral to Agree answer levels). This suggests that for hybrid work groups, their reduced face-to-face interactions limit direct, in-person communication. Therefore, they may miss informal interactions, social bonding, and the sense of camaraderie that develops naturally in on-site settings. Organizational culture is often reinforced through physical presence and shared experiences. Therefore, hybrid employees may feel excluded from activities or traditions that are more accessible to on-site workers. On-site employees may have more access to managers and teams, leading hybrid workers to feel overlooked or less valued.

The t-test results for the 2nd Hypothesis also indicated a statistically significant difference in emotional attachment between Flexible and Pre-Determined groups and at the same time accepting the Hypothesis. This suggests that Flexible Hybrid

employees and Pre-Determined Hybrid employees experience differing levels of emotional attachment to the organization. The absence of significant differences in the other OC items suggests that emotional attachment is uniquely impacted by the structure of the hybrid work model, while other aspects of commitment remain consistent.

In the examination of the mean scores for each group, we see that the Flexible Hybrid employees report higher emotional attachment to the organization where they work ( $M=3.92$ , so close to Agree level) than the Hybrid+Remote Group of employees ( $M=3.26$ , very close to the 3rd Neutral level). This suggests that for the employees whose work model is flexible hybrid, they benefit more from the autonomy and adaptability of their work model than the ones whose work model is fixed or pre-determined.

Using ANOVA, the 3rd hypothesis was confirmed with the finding that Age is the only demographic factor showing a significant difference in general OC among its groups. By analyzing the mean of the four OC items as a single composite variable, we found a statistically significant difference in OC scores among the five age groups. Furthermore, by analysing the mean of each age group 26-35 years old ( $M=3.35$ ), 36-45 ( $M=3.83$ ), 46-55 ( $M=4.06$ ) and the last group - above 55 years old ( $M=4.75$ ), we notice that the older the employees are in age the more committed they are to their organization where they work as scored in the OC Scale. This suggests that younger employees may show lower OC scores due to limited tenure or weaker emotional ties to the organization, whereas older employees may exhibit higher OC scores, potentially reflecting stronger bonds developed over time or a sense of stability. It may also indicate that the differences in OC across age groups may reflect generational differences in work values, organizational expectations, or career stages present in their life.

Using ANOVA, we analyzed the five OC items specific to participants with the Hybrid Work Model. The analysis revealed statistically significant differences in two demographic factors: 1. Gender: a significant difference was found in the 5th item: "I don't feel connected to the team and leadership while working remotely" and 2. Civil Status: A significant difference was found in the item: "My hybrid work model has increased my engagement with organizational goals".

For the Gender Factor, this suggests that Male and Female participants differ significantly in how disconnected they feel from the team and leadership while working remotely and that perceptions of remote team and leadership dynamics differ based on gender. In our study Males reported a higher mean score ( $M=3.33$  – between Neutral to Agree level) compared to Females ( $M=2.33$  – close to disagree level). This shows that Males feel more disconnected from their team and leadership while working remotely compared to Females. Males may perceive remote work as creating a greater barrier to effective communication or leadership engagement whereas females, with a lower mean score, appear to feel more connected to their team and leadership while working remotely. These differences could come from variations in communication preferences, differences in leadership styles perceived by Males and Females, Role-specific responsibilities or team dynamics.

For the Civil Status Differences, participants from different civil status groups report differing levels of increased engagement with organizational goals due to the hybrid work model. In the item “My hybrid work model has increased my engagement with organizational goals,” the mean scores reveal significant differences among these groups. Divorced participants reported the highest mean score ( $M=4.5$ ), indicating they feel the most engaged with organizational goals under the hybrid work model. Singles reported a moderately high level of engagement ( $M=3.7$ ) whereas Married participants reported the lowest mean score ( $M=3.0$ ), suggesting they feel less engaged compared to the other groups. The Divorced Group may find the hybrid work model particularly beneficial, as it could offer flexibility and independence that aligns with their personal or professional circumstances and the higher engagement may stand from a strong focus on career goals. Single participants also report relatively high engagement, potentially due to having fewer family-related responsibilities and more capacity to focus on work goals. The hybrid model might offer the balance they need between personal life and professional ambitions. Married participants report the lowest engagement. This could be due to challenges balancing family responsibilities with work, or because the hybrid model might not fully accommodate their unique needs e.g., childcare, spousal support etc.

Overall, the findings emphasize the importance of understanding demographic differences within work model groups and the hybrid model groups in their commitment to the organization.

## 5 Conclusion and recommendations

The analysis of Organizational Commitment (OC) through various hypotheses and demographic factors in this study has provided key insights into the dynamics of employee commitment across different work models and groups.

The conclusion, which can also serve as recommendations for researchers and employers have been summed up as following:

- a) For researchers in the future studies:
  - They should use a larger and more diverse sample to enhance the generalizability of findings across industries and organizations, especially when involving workers through several sectors with different work models and structures.
  - Explore why these differences exist using qualitative methods or additional quantitative factors (e.g., tenure, culture background or family responsibilities) as well as adding more continuous variables that help conduct deeper analysis in order to understand more precisely the cause and effect of these on organizational commitment.
  - Each dimension should be measured separately, using instruments with subscales for categories of organizational commitment (affective, continuance and normative).
  - Future research should aim to deepen our understanding of the complex factors influencing organizational commitment. Expanding the scope to include more diverse demographics, psychological variables, and industry-specific contexts will provide richer insights to help organizations tailor effective strategies in the evolving workplace landscape.
- b) For leaders, managers or supervisors in the company:
  - They need to undertake tailored approaches to ensure all employees, regardless of their work mode, feel emotionally connected to the organization. Since employees working in a hybrid model may experience challenges in forming emotional attachments due to reduced physical interactions, the organizations should foster stronger connections by organizing periodic on-site meetings or team-building activities.



- Regarding the age groups, it is important for the companies to develop programs that address the unique needs and motivations of each age group, promoting inclusivity and enhancing overall organizational commitment. For younger employees they should implement career development programs, mentorship, and leadership opportunities to strengthen their organizational attachment.
- Gender and civil status policies could enhance engagement and reduce feelings of disconnection. Invest in training for leaders to bridge gaps in connection and inclusion for hybrid workers, particularly those who report feeling disconnected. For married employees, offer flexibility to balance work and family responsibilities, such as childcare support or family-friendly schedules. For divorced employees, engage them in leadership roles or organizational goal-driven projects to leverage their high engagement. For single employees, provide opportunities for growth and networking to keep them motivated and connected.

The findings highlight the importance of understanding how work models and demographic diversity influence organizational commitment. By tailoring policies and interventions to the unique needs of different groups, organizations can create a more engaged, connected, and committed workforce.

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# TRANSFORMACIJA BPMN ZAPISA V JAVA PROGRAMSKO KODO

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Uvedba tehnologije veriženja blokov prinaša nove priložnosti za avtomatizacijo in izboljšanje učinkovitosti poslovanja, predvsem z uporabo pametnih pogodb, ki avtomatizirajo izvajanje poslovnih pravil. Kot osnovo za razvoj pametnih pogodb lahko uporabimo BPMN, uveljavljen standard za modeliranje poslovnih procesov. V prispevku predstavljamo transformacijo modelov BPMN v ogrodje Javanske kode, ki jo lahko uporabimo v okolju tehnologije veriženja blokov, specifično na platformi HyperLedger Fabric. Grafična predstavitev procesov v BPMN je zapisana v XML obliki, na osnovi katere lahko osnovne BPMN gradnike implementiramo kot kontrolne strukture v Javanski programski kodi. Predlagana rešitev omogoča hitro, točno in prilagodljivo pretvorbo modelov BPMN, s čimer optimiziramo razvoj pametnih pogodb. Prispevek odpira možnosti za nadaljnje raziskave in širitev metodologije z vključitvijo kompleksnejših gradnikov BPMN ter prilagoditev za različna okolja tehnologije veriženja blokov.

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# TRANSFORMING BPMN NOTATION INTO JAVA CODE

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Introducing blockchain technology brings new opportunities to automate and improve operational efficiency, particularly using smart contracts that automate the implementation of business rules. BPMN, an established standard for business process modelling, can be used to develop smart contracts. This paper presents the transformation of BPMN models into Java code framework that can be used in a blockchain technology environment, specifically on the HyperLedger Fabric platform. The graphical representation of BPMN processes is written in XML format, from which the basic BPMN building blocks can be implemented as control structures in Java program code. The proposed solution enables fast, accurate and scalable conversion of BPMN models, thereby optimising the development of smart contracts. The paper opens opportunities for further research and extension of the methodology by incorporating more complex BPMN building blocks and adaptations for different blockchain technology environments.



## 1 Uvod

V današnjem hitro razvijajočem se poslovnem okolju organizacije potrebujejo agilne in učinkovite procese, ki se lahko hitro prilagajajo spreminjajočim se zahtevam. Za upravljanje poslovnih procesov, pri modeliranju in dokumentiranju procesov, organizacije pogosto uporabljajo standardni zapis Business Process Management Notation (BPMN). BPMN je postal standard za modeliranje poslovnih procesov, saj je grafična predstavitev procesa razumljiva deležnikom v poslovnem procesu in tudi IT strokovnjakom (Object Management Group, 2016). Na osnovi modelov BPMN se oblikujejo tudi programske rešitve, ki podpirajo opisane poslovne procese. Vendar je preslikava modelov BPMN v učinkovite računalniške aplikacije pogosto ročna, dolgotrajna in nagnjena k napakam. Vedno večja kompleksnost poslovnih procesov zahteva avtomatizirane rešitve za prevajanje modelov procesov v izvršljivo kodo.

V zadnjem času se v različnih sektorjih pojavljajo aplikacije, ki temeljijo na tehnologiji veriženja blokov (ang. »*blockchain*«). Tehnologija veriženja blokov preoblikuje razširljive informacijske sisteme in aplikacije z integracijo vse bolj priljubljene umetne inteligence, interneta stvari, računalništva v oblaku in masovnih podatkov (Lu, 2019). Omogoča razvoj decentraliziranih, varnih in transparentnih sistemov, ki jih lahko učinkovito uporabimo v različnih poslovnih procesih, od zavarovalništva (Alamsyah & Setiawan, 2025), zdravstva (Faheem Ahmad Reegu, 2021), gradbeništva (Scott et al., 2021), do celotne oskrbovalne verige (Dutta et al., 2020). Pomemben element tehnologije veriženja blokov so tudi pametne pogodbe, ki predstavljajo implementacijo dejanskih pogodb v izvršljivo programsko kodo in omogočajo avtomatizirano izvajanje dogovorov brez potrebe po posrednikih. Tako lahko pametne pogodbe uporabljamo za varne finančne transakcije ali pa za avtomatizacijo pravnih postopkov. Integracija poslovnih procesov, modeliranih z BPMN, s pametnimi pogodbami odpira nove možnosti za avtomatizacijo kompleksnih poslovnih pravil in zagotavljanje preglednosti in zaupanja v decentraliziranih aplikacijah.

V prispevku prikazujemo transformacijo BPMN modela v Java programsko kodo, ki omogoča integracijo modela BPMN v pametno pogodbo v okolju tehnologije veriženja blokov. Postopek transformacije prikažemo na enostavnem primeru

vzporednega prehoda. V razpravi opisujemo izzive, s katerimi smo se srečevali pri razvoju vmesnika ter predloge za nadaljnje delo.

## 2 Pregled literature

Za celovit prikaz obravnavane problematike smo v pregled literature vključili modeliranje poslovnih procesov, tehnologijo veriženja blokov in pametne pogodbe. V nadaljevanju pa predstavljamo različne poskuse transformacije zapisa poslovnega procesa v BPMN v pametno pogodbo.

### 2.1 Business Process Modeling and Notation (BPMN)

Glavni cilj konzorcija OMG je bil izdelati zapis poslovnega procesa, ki ga bodo različni uporabniki zlahka razumeli (Object Management Group, 2016). Predstavili so BPMN, standardizirano povezavo med oblikovanjem in implementacijo poslovnega procesa. Izkušnje in raziskave uporabe BPMN za modeliranje poslovnih procesov kažejo, da je BPMN zapis razumljiv tako izkušenim kot tudi novim uporabnikom (Gabryelczyk & Jurczuk, 2017). BPMN združuje najboljše prakse poslovnega modeliranja, s katerimi lahko opredelimo zapis in semantiko diagramov sodelovanja (ang. »*Collaboration diagrams*«), diagramov procesov (ang. »*Process diagrams*«) in diagramov koreografije (ang. »*Choreography diagrams*«). Predstavitev poslovnega procesa z BPMN (v nadaljevanju: model BPMN) je sestavljena iz različnih grafičnih elementov, kot so pasovi (ang. »*lines*«), zaporedna opravila (ang. »*sequenced tasks*«), dogodki (ang. »*events*«) in prehodi (ang. »*gateways*«). Tok zaporedja je usmerjena povezava med elementi toka, ki se lahko razcepijo in združijo s prehodi, kar omogoča modeliranje vzporednih nalog in odločitev. Specifikacija notacije poleg grafičnih simbolov definira tudi preslikavo diagrama procesa v izvršljiv jezik XPDŁ ali BPEŁ (ang. »*Business Process Execution Language*«), ki temeljita na XML.

### 2.2 Tehnologija veriženja blokov

Tehnologija veriženja blokov (ang. »*blockchain*«) je postala zanimiva z izdajo prve elektronske valute Bitcoin. Elektronski plačilni sistem temelji na kriptoloških dokazilih in ne na zaupanju, kar omogoča dvema udeležencema neposredne transakcije brez vključevanja tretje, zaupanja vredne entitete (Nakamoto, 2009). Predlagana rešitev temelji na neposredni komunikaciji med dvema strežnikoma (ang.

»peer-to-peer«) za časovno žigosanje in za generiranje izračunljivega dokazila o shranjeni transakciji.

S prihodom okolja Ethereum in z decentraliziranimi replikacijami programskih rešitev je tehnologija veriženja blokov, ki se je prvotno uporabljala na področju kriptovalut, dosegla tudi druga poslovna področja. Novost okolja so pametne pogodbe (ang. »*smart contract*«), ki so zapisane v jezikih Solidity ali Vyper. Tehnologija se je nato razvijala v smeri zasebnih okolij, kjer se uporabniki avtenticirajo (zasebno okolje ali okolje z odobritvami (ang. »*permissioned environment*«)). Eden od predstavnikov zadnje generacije okolij veriženja blokov je Hyperledger Fabric. To je odprtokodni sistem za veriženje blokov, zasnovan za nadgradnjo medpanožnih tehnologij. Kot prvi omogoča izvajanje porazdeljenih aplikacij v standardnih programskih jezikih, brez odvisnosti od fiat ali kripto valut. To ga razlikuje od drugih platform, ki zahtevajo specifične jezike za pametne pogodbe ali temeljijo na kripto valutah. Vključuje tudi integriran sistem upravljanja identitet (Androulaki et al., 2018).

### 2.3 Pametna pogodba

Pametna pogodba je poslovna logika v obliki izvedljive kode, ki deluje na verigi blokov (Hyperledger, 2024). Z logiko pametne pogodbe običajno ustvarjamo nove transakcije, ki se dodajajo v evidenco (ang. »*Ledger*«). Čeprav v pogovoru o verigah blokov izraza pametna pogodba (ang. »*Smart contract*«) in verižna koda (ang. »*Chaincode*«) pogosto zamenjujemo, gre za različna termina in verižna koda predstavlja paket pametnih pogodb v verigi blokov. V evidenci obstajata dve vrsti stanj, in sicer veriga blokov, ki beleži zgodovino vseh transakcij, ter svetovno stanje (ang. »*World state*«), ki vsebuje trenutno vrednost stanj. Primarno pametne pogodbe izvajajo operacije shranjevanja, pridobivanja in brisanja stanj v svetovnem stanju. Veriga blokov pa vsebuje zapis vseh sprememb. Razvijalci pametnih pogodb tako obstoječa poslovna pravila in procese zapišejo kot pametno pogodbo, v določenem programskem jeziku. V okolju Hyperledger Fabric je to običajno JavaScript, Go ali Java (Hyperledger, 2024).

Izvajanje pametnih pogodb vključuje več korakov, kot so razvoj, določitev potrditvenih politik, preverjanje veljavnosti transakcij, uporaba kanalov in komunikacija med pametnimi pogodbami. Za razliko od ostalih sistemov verig

blokov, se v okolju Hyperledger Fabric veljavnost transakcije določi na osnovi politike potrditve (ang. »*Endorsement*«), ki določa, kateri deležniki morajo podpisati transakcijo, da postane veljavna. Transakcija je veljavna, ko jo podpišejo vsi deležniki in se trenutno stanje svetovnega stanja ujema s stanjem transakcij po zaključenem zbiranju podpisov. Pametne pogodbe najpogosteje uporabljamo za določanje poslovnih pravil, razvijalci pa z njimi definirajo tudi nizkonivojsko programsko kodo, ki omogoča delovanje verige blokov.

## 2.4 Transformacija BPMN v pametno pogodbo

V predstavljeni raziskavi se osredotočamo na transformacijo pravil, ki so zapisana v formalizirani obliki, v programsko kodo pametne pogodbe. V literaturi najdemo le nekaj zapisov o podobnih poskusih. V prispevkih López-Pintado, Dumas, et al. (2019) in López-Pintado, García-Bañuelos, et al. (2019) je predstavljen sistem Caterpillar, ki izvaja poslovne procese na verigi blokov. BPMN model prevedejo v pametno pogodbo za okolje Ethereum in ga tako izvajajo v decentraliziranem okolju. Sistem omogoča transformacijo večjega števila elementov BPMN, vključno s podprocesi. Lauster et al. (2020) podaja pregled uporabe BPMN za modeliranje poslovnih procesov na verigi blokov in ugotavlja, da raziskave preučujejo predvsem, kako BPMN diagrame prevesti v pametne pogodbe, noben pristop pa še ni standardiziran. Liu et al. (2022) v prikazanem primeru razširja BPMN s konceptom sodelovalnih transakcij, kar implementirajo v sistemu za avtomatizirano transformacijo modelov v pametne pogodbe. Sistem TABS (Bodorik et al., 2023) prav tako avtomatizira pretvorbo BPMN modelov v pametne pogodbe, tako za okolje Ethereum kot tudi za Hyperledger Fabric. Zaradi možnosti izbire delov poslovnega procesa (procesi na glavni verigi ali procesi na stranskih verigah), predlagana rešitev zmanjša stroške delovanja in omogoča večjo zasebnost.

## 3 Metodologija

Model BPMN poslovnega procesa je zapisan v XML formatu, ki služi kot osnova za transformacijo modela v pametno pogodbo. Vsebina XML datoteke se nato pretvori v strukturo, ki omogoča generiranje Java programske kode, v kateri se doda programska logika za nadzor poteka in izvajanje posameznih nalog skladno s BPMN modelom.



Zapis BPMN je sestavljen iz dveh delov:

- Zapisa gradnikov (objektov) in povezav med njimi - `<bpmn2:process>`
- Zapisa grafičnega prikaza posameznih gradnikov (objektov) v programu za risanje procesov BPMN (npr. ProcessMaker) - `<bpmn2:BPMNDiagram>`

Za pretvorbo BPMN je potrebno uporabiti samo zapis procesa (`<bpmn2:process>` ... `</bpmn2:process>`). V tej raziskavi so bili uporabljeni osnovni gradniki procesa BPMN:

- začetek: `<bpmn2:startEvent>`
- konec: `<bpmn2:endEvent>`
- naloga: `<bpmn2:task>`
- povezava med dvema gradnikoma: `<bpmn2:sequenceFlow>`
- nadzorni gradniki:
  - izključujoč prehod (XOR): `<bpmn2:exclusiveGateway>`
  - vzporedni prehod (AND): `<bpmn2:parallelGateway>`
  - vključujoč prehod (OR): `<bpmn2:inclusiveGateway>`

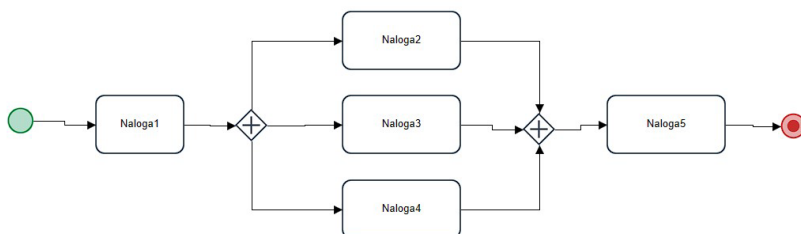
Postopek pretvorbe zapisa BPMN v ogrodje Javanske kode smo izvedli v več korakih. Najprej smo zapis BPMN prenesli v tabelo oziroma matriko povezav med objekti. Nato smo na osnovi obstoja in atributov povezave generirali ogrodje Javanske kode, ki predstavlja izhodišče za pripravo pametne pogodbe v verigi blokov.

## 4 Rezultati

Postopek pretvorbe zapisa BPMN v pametno pogodbo obsega več stopenj, ki jih v nadaljevanju prikazujemo na primeru modela BPMN, predstavljenega na sliki 1.

BPMN model preslikamo v tabelo, kjer vsaka vrstica predstavlja prehod med aktivnostmi in pogoj prehoda. Vsako polje v tabeli vsebuje informacijo o pogoju, ki mora biti izpolnjen, da se povezava izvede. Za medprocesne povezave pogoja za prehod ni treba opredeliti. Pogoje moramo obvezno opredeliti v primeru dveh vrst

kontrolnih stavkov, in sicer izključujoč (XOR) in vključujoč prehod (OR). Povezave v izključujočih ali vključujočih prehodih se izvedejo le, če je pogoj za povezavo izpolnjen. Če ni, se upošteva privzeta vrednost povezave. Pri vzporednih (AND) prehodih pogoji niso potrebni, saj se vse poti izvajajo sočasno.



Slika 1: BPMN diagram s primerom vzporednega prehoda

Vir: Lasten

#### 4.1 Postopek prepisa procesa BPMN v tabelo

Pri prepisu procesa BPMN so objekt, identifikator in ime predstavljeni kot niz znakov, vhod in izhod pa kot tabela znakovnega niza. Sintaksa za posamezne objekte BPMN je definirana v dokumentaciji (Object Management Group, 2016). Prepis zapisa BPMN v tabelo se izvede v več korakih:

1. Branje podatkov o objektih iz zapisa procesa (`<bpmn2:process>`)
2. Priprava tabele, v kateri so viri povezav zapisani v prvi stolpec, povezava pa se zapiše v prvo vrstico
3. Identifikacija začetnega objekta (`<bpmn2:startEvent>`) in podatkov o začetni povezavi (`<bpmn2:sequenceFlow>`).
4. Branje in številčenje objektov povezav (`<bpmn2:sequenceFlow>`) v vrstnem redu. Oznaka izvornega objekta se zapiše v ustrezno polje tabele. Pri kontrolnih objektih se v polje vpiše pogoj, prebran iz podatkovnega polja 'ime'.
5. Razvrščanje po zaporedni številki zapisa v stolpcu in zaporedni številki zapisa v vrstici.

Na sliki 2 je predstavljen primer tabele, ki opisuje diagram, prikazan na sliki 1.

	A	B	C	D	E	F	G	H	I	J	K	L	M
3	Element					bpmn2:task							
4	eL_61506180065636f222ca4e4022933058	1	bpmn2:startEvent		ST	bpmn2:parallelGateway							
5	eL_46143783265636f2226ae96094561825	2	bpmn2:task	Naloga1		TA							
6	eL_19749221665636f72c19fd0041879667	3	bpmn2:parallelGateway				PG						
7	eL_79705082765636f221fff04046807368	4	bpmn2:task	Naloga2			TA						
8	eL_90166900465636f22221c46048174055	5	bpmn2:task	Naloga3				TA					
9	eL_63007491165636f22246298040974308	6	bpmn2:task	Naloga4					TA				
10	eL_82908638065636f9ad3ac55042788496	7	bpmn2:parallelGateway							PG			
11	eL_32252431665636f221dd299036640846	8	bpmn2:task	Naloga5								TA	
12	eL_21901879565636f222b99c2009278295	9	bpmn2:endEvent										EE

Slika 2: Prikaz tabele za primer vzporednega prehoda

Vir: Lasten

Vrstice v tabeli predstavljajo izvorne elemente, stolpci pa ponorne elemente. Vsako polje, presečišče v tabeli, vključuje informacije o nalogi, ki jo je potrebno vključiti v ogrodje kode v Javi, ter pogoje za prehode, ki določajo potek izvajanja. Posebnost predstavljajo kontrolni stavki, pri katerih je na začetku nastavljen kazalnik (stikalo), ki zagotavlja, da se vse nadaljnje aktivnosti pravilno pretvorijo v ogrodje kode Java.

## 4.2 Postopek pretvorbe tabele v ogrodje Javanske kode

Tabela 1: BPMN kontrolni stavki

Kontrolni stavek	Kratka oznaka	Opis	Pogoj
bpmn2:parallelGateway	AND	Vzporedni prehod, kjer se vzporedno izvedejo VSE poti brez preverjanja pogojev.	Ne
bpmn2:inclusiveGateway	OR	Vključujoči prehod, pri katerem lahko proces nadaljuje po ENI, VEČ ali VSEH možnih poteh hkrati, odvisno od izpolnjenih pogojev. Obstajati mora tudi privzeta pot, ki se izvede, če noben pogoj ni izpolnjen.	Da
bpmn2:exclusiveGateway	XOR	Pri izključujočem prehodu se izvede SAMO ENA izmed možnih poti, odvisno od izpolnjenega pogoja. Ko je pogoj izpolnjen, se naslednji ne preverjajo več. Obstajati mora tudi privzeta pot, ki se izvede, če noben pogoj ni izpolnjen.	Da

Prvi element v tabeli sproži generiranje datoteke Java. V tej fazi se dodajo tudi osnovni elementi programskega modula, kot sta »*public class Main*« in »*public static void*«.

Po začetnem delu običajno sledijo posamezne naloge, ki se lahko izvajajo zaporedno ali pogojno, odvisno od kontrolnih stavkov. V Tabeli 1 so predstavljeni različni tipi kontrolnih stavkov. Različni tipi prehodov (XOR, OR, AND) imajo svoje posebnosti pri generaciji kode, saj lahko vsak prehod vodi v eno ali več izhodnih poti, kar vpliva na strukturo in pogoje v ustvarjeni kodi.

```

// bpmn2:parallelGateway Start
// Create an ExecutorService with a fixed pool size
int threadPool_1 = 3;
ExecutorService executorService_1 = Executors.newFixedThreadPool(threadPool_1);

// Create runnable task_1_1
Runnable task_1_1 = () -> {
    // bpmn2:task
    // public static void Naloga2() {
    //     // Add your Naloga2 logic here
    // }
};

// Create runnable task_1_2
Runnable task_1_2 = () -> {
    // bpmn2:task
    // public static void Naloga3() {
    //     // Add your Naloga3 logic here
    // }
};

// Create runnable task_1_3
Runnable task_1_3 = () -> {
    // bpmn2:task
    // public static void Naloga4() {
    //     // Add your Naloga4 logic here
    // }
};

// bpmn2:parallelTask
executorService_1.submit(task_1_1);
// bpmn2:parallelTask
executorService_1.submit(task_1_2);
// bpmn2:parallelTask
executorService_1.submit(task_1_3);
// bpmn2:parallelGateway End
// Shutdown the ExecutorService
executorService_1.shutdown();

try {
    // Wait for tasks to complete
    executorService_1.awaitTermination(Long.MAX_VALUE, TimeUnit.NANOSECONDS);
} catch (InterruptedException e) {
    e.printStackTrace();
}

```

Slika 3: Izsek programske kode Java za opis vzporednega prehoda

Vir: Lasten

Rezultat pretvorbe tabele je ogrodje Java programske kode, ki predstavlja osnovno strukturo. Koda še ne vsebuje natančnih pogojev za izvajanje nadzornih stavkov (if-else, while itd.). Ker model BPMN običajno ne vsebuje specifičnih pogojev za

odločanje, temveč le splošno strukturo procesa, pogoje dodajamo kasneje, ročno ali z drugim delom avtomatiziranega procesa. Na sliki 3 je prikazan izsek programske kode Java za opis vzporednega prehoda, prikazanega na sliki 1.

## 5 Zaključek

V raziskavi je predstavljen postopek pretvorbe BPMN modela v ogrodje Java kode prek dvodimenzionalne tabele, pri čemer se uporablja neobdelana BPMN koda v razširjenem XML formatu. Razvita rešitev omogoča hitro in preprosto uporabo modela BPMN za avtomatsko generiranje osnovne strukture kode, ki se nato dopolni s pogoji in programskimi ukazi. Trenutna implementacija podpira osnovne gradnike BPMN, kar omogoča učinkovito inicializacijo programske kode. Pametno pogodbo z Javansko programsko kodo lahko uporabimo v okolju Hyperledger Fabric.

Tehnologija veriženja blokov v poslovnem procesu izboljša sledljivost procesov, saj zapisi v verigi blokov ostanejo trajno shranjeni, kar odpravlja potrebo po dodatnih revizijskih sledih in omogoča transparentno preverjanje zgodovine izvajanja procesov. Del te tehnologije so tudi pametne pogodbe, s katerimi implementiramo poslovno logiko. Uporaba prikazane metode bi lahko znatno pospešila razvoj pametnih pogodb ter omogočila njihovo neposredno integracijo v rešitve veriženja blokov. Uporaba avtomatizirane pretvorbe bi imela več koristi, vključno z zmanjšanjem stroškov razvoja, povečanjem varnosti poslovnih procesov ter zmanjšanjem napak pri pripravi kode.

V prihodnje bi bilo smiselno razširiti metodo z dodatnimi gradniki BPMN ter nadgraditi prevajalnik BPMN-to-Java z naprednejšo podporo za kompleksne procese. S tem bi omogočili še bolj avtomatizirano in natančno generacijo kode, kar bi dodatno povečalo uporabnost rešitve v različnih domenah poslovnih procesov in aplikacij tehnologije veriženja blokov. Prav tako bi lahko BPMN pretvorili v druge programske jezike ter tako razširili uporabnosti tudi na druge verige blokov.

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# ENTREPRENEURSHIP EMPOWERED BY ARTIFICIAL INTELLIGENCE

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Artificial Intelligence (AI) is changing entrepreneurship by transforming how companies innovate, operate and stay competitive in the digital era. This paper examines how AI is becoming part of entrepreneurial practices and its impact on improving operations. This research combines theoretical frameworks with practical examples to outline best practices for AI adoption among entrepreneurs. The purpose of this study is to examine how AI contributes to driving innovation, improving operational efficiency and increasing customer engagement. The aim of this paper is to provide actionable insights into leveraging AI for competitive advantage. The intention of this paper is to inspire entrepreneurs to adopt responsible and strategic approaches to AI integration. By synthesizing theoretical insights and practical findings, this paper underscores the transformative potential of AI, guiding entrepreneurs toward growth and progress in the digital economy.

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## 1 Introduction

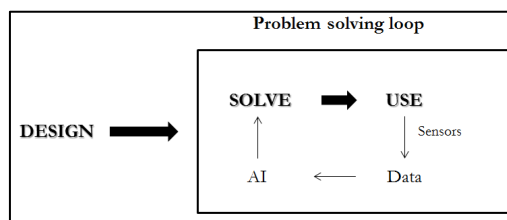
In recent years, rapid progression of Artificial Intelligence (AI) technology has transformed the landscape of entrepreneurship and business economics. By using advanced analytics, machine learning and automated decision-making, entrepreneurs can drive innovation and fundamentally rethink how they create and deliver value in today's market conditions (Wajahat, 2024). Integrating AI into daily operations brings many challenges, such as (Kaplan & Haenlein, 2019): privacy issues, liability, job displacement, adapting to rapid technological changes and others. This shift towards digital technologies is becoming a key force in shaping entrepreneurial ecosystems, prompting new developments and creating new opportunities (Jovanović et al., 2024). Entrepreneurship consists of utilizing resources based on opportunities, requiring social skills alongside market and technical expertise, aligning with key benefits AI delivers (Giuggioli & Pellegrini, 2022; Johannisson, 1998): identifying opportunities, improving decision-making, enhancing performance and advancing research and education. The path to effectively incorporating AI into business is accompanied by various barriers (Cubric, 2020): economic (cost, support infrastructure), technical (availability of large training datasets, creating models) and social (lack of knowledge, safety, trust). Despite existing barriers, Small and Medium Enterprises (SMEs) show a strong awareness of market needs, driving higher innovation intentions (Rojas-Córdova et al., 2020). The structure of the paper is as follows. After the introductory section, the second section presents the impact of AI on product development, marketing, risk management and talent acquisition, pointing to the improvements in business growth by improved decision-making and seizing opportunities. The third section includes examples from two companies that leveraged AI to achieve rapid growth and gain a strong market presence, as well as two major corporations that utilize AI to maintain their competitive edge at the top of their industries, showing that AI adoption is not limited by the size of the company. The fourth section presents the conclusion of the paper.

## 2 AI-driven transformation

AI is revolutionizing product innovation by enabling companies to create »smarter«, more personalized and efficient solutions. By utilizing AI technologies (machine learning, computer vision, generative AI and others) companies can analyze large



data sets to identify consumer preferences and needs. With AI-driven insights, companies can adjust products and services to individual customers. As a result, AI has a critical role in fostering personalization (Choppadandi, 2023). The integration of AI into system development has revolutionized the way solutions are conceived and implemented. Design, in the context of AI-driven systems, refers to the process of creating the foundational framework and problem-solving loops that enable AI to autonomously make decisions (Verganti et al., 2020). AI-driven systems rely on autonomous problem-solving loops, reducing human involvement in designing these loops (Figure 1) that replace humans, scale easily and generate different solutions with minimal additional effort.



**Figure 1: Design in the context of AI**

Source: (Verganti et al., 2020)

Transition to AI-driven systems boosts efficiency and speeds up the processes of prototyping and testing (Goel et al., 2024). By automating repetitive and intensive tasks, AI allows companies to allocate resources towards more strategic initiatives. AI-driven design frameworks foster iterative development where systems continuously learn and improve from data inputs, leading to optimized solutions over time (Kumar, 2021). This dynamic adaptability enables companies fast respond to market changes establishing market leadership in dynamic industries. Generative design algorithms further enhance innovation by enabling rapid exploration of optimized design solutions. Generative design algorithms, for instance, enable engineers and designers to faster explore thousands of design variations. This capability reduces the time to market while ensuring that the final product meets or exceeds customer expectations (Voola, 2021). This capability also reduces the costs of experimentation, helping companies improve product attractiveness and diversify their portfolio (Babina et al., 2023). For this reason, companies can maintain a competitive advantage by bringing faster superior products to consumers. AI is transforming the company's marketing strategies by enabling the delivery of

personalized campaigns. Enabling data-driven decision-making and efficient campaign strategies that consist of chatbots, automated content creation, image recognition and e-mail, marketing has become a vital tool in modern marketing (Murgai, 2018). AI has revolutionized corporate marketing by enhancing effectiveness, modernizing strategies and optimizing performance through its integration into pricing, promotion, digital engagement and customer relationship management (Shaik, 2023). This combination of precision and adaptability establishes AI as a key driver of long-term success in modern marketing (Yang et al., 2021).

AI goes beyond marketing and helps entrepreneurs to manage risks more effectively by identifying and reducing potential threats. According to (Aziz & Dowling, 2018), when combined with machine learning, AI can be applied in different areas of risk management, including credit risk (modeled with statistical methods that offer greater accuracy and practical applications in areas, such as SMEs or consumer lending), market risk (linked to the financial market, market risk is managed with both AI and machine learning to improve model testing, reduce costs, adapt trading strategies and identify hidden risks) and operational risk (identifying and reducing financial losses from internal issues or external events, system failures or frauds, by automating tasks, analyzing data, ensuring compliance). In addition to risk management, AI is transforming human resource functions. AI is revolutionizing recruitment by automating processes, improving decision-making accuracy, enhancing candidate engagement and enabling data-driven talent acquisition strategies (Sasi, 2024). Technological advances including AI are transforming recruitment by enabling platforms to filter and match candidates to jobs more effectively through direct or third-party applications (Van Esch et al., 2018). AI has the potential to revolutionize career guidance by supporting career planning, enhancing counselling interactions, recognizing and mapping skills, identifying competence gaps, anticipating guidance needs and leveraging networks for employment opportunities (Westman et al., 2021). This leads to better talent acquisition and retention strategies.

### 3 Organizational and economic impacts of AI – examples from the practice

AI is transforming entrepreneurship by driving significant organizational and economic changes. It significantly influences various business areas, such as risk management – by improving predictive analytics and fraud detection (Arsic, 2021); cost efficiency – through automation and resource optimization (Waqar et al., 2024); market agility – by enabling personalized experiences and adaptive strategies (Kumar et al., 2019) and customer relationships – by enhancing engagement through advanced algorithms (Wang et al., 2022). The following subchapters will explore these four areas, illustrating how AI is helping businesses grow. When it comes to risk management and market agility, two smaller companies highlight the benefits of early AI adoption, using its capabilities long before companies became widely popular. Their success demonstrates how AI empowered smaller businesses to adapt quickly and achieve remarkable results in competitive markets. On the other hand, improved cost efficiency and strengthened customer relationships are presented by two of the world's largest corporations. Large companies are highlighted because entrepreneurs usually avoid sharing their strategies or knowledge early on to protect their business interests (Connelly et al., 2011). These four examples demonstrate that both emerging startups and leading global enterprises can benefit by strategically integrating AI into their operations.

#### 3.1 Risk management

AI can support companies throughout the risk management process, including identifying risk exposure, measuring, estimating and evaluating its effects (Sanford & Moosa, 2013), presented in Figure 2. An example from the practice is the company »Kabbage«, a small fintech company, that offers eligible small businesses flexible lines of credit from \$2.000 to \$250.000, helping them manage cash flow and growth (American Express, 2022). This company has successfully utilized AI with machine learning algorithms to enhance credit risk management by analyzing data from public online profiles, social media and news reports (Deepthi & Nagajyothi, 2017). This allowed »Kabbage« to build comprehensive credit risk profiles for small businesses, enabling faster and more accurate lending decisions. In 2020, »Kabbage« was bought by American Express and renamed in »American Express Business Blueprint« (Treece & Tarver, 2022).

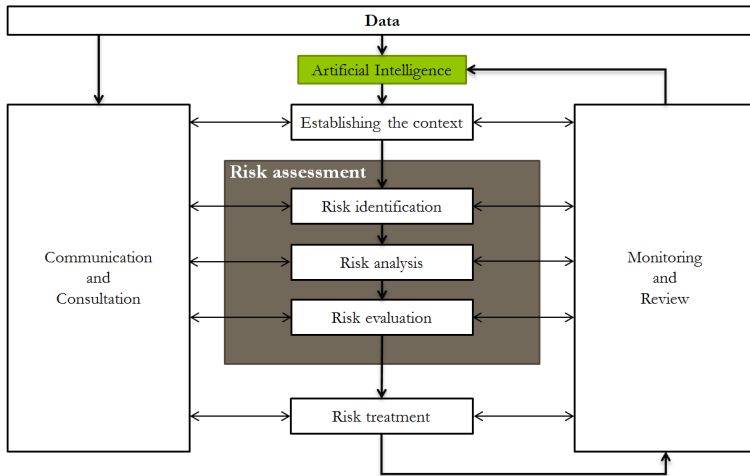


Figure 2: Risk management process empowered by AI

Source: (Žigienė et al., 2019)

### 3.2 Cost efficiency

AI application helps cost reduction by optimizing procurement, supply chain and maintenance processes through data-driven strategies, efficient sourcing and predictive problem-solving (Parekh & Mitchell, 2024). It also enables manufacturers to optimize key performance indicators and monitor them in real time, for instance, virtual modeling helps in predicting, identifying and preventing staffing and material bottlenecks, improve energy efficiency and proactively alert engineers to potential issues while suggesting solutions (Dash et al., 2019). AI-driven manufacturing, not only enhances the efficiency of assembly line operations but also reduces costs and waste (O'Reilly & Binns, 2019). Table 1 provides a few additional examples of how AI tools can be applied to reduce manufacturing costs. Company »Siemens« is transforming manufacturing processes with AI, making them more efficient, scalable and sustainable while providing powerful solutions, because company »Siemens« (Siemens, 2024):

- Collaborates with partners, academia and customers to create robust systems: AI-based predictive maintenance, autonomous robots for item picking, packing and AI-accelerated search engines;

- Provides accessible AI tools, lifecycle support and industrial foundation models: AI-assisted accelerated problem solving, engineering with the Industrial Copilot, AI-based visual quality inspection and »Green hydrogen« with GenAI;
- Offers AI solutions for quality assurance and sustainability: AI-based leak detection, AI-based soft sensor, product design with generative AI and simulation and computer vision-based Printed Circuit Board (PCB) assembly inspection.

**Table 1: Cost reduction through AI implementation in manufacturing**

	Examples of cost reduction areas
AI-based predictive maintenance	Predicting failures in advance reduces unplanned downtime; early detection of issues prevents damages; efficient scheduling of maintenance tasks minimizes overtime; preventing malfunctions ensures consistent production quality and reduces waste.
Autonomous robots for item picking and packing & AI-based visual quality inspection	Reducing reliance on manual labour for repetitive tasks lowers workforce expenses; minimizing picking and packing errors; automating tasks eliminates the need for overtime during peak periods; reducing the costs of training new employees.
AI-based leak detection	Early detection of leaks prevents damages; identifying and fixing leaks minimizes energy waste and decreases utility costs; proactively addressing leaks avoids production stoppages.

Source: The authors of the paper

### 3.3 Market agility

Agility in manufacturing and marketing is the capacity to adapt processes with minimal costs, foster innovation by responding to customer needs and adjust to changing environments, allowing businesses and suppliers to meet varied demands and explore new opportunities (Alghamdi & Agag, 2023). Similarly, agility principles are evident in how »Duolingo« rapidly adapts its platform to emerging language needs and user feedback. »Duolingo« is an application that offers a wide range of foreign language learning materials that help users strengthen their foreign language skills. By the third quarter of 2022, »Duolingo« had over 500 million users worldwide, with around 56.5 million active every month (Nugraha et al., 2023). »Duolingo« leverages AI in several ways to enhance its market agility and broaden global reach (Wodzak, 2023): personalized learning (AI customizes lessons based on

user strengths and weaknesses, corrects grammar, improves pronunciation and suggests writing tips), fun and accessible tools (AI powers engaging features like character voices and makes the language tests faster, cheaper and available from home) and safe and responsible AI («Duolingo» uses advanced AI responsibly, ensuring fairness, security and transparency in tests). «Duolingo» started as a free platform developed at Carnegie Mellon University in 2009 and attracted millions of users with its engaging approach. Figure 3 illustrates the success of the company «Duolingo», where the left side presents the revenue growth trend and the right side highlights the growth trend of monthly active users.

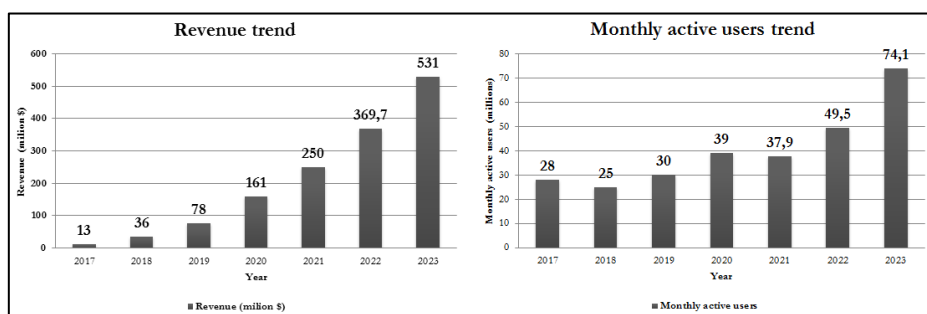


Figure 3: «Duolingo» growth trend – revenue (left) and monthly active users (right)

Source: (Curry, 2024)

### 3.4 Customer relationship

There are many ways to strengthen customer relationships but one of the most effective methods is using AI, particularly through the use of chatbots (Wang et al., 2022). Chatbot is a computer program that interacts intelligently through text or voice, understanding one or more human languages using Natural Language Processing (Khanna et al., 2015). The strength of relationships with customers was largely influenced by the chatbot's ability to deliver accurate, credible and competent communication, even while offering various relationship maintenance functions (Cheng & Jiang, 2021). Company «Amazon» enhances its self-service customer experience with AI through «Amazon Lex», that provides chatbots with advanced speech and text recognition capabilities to understand and fulfil user intent accurately (Hunt, 2017; Nadeem et al., 2024):

- When the user calls »Amazon«, »Amazon Connect« integrates with an »Amazon Lex« bot;
- If the bot cannot identify the caller's intent it usually leads to failed interactions that frustrate users (they may need to repeat themselves, experience incorrect routing or be unnecessarily escalated to live agents). To prevent this, a »AWS Lambda« is activated;
- The function sends the customer transcript to a foundation model in »Amazon Bedrock« that analyzes and determines the caller's intent;
- The »AWS Lambda« function routes the call to the correct intent for a solution. A customer scheduling query triggers »AWS Lambda« to access Customer Scheduling software and »Amazon Connect« confirms the appointment via SMS.

#### 4 Conclusion

AI boosts efficiency, promotes adaptability and enables data-driven decision-making across areas ranging from product development to risk management. Through the use of AI, companies can innovate faster, enhance customer experiences and identify different types of risks. By integrating AI into the product lifecycle, companies can continuously adapt to changing customer needs. This encourages innovation and strengthens customer loyalty. Because the automated iterative approach allows companies to innovate more effectively, entrepreneurs can experiment more with new ideas and with fewer risks, by application of AI-powered tools for design and product development. Besides that, AI has shown great utility in enhancing credit risk management by processing vast amounts of data from different sources which increases financial certainty. In manufacturing, AI optimizes processes through predictive maintenance and automation, leading to cost reductions and improved efficiency. Its role in market agility is evident in the successful adaptation to individual needs. AI-powered chatbots have transformed the way companies connect with customers offering accurate and efficient support, allowing them to focus on other challenges. All of these advancements highlight AI's role in supporting business growth and innovation. The examples presented in this paper show that companies, despite size, can significantly improve their business by integrating AI into their businesses. Smaller companies can achieve remarkable success by adopting AI early, while larger corporations, with their vast resources and data, show how AI can

achieve cost efficiency and keep customer engagement at a very high level. By using AI, entrepreneurs can unlock growth opportunities. Examples show that the key to improvements lies in aligning AI capabilities with the willingness to adapt and innovate.

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# VARSTVO PRED SPLETNIMI PREVARAMI

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Družbena odgovornost, kritično mišljenje ter kreativnost so temeljne agende v postmodernem svetu. Družbeno odgovornost lahko razširimo tudi na širše – spletno okolje. Tako smo vsak trenutek izpostavljeni novim tehnološkim izumom in napravam, pa tudi nenehno novim načinom uporabe tehnologije, na prvi pogled učinkovitejše. Bolj podroben pogled, pa ob navidezni večji storilnosti pokaže, da se počasi oddaljujemo in odtujujemo od bistva. Obdaja nas tehnologija, ki jo včasih tudi ne znamo uporabljati na ustrezen način. Raznovrstna družbena omrežja, spletni forumi ter vedno nove ob aplikacija predstavljajo vir in novo okolje za profesionalno delo in tudi preživljanje prostega časa. Ta nova okolja pa nosijo s seboj tudi precejšnja varnostna tveganja. Internet predstavlja zelo uporabno in skorajda nujno orodje za urejanje, deljenje ter dostop do podatkov za vsakršne namene. Tako moramo danes, bolj kot kdaj koli, poznati njegovo delovanje in pasti, ki prežijo na nas. Sobivanje z novimi načini uporabe tehnologije postaja zahtevnejše.

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social media,  
security risk

# PROTECTION AGAINST ONLINE SCAMS

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Nature conservation and environmental protection are fundamental agendas in our postmodern world. The security of the environment can also be extended to the wider online environment. Thus, every moment we are exposed to new technological inventions and devices, as well as constantly new ways of using technology, at first glance more efficient. A more detailed look, however, with apparent greater productivity, shows that we are slowly drifting away and alienating ourselves from the essence. We are surrounded by technology, which sometimes we don't even know how to use properly. Various social networks, online forums and new applications are a source and a new environment for professional work and leisure. These new environments also carry significant security risks. The Internet represents a very useful and almost necessary tool for editing, sharing and accessing data for any purpose. So today, more than ever, we need to know its operation and the pitfalls that lie in wait for us. Coexistence with new ways of using technology is becoming more challenging. Let's look back to the bottom line and sharpen our perspective on the fact that we are in fact leading by example. In the eyes of male and female colleagues, male and female students, male and female students, we are not what we say, but what we live. Thus, in addition to nature conservation and environmental protection, we must also keep in mind the protection of the online environment.



## 1 Uvod

Živimo v hitro razvijajočem se svetu, kjer smo vsak trenutek izpostavljeni novim tehnološkim izumom in napravam, poleg tega pa tudi nenehno novim načinom uporabe tehnologije. V življenju smo že od začetka obdani s tehnologijo, ki jo včasih tudi ne znamo uporabljati na ustrezen oziroma pravilen način. Razna družbena omrežja, spletni forumi ter nove aplikacije predstavljajo novi vir in novo okolje za preživljanje prostega časa, vendar ta okolja nosijo s seboj tudi določena varnostna tveganja.

Internet predstavlja zelo uporabno in skorajda nujno orodje za urejanje, deljenje ter dostop podatkov za vsakršne namene, zato pa moramo danes bolj kot kdaj koli poznati njegovo delovanje in pasti, ki se tam pojavljajo.

Glede varnosti je potrebno omeniti pomembne dejavnike, ki pomagajo do regulacije objave osebnih podatkov, varnosti pred zlonamernimi kodami ter lažnimi objavami na internetu, tj. preventiva in seznanjanja uporabnikov interneta o tveganjih javne objave podatkov, medijske pismenosti ter splošne seznanitve z zlonamernimi kodami kot način, da pridemo do kritičnih in zdravih uporabnikov interneta.

V zadnjih letih čas, ki ga preživimo na spletu, konstantno narašča, prav tako pa tudi narašča število ljudi, ki do spleta dostopa. Današnja generacijo predvsem pa otroke in mladino lahko poimenujemo tudi digitalna generacija, saj odraščajo s tehnologijo in so v stiku z njo praktično vsakodnevno že od malih nog. Današnji uporabniki interneta tako predstavljajo zelo pomembne medijske uporabnike, predvsem zato, ker bodo s tehnologijo v stiku vse življenje. Včasih smo si želeli nove igrače (lego kocke), danes pa nov zmogljiv mobilni telefon ali celo kaj več v zvezi z digitalizacijo. Pri oblikovanju teh navad igra ozaveščanje pred nevarnostjo zelo močno vlogo, saj se moramo zavedati nevarnosti internetne tehnologije z namenom, da jo bomo lahko varno in odgovorno uporabljali (Grilc, 2017).

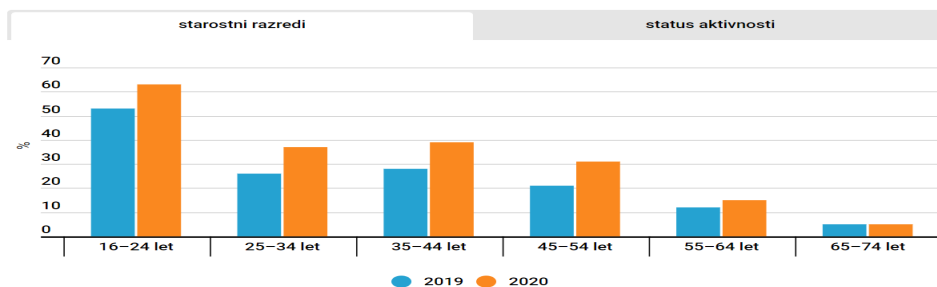
Uporaba informacijsko-komunikacijske tehnologije (IKT) že nekaj časa predstavlja osrednji element sodobne družbe, zato bi bilo potrebno uporabnike te tehnologije že od malih nog poučiti pravilno uporabljati. Ali to dejansko počnemo? Osnovno znanje mladi dobijo v šoli, npr. uporaba orodij Microsoft Office, e-poštnega

nabiralnika, brskanje po spletu, itd, vendar bi morali mlade že od začetka poučiti o varnosti podatkov, zlonamernih kodah ter lažnih novicah.

## 2 Statistika uporabe interneta

Po podatkih Statističnega urada Slovenije (SURS) ima v Sloveniji v letu 2023 dostop do interneta 93% delež gospodinjstev (osebe med 16 in 74 letom), 71% delež e-kupcev (osebe stare od 16 do 74 let ki so v zadnjih 12 mesecih nekaj naročil ali kupili preko spleta) ter 85% delež oseb (osebe med 16 in 74 letom), ki uporabljajo internet vsak dan ali skoraj vsak dan (SURS 2021).

Po podatkih SURS 2021 jih 27% starih od 16 do 74 let ni vedlo da imajo na svojem pametnem telefonu nameščen varnosti program, 4% pa jih je na svojem pametnem telefonu zaradi zlonamerne kode ali drugih vrst sovražnih programov izgubile informacije, dokumente, slike ali druge podatke (SURS 2021).



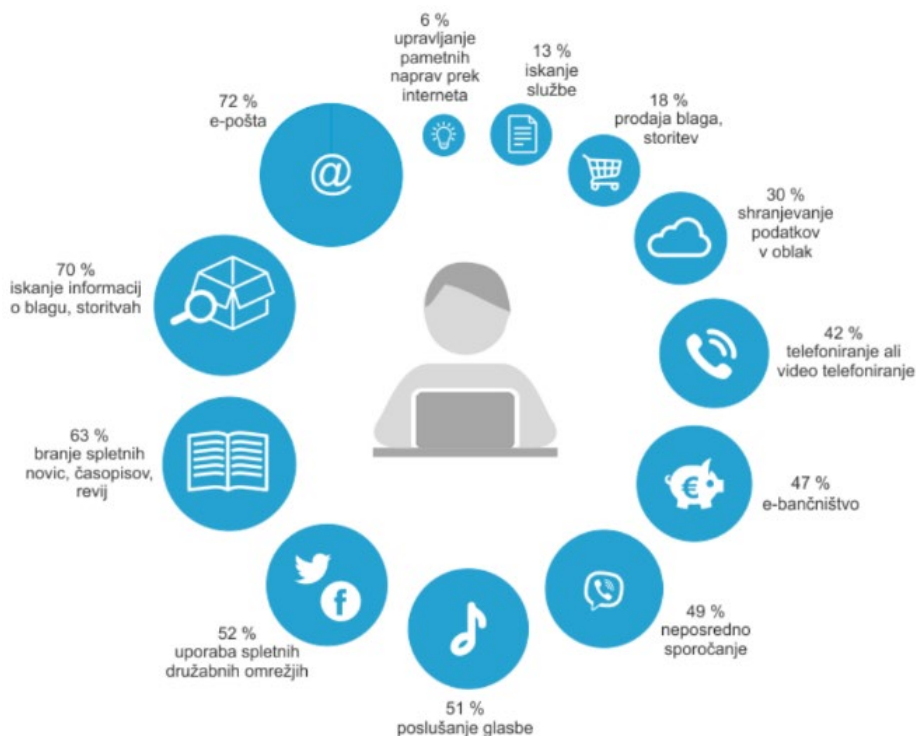
Slika 1: Delež oseb, starih 16–74 let, ki so se izobraževale prek interneta, Slovenija, 2019–2020

Vir: SURS, 2021



Slika 2: Koliko rednih uporabnikov interneta je v posamezni starostni skupini

Vir: SURS, 2021



Slika 3: Delež uporabnikov interneta (16 -74) po namenih uporabe interneta

Vir: SURS, 2021

### 3 Zlonamerna koda

Zlonamerna koda je izraz, ki se uporablja za opis katere koli kode v katerem koli delu programskega sistema ali skripte, ki naj bi povzročil neželene učinke, varnostne kršitve ali škodo na sistemu. Zlonamerna koda je varnostna grožnja aplikacije, ki je ni mogoče učinkovito nadzorovati samo s konvencionalno protivirusno programsko opremo. Zlonamerne kode opisujejo široko kategorijo sistemskih varnostnih izrazov, ki vključujejo napadne skripte, viruse, črve, trojanske konje, trojanska vrata in zlonamerno aktivno vsebino (VERACODE, 2021).

Zlonamerna koda lahko vključuje tudi časovne bombe, kriptografsko kodiranje podatkov, namerno uhajanje informacij in podatkov, rootkite in tehnike za preprečevanje odpravljanje napak. Te ciljne grožnje z zlonamerno kodo so skrite v

programski opremi, da se izognejo odkrivanju s tradicionalnimi varnostnimi tehnologijami.

Ko je zlonamerna koda v vašem okolju (računalniku, pametnemu telefonu, itd.), ta vstopi v omrežje in se širi. Zlonamerna koda lahko povzroči preobremenitev omrežja in poštnega strežnika s pošiljanjem e-poštnih sporočil, krajo podatkov in gesel, brisanje datotek in dokumentov, itd (Tekavec, 2021). Ločimo več vrst zlonamernih kod, ki jih predstavljam v nadaljevanju

### 3.1 Virus

Je vrsta zlonamerne programske opreme, ki se širi tako, da vstavi svojo kopijo v drug program in postane del drugega programa. Širi se z enega računalnika na drugega in med potovanjem pušča okužbe. Resnost virusov se lahko razlikuje vse od povzročanja zmerno nadležnih učinkov pa vse do škodovanja podatkov ali programske opreme. Skoraj vsi virusi so priloženi izvedljivi datoteki (.exe), kar pomeni da virus morda obstaja v sistemu, vendar ne bo aktiven ali se ne bo mogel širiti dokler uporabnik ne zažene ali odpre te izvedljive datoteke. Običajno gostiteljski program še naprej deluje, ko ga okuži virus zato ga je težko odkriti na golo oko. Virus se širijo, ko se programska oprema ali dokument, ki vsebuje virus prenese iz enega računalnika na drugega z uporabo omrežja, diska, skupne rabe datotek ali okuženih e-poštnih prilog.

Najhujši računalniški virusi v zgodovini (Gerencer, 2020):

1. Mydoom – 38 milijard dolarjev v letu 2004
2. Sobig – 30 milijard dolarjev v letu 2003
3. Klez – 19.8 milijard dolarjev v letu 2001
4. ILOVEYOU – 15 milijard dolarjev v letu 2000
5. WannaCry – 4 milijarde dolarjev v letu 2017
6. Zeus – 3 milijarde dolarjev v letu 2007
7. Code Red – 2.4 milijarde dolarjev v letu 2001
8. Slammer 1.2 milijarde dolarjev v letu 2003
9. CryptoLocker - 665 milijonov dolarjev v letu 2013
10. Sasser – 500 milijonov dolarjev v letu 2004



### 3.2 Izsiljevska programske koda (ang. Ransomware)

Ransomware je vrsta zlonamerne programske kode ki grozi, da bo objavila podatke žrtve ali pa trajno blokirala dostop do njih, ter šifrira razne diske, datoteke in mape, razen če je plačana odkupnina. Medtem ko lahko neka preprosta izsiljevska programska oprema zaklene sistem na način, ki ga poznavalcem ni težko spremeniti, lahko tudi naprednejša koda popolnoma zaklene/šifrira dostop do nekih podatkov, ki jih brez ključa ni možno odkleniti. Velikokrat tudi po prejemu plačila ne dešifrirajo datotek, map ali diskov (Janhar, 2021).

Primer: CryptoLocker je bil eden najbolj donosnih pri izsiljevalskih programskih kodah. Med septembrom in decembrom 2013 je okužil več kot 250.000 sistemov in je ustvarjalec zaslužil več kot 4 milijone dolarjev preden je bil leta 2014 odstranjen.



Slika 4: Primer izsiljevanja

Vir: Canva

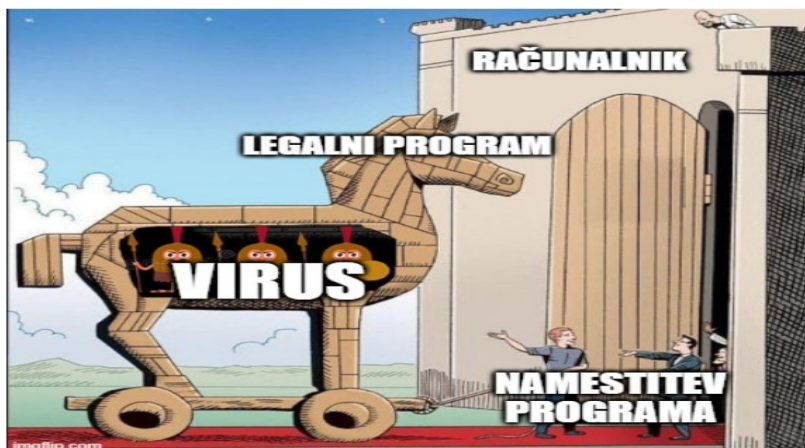
### 3.3 Črv (Worms)

So podobni računalniškemu virusu, ker se tudi razmnožujejo in lahko povzročajo enako vrsto škode. V nasprotju z virusi, ki zahtevajo širjenje okužene gostitelje datoteke, so črvi samostojna programska oprema in za širjenje ne potrebujejo

gostiteljskega programa ali človeške pomoči. Za širjenje izkoriščajo ranljivost sistema ali pa uporabljajo nekakšen socialni inženiring, da uporabnike ukanejo/zavedejo da jih poženejo. Črv vstopi v računalnik skozi ranljivost v sistemu in izkoristi funkcije prenosa datotek ali informacij v sistemu, kar mu omogoča potovanje brez pomoči. Naprednejši črvi uporabljajo tehnologijo šifriranja, brisanja ali kodiranja opreme, z namenom da škodijo svojim tarčam.

### 3.4 Trojanski konj

Je vrsta zlonamerne koda, ki je dobila ime po lesenem konju, so ga Grki uporabili za infiltriranje v Trojo. To je škodljiva programske oprema, ki na površini izgleda legitimna. Uporabniki so običajno zavedeni, da ga naložijo in izvedejo v svojih sistemih. Ko je naložen, lahko doseže poljubno število napadov na uporabnika, vse od draženja uporabnika (po skakanje oken ali spreminjanje namizij) pa vse do večjega škodovanja (brisanje datotek, krajo podatkov ali aktiviranje in širjenje druge zlonamerne programske opreme kot so virusi). Znano je tudi da trojanski konj ustvarja stranska vhodna vrata (ang. Backdoor), ki omogočijo dostop do sistema. Za razliko od virusov in črvov se trojanski konj sami ne razmnožujejo, tako da okužijo druge datoteke. Širijo se preko uporabniške interakcije kot je odpiranje e-pošte ali zagon nekih datotek, ki smo jih prenesli preko interneta.



Slika 5: Primer delovanja trojanskega konja

Vir: Canva

### 3.6 Stranska vhodna vrata (Backdoor)

Nedokumentiran način dostopa do sistema, ki zaobide običajne mehanizme preverjanja prisotnosti. Nekatera stranska vhodna vrata namesti tisti programer ki je ustvaril nek program, druga pa so nameščena s sistemsko ogroženostjo, kot je virus, črv ali trojanski konj. Napadalcı običajno uporabljajo stranska vrata za lažji dostop do sistema, z namenom pridobivanja datotek, podatkov in informacij (Janhar, 2021).

### 3.6 Vohunska programska oprema (Spyware)

Vohunska programska oprema je splošno ime celo paleto programske opreme, ki nadzira uporabnikove aktivnosti, zbira informacije kot so pritisnjene tipke, snema zaslone in datotečne mape, vse to pa lahko shranjuje ali pošilja na oddaljeno lokacijo, seveda brez uporabnikovega privoljenja in zavedanja. Za razliko od računalniških virov in črvov, se vohunska programska oprema ne razmnožuje avtomatični, vendar pa vseeno izkorišča računalniške sisteme za komercialno korist. Znano je, da večina spletni strani, ki omogočajo prenašanje programov in datotek, poleg zelenih datotek namesti tudi spyware. Nameščena je lahko na prikrite načine kot trojanski konj, del virusa in črva ali prenesen na skrit način.

### 3.7 Rootkit

Je zlonamerna koda, ki je izrecno narejena z namenom preminjanja procesov v operacijskem sistemu s čimer bi dosegel nestandardno delovanje. Rootkit spada med najbolj napredne tipe zlonamerne kode, ki so zgrajeni za delovanje v popolni prikritosti. Njihovo odkritje in odstranjevanje močno otežuje dejstvo, da se maskirajo in skrivajo med preostale neškodljive procese, ki potekajo na računalniku. Kljub temu, da jih ni popolnoma mogoče odkriti, pa je za navadnega uporabnika skoraj nemogoče, da jih odstrani, saj pri tem velikokrat ne uspe tudi za to specializiranim protivirusnim programom.

## 4 Obramba pred zlonamerno kodo

### 4.1 Protivirusni programi

Dobri protivirusni programi so nosilni stebri obrambe našega računalnika, saj se tega zavedajo tudi proizvajalci teh protivirusnih programov. Ponujajo nam zaščito pred virusi, črvi, trojanskimi konji in številnimi drugimi grožnjam.

So tri temeljne protivirusne tehnike:

1. Specifične metode odkrivanja
2. Tovrstne metode iščejo in identificirajo specifične tipe virusov. Ko je odkrita nova zlonamerna koda, jo strokovnjaki analizirajo, razstavijo njeno kodo in jo tako skušajo spoznati ter ugotoviti, kako jo v prihodnje prepoznati ter izbrisati. Glede na zapletenost zlonamerne kode je to lahko zelo dolg in zapleten proces.
3. Splošne metode odkrivanja virusa
4. Pri tej metodi se ne išče točno določene kode, ampak zgolj sumljivo aktivnost in nepooblaščenke modifikacije procesov v računalniškem sistemu.
5. Preventivne metode
6. Tovrstne metode ustvarijo računalniško okolje, kjer zlonamerna koda »okleva« preden vstopi v sistem, ali pa se po vstopu ne more izvršiti. Večina teh tehnik vsebuje uporabo zdravega razuma.

### 4.2 Požarni zid

So poleg protivirusnih programov steber obrambe našega sistema pred zlonamerno kodo in vdori. Požarni zid bi lahko definirali kot nekakšen filter, ki identificira poskuse različnih aplikacij, ko le-te poskušajo preko spleta dostopati do našega računalnika. Pri požarnem zidu velja tudi obratno, in sicer nas obvešča o aplikacijah nameščenih na našem sistemu, ko skušajo dostopati do spleta. Se pravi, požarni zid nas ščiti pred potencialnimi zlonamernimi kodami, ko ta skuša dostopati do našega računalnika.

Poznamo požarne zidove:

1. Požarni zidovi s filtriranjem paketov
2. Je najbolj osnoven tip in filtrira le omrežni in transportni nivo. Deluje tako da sprejme paket in na podlagi nastavitvev določi ustrezno dejanje in to dejanje izvrši na paketu.
3. Požarni zidovi, ki pregledajo celoten paket
4. Isto kot zgoraj, dodatno pa še nadzirajo stanje prispelih paketov.
5. Požarni zid na aplikacijskem nivoju
6. Ta tip lahko filtrira promet na omrežnem, transportnem in aplikacijskem nivoju.
7. Krožni požarni zidovi s prehodom
8. Je najmanj uporabljan in ne omogoča nikakršne večje zaščite, le da skrije omrežje ali posamezen računalnik na požarnim zidom.

## 5 Socialni inženiring

Pri socialnem inženiringu lahko po domače povemo, da gre za prevaro s katero prevaranti pridejo do določenih zaupnih podatkov. Je ne tehnični vdor, ki se pretežno zanaša na človeške interakcije in pogosto vključuje prevare ljudi z namenom zaobiti varnostne postopke. Širša definicija je »tehnika, s katero ciljne osebe (žrtve) z uporabo poznavanja psihologije ljudi, delovanja računalniških sistemov in terminologije ter z uporabo majhnih in verjetnih laži pripravimo do tega, da ravnajo (ali pa opustijo neko ravnanje), ki v običajnih okoliščinah ko imamo opravke s tujci oz. nepoznanimi osebami, ne bi nikoli« (Pagon, 2021).

Pri socialnem inženiringu pride do tega da individualne osebe uporabljajo vpliv in prepričljivost za prevaro ljudi tako, da jih prepriča, da je socialni inženir nekdo, ki to ni oz. jih prevara z manipulacijo (Suša, 2009).

Razlika med hekerjem ter socialnim inženirjem je torej v tem, da socialni inženir ne potrebuje nujno vrhunskega računalniškega znanja, pač pa mora biti le prepričljiv in dobro poznati psihologijo človeka. Ta način kraje podatkov in ostalih nelegalnih početih je mnogo hitreje in cenejše od hekerskega vdiranja v sistem, vendar je za osebe in podjetja, ki pa hočejo svoje podatke zaščiti veliko boljše nevaren.

Pri socialnem inženiringu nam namreč bolj malo pomaga zaščitna tehnologija kot so protivirusni programi, požarni zidovi, posodobljeni računalniški sistemi, itd. Tukaj sta poglavitni zaščiti pazljivost in zdrava pamet vsakega posameznika. Poznamo več vrst socialnega inženiringa. Dominirajo v nadaljevanju opisane oblike.

## 5.1 Ribarjenje (Phishing)

Je najpogostejša vrste socialnega inženiringa na internetu. Ribarjenje je kraja podatkov s pomočjo ponarejenih elektronskih sporočil in spletnih strani. Najpogosteje ponarejene so strani finančnih organizacij, strani spletnih prodajaln oz. »oglasnikov« in ponudnikov internetnih storitev. Vse pogosteje pa so tarča ribarjenja socialna omrežja kot so Facebook, Twitter, Reddit, itd (Suša, 2009)..

Ribarjenje poteka nekako tako:

1. Prevarant najprej izbere organizacijo, za katero se bo izdajal in nato izdelal podobno oziroma identično stran
2. Ko je stran izdelana, potrebuje uporabnike, ki jih bodo nasedli
3. Potencialnim uporabnikom pošlje veliko e-sporočil
4. Pri sporočilu prevarant navede, da je prišlo do procesne napake in je potrebno ali resetirati geslo ali uporabniško ime.



Dear valued customer of TrustedBank,

We have recieved notice that you have recently attempted to withdraw the following amount from your checking account while in another country: \$135.25.

If this information is not correct, someone unknown may have access to your account. As a safety measure, please visit our website via the link below to verify your personal information:

<http://www.trustedbank.com/general/custverifyinfo.asp>

Once you have done this, our fraud department will work to resolve this discrepancy. We are happy you have chosen us to do business with.

Thank you,  
TrustedBank

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### Slika 6: Primer ribarjenja

Vir: Canva

Kako preprečiti ribarjenje:

1. Naučiti identificirati potencialne prevare
2. Preveriti vir prejetih sporočil – Pokličemo banko direktno in povprašamo
3. Nikoli ne klikamo na povezave v e-poštah

## 5.2 Pharming

Je zelo podobna prevari phishing, vendar se razlikuje v tem da jo je težje odkriti. Pharming je »preusmerjanje z legitimnih strani na nelegitimne z namenom pridobitve zasebnih podatkov«. Kako deluje? Domenski strežnik (DNS) je strežnik, ki poskrbi, da posamezniku da odpiranje neke strani kot je npr. [www.ff.uni-lj.si](http://www.ff.uni-lj.si) ni potrebno v brskalnik vpisovati IP naslov te strani ki je npr, 193.2.106.66 (izmišljeno), pač pa le domeno, ki si jo je veliko lažje zapomniti. Se pravi DNS strežnih usmerja internetne domene na pravi IP naslov. Pharming pa spremeni DNS strežnik, ter nas usmerja na svoj (nepravi) IP naslov. Pharming napadov je več in sicer, sprememba host datotek na posameznem računalniku ali pa spremembe na routerjih oz. usmerjevalnikih. To se običajno izvede preko trojanskega konja.

## 5.3 Napad s posrednikom (man in the middle MITM)

Še bolj napreden napad kot je pharming je napad s posrednikom. Gre za napad kjer napadalec prestreza komunikacijo med dvema sistemoma kot na primer med uporabnikom in spletno banko. Tak način je težje prepoznati, saj vse strani delujejo normalno kot prej, ugotoviti da nam nekdo prisluškuje pa je zelo težko. Zaščita pred tem napadom je upraba vatnih povezav. Verjetno najboljša zaščita pa je uporaba dvofaktorne avtentikacije preko drugega komunikacijskega kanala (Telefon ali aplikacija).

## 5.4 Smishing

Podobna oblika kot ribarjenje vendar je preko SMS sporočil. Prejemnik dobi sporočilo na mobilni telefon od banke, spletne prodajalne ali druge finančne ustanove, kjer zahtevajo potrditev določenih podatkov, tako da kliknete na določeno povezavo ali pokličete na določeno telefonsko številko. Na ta način prevaranti

pridobijo zasebne podatke. Smishing je prevara, ki naj bi bila v porastu, prevaranti pa se je poslužujejo predvsem zato, ker smo uporabniki postali sumničavi na zahteve bank po elektronski pošti.

### **5.5 Vishing**

Temelji na telefoniji preko interneta. Oblikovan je tako, da na več tisoč telefonskih številki pošljejo posneto telefonsko sporočilo različnih organizacij, ki zahtevajo določeno akcijo. Tako na primer zahtevajo, naj uporabnik pokliče klicni center, saj so zaznali, da je bila njihova kreditna kartica zlorabljena. Uporabnika nato v telefonskem pogovoru zaprosijo za številko kreditne kartice in kodo, da bi preverili, če je šlo res za napako, ter mu nato sporočijo, da je vse v redu.

### **5.6 Nigerijska pisma**

So prevara preko e-pošt, v katerih se nekdo pretvarja, da je npr. sin nekega predsednika, uslužbenca, poslovneža, včasih tudi da so neka oddaljena žlahta, itd. V tej e-pošti pojasnjuje, da ima na račun večjo količino denarja, ki jo mora spraviti iz države oz. ne more dostopati do nje. Za pomoč prosi nas, v zameno pa nam obljubi določen odstotek nakazane vsote. Ko žrtev izkaže voljo za sodelovanje, mu običajno naročijo, naj nakažejo nekaj malega denarja za ureditev papirjev, itd. Zadeva se ponovno zatakne in si izmislijo drug izgovor, zakaj denarja ni še na računu in da ponovno potrebuje denar. To se ponovi večkrat, dokler prevarani ugotovi, da je vse skupaj prevara.

### **5.7 Zaščita pred socialnim inženiringom**

Ultimativne zaščite pred socialnim inženiringom ni. Lahko le zmanjšujemo ali omilimo posledice. In če je prav človek tisti, ki je najšibkejši člen v tem sistemu obrambe, saj ha je zlahka prevarati, si lahko predstavljamo, da je ključni faktor obrambe izobrazba ljudi v smislu zavedanja tovrstnih prevar. Tak problem najlažje rešimo z informativnimi varnostnimi tečajji. Ljudi moramo naučiti postopkov in standardov, kako v takih primerih ukrepati.



Tovrstne napade lahko preprečimo (Pagon, 2021):

1. Z izobrazbo in poznavanjem problema. Z različnimi tipi prevar se tudi obramba od razlikuje od primera do primera.
2. Nikoli ne klikajte na priponke ali povezave v e-pošti – Če dobite neko e-pošto se izogibajte odpiranju priponk ali klicanju na neke povezave
3. Če dobite takšno e-sporočilo ja najbolje v primeru, da morate spremeniti geslo zaradi varnosti, obiskati spletno stran direktno preko brskalnika in ne preko povezav, ki so pritrjene na e- poštah.
4. Znano je, da podjetja nikoli od vas ne bodo zahtevala gesel. Se pravi če vas nekdo sprašuje po geslu potem takoj veste, da gre za prevaro
5. Uporaba programov za preprečevanje neželene e-pošte.

## 6 Gesla

Gesla preprečujejo nepooblaščen uporabo osebnih podatkov, e-pošte, sporočil, klicev, spletne banke in družbenih omrežij. Glavna težava pri geslih je, da uporabnik pri oblikovanju gesel niso inovativni. Pogosto se gesla tako enostavna, da je le vprašanje časa, kdaj bodo nepridipravi vdrlji v naše profile.

### 6.1 Velikost gesla

Pomembno je omeniti tudi Moorov zakon. Moč GPU in CPU se vsake dve leti podvoji, zato je tudi vedno lažje vdreti v gesla. To pomeni da če danes potrebujemo 120 let za vdor gesla, bomo čez 18 mesecev potrebovali 60 let in čez 26 mesecev bi potrebovali 30 let. Priporočljivo je da se gesla najmanj menjajo vsakih 30-90 dni, največ pa vsakih 1-2 leti

### 6.2 Varovanje gesel

NordPass je izvedel raziskavo v kateri je navedel, da naj bi si v povprečju individualna oseba morala zapomniti 100 različnih gesel (Rowe, 2021). Za individualno osebo je, da si mora zapomniti že 20-30 gesel preveliko, še posebej v današnjem času, ko je priporočljivo, da so gesla dolga in vsebujejo vsaj en znak, eno veliko črko in eno številko poleg tega pa naj nebi uporabljali osebnih podatkov pri geslih ter naj jih nebi ponavljalo za druge uporabniške račune.

	8 znakov	10 znakov	12 znakov
Samo male črke	Takoj	Takoj	Nekaj tednov
+ 1 velika črka	pol ure	1 mesec	5 let
+ 1 številka	eno uro	6 let	2 tisoč let
+ 1 simbol	en dan	50 let	63 tisoč let

Slika 7: Obseg gesla

Vir: Lasten

Slaba gesla:

- enaka gesla za več storitev
- zaporedje znakov (12345678 ali qwert ali asdfgh)
- izražanje čustev v geslih (»ljubimte«, »ljubezen«, »sranje«)
- ime kot geslo (cocacola, linkedin, facebook)

Dobra gesla:

- + za vsako spletno stran drugo geslo
- + vsaj 8 znakov dolga gesla
- + kombinacija malih, velikih črk, ter števil in znakov
- + izogibanje splošnih imen
- + izogibanje uporabe osebnih podatkov (imena, datum rojstva)
- + redno spreminjajte gesla

Glede na to, da si moramo v današnjem času zapomniti toliko različnih in dolgih gesel, je priporočljiva uporaba programov kateri nam omogočajo shranjevanje teh gesel, pri tem pa je program sam zaščiten z zelo dolgim geslom ter dvojno faktorsko avtentikacijo (2FA).

## 7 Deepfake

Je digitalni ponaredek, ustvarjen s pomočjo globokega učenja. Deepfake lahko ustvari popolnoma novo ali manipulira že obstoječo vsebino, prav tako pa video, zvok (avdio), fotografije – grafiko in tekst. Lahko se uporablja za očrnitev ugleda izbranih žrtev, lažno oponašanje določenega politika ali funkcionarja za izsiljevanje, ter za kibernetске kriminalne operacije (Zadravec, 2020).

Manipulirana vsebina je za družbo problematična že z vidika manipuliranja samega in njegovih posledic. V družbi je velik poudarek na vplivu deepfake-ov na političnem in demokratičnem področju, vendar nebi smel biti zapostavljen na posameznika, predvsem zasebnika. Ko je javnost, preko deepfake.ov, opremljena s tehnologijo zavajanja, lahko uspešno zavaja druge, zato so na udaru vsa področja družbenega zasebnemu kot tudi poslovnemu ugledu posameznika in institucij. Znotraj družbe negativne posledice deepfake-ov občutijo tudi organizacije. Mnogo podjetij in organizacij lahko postane tarča raznih prevar in goljufij. Deepfake-i so lahko tudi grozeči zaradi izsiljevanja podjetij in organizacij preko algoritmov (Zadravec, 2020).

## 8 Zaključek

Spletni socialni inženiring, zlonamerne kode, manipuliranje podatkov ter slaba ozaveščenost ljudi glavni vir pridobivanja podatkov posameznikov ter podjetij in organizacij, in je vse pogostejša. Poznani so številni primeri zlonamernih napadov, a je kljub temu zaskrbljujoče dejstvo, da je osveščenost še vedno prenizka.

Zavedati se moramo, da se tehnologija posodablja in izboljšuje iz dneva v dan je vsem tem spremembam težko slediti. Zaradi tega se morajo ljudje, ki so v dobi tehnologije in ki odraščajo v dobi tehnologije zavedati, da niso nedotakljivi

Samoozaveščanje bi se moralo pričeti že pri starših, da bi lahko to informacijsko znanje prenašali na svoje otroke, saj jim le-ti najbolje zaupajo že od ranih let. Poleg tega pa bi morali izobraževanje, vsaj v osnovni meri, izvajati tudi v šolah. Danes se skoraj vse modernizira, ljudje opravijo veliko dela na spletu in pametnih napravah in prav zaradi tega bi jim morali pojasniti nevarnosti in posledice.

Res je, da vseh napadov ne bomo uspeli preprečiti, saj se dogajajo iz dneva v dan z novimi tehnikami. Lahko pa opozorimo in poučimo o najbolj pogostih napakah in tako preprečimo nepotrebne žrtve. Poleg tega jim bo redno ozaveščanje o spletnem socialnem inženiringu, zlonamernih kodah ter lažnimi informacijami predstavilo nove tehnike napadov, ki se razvijajo iz dneva v dan in bodo tako nanj bolj pozorni.

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# TEMELJI EU MREŽE CENTROV ZA CELOSTNO OBVLADOVANJE RAKA USPEŠNO POSTAVLJENI

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Skladno z Evropskim načrtom za boj proti raku bo v Evropi vzpostavljena Evropska mreža centrov za celostno obvladovanje raka (EUNetCCC). Temelji za mrežo, vključno s strokovnim, znanstvenim, izobraževalnim in administrativnim okvirjem za trajnostno strukturo so bili pripravljene v sklopu projekta CraNE Joint Action (JA), ki se je zaključil konec leta 2024. Mreža, ki bo povezala centre za celostno obvladovanje raka (CCC) bo pripomogla k zagotavljanju kakovosti diagnostike, zdravljenja, raziskovanja in usposabljanja v Evropi. Cilj Evropske komisije je, da ima do leta 2030 do nove mreže zagotovljen dostop 90% bolnikov z rakom. Glavni dosežek projekta CraNE JA je bila vzpostavitev strukture vodenja in upravljanja bodoče EUNetCCC. Razviti so bili tudi sklopi standardov za certificiranje teh centrov in pilotnih mrež za obravnavo pljučnega raka ter zrelostni model za samoocenjevanje in nadaljnji razvoj CCC. Na teh izhodiščih se je pričel EUNetCCC JA, ki bo vzpostavil novo mrežo z začetkom postopkov certificiranja CCC.

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# FOUNDATIONS OF EU NETWORK OF COMPREHENSIVE CANCER CENTERS SUCCESSFULLY LAID

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European Network of Comprehensive Cancer Centers (EUNetCCC) will be established in Europe in accordance with the Europe's Beating Cancer Plan. The foundations for the network, including the professional, scientific, educational and administrative framework for a sustainable structure, were prepared as part of CraNE Joint Action (JA), which ended in 2024. EUNetCCC will help to ensure the quality of diagnostics, treatment, research and education in Europe. The goal of the EU Commission is that 90% of cancer patients have access to EUNetCCC by 2030. The main achievement of CraNE JA was the establishment of the leadership, management structure of the EUNetCCC. The set of standards for certification of centers, pilot networks for the treatment of lung cancer, and maturity model for self-assessment and further development of the CCC were developed. On these starting points is based EUNetCCC JA, which will establish the network with the start of CCC certification procedures.



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## 1 Obvladovanje raka

Obvladovanje rakavih bolezní še vedno predstavlja velik izziv na področju zdravstva v Evropski uniji (EU). Pri reševanju te problematike je ključnega pomena združitev moči in uskladitev pristopa vseh evropskih držav. V EU so maligne bolezni pomemben vzrok obolevnosti predvsem z vidika staranja prebivalstva, saj se incidenca tovrstnih obolenj povečuje s starostjo. Evropska komisija (EK) se zaveda, da se lahko incidenca v primeru neukrepanja in v luči staranja populacije ter socio-ekonomskega položaja v prihodnjih letih še poveča. Pri obvladovanju raka, ki predstavlja izjemno kompleksno in zahtevno področje je ključnega pomena pravilno planiranje, načrtovanje hitrega in učinkovitega preprečevanja, odkrivanja in zdravljenja raka, vse v skladu s potrebami prebivalstva (Jelenc in Albreht, 2020; Atun, Ogawa in Martin-Moreno, 2009). Vsak pacient bi moral imeti dostop do visoko kvalitetne obravnave (Howard, 2008).

### 1.1 Evropski načrt za boj proti raku

Evropski načrt za boj proti raku (*angl. Europe's Beating Cancer Plan - EBCP*) predstavlja krovni dokument na področju načrtovanja obvladovanja raka v EU. EK ga je sprejela februarja leta 2021. V načrtu je jasno zapisano, da mora biti 90 % upravičnim bolnikom zagotovljen dostop do Evropske mreže nacionalnih centrov za celostno obvladovanje raka (*angl. European Network of National Comprehensive Cancer Centres*) do leta 2030 (European Commission, 2021). Izhodišče Evropskega načrta za boj proti raku so raziskave, inovacije in nove tehnologije. Gre za popolnoma nov pristop EU k preprečevanju raka, zdravljenju in oskrbi na področju raka. Temelj načrta predstavljajo štiri tako imenovani stebri (*angl. pillars*), ki so v bistvu štiri najpomembnejša področja obvladovanja raka: preventiva in zgodnje odkrivanje raka, diagnostika z zdravljenjem ter kakovost življenja bolnikov z rakom, vključno z osebami, ki so bolezen prebolele, oz. s preživelimi. Načrt ima tudi tako imenovane presečne (*angl. cross cutting*) teme, kamor so uvrščene tudi inovacije, raziskave, področje zmanjševanja neenakosti in personalizirana medicina. Tematska področja Evropskega načrta za boj proti raku vključujejo 10 vodilnih pobud (*angl. flagship initiatives*) in 32 ukrepov. Na uresničevanje vodilnih pobud so vezani številni projekti, preko katerih EK uresničuje svojo vizijo. EK je za izvedbo Evropskega načrta za boj proti raku in vse nanj vezane projekte namenila štiri milijarde evrov (Jelenc, idr., 2021; European Commission, 2021). Vsebina omenjenih projektov je zastavljena

širše, saj so vezani na tudi na področje izobraževanja, socialne politike in enakosti, zaposlovanja, okolja, podnebja, kmetijstva, trženja, energije, prometa, obdavčenja in kohezijske politike (European Commission, 2021).

Evropski načrt za boj proti raku je tesno povezan tudi z misijo rak. Zastavljenih je namreč pet tematskih misij, ki so naslednje: klimatsko nevtralna in pametna mesta, prilagoditev podnebnim spremembam, vključno s preobrazbo družbe, zdravi oceani, morja, obalne in celinske vode, zdravje tal in hrane ter misija rak. Misije so ambiciozno zastavljene pobude, ki so usmerjene k zagotavljanju rešitev največjih družbenih izzivov v okviru programa EU za raziskave in inovacije Obzorje Evrope (Mazzucato, 2018). Edina misija s področja zdravstva je torej misija rak. Cilj misije rak je do leta 2030 z boljšo preventivo rešiti več kot tri milijone življenj ter čim več ljudem omogočiti daljše in bolj kakovostno življenje (Hribar & Jelenc, 2020).

## 2 Evropska mreža centrov za celostno obvladovanje raka in njeno vzpostavljanje

Peta vodilna pobuda Evropskega načrta za boj proti raku je namenjena vzpostavitvi Evropske mreže nacionalnih centrov za celostno obvladovanje raka (*angl. European Network of National Comprehensive Cancer Centres*). Mreža naj bi povezala nacionalne centre za celostno obvladovanje raka že v letošnjem letu, kar bi doprineslo k zagotavljanju kakovosti diagnostike, zdravljenja, usposabljanja, raziskovanja ter kliničnih študij v EU. Centri za obvladovanje raka so se začeli organizirati v Združenih državah Amerike že v začetku prejšnjega stoletja. Do poznih petdesetih in šestdesetih let jih je bilo sicer ustanovljenih relativno malo. Njihovo ustanavljanje je leta 1971 močno pospešil Nacionalni zakon o raku (*angl. National Cancer Act*), ki je uvedel novo dobo, saj je bil glavna spodbuda za razvoj tako imenovanih centrov za celostno obvladovanje raka (*angl. Comprehensive Cancer Centres-CCC*), ki so področje obvladovanja raka postavili na bistveno višji nivo (Shingleton, 1989).

Vzpostavljanje Evropske mreže centrov za celostno obvladovanje raka je s strani EK zastavljeno in financirano v dveh projektnih korakih: prvi korak predstavlja dvoletni projekt skupnega ukrepanja (*ang. Joint Action-JA*) CraNE, drugi korak pa štiriletni projekt European Network of Comprehensive Cancer Centers (EUnetCCC) JA.



### 3 Postavitev temeljev Evropske mreže centrov za celostno obvladovanje raka – projekt skupnega ukrepanja CraNE

Glavni cilj v letu 2024 zaključenega projekta skupnega ukrepanja CraNE je bila postavitev temeljev Evropske mreže centrov za celostno obvladovanje raka, s kratico *EUNetCCC*, kot podpore zagotavljanju kakovostnega zgodnjega odkrivanja raka, presejanja, diagnostike in zdravljenja, podpore osebam, ki so raka prebolele, raziskovanja in usposabljanja delovne sile na področju obvladovanja raka (Jelenc, idr., 2023). Vse naštetu bo nedvomno pripomoglo k zagotavljanju kakovostnejše oskrbe, zmanjšalo neenakosti v EU in bolnikom omogočilo možnost diagnostike in zdravljenja blizu doma. CraNE JA, ki se je zaključil konec leta 2024 je potekal dve leti (2022 – 2024). V visokem deležu ga je sofinancirala Evropska izvajalska agencija za zdravje in digitalno tehnologijo HaDEA. Pojem skupno ukrepanje predstavlja poseben mehanizem financiranja iz sredstev programa EU za zdravje. Projekt CraNE JA je postavil temelje Evropske mreže centrov za celostno obvladovanje raka, oz. strokovni, znanstveni, izobraževalni in administrativni okvir za trajnostno strukturo. Obsežno delo na projektu CraNE JA je bilo organizirano v 8 delovnih skloпов (*angl. work packages*). Štirje delovni sklopi so bili obvezni, horizontalni (1. Koordinacija, 2. Diseminacija, 3. Evalvacija in 4. Trajnost), štirje pa vsebinski ali vertikalni delovni sklopi. Delo 5. in 7. sklopa je potekalo koordinirano, saj je bilo namenjeno vzpostavitvi Evropske mreže centrov za celostno obvladovanje raka. Tudi delo 6. in 8. sklopa, ki je bilo namenjeno standardom in kvaliteti mreže centrov za celostno obvladovanje raka se je dopolnjevalo in potekalo usklajeno. Sicer je bil CraNE JA že četrti večji evropski projekt skupnega ukrepanja na področju raka. V sklopu dela predhodnih projektov CanCon JA in Inovativno partnerstvo za boj proti raku (*angl. Innovative Partnership for the Action Against Cancer JA - iPAAC JA*) so nastali številni izdelki, ki so v pomoč pri vzpostavljanju Evropske mreže centrov za celostno obvladovanje raka. Standardi za EU mrežo centrov za celostno obvladovanje raka in njeno certificiranje so nastali v sklopu projektne delu iPAAC JA, v sklopu dela na projektu CanCon JA pa je nastal Evropski vodnik za izboljšanje kvalitete celostnega obvladovanja raka (*angl. European Guide for Quality Improvement in Comprehensive Cancer Control*). V publikaciji je jasno priporočena vzpostavitev Evropske mreže centrov za celostno obvladovanje raka (Albreht, Kiasuwa in Van den Bulcke, 2017). Glavni cilj CraNE JA je bil zagotoviti trajnost rezultatov projekta za prihodnjo implementacijo v različne strukture, ki bodo razvite v državah članicah z namenom obvladovanja raka. V sklopu projekta je bil razvit tako imenovani model

ocenjevanja zrelosti centrov, oz. pripravljenosti centrov (*angl. maturity model*), kot orodje za samoocenjevanje in krepitev zmogljivosti centrov za celostno obvladovanje raka. Pripravljen je bil tudi načrt procesov in korakov za razvoj mreže EUNetCCC, ki je poimenovan z angleško besedo Blueprint. Prav tako je bil razvit model upravljanja mreže EUNetCCC in načrt pristopanja centrov za celostno obvladovanje raka k mreži, razvite so bile dejavnosti sodelovanja, vzpostavljena je bila uskladitev s ključnimi deležniki in pobudami EU za podporo trajnostne rasti, angažiranosti in povezave med zdravljenjem in raziskavami. Narejen je bil pregled/mapiranje glavnih ustanov za zdravljenje raka v Evropi, ki zagotavljajo kakovost v sklopu centrov za celostno obvladovanje raka. Razvit je bil celovit okvir za zagotavljanje kakovosti in nenehno izboljševanje tovrstnih centrov ter model za izboljševanje kakovosti v obstoječih in ambicioznih centrih s koraki samoocenjevanja, načrtom izboljšav in zahtevami za nenehen razvoj za ponovno certificiranje.

Opravljen je bila tudi analiza trinajstih omrežij, zgrajenih okoli centrov za celostno obvladovanje raka (*angl. Comprehensive Cancer Care Networks-CCCN*), ki obstajajo v Evropi in so poleg centrov za celostno obvladovanje raka še ena izmed drugih oblik organiziranosti zdravstvene dejavnosti na področju raka, ki pa je ne eksplicitno podpira EBCP. Izvedena je bila študija o tem, kako ena edinstvena integrirana pot oskrbe (*angl. integrated care pathway*) za pljučnega raka, ki si jo delijo različne bolnišnice, pomaga pri njihovem povezovanju in medsebojnem sodelovanju. Proučevali so najpogostejši instrument, ki se uporablja v zdravstvenih sistemih EU za uresničitev potenciala natančne onkologije (*angl. precision oncology*), v angleščini tako imenovan *Molecular Tumor Board* - MTB. Izvedena je bila raziskava, katere cilj je bil zagotoviti pregled predikcij vrnitve na delo (*angl. return to work*) za osebe, ki so preživele raka v Evropi, in ugotoviti najboljše prakse. Razvit je bil tudi nabor standardov, indikatorjev kakovosti in pacientovih poti (*angl. patient pathways*), ki se izvajajo v CCCN (Consortium CraNE, 2024).

#### **4 Vzpostavlanje Evropske mreže centrov za celostno obvladovanje raka – projekt skupnega ukrepanja EUnetCCC**

Projekt EUnetCCC JA se je začel 1. oktobra 2024, koordinira pa ga Institut National du Cancer (INCa) iz Francije v sodelovanju s so-koordinatorji iz treh izkušenih evropskih inštitucij, ki so Nacionalni inštitut za javno zdravje (NIJZ) iz Slovenije,

Center za celostno obvladovanje raka Univerzitetne bolnišnice Oslo (*angl. Comprehensive Cancer Centre of the Oslo University Hospital- OUS*) in Belgijski zvezni inštitut za javno zdravje - Sciensano. Vzpostavitev sestane (angl. *Kick-off meeting*) projekta je potekal 22. oktobra 2024 v Parizu. NIJZ, ki je pri tem projektu pridružen partner (*angl. affiliated entity*) nastopa tudi v funkciji sovodje obveznega delovnega sklopa (*angl. work package-WP*) WP4 – Trajnost (*angl. sustainability*) ter vodi nalogo (*angl. task*), ki je namenjena organizaciji in izvedbi pilotnih projektov za vzpostavitev centrov za celostno obvladovanje raka in njim podobnih struktur v državah EU, Islandiji, Norveški, Ukrajini in Moldaviji. Ključni partner (*angl. competent authority*) iz Slovenije je Onkološki inštitut. Ker bo v naši državi vzpostavljena nacionalna mreža centrov, ki je ena izmed možnih oblik centrov za celostno obvladovanje raka, je v projektno delo vključen tudi konzorcij, ki ga sestavljajo Univerzitetni klinični center Ljubljana, Univerzitetni klinični center Maribor, obe Medicinski fakulteti (Ljubljana in Maribor), Klinika Golnik, ki se ukvarja z zdravljenjem rakov pljuč, Onkološki inštitut ter NIJZ. Skupno na projektu sodeluje kar 163 partnerjev. V projektno delo je namreč vključenih 31 držav, poleg 27 držav članic EU še Islandija, Norveška, Moldavija in Ukrajina. Ciljna skupina EUNetCCC JA, kot tudi predhodnega projekta CraNE JA so vsi, ki se bodo ukvarjali z razvojem Evropske mreže centrov za celostno obvladovanje raka: predstavniki držav članic, predstavniki mrež centrov za celostno obvladovanje raka, različne evropske organizacije ter pacienti in številni strokovnjaki.

Projektno delo na EUNetCCC JA je organizirano v devet delovnih sklopov in številne podsklope. Štirje delovni sklopi so tako imenovani obvezni delovni sklopi projektov iz skupine JA (1. Koordinacija, 2. Diseminacija, 3. Evalvacija in 4. Trajnost), pet delovnih sklopov pa je vsebinskih (5. Vključevanje, certificiranje in pristop k mreži EUNetCCC, 6. Ojačitev kapacitet in izboljšanje kvalitete mreže EUNetCCC, 7. Upravljanje, članstvo in povezovanje v mreži EUNetCCC, 8. Razvoj aktivnosti mreže EUNetCCC in 9. Implementacija mrež tipa CCCN za zagotavljanje celovite, visoko kvalitetne zdravstvene oskrbe).

## 5 Vloga Slovenije

Slovenija je že od prvega predsedovanja EU, ko je izpostavila problematiko raka, kot svojo prioriteto zelo aktivna na področju obvladovanja raka v EU. Glede na podatke Onkološkega inštituta, oz. Registra raka, ki namreč kažejo, da v Sloveniji za rakom

zboli vsako leto več kot 15 000 ljudi, okoli 6500 pa jih umre je razvidno, da je rak tudi pri nas velik javnozdravstveni problem (Škrbec, 2021). Pri moški populaciji je rak prvi vzrok smrti, pri ženski populaciji pa drugi. V naši državi živi okrog 110 000 ljudi, ki jim je bila diagnoza rak postavljena vsaj enkrat v življenju. Nekateri raki se pojavljajo zelo redko, določeni pa se pojavljajo pogosteje. Najpogostejši raki so pri nas rak dojk, prostate, debelega črevesa in danke, pljučni rak in kožni rak, poznamo sicer okrog 200 vrst rakavih bolezni (Škrbec, 2021).

Tudi na podlagi vsega navedenega je Slovenija sodelovala in koordinirala številne projekte s področja obvladovanja raka, tudi zelo zahtevne. Evropska komisija je NIJZ-ju na podlagi uspešnega koordiniranja prvega velikega projekta s področja obvladovanja raka, poimenovanega Evropsko partnerstvo za boj proti raku (*angl. European Partnership for the Action Against Cancer*) - EPAAC JA (2011 - 2014), zaupala tudi vodenje drugega projekta skupnega ukrepanja s področja raka, CanCon JA, ki se je začel leta 2014, zaključil pa se je leta 2017, tretjega projekta skupnega ukrepanja s področja raka iPAAC JA (2018 - 2021) ter četrtega projekta skupnega ukrepanja CraNE JA (2023-2024) (Commission of the EC, 2009; Jelenc, idr., 2011; Jelenc, idr., 2018; Jelenc, idr., 2023). Rezultati omenjenih projektov so številni in nedvomno prispevajo k uspešnejšemu obvladovanju raka. NIJZ trenutno koordinira projekt skupnega ukrepanja s področja obvladovanja raka OriON, usmerjen v zmanjševanje neenakosti na področju raka, ki še vedno predstavljajo problem v EU (Jelenc, 2024; Jelenc, idr., 2024; Peiró Pérez, idr. 2017). Tudi pri projektu EUnetCCC JA ima NIJZ eno izmed vidnih funkcij, saj so-vodi ta izjemno obsežen in zahteven projekt, ki bo vzpostavil mrežo centrov za celostno obvladovanje raka v EU.

## 6 Zaključek

Obvladovanje rakavih bolezni, ki še vedno predstavljajo v EU velik javnozdravstveni problem nujno zahteva reševanje in usklajen pristop vseh držav. Evropski načrt za boj proti raku, ki je ključen dokument obvladovanja raka v EU v svoji peti vodilni pobudi svetuje vzpostavitev Evropske mreže nacionalnih centrov za celostno obvladovanje raka. EK omenjeno mrežo vzpostavlja s sofinanciranjem dveh projektov iz skupine skupnega ukrepanja, in sicer konec 2024 zaključenega CraNE JA, ki ga je koordinirala Slovenija (NIJZ) in EUnetCCC JA, ki se je nedavno začel in katerega koordinira Francija ob so-koordinaciji treh izkušenih institucij, med katerimi je NIJZ. Projekt CraNE JA je razvil temelje Evropske mreže centrov za

celostno obvladovanje raka ter administrativni, strokovni in znanstveni ter izobraževalni okvir za trajnostno strukturo. Projekt je torej postavil temelje za mrežo centrov za celostno obvladovanje raka, ki jo vzpostavlja nov projekt skupnega ukrepanja EUnetCCC. V okviru tega projekta bodo v sklopu pilotnih projektov certificirani tudi številni novi centri za celostno obvladovanje raka, ki bodo povezani v mrežo. Skladno z Evropskim načrtom za boj proti raku naj bi bil do leta 2030 tako glavnini bolnikov zagotovljen dostop do nove Evropske mreže centrov za celostno obvladovanje raka, kar bo vplivalo na zmanjšanje neenakosti v EU, za bolnike pa bo pomenilo kakovostnejšo oskrbo blizu doma.

### Opomba

Ta prispevek izhaja iz skupnega ukrepa EUnetCCC (angl. EUnetCCC Joint Action), ki je prejel sredstva Evropske unije preko Evropske izvajalske agencije za zdravje in digitalno tehnologijo (angl. European Health and Digital Executive Agency-HaDEA) v okviru programa EU za zdravje (angl. EU4Health) 2021-2027.

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# UNLOCKING THE FUTURE OF TALENT ACQUISITION: INTEGRATING AI AND INNOVATIVE TOOLS FOR ENHANCED EFFICIENCY

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As the recruitment landscape becomes increasingly competitive, organizations must adopt innovative tools to improve efficiency and decision-making. The study focuses on a gradual approach to introducing AI-driven technologies and new tools, with a strong emphasis on progressively building TA capabilities to achieve better results. By detailing the real-world implementation, the case highlights the key steps, challenges, and outcomes of this transition, including how the integration of new technologies enhances the recruitment process. The findings demonstrate that a strategic, phased approach to technology adoption improves not only operational efficiency but also candidate experience and overall organizational performance. This case study offers valuable insights for HR professionals and organizations aiming to modernize their TA functions, optimize resource utilization, and stay competitive in a rapidly evolving market.

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## 1 Introduction

Artificial intelligence (AI) has emerged as one of the most transformative forces in modern organizations, driving profound digital transformation across industries. Beyond its technical capabilities, AI is reshaping workplace dynamics and redefining how companies engage with employees and customers. This disruptive technology fundamentally alters when, how, where, and by whom tasks are performed, challenging traditional organizational practices and workflows (Varsha, 2023). Among its most significant impacts is its influence on human resource management (HRM), particularly within talent acquisition (TA).

As a core function of HRM, TA involves the strategic process of identifying, attracting, and securing candidates who best align with organizational needs (Opada et al., 2024). With global competition for talent intensifying, organizations are increasingly turning to innovative methods to gain a competitive edge in recruitment. Artificial intelligence, with its capacity to enhance decision-making and optimize complex processes, has become a pivotal tool in this evolution. However, the integration of AI into TA signifies more than technological adoption—it represents a fundamental shift toward proactive, data-informed strategies designed to align with long-term organizational goals.

While understanding the benefits, challenges, and prospects of AI in TA is essential, future research emphasizes the importance of establishing a robust theoretical framework, proposing effective implementation strategies, and advancing ethical guidelines (Mir, 2024). Thus, an equally critical consideration is how organizations can practically implement these technologies in real-world settings.

This paper seeks to present a roadmap for the progressive introduction of AI-driven tools in TA, highlighting real-world implementation strategies, the challenges encountered, and the outcomes achieved. The proposed solution is both innovative and pragmatic, as it requires minimal investment while enabling TA professionals to make a quantum leap in capitalizing on AI. By offering a structured yet accessible framework for AI adoption, this approach equips HR teams with the perspective and confidence needed to transition effectively. The paper contributes to the growing discourse on the transformative role of AI in reshaping the future of recruitment.



## **2 Understanding the Impact of Artificial Intelligence on Talent Acquisition**

Traditional talent acquisition processes have historically been labor-intensive and prone to inefficiencies and human biases. However, advancements in artificial intelligence technologies, such as natural language processing (NLP) and predictive analytics, are revolutionizing recruitment practices. Despite the challenges associated with AI adoption, organizations increasingly recognize that its benefits often outweigh the associated obstacles (George & Thomas, 2019).

One of the most notable advantages of AI in talent acquisition (TA) is its capacity to enhance efficiency (Rathore, 2023) by streamlining labor-intensive tasks. Traditional recruitment often involves extensive manual efforts, such as reviewing large volumes of applications—a process that can take weeks. AI-driven recruitment methods, including resume screening, candidate matching, video interviewing, chatbots, predictive analytics, gamification, virtual reality-based assessments, and social media evaluations, offer significant advantages. For instance, AI-driven applicant tracking systems (ATS) expedite this process by analyzing large datasets and identifying qualified candidates within seconds, thereby accelerating recruitment processes while simultaneously allowing recruiters to focus on high-value activities (Peicheva, 2023). Research demonstrates that AI systems can reduce time-to-hire by up to 30%, offering substantial resource savings for organizations (Deloitte, 2024). A study by Raji et al. (2024) reported that AI can reduce hiring time by up to 50%, further enhancing efficiency, lowering costs (Nawaz et al., 2024), and improving the quality of hires (Albassam, 2023). Additionally, AI-powered tools enable HR teams to process vast amounts of candidate data, facilitating informed and efficient decision-making (Malik et al., 2022).

Beyond enhancing efficiency, AI's second major benefit lies in improving candidate-job matching. By leveraging advanced algorithms, AI matches candidates to roles based on a combination of skills, qualifications, and behavioral traits, resulting in more precise and effective hiring decisions. Tools like IBM Watson Recruitment have achieved a 30% decrease in recruitment costs by aligning candidates' attributes with job requirements (Biradar et al., 2024). Similarly, Heidrick & Struggles, a global executive search firm, reported a 25% improvement in the accuracy of candidate

matches after implementing an AI-driven platform, underscoring the transformative potential of AI in talent acquisition (“AI-Driven Executive Search”, 2024).

AI also plays a pivotal role in promoting diversity and inclusion by mitigating unconscious biases when implemented responsibly. For example, Pymetrics, an AI-driven matching platform, uses assessment games to ensure bias-free evaluations aligned with the Equal Employment Opportunity Commission’s Four-Fifths Rule. Its open-source auditing tool rigorously evaluates algorithms to eliminate potential sources of bias, resulting in increased recruitment of diverse talent (Lynch, 2022). Similarly, organizations leveraging AI tools for recruitment can adapt to the dynamics of remote work while promoting fairness and inclusivity (Oman et al., 2024).

However, the ethical implications of AI systems must be carefully addressed. Biases embedded in historical data can inadvertently perpetuate discrimination if algorithms are not continuously audited and refined (Angwin et al., 2016). The data and inputs used to develop algorithms can unintentionally introduce new forms of bias. For instance, algorithms may reflect the unconscious biases of their developers (Jha, Jha, & Gupta, 2020). For example, Amazon’s AI recruitment system revealed gender bias due to prejudiced training data, demonstrating the need for vigilant oversight (Han, 2020). Thus, ethical AI practices, including rigorous algorithmic audits, are critical to ensuring fairness in recruitment processes.

Additionally, AI significantly enhances the candidate experience, a key factor in employer branding within competitive talent markets (Baratelli & Colleoni, 2024). AI-powered chatbots and virtual assistants, such as HireVue and Paradox’s Olivia, engage with candidates in real-time, providing instant responses and updates throughout the recruitment process. Studies suggest that AI-driven communication improves candidate perceptions, with applicants finding these technologies both useful and easy to use (Horodyski, 2023). According to Sasi (2024), AI-powered chatbots and virtual assistants not only facilitate real-time communication but also enhance engagement with potential hires, fostering a positive candidate experience. Balasundaram, Venkatagiri, and Sathiyaseelan (2022) found that AI reduces candidate wait times, improving their overall experience. Interestingly, a recent Aptitude Research report revealed that 62% of candidates believe AI makes their recruitment experience feel more “human” (Laurano, 2024).

AI's analytical capabilities empower HR teams to make data-driven hiring decisions. Predictive analytics tools assess candidates' future performance, cultural fit, and retention potential, enabling recruiters to make informed decisions. For example, Peicheva (2023) highlights that ATS systems free up recruiters' time for deeper analysis of recruitment metrics, such as cost-per-hire and applicant conversion rates. These insights help organizations optimize their recruitment strategies and ensure alignment with broader organizational goals (Laurano, 2024). Similarly, LinkedIn's report (2024) indicates that 67% of recruiters have halved their candidate screening time through AI-enabled tools, allowing HR teams to focus on strategic topics and improving candidate engagement.

According to McKinsey (2023), organizations employing AI significantly enhances talent management by enabling business leaders to accelerate and optimize candidate recruitment, streamline resource allocation, customize skill development programs, and elevate overall employee engagement and satisfaction. Supporting this, McKinsey research reveals that organizations leveraging advanced people analytics experience substantial benefits, including an 80% improvement in recruitment efficiency, a 25% boost in business productivity, and a 50% reduction in employee turnover rates.

In conclusion, AI-driven tools are transforming TA processes across industries, offering unparalleled advantages such as enhanced efficiency, objectivity, improved decision-making, and elevated candidate experiences. However, AI applications are not one-size-fits-all solutions but rather a versatile toolbox tailored to diverse tasks. The success of these tools depends on HR professionals who strategically integrate them into TA processes to align with organizational objectives and ensure long-term success.

### **3 Initiating AI-Driven Talent Acquisition: Insights from a Case Study**

The contemporary business environment is evolving rapidly, driven by technological advancements that challenge traditional processes and necessitate innovative solutions. Talent acquisition is one such critical organizational function requiring constant evolution to remain effective. For multinational organizations, TA is further complicated by geographical dispersion, diverse workforce structures, and

varying levels of expertise among HR professionals. This section explores a case study of Company ZZZ, which undertook pioneering steps to leverage artificial intelligence, specifically ChatGPT, to optimize its TA practices.

### **3.1 Challenges and Context**

Company ZZZ, a global organization, encountered numerous challenges in its TA operations. These included a low average of six applicants per job posting, significant variations in HR team structures across its affiliates, and a wide range of professional expertise among HR personnel. Larger affiliates had dedicated TA teams, while smaller affiliates relied on single HR professionals performing multiple roles, including those of HR business partner, recruiter, and administrator.

The structural heterogeneity of Company ZZZ's HR framework posed significant obstacles to achieving a unified and efficient TA strategy. Affiliates with specialized TA teams benefitted from seasoned professionals, while those relying on generalists struggled with inconsistent practices and inefficiencies, ultimately limiting the organization's ability to attract top-tier talent. Additionally, the limited applicant pool for each job opening underscored an urgent need for innovative approaches to enhance the organization's reach and appeal.

To address these inefficiencies, Company ZZZ established a Talent Acquisition Center of Excellence (CoE) and integrated AI-powered tools, such as ChatGPT, into its TA processes. This initiative aimed to introduce AI-driven solutions as a low-risk, zero-investment opportunity to familiarize HR teams with AI technology and build confidence in leveraging more advanced tools in the future.

### **3.2 Key Implementation Steps**

Recognizing AI's potential to transform its TA operations, Company ZZZ implemented a structured change management approach focused on introducing ChatGPT as a foundational tool. The initiative consisted of regular, structured sessions designed to demonstrate ChatGPT's capabilities and equip HR professionals with tailored training. This phased approach ensured the initiative addressed the diverse needs and experience levels within the HR team.

Each session, scheduled monthly as a 60-minute virtual meeting, comprised two key components:

- Tailored Training - Training sessions were led by internal HR volunteers who possessed relevant expertise and confidence in utilizing ChatGPT. These sessions focused on practical applications such as crafting and refining job descriptions, developing Boolean strings for LinkedIn searches, and creating employer branding content. The agenda and session topics were announced well in advance, allowing attendees to choose sessions based on their interest and relevance.
- Discussion and Peer Learning - Following the training, an interactive segment was dedicated to open discussions, Q&A, and experience sharing among participants. This peer-learning model facilitated knowledge exchange, addressed practical challenges, and helped build confidence among HR professionals responsible for TA.

Through these sessions, Company ZZZ effectively demonstrated ChatGPT's ability to reduce administrative burdens on HR professionals while enhancing the consistency and quality of TA deliverables. The collaborative and application-driven approach encouraged engagement and ensured the successful integration of AI into existing processes.

### **3.3 Outcomes and Impact**

The implementation of AI brought about notable outcomes for Company ZZZ, both quantitatively and culturally. The introduction of AI not only improved operational metrics but also fostered a cultural transformation within the organization's HR community. The collaborative sessions organized by the Talent Acquisition CoE served as a unifying platform for a highly diverse group of HR professionals. These sessions established consistent TA practices across affiliates while promoting a spirit of collaboration and mutual support.

The involvement of internal volunteers in leading training sessions proved to be a critical success factor. Initially, the CoE preselected volunteers who had previously demonstrated success in leveraging ChatGPT for specific TA functions, such as job description optimization or Boolean string creation. After these initial sessions, HR

professionals began volunteering independently, driven by a newfound sense of empowerment and confidence. This self-motivation to share knowledge and experiences—including vulnerabilities—fostered a culture of openness and trust within the HR community.

Importantly, despite the sessions being optional, attendance consistently exceeded 50%, underscoring the perceived value of these initiatives among HR professionals. This high participation rate indicates a growing interest in AI tools and a recognition of their potential to enhance daily workflows. Moreover, the voluntary nature of attendance implies genuine engagement and willingness among employees to learn and contribute to organizational growth, further solidifying the cultural impact of the initiative.

Beyond fostering collaboration, the integration of ChatGPT into TA workflows strengthened the organization's employer branding. AI-powered content creation significantly improved the appeal and reach of job postings, enabling Company ZZZ to attract a wider pool of talent. The increase in the number of applicants per job posting, from six to 15 within 12 months, further underscores the enhanced effectiveness of these postings.

Additionally, the cultural and operational improvements indirectly benefited candidate experience. By streamlining TA processes and enhancing job postings, candidates experienced more engaging and informative application processes. The increased confidence of over 80% of HR personnel in using AI tools also contributed to a more responsive and personalized interaction with applicants. These advancements not only improved internal efficiency but also positioned Company ZZZ as a forward-thinking employer capable of delivering a more humanized and positive recruitment experience.

In summary, the integration of ChatGPT demonstrated significant quantitative and qualitative benefits for Company ZZZ. The organization achieved measurable improvements in recruitment metrics, fostered collaboration among HR professionals, and enhanced its employer brand. Most importantly, the initiative also contributed to a better candidate experience, reinforcing the value of strategic AI adoption in talent acquisition.

## **Conclusion**

The case study of Company ZZZ underscores the transformative potential of artificial intelligence in addressing complex talent acquisition challenges. By establishing a Center of Excellence and incorporating tools like ChatGPT, the organization successfully tackled inefficiencies and inconsistencies in its TA processes. This initiative not only streamlined recruitment operations but also fostered a culture of collaboration and innovation within the HR community, positioning the organization to navigate future challenges more effectively.

A key insight from this case study is that AI integration into TA processes does not necessarily require significant financial or time investments. Instead, careful planning, strategic implementation, and targeted training can enable organizations to achieve measurable improvements with minimal disruption. However, the successful adoption of AI technologies hinges on a strong focus on change management and capability building among HR professionals to maximize their potential benefits.

While AI offers unparalleled opportunities to optimize recruitment, it is not a one-size-fits-all solution. AI technologies are tools designed to address specific challenges within TA, and their effectiveness depends on their alignment with organizational goals and priorities. Ethical considerations, such as data privacy and algorithmic fairness, must also be carefully managed to build trust and ensure accountability in AI-driven systems.

The integration of AI, as illustrated in the case of Company ZZZ, offers significant opportunities to enhance various aspects of TA. Despite these benefits, the study has limitations. As a single-case study, the findings may not be fully generalizable to other organizations with different structures, resources, or challenges. Future research should explore AI integration in TA across diverse industries and organizational contexts to validate and expand these insights. Additionally, further studies could investigate the long-term impact of AI adoption on employee satisfaction, recruitment efficiency, and organizational performance to develop a more comprehensive understanding of its transformative potential.

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# STRATEŠKO PREDVIDEVANJE ZELENE IN DIGITALNE TRANSFORMACIJE V PERSPEKTIVI NAJBOLJŠIH RAZPOLOŽLJIVIH TEHNOLOGIJ

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Prispevek naslavlja tematiko zelene in digitalne transformacije v luči Strategije prilagajanja EU podnebnim spremembam, s ciljem, da bo do leta 2050 EU postala družba, odporna na podnebne spremembe. Zelena transformacija po Seviljskem procesu opredeljuje najboljše razpoložljive tehnike (Best Available Techniques, BAT) za vrsto industrij. Dolgoročno bodo morali vsi industrijski deležniki dosegati parametre, opredeljene z BAT referenčnimi dokumenti (BAT Reference Documents, BREFs). Ti določajo učinkovitost porabe virov ali omejujejo izpuste in druga okoljska bremena. V prispevku predstavimo različna znanstvena in strokovna orodja za pomoč podjetjem pri zelenem in digitalnem prehodu ter si ogledamo stanje izobraževanja na tem področju. Pri tem se osredotočimo predvsem na rabo teorije Foresight. Podrobneje predstavljamo inovacijo BAT Inkubator. Ta vzpostavlja poslovne procese uporabe razvitega zrelostnega modela, ki vrednoti zrelost poslovnih subjektov glede komponent zelenega in digitalnega prehoda. Že razviti in objavljeni model je bil preizkušen na pilotnem vzorcu 35 različnih podjetij. Inovacija kombinira znanja, posredovana z učnimi enotami v zelenem in digitalnem naboru UM (UEZDN) in učinkovit vpogled v kazalnike BREF s poslovnimi procesi podjetij in s tem gradi most med znanji univerze in poslovnim svetom. Podjetja opolnomoči za konkurenčen zeleni in digitalni prehod ob hkratnem usposabljanju študentov, da tovrstna znanja prinesejo v podjetja.

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# STRATEGIC FORESIGHT OF GREEN AND DIGITAL TRANSFORMATION IN THE PERSPECTIVE OF BEST AVAILABLE TECHNOLOGIES

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## Keywords:

green transition,  
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maturity models,  
digital transition

The paper addresses the topic of green and digital transformation in light of the EU Strategy on Adaptation to Climate Change by aiming for a climate-resilient EU by 2050. This includes adapting to the unavoidable consequences of climate change, which are already being observed. The green transformation, according to the Seville Process, defines the Best Available Techniques (BAT) for various industries. In the long term, all industrial stakeholders will likely need to meet BAT Reference Document (BREF) standards, ensuring resource efficiency and limiting environmental burdens. The paper presents scientific and professional tools supporting businesses in this transition and assesses education in the field, with a focus on Foresight theory. A key innovation introduced in the paper is the BAT Incubator, which establishes business processes for implementing a developed maturity model. This model evaluates the maturity of business entities concerning components of the green and digital transition. This model, already published and tested on 35 companies across sectors, integrates educational modules from UM (UEZDN) with BREF analysis and business processes. By bridging university expertise with industry needs, the initiative enhances companies' competitive sustainability while training students to apply these competencies in businesses.



## 1 Uvod

V zadnjih letih smo priča ekstremnim vremenskim pojavom in zviševanju povprečnih temperatur ozračja kot posledice tople grede na zemljini površini. Do tega je vodilo preveliko izkoriščanje neobnovljivih virov energije in posledično velike količine izpustov toplogrednih plinov ter splošno onesnaževanje tal, zraka in vode. Države članice EU so z ratifikacijo Pariškega sporazuma sklenile, da želijo prekiniti trend naraščanja povprečne temperature zraka in za cilj postavile, da se globalno segrevanje zameji na +1,5 °C v primerjavi s predindustrijsko ravno. Temu cilju sledi tudi Evropski zeleni dogovor, ki se je začel izvajati v letu 2019. Sestavljen je iz svežnja pobud, ki so usmerjene v zeleni prehod in bodo prispevale k uresničitvi glavnega cilja, da do leta 2050 EU postane prva podnebno nevtralna družba (Evropska komisija, 2019). Februarja 2021 je Evropska komisija sprejela novo Strategijo prilagajanja EU podnebnim spremembam. Ta je eden od ključnih ukrepov, opredeljenih v evropskem zelenem dogovoru. Z njo se udejanja dolgoročna vizija, po kateri bo EU do leta 2050 postala družba, odporna na podnebne spremembe in s tem prilagojena neizogibnim posledicam sprememb podnebja, ki jih že zaznavamo. Štirje glavni cilji strategije so pametnejše, hitrejše, bolj sistemsko in mednarodno usklajeno prilagajanje na podnebne spremembe (EU Adaptation Strategy, 2021).

Če je vsem skupno okolje in z njim podnebje prvo pomembno povezano področje, je drugo pomembno gonilo sprememb digitalizacija. Tehnologije, ki omogočajo zbiranje in obvladovanje zgodovinsko neslutnih količin podatkov o procesih, njihovo avtomatizirano obdelavo v realnem času in njihovo uporabo za upravljanje procesov, so v zadnjem desetletju ali dveh prodrle v vsak vidik poslovnih procesov. Domeno obvladuje nekaj svetovnih gigantov, tehnoloških podjetij, ki ustvarjajo platformsko ekonomijo in se jim na področju ni niti smiselno niti mogoče izogniti. Vseeno pa je treba za uspešno rabo te tehnologije za vodenje lastnih poslovnih procesov pridobiti nova znanja, zbirati in ustrezno deliti nove podatke in prilagoditi poslovne procese, da bodo omogočali in postopoma vključevali najprej podatkovno gnano preverjanje intuitivnega odločanja in kasneje intuitivno preverjanje podatkovno gnanega odločanja (Bokal et al., 2024).

Kot odziv na izzive, povezane z digitalizacijo, je Evropska komisija vpeljala podatkovno strategijo, Akt o podatkih, ki je stopila v veljavo januarja 2024 in katere slogan je 'Making the EU a role model for a society empowered by data'. S tem je

implementirala nova pravila o dostopnosti podatkov v vseh ekonomskih sektorjih Evropske unije. Ta pravila naslavljajo legalne, ekonomske in tehnične težave, ki pripeljejo do neučinkovite izrabe podatkov. Odprava ali vsaj zmanjšanje teh težav predvideva znatno povečanje GDP-ja za vse članice EU do leta 2028 (EU Data act, 2022).

Tekom članka predstavimo že znane strokovne in znanstvene pristope, ki pomagajo pri učinkoviti digitalni in zeleni transformaciji, pri čemer upoštevamo različne vidike. V drugem razdelku si ogledamo vidik izobraževanja in doprinosa znanosti v zeleni in digitalni transformaciji. Vidik gospodarstva predstavimo v tretjem razdelku, kjer podrobneje predstavimo BAT tehnologije ter metodologijo strateškega Foresight-a za podjetja v luči zelene in digitalne transformacije. Zadnji razdelek služi kot most med obema vidikoma, v njem pa predstavimo našo inovacijo BAT inkubator ter nakažemo smer nadaljnjega razvoja.

## **2 Podporni strokovni in znanstveni pristopi za učinkovito zeleno in digitalno transformacijo**

Kot omenjeno uvodoma, so na Pariškem sporazumu o podnebnih spremembah 2015 sodelujoče države med drugim zastavile cilj rasti temperature do leta 2100 za maksimalno 1,5 °C. Zadnje projekcije predvidevajo precej večji dvig temperatur, zaradi česar se je urgentnost naslavljanja podnebnih sprememb povečala. Kljub temu ostaja trajnost zelo slabo zastopana tema v znanosti. Zato je avgusta 2023 United Nations General Assembly (UNGA) deklariral obdobje 2024-2033 kot "Mednarodno desetletje znanosti za trajnostni razvoj". Pod vodstvom UNESCO je to desetletje namenjeno povrnitvi zaupanja v znanost, vzpodbujanju kritičnega mišljenja in povečanju mednarodnega sodelovanja na področju znanosti.

### **2.1 Metodologije in okvirji za podporo razvoja in vpeljave tehnoloških inovacij**

Glavni doprinos znanosti k zelenemu in trajnostnemu razvoju je sodelovanje z gospodarstvom in inoviranje tehnoloških rešitev, ki bi temu pomagale. V prispevku torej razmišljamo o vlogi znanosti v družbi, podobno, kot smo v prispevku (Bokal et al., 2024) razmišljali o vlogi energetike v družbi.

Prehod na zeleno in trajnostno gospodarstvo je mogoč z inovativnimi tehnološkimi rešitvami, ki bi imele sorazmerno nizek strošek vpeljave in visoko učinkovitost. Predlogov za takšne inovacije je veliko, vendar se vse ne bodo izkazale kot učinkovite pri reševanju problemov, za katere so bile razvite. Zaradi kompleksnosti inovacij in omejenih virov je nujno slediti in preverjati, katere izmed njih bodo prestale preizkus časa in se uveljavile na trgu in katere bodo propadle. Med pomembnejše teste preživetja uvrščamo teorijo odločanja in evolucijsko teorijo iger. Stanje razvoja tehnoloških rešitev lahko vrednotimo z zrelostnim modelom Technology Readiness Levels (TRL), ki uporablja 9 stopenjsko lestvico: Osnovni principi – opaženi in zabeleženi, oblikovan (ne) tehnološki koncept, eksperimentalna ali analitična potrditev koncepta, potrditev tehnologije v laboratorijskem okolju, potrditev tehnologije v primerljivem (ustrezno oblikovanem) okolju, demonstracija tehnologije v primerljivem (ustrezno oblikovanem) okolju, demonstracija prototipa tehnološkega sistema v operativnem okolju, tehnološki sistem dokončan in preverjen, tehnološki sistem preizkušen v operativnem okolju. Slednjega je Evropska komisija povzela po zrelostnih modelih, ki so jih razvili pri NASI in nadgradila za potrebe projektov Horizon Europe. TRL se uporablja za spremljanje celotnega cikla inovacije.

Z vzpenjanjem po TRL lestvici se vpliv odločitev, ki jih sprejemamo, večja. Ne le z vidika vpliva na zeleno in digitalno transformacijo podjetja, pač pa tudi z vidika rabe finančnih in časovnih virov. Zato so orodja, ki nam pomagajo sprejemati odločitve, ki bodo projekt/razvoj tehnologij pripeljale do končnih uporabnikov, zelo dobrodošla.

Predstavimo še dve orodji, ki nam olajšata sprejemanje odločitev. Kot pomoč pri soočanju z odločitvenimi miljeji različne predvidljivosti posledic in stopnje znanja je Snowden uvedel taksonomijo miljejev odločanja in jo poimenoval **Cynefin**. Model odločitvene miljeje razdeli v pet domen: kaotično, kompleksno, zahtevno, enostavno in zmedo (Snowden, 2007; French, 2017; Fic Žagar et al., 2021; Bokal et al., 2024). Za modeliranje po Cynefin modelu predlaganih procesov sprejemanja odločitev lahko uporabimo **univerzalni model procesa**. Diagram univerzalnega modela procesa nam omogoča prepoznavo agentov in aktivnosti našega problema. Kaotično realnost s pomočjo tega modela opremimo z natančno opredeljenimi, po matematično, dobro definiranimi koncepti. Ti koncepti omogočajo razpravo, razmislek o posledicah in preverjanje ponovljivosti posledic odločitev agentov. Zato

lahko v skladu s Cynefin kategorijami odločitvenih miljejev rečemo, da s koncepti univerzalnega modela opremljena kaotična realnost postane kompleksen odločitveni milje.

Poglejmo, kako nam orodje Cynefin lahko pomaga pri odločanju ob vpeljavi novih tehnologij v podjetje. V kolikor vpeljujemo v podjetje tehnologijo na stopnji tehnološke zrelosti 8-9, bomo v enostavnem miljeju, saj je bil tehnološki sistem dokončan in preverjen bomo tehnologijo uporabljali preko infrastrukture, ki jo vzdržuje ponudnik te rešitve. V tem primeru uporabljamo proces zaznaj-kategoriziraj-reagiraj. Torej sledimo receptom ali navodilom, ki jih je pripravil ponudnik tehnologije. Z zniževanjem zrelosti tehnologije, ki jo želimo vpeljati v podjetje, bodo posledice dejanj ali odločitev vedno manj predvidljive. Če vpeljujemo tehnologijo, katere prototipi je bila potrjena ali demonstrirana v željenem okolju (TRL 5/6/7), bo podjetje moralo pripraviti strokovno analizo o izkušnji uporabe tehnologije v realnih procesih, da bo lahko predvidelo posledice izbrane odločitve na vse deležnike procesa. V tem primeru se nahajamo v zahtevnem miljeju, kjer uporabljamo proces zaznaj-analiziraj-reagiraj. Pri vpeljevanju tehnologij na srednji tehnološki stopnji zrelosti med okoli 4/3 ali 5/4 se bomo znašli v kompleksnem miljeju. Razvoj na tej stopnji namreč terja usklajevanje konceptov in vmesnikov med njimi, vzpostavljanje in opazovanje sodelovanja in reakcij med deli sistema ipd. To pomeni, da bo v podjetju potrebno pridobiti znanje, kako koncepte, ki so se razvili v tehnologijo povezati v enovit, delujoč sistem in s tem nadgraditi do vsaj TRL 6, ki bo omogočala nadaljnjo uporabo. Pridobljeno znanje bo pomagalo pri tem, da bodo posledice uporabe tehnologije in z njo povezanih odločitev postale predvidljive. V tem miljeju uporabljamo proces poskusi-opazuj-reagiraj. Ko se podjetje prvič spušča v razumevanje principov BAT tehnologij, bo vstopilo v kaotični milje, saj še nikoli ni bilo v tej situaciji. Spoznati bo moralo vrsto novih konceptov, povezanih z regulatornimi dokumenti in razpoložljivimi tehnologijami, ter te koncepte povezati s tistimi, ki jih že uporabljajo v svojih procesih. V tem primeru uporabimo proces ukrepaj-opazuj-reagiraj, ki nam omogoča, da odkrivamo, opredeljujemo, usklajujemo nove koncepte. Ti postanejo temelj stabilnosti, s katerim lahko pojasnujemo posledice odločitev ali dejanj.

Vsa omenjena orodja lahko apliciramo na več inovacij, ki podpirajo zeleni prehod, s področja fizike, ohranjanja biotske raznovrstnosti, gradbeništva in medicine.



## **2.2 Foresight in trajnosti razvoj**

Foresight in trajnostni razvoj sta povezana že od začetka sedemdesetih let, ko se je prvič oblikoval koncept trajnostnega razvoja z napovednimi analizami, kot so Meadowsova poročila in različna poročila projekta Interfutures, Organizacije za gospodarsko sodelovanje in razvoj (OECD) (Meadows, 1972; Andersson, 2019). V hitro spreminjajočem se svetu je razmišljanje o prihodnosti vse pomembnejše. Napovedovanje, predvidevanje in oblikovanje scenarijev pa otežujeta negotovost in kompleksnost: od meteoroloških do političnih ali družbenih vidikov je razvoj kompleksnih sistemov mogoče predvideti le do določene mere. V obdobju okoljske krize so dolgoročne napovedi pogosto problematične in lahko vodijo v pesimizem (United Nations, 2023).

Pristopi teorije Foresight omogočajo aktivno vključevanje državljanov in deležnikov v razprave o prihodnjih trajnostnih načinih življenja. Ta participativna metoda spodbuja vključevanje in skupno odločanje, kar je ključno za razvoj trajnostnih praks v izobraževanju in širše (Mao et al., 2020). "Futures thinking" (razmišljanje o prihodnosti) in teorija Foresight sta tesno povezana koncepta, ki vključujeta predvidevanje in načrtovanje možnih prihodnjih scenarijev. "Futures thinking" razumemo kot sposobnost zamišljanja in premisleka o različnih možnih prihodnostih, medtem ko teorija Foresight definira strukturiran proces, ki to razmišljanje uporablja za oblikovanje strategij in sprejemanje odločitev (Fuller & Loogma, 2009). Rhisiart et al. (2015) trdijo, da uporaba Futures thinking v procesih teorije Foresight izboljšuje učenje in kognitivne sposobnosti, kar posameznikom in organizacijam omogoča boljše razumevanje in odzivanje na prihodnje izzive. Foresight procesi, podprti z uporabo Futures thinking, so ključni za strateško načrtovanje in upravljanje, zlasti pri reševanju kompleksnih vprašanj, kot so podnebne spremembe in trajnostni razvoj (Vervoort & Gupta, 2018; Bezold, 2010).

## **2.3 Izobraževanje za trajnostni razvoj**

Pomembno je poudariti, da je izobraževanje po naravi usmerjeno v prihodnost, vendar je ta povezava pogosto implicitna (Poli, 2021). V izobraževanju o trajnosti pa je ta odnos bolj izrazit: na primer, evropski okvir trajnostnih kompetenc GreenComp izpostavlja "vizualizacijo trajnostnih prihodnosti" kot ključno trajnostno kompetenco (Laherto et al., 2023). Po definiciji kompetence vizualizacije

trajnostnih prihodnosti v okviru GreenComp to področje vključuje sistemsko in kritično razmišljanje, pismenost o prihodnosti, raziskovalno razmišljanje, oblikovanje problemov in politično avtonomijo. Po drugi strani pa je trajnost osrednje vprašanje tudi v literaturi o izobraževanju na področjih teorije Foresight (na primer Häggström & Schmidt, 2021).

Zelo je razširjeno prepričanje, da so takšne miselne spretnosti nujne: poročilo UNESCO (2017) o izobraževanju za cilje trajnostnega razvoja poudarja potrebo po sistemskem razmišljanju, predvidevanju, normativni refleksiji, sodelovanju, kritičnem razmišljanju, samozavedanju in reševanju problemov. Združujoč te kompetence UNESCO (2017) ugotavlja, da so za prihodnost potrebne miselne spretnosti tiste, ki razumejo kompleksnost, sprejemajo negotovost, ocenjujejo posledice, postavljajo pod vprašaj normativnost in sodelujejo pri ustvarjanju boljših rešitev za trajnostno izobraževanje (Hyypä et al., 2024).

## 2.4 Izobraževanje za Foresight

V luči prej omenjenega se zdita teorija Foresight in "Futures thinking" ključni orodji pri obravnavi trajnostnega razvoja v procesu izobraževanja, saj omogočata predstavo možnih prihodnosti in sprejemanje informiranih odločitev tako študentom, kot tudi profesorjem. Ta pristop poudarja participativne procese, ki vključujejo raznolike deležnike in s tem izboljšujejo izobraževalno izkušnjo z integracijo različnih perspektiv. Uporaba teorije Foresight v izobraževalnih okoljih izpostavlja pomen usklajevanja kurikulumu s cilji trajnostnega razvoja. Osebe teh ustanov izkazuje močno zavezanost k spodbujanju trajnostnega razvoja, kar nakazuje, da lahko izobraževalni okviri s pomočjo metodologij iz teorije Foresight izboljšajo svoj vpliv na družbo (Koivunen et al., 2024).

Do sedaj je bilo izobraževanje na področju teorije Foresight obravnavano skozi perspektivo razvijanja večšin za oblikovanje prihodnosti. Levrini et al. (2021) so proučevali vidike izobraževanja, usmerjenega v prihodnost, ki se osredotoča na organizacijo obstoječega znanja, imaginacijo prihodnosti ter dinamično in zavestno gibanje v prostoru in času prihodnosti (Tasquier et al., 2019). V okviru istega mednarodnega raziskovalnega projekta o poučevanju in razvoju sposobnosti razmišljanja o prihodnosti so Bol et al. (2023) oblikovali smernice za spodbujanje Futures thinking metod v razredu, ki vključujejo nenehno spreminjanje, refleksijo o

pomenu časa, sprejemanje negotovosti in dvoumnosti, spodbujanje dolgoročnega in systemskega razmišljanja ter radovednosti, razvijanje imaginacije in odprtosti misli, zavestno razumevanje vpliva odločitev ter aktivno sodelovanje pri soustvarjanju prihodnosti. Rasa et al. (2023) so nadalje raziskovali večšine razmišljanja o prihodnosti skozi prizmo tehnologij in avtonomije, pri čimer so primerjali statične in transformacijske prihodnosti ter proučevali, kako študenti dojemajo in obravnavajo kompleksne družbene spremembe v prihodnosti.

Dejstvo, mimo katerega ne moremo, je, da se v Podonavski regiji soočamo s pomanjkanjem znanja in strokovnjakov na področju foresighta, ki bi bili ustrezno usposobljeni za strateško načrtovanje in obvladovanje prihodnjih izzivov. Pomanjkanje sistematičnih pristopov k prepoznavanju trendov in oblikovanju dolgoročnih strategij ovira učinkovito odzivanje na spremembe ter omejuje razvoj inovativnih rešitev v regiji. S tega naslova zelo pozitivno iniciativo predstavlja projekt ForeDanube, ki ga vodi Univerza v Mariboru v sodelovanju z mednarodnimi partnerji (<https://interreg-danube.eu/projects/foredanube/about-us>). Cilj projekta je spodbujati ozaveščenost o foresight metodah ter krepitev zmogljivosti za strateško načrtovanje v regiji. V sklopu projekta bodo razviti izobraževalni programi in orodja, kar bo omogočilo bolj inovativno in trajnostno prihodnost regije.

### **3 Zelena in digitalna transformacija ter gospodarstvo**

#### **3.1 Vloga BAT tehnologij za zeleno in digitalno transformacijo gospodarstva**

Rešitev in pomemben korak k uresničitvam ciljev in zavez evropskega zelenega dogovora predstavljajo tudi vpeljava najboljših razpoložljivih tehnik (Best Available Techniques, BAT) v vse gospodarske panoge. BAT so najučinkovitejše tehnološke rešitve, ki omogočajo doseganje celostnega varstva okolja ter so ekonomsko in tehnično razvite do stopnje, ko je njihova vpeljava v gospodarstvu izvedljiva. BAT so tako rešitve, ki s tehnološkimi in organizacijskimi ukrepi omogočajo zmanjšanje negativnega odtisa na okolje s karseda majhnimi finančnimi vložki (Dijkmans, 2020). BAT je utemeljen z BAT referenčnimi dokumenti, ki jih Gospodarska zbornica Slovenije definira kot zbrane informacije o stanju tehnik na določenem področju, ki so jih prispevali strokovnjaki iz industrije, predstavniki upravnih organov držav članic, raziskovalne ustanove in nevladne organizacije. Vsebina teh dokumentov je

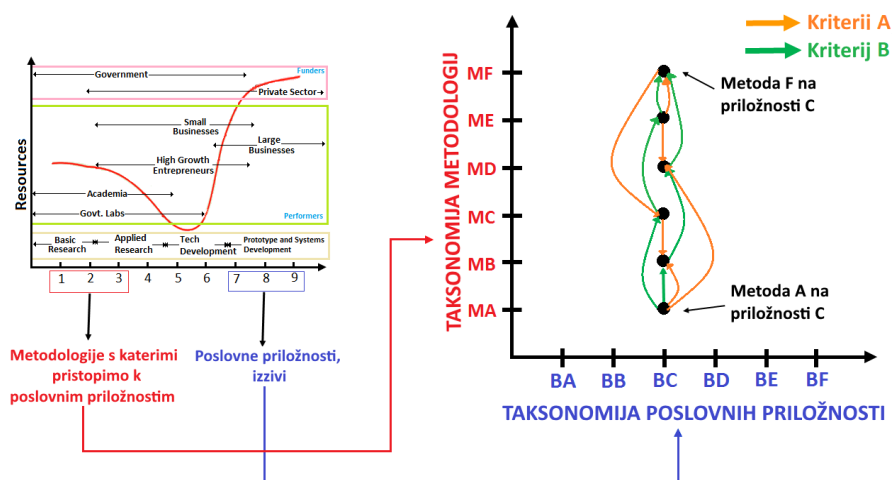
dinamična in se obnavlja približno vsakih 10 let, pri čemer se posodablja z novimi tehnikami in zajema vse širši nabor vidikov vplivov na okolje (SVO - Služba za varstvo okolja, n. d.). Obstajata dve vrsti BREF dokumentov, in sicer sektorski, ki je namenjen posameznim sektorjem, in horizontalen, ki ga uporablja več sektorjev (Laforest, 2014).

Uporaba BAT tehnologij za pridobitev okoljevarstvenih dovoljenj v državah članicah EU je obvezna. To soglasje sicer potrebujejo samo veliki onesnaževalci in je opredeljeno z Zakonom o varstvu okolja (ZVO-2, 2022). Ta pravi, da je okoljevarstveno dovoljenje potrebno pridobiti za obratovanje naprav ali za vsako večjo spremembo v obratovanju, če se v njej izvajajo dejavnosti, ki povzročajo emisije v zraku, vodi ali tleh in so zanje predpisane mejne vrednosti emisij (Volfand, 2018). Vpeljava BAT tehnologij v podjetje na začetku zahteva pregled in klasifikacijo vseh poslovnih priložnosti podjetja, kjer je uporaba BAT tehnologij možna oziroma analizo, če uporaba teh tehnologij podjetju prinesla pozitivne učinke. Ti učinki se lahko odražajo v optimiziranih procesih podjetja ali celo v večjih prihodkih ali nenazadnje v dobičku. Orodje, ki nam pri tem lahko pomaga, so učni prostori, ki nam omogočajo strukturiran pregled nad vsemi možnimi BAT tehnologijami, s katerimi se moramo spoznati. Učni prostori so strukture znanja, ki vsebujejo množici znanj in stanj ter zadostijo pogoju dostopnosti in konsistentnosti znanja (Falmagne & Doignon, 2010). Pogoj dostopnosti nam pove, da se vedno lahko priučimo manjkajočih znanj, da iz trenutnega stanja dosežemo zeleno stanje. Pogoj konsistentnosti pa nam pove, da se lahko vedno naučimo nekaj novega, tudi če znamo več.

V našem primeru bi učni prostor BAT tehnologij v množici znanj imel vse obstoječe BAT tehnologije, množica stanj pa vse možnosti, ki povedo, kako se spoznati z vsako izmed teh tehnologij. Ker pa naš cilj ni učenje vseh razpoložljivih BAT tehnologij, moramo za vpeljavo teh v podjetje imeti tudi učni prostor vseh poslovnih priložnosti, ki jih želimo nasloviti z BAT tehnologijami. V tem primeru lahko s pomočjo kriterijev, ki minimizirajo ali maksimizirajo rezultate izbranih metodologij ali tehnologij na izbranih poslovnih priložnostih, analiziramo učinek vpeljav izbranih BAT tehnologij v podjetje. Kot prikazano na desni strani slike 1, lahko naredimo produkt učnega prostora metodologij ali tehnologij in učnega prostora poslovnih priložnosti ter nanj za vsako poslovno priložnost apliciramo različne kriterije. Kadar se kakšna metodologija oziroma tehnologija ne more uporabiti na izbrani poslovni

priložnosti, bo to vidno iz rezultata, saj tega ne bo, torej nanj ne bomo mogli aplicirati izbranega kriterija. S pomočjo izbranih kriterijev lahko izberemo metodo oz. tehnologijo, ki je najbolj primerna za izbrano poslovno priložnost, na takšen način, da bo podjetje imelo pozitiven učinek z uvajanjem izbrane tehnologije.

Ob tem moramo imeti v mislih, da so tehnologije in metodologije navadno na nizkih stopnjah tehnološke zrelosti, medtem ko so poslovne priložnosti na visokih stopnjah tehnoloških zrelosti, kot je prikazano na sliki 1 na levi strani. Večino sredstev podjetja in države vlagajo v obe strani tako imenovane doline smrti, zato se moramo potruditi, da le to presežemo, če želimo te tehnologije uporabiti v podjetjih in investirati v njihov razvoj, da bodo prišle do višjih stopenj tehnološke zrelosti (Bokal & Goričan, 2017).



Slika 1: Dolina smrti med metodologijami na nizkih stopnjah tehnološke zrelosti in med poslovnimi priložnostmi na visokih stopnjah tehnoloških zrelosti

Vir: Bokal & Goričan, 2017

### 3.2 Foresight v gospodarstvu

V tem segmentu se osredotočamo na strateški Foresight, ki vključuje razumevanje prihodnosti in uporabo vpogledov, usmerjenih v prihodnost, za strateške dejavnosti organizacije in procese odločanja. Strateški Foresight pomeni opazovanje,

zaznavanje in zajemanje dejavnikov, ki bodo verjetno povzročili prihodnje spremembe, ter obravnavanje teh sprememb z določitvijo ustreznih organizacijskih odzivov (Iden et al., 2017). V splošnem strateški Foresight obsega šest korakov: (i) določitev obsega; (ii) zbiranje vhodnih podatkov; (iii) analiziranje signalov; (iv) interpretacijo informacij; (v) določanje ukrepov; in (vi) implementacijo rezultatov (Cook et al., 2014).

Strateški Foresight je ključno orodje za organizacije, ki si prizadevajo krmariti skozi kompleksnost trajnostnega razvoja s predvidevanjem prihodnjih izzivov in priložnosti. Ta pristop omogoča podjetjem in vladam sprejemanje informiranih odločitev, ki so usklajene s cilji trajnostnega razvoja. Haarhaus in Liening (2020) opredeljujeta strateški Foresight kot niz tehnik in aktivnosti, ki krepijo dinamične zmožnosti organizacij za obstanek v negotovih in spreminjajočih se okoljih.

Za reševanje problemov okoljskega upravljanja sta najpogosteje uporabljeni metodi Foresight-a skeniranje obzorja (angl. horizon scanning) in načrtovanje scenarijev(angl. scenario planning). Navadno se ti metodi uporabljata ločeno in ne kot del celovitega procesa strateškega Foresight-a, čeprav pogosto neformalno zajemata več kot enega od prej omenjenih šestih korakov strateškega Foresight-a (Cook et al., 2014).

**Horizon scanning** je definiran kot sistematično iskanje potencialnih groženj in priložnosti, ki so trenutno slabo prepoznane (Sutherland & Woodroof, 2009). V okviru literature o Foresight-u je metoda opisana kot orodje za zbiranje in organiziranje različnih tokov informacij za prepoznavanje nastajajočih vprašanj ter boljše razumevanje že identificiranih vprašanj (Amanatidou et al., 2012).

**Scenario planning** metoda je definirana kot "orodje za urejanje lastnega dojetja alternativnih prihodnjih okolij, v katerih bi se lahko odvijale odločitve" (Schwartz, 1997). Gre za orodje Foresight-a, ki se uporablja za interpretacijo informacij, pri čemer se opira na široko bazo znanja in jasno razumevanje dejavnikov sistema ter trendov, ki se vzpostavijo med procesom Foresight-a (Cook et al., 2014). To je sistematična metoda za ustvarjalno razmišljanje o dinamiki sistema, ki lahko privede do različnih možnih prihodnosti (Peterson et al., 2003) in kako te različne prihodnosti vplivajo na trenutne odločitve (Schoemaker, 1995).

Z uporabo teh orodij strateški Foresight pomaga spremljati obstoječe okoljske probleme, prepoznavati nastajajoče grožnje in preverjati odpornost obstoječe politike podjetja. Ker trajnost postaja sestavni del strateškega načrtovanja, se te metode vse pogosteje uporabljajo za izboljšanje procesa sprejemanja odločitev in dolgoročne krepitve zmogljivosti.

V študiji, ki sta jo izvedla Haarhaus in Liening (2020), je bilo ugotovljeno, da ima strateški Foresight pomemben vpliv na strateško fleksibilnost podjetja, kar je sposobnost organizacije, da se odzove na pomembne spremembe v svojem zunanjem okolju s prerazporeditvijo potrebnih virov. Tako lahko menedžerji, ki se intenzivno ukvarjajo s strateškim Foresight-om, povečajo prilagodljivost in odzivnost svojega podjetja s hitrim prepoznavanjem ter odzivanjem na spremembe v okolju. Poleg tega je bila tekom študije ugotovljena močna povezava med strateškim Foresight-om in racionalnostjo odločitev. Zato se zdi, da je strateški Foresight ustrezen pristop za obvladovanje naraščajoče dvoumnosti in kompleksnosti informacij, saj izboljšuje kakovost razprav in sprejemanja odločitev.

#### **4 BAT inkubator**

BAT inkubator je inovacija, ki jo je v sodelovanju s FNM UM razvilo podjetje DataBitLab d.o.o. Inovacija implementira in razvija zrelostni model, ki ocenjuje zrelost poslovnih procesov v kontekstu učinkovitosti in prizadevanj za podnebno nevtralnost, pri čemer črpa navdih iz zaveze EU k doseganju podnebne nevtralnosti do leta 2050. Zrelostni model tako podjetjem nudi vpogled v zrelost podjetij na področju zelene in digitalne preobrazbe ter samih poslovnih procesov, hkrati pa prepoznava povezavo med zrelostjo poslovnih procesov in trajnostnim razvojem za doseganje ciljev podnebne nevtralnosti. Razviti model, ki vključuje pet nivojev zrelosti in združuje različne standarde ISO, je bil preizkušen na pilotnem vzorcu 35 podjetij iz različnih sektorjev in velikosti. Vsako podjetje je bilo razvrščeno v enega od definiranih zrelostnih nivojev (Potrč et al., 2023). Ta zrelostni model se v procesih BAT inkubatorja uporabi kot osnova za identifikacijo poslovnih, tehnoloških in razvojno-raziskovalnih priložnosti, ki jih podjetju ponuja uvajanje najboljših tehnologij v poslovne procese.

#### 4.1 Implemetacija Foresight-a za nadaljnji razvoj BAT inkubatorja

Razvoj BAT direktiv v prihodnosti bo odvisen tako od političnih strategij kot tudi od vodilnih organov v gospodarstvu. V nadaljnjem razvoju BAT inkubatorja bomo uporabili orodja teorije Foresight, da s pomočjo iskanja ravnovesja med interesi gospodarstvenikov in politikov predvidevamo stanje in razvoj BAT v prihodnosti. Vključitev Foresight-a v BAT inkubator bo omogočila proaktivno načrtovanje in razvoj najboljših razpoložljivih tehnik (BAT) na podlagi dolgoročnih trendov, scenarijev in tehnoloških inovacij. Pri identifikaciji ključnih megatrendov in disruptivnih tehnologij s ciljem prepoznavanja tržnih, okoljskih, tehnoloških in regulativnih trendov, ki bodo vplivali na BAT tehnologije, lahko uporabimo različne metode teorije Foresight, kot na primer Horizon scanning in Delphi metodo. Za razvoj prihodnjih scenarijev za industrijsko uporabo BAT tehnologij lahko poleg metode Horizon scanning uporabimo tudi načrtovanje na podlagi scenarijev (angl. Scenario-driven roadmapping) ali analizo navzkrižnega vpliva (angl. Cross-impact analysis). Foresight metode lahko poleg omenjenega implementiramo tudi na drugih stopnjah razvoja BAT inkubatorja, kot na primer testiranje in validacija inovativnih rešitev.

#### 4.2 Tveganja in pasti nepremišljene implementacije zelenih tehnologij

BAT inkubator opozarja tudi na možne probleme prenačljene implementacije zelenih tehnologij. Konkretno si lahko ogledamo primer Taluma, ki je po implementaciji vrste zelenih inovacij za proizvodnjo aluminija (Talum d.d., 2024) zaradi neobvladljivih sprememb na trgu energentov postal nekonkurenčen, politično-poslovno okolje pa ni znalo izkoristiti zelene prednosti procesov podjetja, kar je vodilo v poslovno odločitev ukinitve proizvodnje primarnega aluminija. S tem je na izgubi tako lokalno gospodarstvo, ki je primorano aluminij pridobivati drugje,, kot tudi zeleni napredek, saj ima komercialno konkurenčen primarni aluminij bistveno višji ogljični odtis. Nenazadnje velike negativne posledice občutijo sami delavci, ki izgubijo zaposlitev. Primer nakazuje, da je potrebno zelene tehnologije uvajati ob temeljitem premisleku o poslovnih tveganjih tovrstnih procesov in sprotnem razvoju varovalk pred tovrstnimi tveganji



Kot drugi primer prenagljene in morda tudi preveč rigorozne implementacije zelene transformacije lahko omenimo primer cementarne Salonit Anhovo, ki je že dalj časa tarča kritik nevladnih organizacij zaradi onesnaževanja okolja. Za cementarne-  
sosežigalnice odpadkov s proizvodno zmogljivostjo, kot jo dosegajo v Anhovem, je Evropska komisija izdala priporočila o najboljših razpoložljivih tehnologijah BAT. Lokalni regulatorni procesi so dosegli, da je lokalna regulativa uzakonila delovanje  
sosežigalnic odpadkov po kazalnikih BAT za sežig odpadkov. Ob polnem zavedanju kompleksnosti problematike ne želimo polemizirati z zagotovo temeljito pretehtanimi argumenti, ki so pripeljali do tega rezultata. Gotovo pa je, da se v tem primeru ponuja priložnost za izboljšavo tehnoloških, komunikacijskih in razvojno-raziskovalnih procesov, ki bi pomagali preseči konflikt v skupnosti, ki po eni strani živi od podjetja, po drugi strani pa v okolju trpi posledice njegove dejavnosti. BAT inkubator želi ozaveščati o omenjenih problemih in jih presegati s pomočjo sodelovanja poslovne in akademske sfere, k čemur usmerjajo tudi ESRS standardi trajnostnega poročanja.

## **5 Zaključek**

V prispevku smo predstavili različna znanstvena in strokovna orodja za pomoč podjetjem pri zelenem in digitalnem prehodu; zrelostni model TRL, taksonomijo miljejev odločanja Cynefin, univerzalni model procesa in teorijo Foresight-a. Ta znanstvena in strokovna orodja nam pomagajo pri obvladovanju kompleksnih situacij, predvidevanje prihodnjih razvojnih trendov in sprejemanje informiranih odločitev v vse bolj negotovem okolju. Z integracijo matematičnega razmišljanja s strateškim predvidevanjem izboljšujemo našo sposobnost reševanja raznolikih izzivov trajnostnega razvoja in digitalne preobrazbe.

Pomen teh pristopov je v njihovi zmožnosti povezovanja teorije in prakse. Teorija Foresight omogoča proaktivno načrtovanje, Cynefin nudi prefinjeno razumevanje različnih problematičnih domen, univerzalni procesni model pa zagotavlja sistematičen pristop k optimizaciji procesov. Skupaj tvorijo celovit nabor orodij za politike, raziskovalce in gospodarstvenike, ki si prizadevajo za trajnostno in tehnološko napredno prihodnost.

Učinkovitost omenjenih orodij temelji na zmožnosti prilaganja kontekstu in interdisciplinarnem sodelovanju. Prihodnje raziskave bi bile lahko usmerjene v integracijo teh okvirjev z novimi tehnologijami, kot so umetna inteligenca in napredna analitika podatkov, kar smo nakazali z inovacijo BAT inkubator.

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# DIGITALNA PODPORA KROŽNEMU GOSPODARSTVU – PROJEKT DECIDE

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V prispevku so podani okviri in cilji raziskovalnega projekta DECIDE. Opisano je njegovo izvajanje in nekateri vmesni rezultati. Projekt naslavlja digitalne storitve za krožno gospodarstvo. V njem razvijamo in preizkušamo uporabnost metod in orodij za podporo krožnemu gospodarstvu za regionalne razvijalce in mala ter sredna podjetja. Izvaja se v okviru transnacionalnega programa Interreg za Podonavje, pod prednostno nalogo povečevanja konkurenčnosti in krepitve inovacij ter prenosa tehnologij v makro regiji. V projektu člani Laboratorija za proizvodne in produkcijske sisteme, Fakultete za organizacijske vede, Univerze v Mariboru, sodelujemo skupaj z 15 partnerji iz 10 držav. Projekt se loteva kritične raziskave dinamike krožnih gospodarstev v sektorjih prehrane, baterij, tekstila, embalaže in pametnih mest. Ključni cilj je identificirati specifične izzive in priložnosti za krožna gospodarstva, s poudarkom na inovativnih digitalnih orodjih za analizo, razvoj in podporo. Ta temeljna raziskava je zato ključna za ustvarjanje prilagojenih rešitev za makro regijo.

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digitalne storitve  
krožno gospodarstvo  
podonavska makro regija  
poslovni modeli



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# DIGITAL SERVICES FOR CIRCULAR ECONOMY - PROJECT DECIDE

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The paper presents the framework and objectives of the DECIDE research project. Its implementation and some interim results are described. The project addresses digital services for the circular economy. In it, we develop and test the usability of methods and tools to support the circular economy for regional developers and small and medium-sized enterprises. It is implemented within the framework of the transnational Interreg Danube Region program, prioritizing increasing competitiveness and strengthening innovation and technology transfer in the macro-region. In the project, the Laboratory for Manufacturing and Production Systems, Faculty of Organizational Sciences, University of Maribor members are collaborating with 15 partners from 10 countries. The project undertakes critical research into the dynamics of circular economies in the food, battery, textile, packaging, and smart cities sectors. The key objective is identifying specific challenges and opportunities for circular economies, focusing on innovative digital tools for analysis, development, and support. This fundamental research is, therefore, crucial for creating tailored solutions for the macro-region.



## 1 Uvod

Krožno gospodarstvo: je regenerativni sistem, v katerem se poraba virov in proizvodnja odpadkov, emisije in energetske izgube zmanjšajo na najmanjšo možno mero s upočasnitvijo, zmanjšanjem in zaprtjem energetskih in snovnih krogov. To je mogoče doseči s trajno zasnovo, vzdrževanjem, popravilom, ponovno uporabo, predelavo, obnovo in recikliranjem (kar je praviloma zadnja izbira) (Wiwsmnth, 2021, Decide, 2024/1).

Prehod na krožno gospodarstvo predstavlja ključen izziv za številne evropske regije. Pri tem Podonavske makro regije, kjer tradicionalni linearni poslovni modeli omejujejo trajnostni gospodarski razvoj, nikakor ne moremo izvzeti. V projektu DECIDE, ki poteka v okviru Programa Interreg Danube Transnational, razvijamo inovativne digitalne rešitve, katere podpirajo širjenje in implementacijo krožnega gospodarstva, še posebej (vendar ne izključno) med malimi in srednjimi podjetji (MSP) ter ostalimi regionalnimi deležniki (Decide, 2024/2).



**Slika 1: Poster in logotip projekta DECIDE**

Vir: (Decide, 2024/2)

Namen projekta je olajšati prehod na krožno gospodarstvo z novimi metodami in pripadajočimi digitalnimi orodji, ki omogočajo oblikovanje posnetkov stanja, analize in ter prenovo poslovnih sistemov. Poleg tega ta orodja omogočajo spremljanje uvajanja in simulacijo izvajanja poslovnih procesov ter optimizacijo poslovnih modelov in verig dodane vrednosti v različnih industrijskih sektorjih.

## 1.1 Pregled projekta in terminski plan

Raziskovalni projekt DECIDE, s proračunom v višini 2.886.750 EUR, vključuje 16 projektnih partnerjev iz 10 držav, vključno z raziskovalnimi organizacijami, organizacijami za podporo podjetjem, pilotnimi partnerji in strateškimi deležniki (Decide, 2024/2). Projekt se osredotoča na dve ključni strateški področji: spodbujanje inovacij v krožnem gospodarstvu ter čezmejno sodelovanje med regijami. Z izvajanjem sedmih ključnih faz projekta, ki vsebujejo 26 delovnih paketov imamo partnerske organizacije namen razviti metodologije in orodja za podporo prehodu v krožno gospodarstvo. Te metodologije in pripadajoča orodja želimo preizkusiti na pilotnih projektih, jih validirati in poskrbeti za širjenje znanja med deležniki.

Deliverables / Work Packages	DECIDE GANTT & Milestone Plan Overview 01.01.2024 - 30.06.2026		Delivery Periods X				
			Milestones X				
			1	2	3	4	5
Activity 1.1 SWOT (Identification of Challenges + Opportunities reg. CE in the Areas of Food, Battery, Textile, Packaging + Smart City)							
Activity 1.2 Tool Set (Development + Validation of Tool Set for Analysis + Development of CE Business Models)							
Activity 1.3 Tool Integration (Integration of Tools for Analysis + Development of CE Business Models into DECIDE Tool Set)							
Activity 1.4 Best Practice Transfer (Transfer of Best Practice CEBMs to Identified transnational and intersectoral Potentials)							
Output 1.1 Pilot actions developed jointly + implemented in projects. Target: 5 pilot actions					X		
Output 1.2 Jointly developed solution. Target: 1 Solution						X	
Activity 2.1 Best Practice Identification + Modelling (Identification + Modelling of Best Practice CE Business Models)							
Activity 2.2 Establishing High Quality CEVC Data Platform + Data Quality Gateway							
Activity 2.3 Dissemination + Knowledge Sharing with SMEs, Startups and Municipal/Regional Economic Developers							
Output 2.1: Organisations cooperating across borders. Target: 22 organisations				X			
3.1 Project Lead & Management							
3.2 Communication							
3.3 Quality Assurance							

Slika 2: Terminski plan projekta

Vir: (Decide, 2024/3)

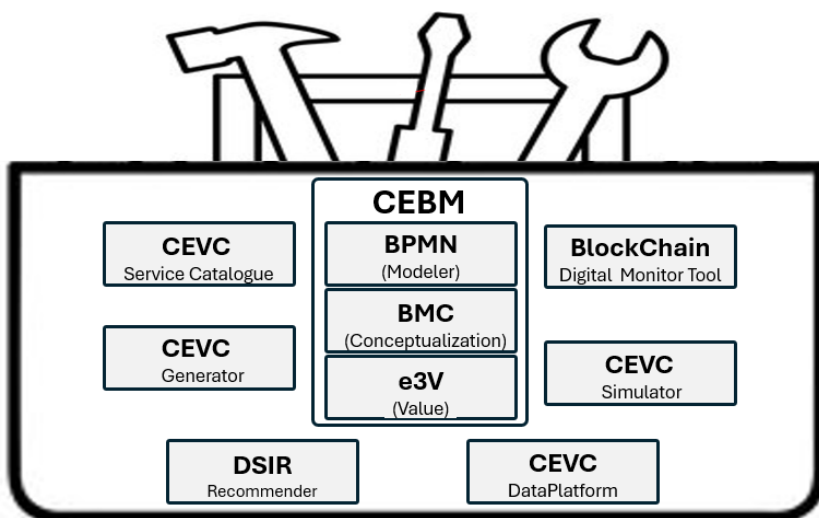


## 1.2 Področja raziskovanja v okviru projekta

Projekt se osredotoča na identifikacijo specifičnih izzivov in priložnosti za krožno gospodarstvo v Podonavski regiji, še posebej v sektorjih, kot so živilski, tekstilni, sektor energetike s poudarkom na prenosu in hranjenju energije, sektorju embalaže in na področju pametnih mest. Preučuje te sektorje z namenom prepoznavanja priložnosti in morebitnih ovir ter izbiro metodologij, tehnik in orodij, prilagojenih specifičnim potrebam posameznih industrij. Projekt temelji na nizu predhodnih raziskav (Fauser, 2019).

## 2 Razvoj in integracija metod in orodij v okviru projekta

Osrednji rezultat projekta DECIDE bo razvita in preizkušena metodologija s pripadajočo informacijsko tehnologijo, ki vključuje širok spekter orodij za modeliranje, analizo in simulacijo, ki nudijo pomoč podjetjem pri prehodu v krožno gospodarstvo. Projekt se osredotoča na integracijo novih in že obstoječih orodij v enoten splet (»Toolbox«), ki bo omogočal prepoznavanje in spremljanje poslovnih modelov krožnega gospodarstva v različnih sektorjih.



Slika 3: Decide Toolbox

Vir: Lasten

Projekt se še izvaja in je trenutno v tretji fazi glede na terminski plan projekta. To pomeni, da so nekatera orodja že prilagojena in se preizkušajo na pilotnih projektih. Nekatera orodja še niso prilagojena in bodo vključena v testiranje v naslednjih fazah projekta. V prispevku podrobneje opisujemo tista orodja, ki se trenutno preizkušajo na 15 pilotih.

Med ključnimi metodami in spremljajočimi orodji, ki se testirajo na pilotnih projektih so orodja, ki so namenjena poslovnemu modeliranju. Ta orodja so tesno povezana in prepletena, saj temeljijo na istih podatkih. Zato so združena v t.i. »**Metodologijo in orodja za poslovno modeliranje v krožnem gospodarstvu**« (Circular Economy Business Modeller - CEBM).

Dejansko je to integrirana metodologija za sistematičen razvoj, dokumentiranje in analizo poslovnih modelov krožnega gospodarstva, saj omogoča prikaz kompleksnosti odnosov med deležniki v poslovnih verigah, preverjanje ekonomske upravičenosti poslovnih povezav med njimi in analizo različnih vidikov trajnosti tovrstnih povezav.

DECIDE Circular Economy Business Modeller (CEBM) vključuje naslednje metodologije in pripadajoča orodja:

- Business Process Model and Notation (BPMN).
- Business Model Canvas (BMC).
- e3Value Modelling Component (e3Value or. e3V).

V nadaljevanju so te metodologije in pripadajoča orodja, ki so prilagojena modeliranju v krožnem gospodarstvu, podrobneje opisana.

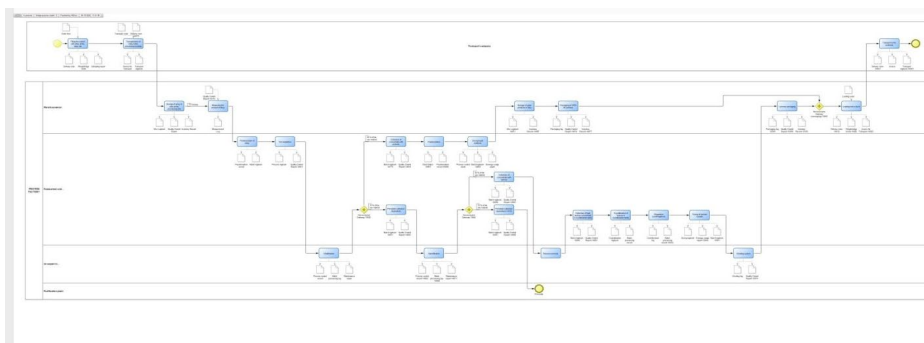
## 2.1 Business Process Model and Notation (BPMN)

Metoda in pripadajoče orodje omogoča standardiziran zapis poslovnih procesov. Notacijo je razvila in jo vzdržuje skupina Object Management Group (OMG) (OMG, 2025). Uporablja se za vizualizacijo procesnih korakov v poslovnem procesu. Notacija je razumljivejša informatikom kot poslovnim uporabnikom, saj je dokaj tehnično usmerjena. Po drugi strani uporablja niz gradnikov, kot so; poslovni

objekti, njihove relacije in pravila. Ti gradniki so standardizirani, zato je so univerzalno razumljivi, kar daje notaciji prednost pri širši uporabi na vseh organizacijskih nivojih in enotah podjetij in tudi med podjetji.

Osnovni gradniki notacije so:

- **Objekti poslovnega toka:** vključujejo dogodke (sprožilce in/ali rezultate), aktivnosti (delo, ki ga je treba opraviti) in operatorje (točke odločanja ali združevanja procesa).
- **Relacijski objekti:** prikazujejo, kako so objekti poslovnega toka povezani in soodvisni z vidika vrstnega reda izvajanja ali prenosa sporočil.
- **Steze (pasovi):** so grafične uprizoritve delovnih vlog, organizacijskih enot ali poslovnih sistemov, ki izvajajo aktivnosti.
- **Artefakti:** ponazarjajo dodatne informacije, kot so podatkovni objekti ali različne opombe, ki povečajo razumljivost modela.

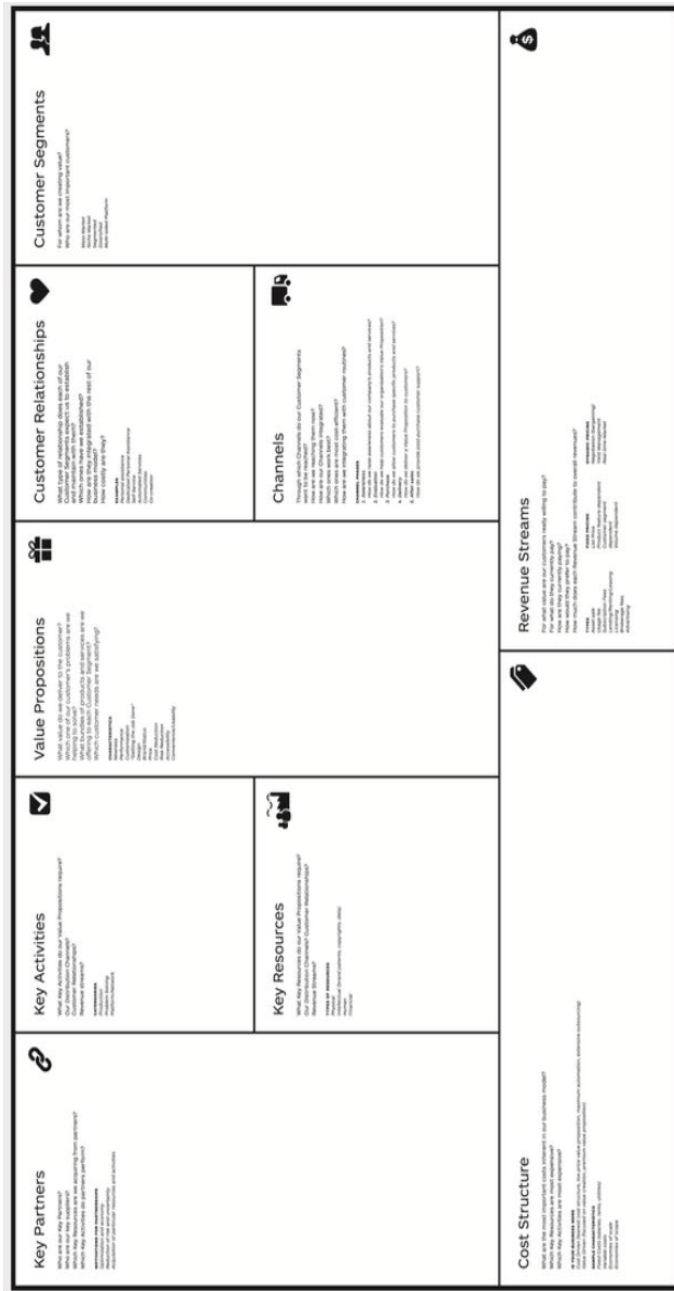


Slika 4: BPMN model v krožni ekonomiji

Vir: (DECIDE, 2024/4)

## 2.2 Business Model Canvas (BMC)

Metoda in pripadajoče orodje sta namenjena vizualizaciji, oblikovanju in analizi poslovnih modelov. Za konceptualizacijo poslovnih modelov se često uporablja v širokem spektru poslovnih sistemov. Avtorja sta Alexander Osterwalder in Yves Pigneur (Wikipedia, 2025), gre pa za metodo in ogrodje, razdeljeno na devet bistvenih gradnikov, ki pomagajo razumeti, kako podjetje ustvarja vrednost.



Slika 5: Business Model Canvas (BCM)  
Vir: Business Model Canvas (Wikipedia, 2025)

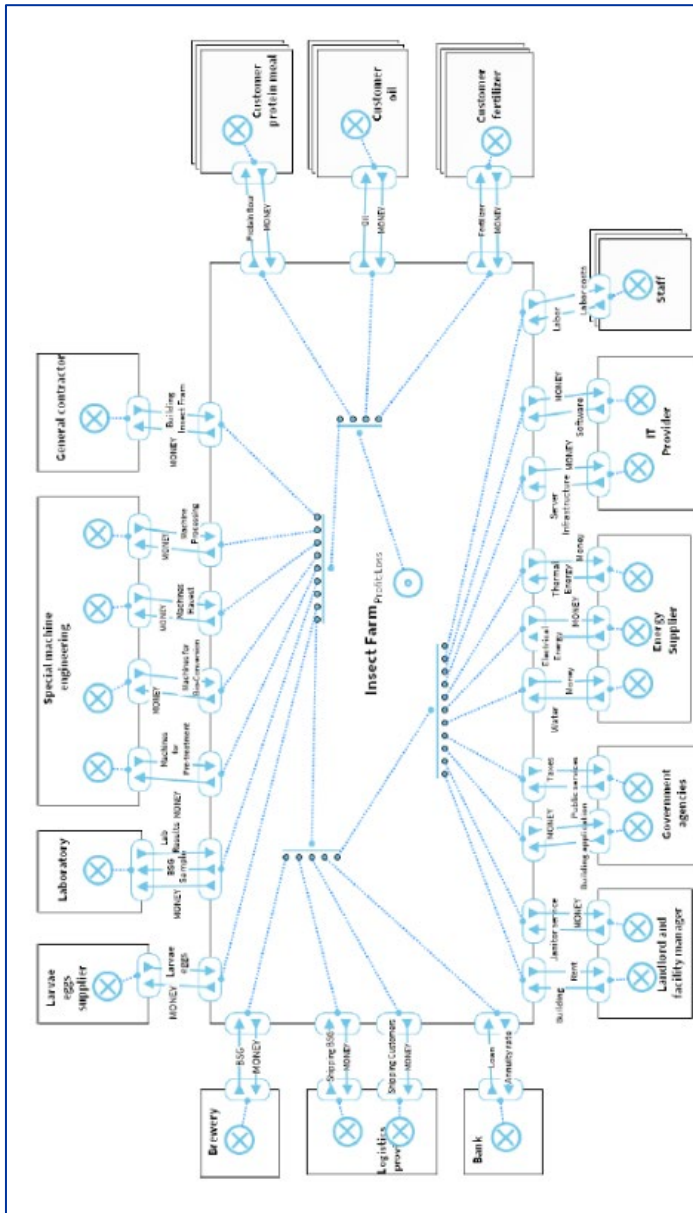
Ti gradniki so:

- **Ključna partnerstva:** gradnik prepozna partnerska podjetja, ki imajo ključno vlogo pri uspehu podjetja in zmanjševanju tveganj pri poslovanju.
- **Ključne aktivnosti:** gradnik opredeljuje ključne aktivnosti, ki so potrebne za dodajanje vrednosti in s tem delovanje poslovnega modela.
- **Ključni resursi:** gradnik obravnava resurse (oz. vire), ki so potrebni za zagotavljanje ponudbe in vzdrževanje dejavnosti podjetja. Ti resursi so lahko človeški, lahko so fizična sredstva ali intelektualni potencial.
- **Vrednosti:** v tem gradniku se vrednotijo izdelki ali storitve, ki ustvarjajo vrednost in zadovoljujejo potrebe odjemalcev.
- **Odnosi s odjemalci:** gradnik opisuje vrsto odnosa, ki ga podjetje vzpostavi s posameznimi segmenti svojih odjemalcev. Ta je lahko: osebni, partnerski, avtomatiziran, itd.).
- **Kanali:** gradnik opisuje prodajne, nabavne (v splošnem logistične) kanale in načine, preko katerih podjetje svojim odjemalcem zagotavlja izdelke ali storitve.
- **Segmenti odjemalcev:** gradnik, ki obravnava segmente odjemalcev na katere se osredotoča podjetje in posledično oblike zadovoljevanja potreb posameznega segmenta (masovna prodaja, segmentna prodaja, idr.). Za oblikovanje učinkovitega poslovnega modela mora podjetje ugotoviti katerim strankam se želi posvetiti.
- **Tokovi prihodkov:** Vključujejo podrobnosti o tem, kako podjetje zasluži sredstva od posameznega segmenta odjemalcev. Primeri so; prodaja izdelkov, prodaja storitev, izposoja, licenciranje in drugo).
- **Struktura stroškov:** gradnik opisuje najpomembnejše finančne posledice poslovanja v okviru različnih poslovnih modelov (modeli, ki v ospredje postavljajo stroškovno učinkovitost, modeli, ki v ospredje postavljajo kakovost, itd.).

### 2.3 e3Value Modelling Concept (e3V)

Koncept e3V se uporablja kot okvir za razumevanje in oblikovanje strategij za različne deležnike, ki sodelujejo v verigah dodajanja vrednosti v krožnem gospodarstvu. Pomaga pri iskanju ravnotežja med ekonomskimi, ekološkimi in

izkušnjijskimi vrednotami ter omogoča oblikovanje trajnostnih poslovnih modelov (Yong, 2011).



Slika 6: e3Value Modelling Concept)

Vir: (DECIDE, 2024/4)

Vsak deležnik, ki sodeluje v verigi dodajanja vrednosti, torej pri produkciji, logistiki ali uporabi izdelkov oziroma storitev ima svoj e3V sistem vrednot, ki vključuje:

- **Ekonomске vrednote**, katere obravnavajo zmanjšanje stroškov in povečanje prihodka, ki ga je mogoče doseči z diferenciacijo, ustvarjanjem trga, pridobivanjem in ohranjanjem odjemalce in drugo.
- **Ekološke vrednote**, ki obravnavajo vprašanja, kot so varčevanje z energijo in vodo, dematerializacija, zmanjšanje količine odpadkov, ponovna uporaba in recikliranje.
- **Izkustvene vrednote**, katere obravnavajo k ljudem usmerjena stališča, vključno z utilitarnimi in hedonistični vidiki.

Metoda uporablja vozlišča in konektorje, ki označujejo akterje oziroma prenose vrednosti, kar uporabnikom pomaga razčleniti poslovne modele na obvladljive dele.

## 2.4 CEVC Service Catalogue

Katalog storitev vrednostnih verig krožnega gospodarstva (CEVC Service Catalogue), je dejansko vhodna točka v DECIDE Toolbox za različne deležnike. Katalog ni eno izmed orodij, ampak ponuja seznam razpoložljivih orodij in storitev za zainteresirane deležnike. Vključuje gradiva, šablonske dokumente in primere uporabe metodologij in orodij za obvladovanje vrednostnih verig krožnega gospodarstva. Omogoča testiranje in validacijo orodij, kar zagotavlja njihovo uporabnost v praksi. Katalog je v okviru projekta oblikovan. Opisane so metode in orodja, ki se v tej fazi projekta testirajo ter izkušnje ki so že pridobljene. Katalog se bo dopolnjeval do zaključka projekta in tudi kasneje ob uporabi metodologije v realnem okolju (Decide, 2024/4).

## 2.5 Circular Economy Value Chain Generator (CEVCG)

Generator vrednostne verige v krožnem gospodarstvu (Circular Economy Value Chain Generator- CEVCG) je platforma, zasnovana na tehnologiji oblaka (Osterwalder, 2025). Vključuje umetno inteligenco (AI), ki deluje na osnovi velike količine podatkov (BigData). Oblikovana je tako, da prepozna morebitne sinergije med podjetij v katerih se pojavijo industrijski odpadki, ponudniki tehnologij, ki

odpadke predelujejo v surovine in potencialnimi uporabniki teh surovin. V kolikor platforma prepozna ujemanje, to omogoča ponovno uporabo predelanih odpadkov. Pri tem platforma oblikuje vrednostne verige in t.i. krožne poslovne povezave med sektorskimi podjetji.

Notacija zapisa CEVCG vsebuje naslednje ključne gradnike:

- Avtomatizirano **odkrivanje potenciala** za krožne rešitve.
- **Ocenjevanje in potrjevanje potencialov** z vidika gospodarskega, okoljskega in podnebne vpliva ter tehnične zmožnosti.
- **Oblikovanje povezav** med najprimernejšimi podjetji in ponudniki tehnologij za izkoriščanje teh priložnosti.

Generator je bil v enem od pilotov že preizkušen. Rezultati se bodo v naslednjih fazah ponovno preverili tudi na preostalih pilotih (EIC, 2025, Decide, 2024/4).

## 2.6 Ostala orodja v orodjarni

Kot je bilo v uvodu omenjeno, je raziskovalni projekt DECIDE v fazi izvajanja, zato vsa orodja, ki so namenjena obvladovanju vrednostnih verig krožnega gospodarstva, še niso povezana v celoto in še niso testirana na pilotih. So pa vsa orodja že zasnovana in so v fazi prilagajanja (Decide, 2024/4).

Preostala orodja so:

- **Svetovalec za implementacijo digitalnih storitev (Digital Service Implementation Recommender - DSIR)**, ki omogoča opredelitev ustreznih informacijskih podsistemov in podpornih procesov za modele procesov vrednostnih verig krožnega gospodarstva. ,
- **Platforma za podatke visoke kakovosti v vrednostni verigi krožnega gospodarstva (High Quality Circular Economy Value Chain Data Platform - HQCEVC)**, je podatkovna hrbtnica orodij projekta DECIDE in je namenjena za shranjevanje visokokakovostnih podatkov, ki se pridobijo z modeliranjem v sistemu CEBM. Omogoča zajem podatkov o pilotih in podatkovnih zbirkah podjetij, ki sodelujejo v verigah krožnega



gospodarstva. Platforma HQCEV, uporablja tehnologijo veriženja blokov za doseganje transparentnosti in celovitosti podatkov, kar je tudi v skladu z strategijami EU.

- **Simulator vrednostnih verig (Circular Economy Value Chain Simulator - CEVCS)**, omogoča analizo in simulacijo vrednostne verige krožnega gospodarstva z vidika ekonomske, socialne in okoljske učinkovitosti. Analiza in simulacija modelov z uporabo systemske dinamike omogoča izračunavanje donosnosti naložbe, stroškov in praga donosnosti. Simulator lahko analizira ekonomske in ekološke razsežnosti. Simulacije potrjujejo ali ovržejo izvedljivost in trajnost modela pred implementacijo in izvajanjem.
- **Orodje za digitalno spremljanje na podlagi tehnologija BlokChain (Blockchain Protected Digital Monitoring Tool - BPDMT)**
- Orodje BPDMT je centralizirana platforma za spremljanje in vizualizacijo podatkov iz poslovnih modelov krožnega gospodarstva, ki z uporabo tehnologije veriženja blokov omogoča spremljanje sprememb vrednosti v verigi v realnem času. Deležnikom omogoča sledenje okoljskim in podnebnim ciljem preko enotnega nadzornega panela. To omogoča preglednost in uporabne vpogleda, kar omogoča učinkovito sprejemanje odločitev in merjenje učinkovitosti in uspešnosti vzpostavljenih modelov. BPDMT se povezuje se ostalimi orodji in platformo HQCEVC, kar zagotavlja zanesljive, natančne in točne podatke. Njegova razširljivost, deležnikom prijazna zasnova ter preglednost omogočajo optimizacijo strategij.

Glavni elementi orodja so:

- **Vhodni modul:** Ponuja odziven in uporabniku prijazen vmesnik za vizualizacijo podatkov z interaktivnimi grafi in prilagodljivimi nadzornimi paneli.
- **Zaledni modul:** Skrbi za obdelavo podatkov, kar zagotavlja varno in učinkovito komunikacijo z zunanji viri podatkov. Vključuje tudi združevanje, validacijo in obdelavo podatkov iz različnih virov za točen izpis na nadzornem panelu.

- **Integracijski sloj:** Omogoča povezovanje in integracijo podatkov iz DECIDE orodij preko vmesnikov, kar zagotavlja nemoteno delovanje in kompatibilnost z zunanjimi sistemi.

### 3 Predvideni rezultati projekta in vpliv na Podonavsko regijo

V okviru projekta se izvajajo pilotni projekti, ki preizkušajo metodologije in orodja in so namenjeni oblikovanju najboljše prakse krožnega gospodarstva v različnih sektorjih. Na ta način bo zagotovljena uporabnost metodologij in orodij v realnih okoljih, hkrati pa bo zagotovljena tudi kakovost celotnega pristopa.

Projekt DECIDE vključuje organizacijo in izvedbo več delavnic, seminarjev in usposabljanj za širjenje informacij o izsledkih projekta. To je namenjeno ozaveščanju o prednostih krožnega gospodarstva zlasti med malimi in srednjimi podjetji, startup podjetji in ostalimi regionalnimi deležniki. Ti dogodki omogočajo izmenjavo idej, predstavitev študij primerov in zgodbe o uspehu.

Poleg formalnih dogodkov projekt DECIDE vzpodbuja interaktivno izmenjavo znanja in gradnjo dolgoročne skupnosti med deležniki preko digitalnih platform in socialnih omrežij. Digitalne platforme in socialna omrežja omogočajo hitro in neomejeno širjenje znanja o krožnem gospodarstvu ter lažje povezovanje med podjetji, raziskovalci in regionalnimi razvijalci.

Projekt DECIDE je že dosegel pomemben napredek pri razvoju orodij in metodologij za implementacijo krožnih poslovnih modelov. Z uporabo digitalnih orodij in najboljših praks bo mogoče natančneje spremljati okoljske, ekonomske in socialne vplive krožnega gospodarstva, kar prispeva k doseganju trajnostnih ciljev in spodbujanju regionalnega razvoja.

### 4 Zaključek

Projekt DECIDE predstavlja pomemben korak pri spodbujanju krožnega gospodarstva v Podonavski regiji. Z razvojem metodologij in digitalnih orodij za podporo prehoda na trajnostne poslovne modele, projekt prispeva k večji konkurenčnosti in vsestranskemu razvoju regije. Nadaljnje širjenje znanja med

malimi in srednimi podjetji ter ostalimi deležniki bo omogočilo nadaljnji razvoj in implementacijo krožnih poslovnih modelov.

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# UMETNA INTELIGENCA IN KOMUNIKACIJA VISOKOŠOLSКИH ZAVODOV Z MEDNARODNIMI ŠTUDENTI

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Članek predstavlja dejavnike komunikacije v visokošolskih zavodih v povezavi z umetno inteligenco (v nadaljevanju UI) in komunikacijo visokošolskih zavodov z mednarodnimi študenti. Predstavljeni so ključni dejavniki komunikacije, kot so jasnost, transparentnost, pravočasnost, odzivnost in personalizacija. V povezavi z dejavniki komunikacije ugotavljamo, da UI omogoča učinkovitejše posredovanje informacij, hitro odzivnost ter prilagoditev komunikacije specifičnim potrebam študentov. Poleg teh prednosti UI prispeva k izboljšanju transparentnosti in proaktivnosti komunikacije, kar krepi zaupanje in dolgoročno pripadnost študentov institucijam. Kljub temu ostajajo omejitve pri reševanju kompleksnih in čustveno občutljivih vprašanj, kar poudarja potrebo po kombinaciji UI sistemov in človeške podpore.

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# ARTIFICIAL INTELLIGENCE AND COMMUNICATION BETWEEN HIGHER EDUCATION INSTITUTIONS AND INTERNATIONAL STUDENTS

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## Keywords:

artificial intelligence,  
communication strategies,  
higher education  
institutions,  
international students,  
satisfaction,  
loyalty,  
personalization,  
transparency,  
timeliness

This article presents the factors of communication in HEIs and specifically introduces them in relation to artificial intelligence (AI) and HEIs' communication with international students. Key communication factors such as clarity, transparency, timeliness, responsiveness and personalisation are presented. In relation to the communication factors, we find that AI allows for more efficient information delivery, rapid responsiveness and tailoring of communication to the specific needs of students. In addition to these benefits, AI contributes to improving the transparency and proactivity of communication, which enhances students' trust and long-term commitment to the institutions. Nevertheless, limitations remain in dealing with complex and emotionally sensitive issues, highlighting the need for a combination of AI systems and human support.



University of Maribor Press

## 1 Uvod

Globalizacija, razumljena kot družbena in gospodarska soodvisnost med ljudmi in državami, vpliva na razvoj socialnega kapitala in izobrazbe. Ni presenetljivo, da vse to vpliva na način, kako se univerze spopadajo s trendom internacionalizacije izobraževanja v tem globaliziranem in internacionaliziranem svetu (Finardi, & Rojo, 2015). Hitra globalizacija in zmanjševanje meja med državami so med seboj povezale univerze prek kulturnih in tehnoloških izmenjav. Izmenjave potekajo prek globalnega skupnega jezika kot komunikacijskega orodja (Syarifudin, & Rahmat, 2021). Privabljanje tujih študentov ne predstavlja zgolj vprašanja akademske odličnosti, temveč zahteva tudi visoko raven organizacijskih zmogljivosti in prilagodljivosti, da bi zadovoljili njihove raznolike potrebe. Komunikacija med visokošolskimi zavodi in tujimi študenti je osrednjega pomena za uspešno vključevanje teh študentov v akademsko okolje. To še posebej velja za fazo prijave in vpisa, ko jasnost, transparentnost in pravočasnost informacij neposredno vplivajo na odločitev študentov o izbiri institucije (Soutar, & Turner, 2002).

Unescov statistični inštitut kot mednarodnega študenta opredeljuje vsakogar, ki prestopi mejo ali ozemlje druge države in se vpiše v izobraževalno ustanovo. Mednarodni študenti so iskani po vsem svetu in njihovo število se je znatno povečalo. Leta 2020 je bilo na svetu več kot 6,3 milijona mednarodnih študentov (Unescov statistični inštitut, 2022).

V tem kontekstu postaja UI ključno orodje za optimizacijo komunikacijskih strategij. UI omogoča avtomatizacijo rutinskih nalog, izboljšanje odzivnosti in personalizacijo komunikacijskih procesov, kar visokošolskim zavodom omogoča, da bolje zadostijo potrebam mednarodnih kandidatov. Klepetalni roboti, analitika velikih podatkov in algoritmi strojnega učenja že prinašajo pomembne spremembe v načinu, kako visokošolski zavodi komunicirajo s študenti (Van Rijmenam, 2019). Vendar pa ta tehnološki prehod odpira tudi vrsto vprašanj, povezanih z etiko, zasebnostjo in skladnostjo z zakonodajo, kot je Splošna uredba o varstvu podatkov (GDPR) (Wachter, Mittelstadt, & Floridi, 2017)

Med ključne komunikacijske dejavnike, ki jih visokošolski zavodi uporabljajo pri delu s tujimi študenti, sodijo jasnost, transparentnost, pravočasnost in personalizacija informacij. Boljše celovito sprejemanje sedanje medkulturne raznolikosti, zaznavanja

informacij in praks univerze, kaže na ustrezno pot za vse deležnike v izobraževanju (Syarifudin, & Rahmat, 2021).

Transparentnost velja za ključno sestavino visokošolskega sektorja (Hudson et al., 2017). Vključuje jasno izražanje namena, meril, povratnih informacij in praks, kar je bistveno za usklajevanje pričakovanj študentov s standardi in spodbujanje pravičnih učnih okolij (Bamber, 2015).

Kljub obsežnemu potencialu UI pa ni mogoče zanemariti pomembnosti človeškega stika, zlasti pri obravnavanju bolj zapletenih vprašanj, ki zahtevajo empatijo in kulturno občutljivost. Tehnološke rešitve ne morejo v celoti nadomestiti človeške interakcije, ki ostaja osrednjega pomena za vzpostavljanje zaupanja in izgradnjo dolgotrajnih odnosov med institucijami in študenti (Floridi, & Cowls, 2019). Tako je eden od ključnih izzivov sodobnega visokošolskega izobraževanja iskanje ravnovesja med avtomatizacijo procesov z uporabo UI in ohranjanjem kakovostne človeške komunikacije.

Namen tega prispevka je raziskati vpliv UI na ključne komunikacijske dejavnike, ki določajo zadovoljstvo in zvestobo tujih študentov. Osredotočili se bomo na tezo, da jasna, transparentna in pravočasna komunikacija, podprta z UI, pozitivno vpliva na zaznano kakovost storitev visokošolskih zavodov. V prispevku bomo predstavili teoretična izhodišča in nakazali priložnosti za nadaljnje raziskave.

## 2 Dejavniki komunikacije

### 2.1 Jasnost in transparentnost

Jasnost in transparentnost komunikacije sta ključna elementa uspešnega informiranja tujih študentov, še posebej v zgodnjih fazah njihovega odnosa z visokošolskimi zavodi. Jasnost pomeni, da so informacije, ki jih visokošolski zavodi posredujejo študentom, natančne, nedvoumne in enostavne za razumevanje. Konceptualizacija preglednosti in komuniciranja v institucionalni politiki kljub njeni pomembnosti ostaja zapletena, saj se izraz pogosto uporablja metaforično, da bi predstavljal „videnje“ prej nejasnih procesov, in je zato redko opredeljen (Bearman, & Ajjawi, 2021).



Fakunle (2021) navaja, da so motivi mednarodnih študentov za študij v tujini izobraževalni, aspiracijski, izkustveni in ekonomski. Motivacija številnih mednarodnih študentov za študij v tujini izhaja iz osebnih ambicij in želje po boljših možnostih. Za druge je razlog nizka kakovost izobraževanja v njihovi državi (Bhandari et al., 2018). Poleg tega gospodarski, tehnološki in kulturni dejavniki pomembno vplivajo na mednarodno izobraževanje, zaradi česar je za mednarodne študente lažje dostopno (Organization of Economic Cooperation and Development [OECD], 2021). Ne glede na to, kaj te študente motivira za študij v tujini, bodo morda zaradi nepredvidenih težav potrebovali pomoč pri naselitvi v novi državi in prilagajanju na akademsko življenje. Ti študenti se soočajo z izzivi na skoraj vsaki točki med preходом iz matične države v ciljno državo in po diplomi (Khanal, & Gaulee, 2019).

Transparentnost (jasno določeni roki, postopki in odgovornost vseh vpletenih) je ključna za izpolnjevanje pričakovanj študentov. Visokošolski zavodi morajo zagotavljati informacije, ki so resnične, popolne in pravočasne, saj s tem zmanjšujejo tveganje napačnega razumevanja ali nejasnosti, kar je pogosto povezano s slabšo izkušnjo študentov (Zeithaml, Berry, & Parasuraman, 1996).

Jasnost in transparentnost komunikacije postajata še pomembnejši v digitaliziranem okolju, kjer številne interakcije potekajo prek spletnih platform ali avtomatiziranih sistemov, podprtih z UI. Klepetalni roboti, ki so prilagojeni za odgovarjanje na vprašanja študentov, so lahko učinkoviti pri zagotavljanju jasnih in neposrednih informacij (Wang, et al., 2023).

UI sočasno omogoča prilagoditev informacij specifičnim potrebam študentov. Algoritmi za strojno učenje namreč lahko analizirajo vedenjske vzorce in potrebe študentov ter na podlagi teh podatkov prilagodijo vsebino komunikacije. Na primer, študenti iz določenih držav lahko prejmejo prilagojene informacije o postopkih za pridobitev vize ali kulturnih posebnostih, s čimer se izboljša njihova pripravljenost na študij v tujini (Van Rijmenam, 2019).

Kljub temu vloga UI v zagotavljanju jasnosti in transparentnosti komunikacije prinaša tudi izzive. Če so avtomatizirani sistemi nepravilno zasnovani ali ne vključujejo možnosti nadzora s strani človeških svetovalcev, lahko pride do napačnih ali nepopolnih informacij, kar lahko povzroči nezadovoljstvo med študenti

(Wachter, Mittelstadt, & Floridi, 2017). Transparentnost v takšnem okolju vključuje tudi obveščanje študentov o tem, kdaj in kako so njihove interakcije obdelane s pomočjo UI, zlasti tiste ki vključujejo osebne podatke študentov, ki morajo biti skladne s pravnimi zahtevami, kot jih določa Splošna uredba o varstvu podatkov (GDPR) in področna zakonodaja države visokošolskega zavoda v katerega se vključujejo študenti (European Commission, 2016).

Nazadnje jasnost in transparentnost komunikacije nista zgolj tehnična ali administrativna vidika, temveč sta tesno povezana z vrednotami visokošolskih zavodov. Institucije, ki se zavzemajo za odprtost, integriteto in poštenost v komunikaciji, vzpostavljajo močnejše odnose s študenti in ustvarjajo okolje zaupanja, kar vodi k večjemu zadovoljstvu in dolgoročni zvestobi (Oliver, 1999).

## **2.2 Pravočasnost in odzivnost**

Pravočasnost in odzivnost sta osrednja vidika komunikacije v visokošolskem izobraževanju, še posebej v fazi prijave in vpisa tujih študentov. V tej ključni fazi so študenti pogosto odvisni od hitrosti in kakovosti informacij, ki jim jih posredujejo visokošolski zavodi. Pravočasnost pomeni zagotavljanje informacij ob pravem času, da lahko študenti učinkovito načrtujejo in zaključijo svoje prijavnne procese, medtem ko odzivnost odraža sposobnost institucije, da hitro in ustrezno odgovori na specifične potrebe študentov (Soutar, & Turner, 2002).

V dinamičnem in konkurenčnem okolju visokošolskega izobraževanja je pravočasnost bistvenega pomena za zmanjšanje stresa in negotovosti, s katerima se soočajo tuji študenti. To vključuje posredovanje ključnih informacij o rokih za prijavo, razpoložljivosti nastanitev, finančni pomoči in postopkih za pridobitev vize. Če študenti pravočasno prejmejo te informacije, se poveča njihova verjetnost za uspešno prijavo in odločitev za vpis (Zeithaml, Berry, & Parasuraman, 1996).

V zadnjih letih je UI postala pomembno orodje za izboljšanje pravočasnosti in odzivnosti visokošolskih zavodov. Sistemi, kot so klepetalni roboti in virtualni asistenti, omogočajo avtomatizacijo odgovarjanja na pogosta vprašanja, kar zmanjšuje obremenitev osebja in zagotavlja, da študenti prejmejo informacije v realnem času (Dwivedi et al., 2021).

Poleg avtomatizacije odgovarjanja na vprašanja lahko UI tudi analizira podatke o preteklih interakcijah s študenti in na podlagi teh podatkov predvidi njihove potrebe. Tako lahko visokošolski zavodi proaktivno posredujejo informacije, še preden jih študenti zahtevajo. Na primer, sistem lahko prepozna, da je študent z določenim državljanstvom zainteresiran oziroma ima potrebo po informacijah o vizumu, in mu te informacije posreduje brez predhodne zahteve (Brynjolfsson, & McAfee, 2017).

Pravočasnost in odzivnost sta ključna tudi v primeru nepredvidenih situacij, kot so spremembe v zakonodaji, naravne nesreče ali pandemije. Med pandemijo COVID-19 so visokošolski zavodi, ki so uporabljali avtomatizirane sisteme za komuniciranje, lahko hitro in učinkovito obveščali študente o spremembah v študijskih programih, postopkih za pridobitev vize in potovanjih, kar je zmanjšalo negotovost in stres študentov (OECD, 2021).

Kljub temu pa avtomatizirana komunikacija prinaša tudi nekatere izzive. Klepetalni roboti in drugi sistemi UI so lahko omejeni v svoji sposobnosti reševanja bolj zapletenih vprašanj ali čustveno občutljivih situacij. Študenti, ki se soočajo s težavnimi ali osebno pomembnimi vprašanji, pogosto raje govorijo z osebo, ki lahko ponudi empatičen in individualiziran odgovor (Floridi, & Cowsls, 2019).

Etika pravočasnosti in odzivnosti je še en pomemben vidik. Institucije morajo zagotoviti, da njihovi avtomatizirani sistemi delujejo transparentno in skladno z zakonodajo, kot je GDPR, pri tem pa upoštevajo pravice študentov tako do zasebnosti kot točnih informacij. Študenti morajo biti obveščeni, da komunicirajo z avtomatiziranimi sistemi, in imeti možnost, da se obrnejo na konkretno osebo v instituciji, če se pojavijo težave ali vprašanja, ki jih avtomatizirani sistemi ne morejo ustrezno rešiti (European Commission, 2016).

### **2.3 Personalizacija**

Personalizacija komunikacije je eden izmed najpomembnejših dejavnikov pri vzpostavljanju učinkovite komunikacije med visokošolskimi zavodi in tujimi študenti. V kontekstu globalizacije in vedno večje konkurence na področju visokega šolstva postaja personalizacija nujen pristop, ki omogoča visokošolskim zavodom, da se prilagodijo specifičnim potrebam, pričakovanjem in kulturnim kontekstom posameznih študentov (Soutar, & Turner, 2002). Personalizacija ne le izboljšuje

izkušnjo študentov, temveč tudi krepí njihovo zaupanje in občutek pripadnosti instituciji, kar lahko dolgoročno vpliva na njihovo zadovoljstvo in zvestobo (Oliver, 1999).

V preteklosti so visokošolski zavodi personalizacijo pogosto dosegali preko kontaktne osebe v visokošolskem zavodu in z neposredno pisno komunikacijo. Ta tradicionalni pristop, čeprav učinkovit, je omejen z obsegom in zmogljivostjo osebja, kar pomeni, da ne more ustrezno obravnavati velikega števila študentov, značilnega za sodobno internacionalizacijo visokega šolstva. V zadnjih letih je UI postala ključno orodje za izboljšanje personalizacije komunikacije v visokošolskem okolju. Napredni algoritmi za strojno učenje in analitiko podatkov omogočajo visokošolskim zavodom, da analizirajo velike količine informacij o študentih in na podlagi teh podatkov oblikujejo prilagojene komunikacijske strategije (Dwivedi et al., 2021).

UI omogoča tudi proaktivno personalizacijo. To pomeni, da lahko sistemi predvidijo, katere informacije bodo študentje potrebovali, in jih posredujejo še preden jih študenti zahtevajo. Na primer, študentom iz držav, kjer so postopki za pridobitev vize zapleteni, lahko sistem samodejno pošlje podrobne smernice o dokumentaciji in rokih za oddajo vloge, s čimer se ne le izboljšuje izkušnjo študentov, temveč tudi zmanjšuje število vprašanj in administrativno obremenitev zaposlenih (Brynjolfsson, & McAfee, 2017).

Personalizacija komunikacije mora upoštevati tudi kulturne razlike, ki pomembno vplivajo na zaznavanje in razumevanje informacij. Kulturni okvir vpliva na to, kako študenti interpretirajo ton, strukturo in vsebino komunikacije. Na primer, v nekaterih kulturah je osebna obravnava ključnega pomena in cenijo neposrednost in učinkovitost (Hofstede, Hofstede, & Minkov, 2010). Visokošolski zavodi morajo zato oblikovati komunikacijske strategije, ki upoštevajo te razlike, da bi lahko zagotovili, da so informacije razumljene in sprejete na želen način.

UI lahko igra pomembno vlogo pri prilagajanju komunikacije kulturnemu kontekstu. Na primer, algoritmi za prevajanje in obdelavo naravnega jezika (NLP) omogočajo natančno in kulturno občutljivo prevajanje informacij. To zagotavlja, da študenti prejmejo informacije v svojem jeziku in v obliki, ki je skladna z njihovimi kulturnimi normami (Van Rijmenam, 2019).

Kljub številnim prednostim uporabe UI pri personalizaciji komunikacije obstajajo tudi izzivi. Eden od glavnih izzivov je zagotavljanje zasebnosti in zaščite osebnih podatkov. Personalizacija temelji na analizi osebnih podatkov, kar lahko povzroči pomisleke glede skladnosti z zakonodajo, kot je GDPR. Visokošolski zavodi morajo zagotoviti, da so podatki študentov varno shranjeni in obdelani ter uporabljeni skladno z GDPR. (European Commission, 2016).

Drugi izziv je ohranjanje človeškega stika. Čeprav UI omogoča avtomatizacijo in prilagajanje komunikacije, ne more nadomestiti empatije in čustvene občutljivosti človeka. Zato je pomembno, da zavodi uporabljajo kombinacijo avtomatiziranih in človeških interakcij, pri čemer avtomatizirane rešitve služijo kot podpora, ne pa kot nadomestek človeškega stika (Floridi, & Cowls, 2019).

Personalizacija komunikacije ima neposreden vpliv na zadovoljstvo in zvestobo tujih študentov. Študenti, ki se počutijo cenjene in individualno obravnavane, so bolj verjetno zadovoljni s svojo izkušnjo in se bolj pogosto odločajo, da bodo nadaljevali študij na isti instituciji ali jo priporočili drugim (Zeithaml et al., 1996).

### **3 Predstavitev primerov vplivov umetne inteligence na komunikacijo visokošolskih zavodov**

V poglavju predstavljamo dejavnike komunikacije visokošolskih zavodov v povezavi z UI.

#### **3.1 Umetna inteligenca in jasnost ter transparentnost**

Podatki in primeri uporabe UI kažejo, da je jasna in pregledna komunikacija bistvena za učinkovito informiranje tujih študentov in ključnega pomena pri internacionalizaciji visokošolskih zavodov. UI prispeva k poenostavitvi dostopa do informacij s pomočjo klepetalnih robotov, ki zagotavljajo jasne, natančne in strukturirane odgovore o študijskih programih, prijavih in postopkih za pridobitev vize in o drugih upravnih postopkih, s čimer povečujejo zaupanje v visokošolske zavode (Altbach, & Knight, 2007). Transparentne komunikacijske prakse, ob upoštevanju etičnih standardov in zakonodaje, tako omogočajo študentom boljši vpogled v administrativne postopke, kar vodi k povečanju zaupanja študentov in deležnikov (Floridi, & Cowls, 2019).

## 4.2 Umetna inteligenca in pravočasnost ter odzivnost

UI ima sposobnost, da omogoča komunikacijo v realnem času. To je še posebej pomembno za tuje študente, ki pogosto potrebujejo hitre odgovore na vprašanja. Pravočasna obravnava prošenj, vlog in vprašanj študentov zmanjšuje njihovo negotovost in izboljšuje splošno izkušnjo (Dwivedi et al., 2021). UI omogoča dostop do informacij prek avtomatiziranih orodij kot so na primer klepetalni roboti, ki omogočajo pravočasne in personalizirane odgovore 24 ur 7 dni na teden celo leto, kar zmanjša čas čakanja na odgovore in omogoča boljšo odzivnost med kulturnimi in časovnimi razlikami pri mednarodnih študentih (Wang et al., 2023).

## 4.3 Prispevek UI k personalizaciji

UI omogoča segmentacijo podatkov, kar visokošolskim zavodom pomaga pri targetiranju specifičnih skupin študentov in je ključnega pomena pri oblikovanju komunikacijskih strategij visokošolskih zavodov. UI orodja, ki uporabljajo podatke o študentih, kot na primer pretekla komunikacija s študenti, interesi oziroma povpraševanja študentov in podobno, prilagodijo sporočila glede na potrebe študentov oziroma glede na izkazano zanimanje za študijski program, dogodke na visokošolskem zavodu in podobno (Kotler & Fox, 1995). Personalizacija komunikacije kot so personalizirani nasveti in informacije študentom, je ključna za gradnjo tesnejšega odnosa s študenti, saj prispeva k občutku pripadnosti študentov in vodi k višjemu zadovoljstvu in večji zvestobi študentov visokošolskemu zavodu (Zeithaml, Berry & Parasuraman, 1996).

## 4.4 Zadovoljstvo in zvestoba

Kakovost komunikacije pomembno vpliva na zadovoljstvo študentov, kar posledično vodi v njihovo zvestobo instituciji. Zadovoljstvo spodbuja dolgoročno zvestobo, kar je pomembno za ohranjanje odnosa s tujimi študenti tudi po zaključku študija kot je na primer mreženje alumnov ali pripravljenosti študentov, da promovirajo institucijo med vrstniki (Oliver, 1999).

## **5 Zaključek**

Glede na opredelitve dejavnikov komuniciranja, igra umetna inteligenca ključno vlogo pri izboljšanju komunikacijskih strategij visokošolskih zavodov z mednarodnimi študenti. UI pomembno prispeva k jasnosti, transparentnosti, pravočasnosti, odzivnosti in personalizaciji komunikacije, kar pozitivno vpliva na zadovoljstvo in zvestobo študentov. S pomočjo avtomatiziranih sistemov, kot so klepetalni roboti in analitika podatkov, lahko visokošolski zavodi zagotovijo hitre, natančne in prilagojene informacije, ki zmanjšujejo negotovost študentov in izboljšujejo njihovo izkušnjo.

UI omogoča visokošolskim zavodom učinkovitejše obvladovanje velikih količin povpraševanj ter proaktivno obveščanje študentov o študijskih programih, vpisnih postopkih in vpisni dokumentaciji ter različnih postopkih kot so postopki za pridobitev vize, za bivalno dovoljenje in podobno. Poleg tehničnih prednosti personalizirana komunikacija, podprta z UI, povečuje občutek pripadnosti študentov visokošolskim zavodom, kar spodbuja dolgoročno zvestobo. Transparentna uporaba UI ter skladnost z zakonodajo, kot je GDPR, igra ključno vlogo pri ohranjanju zaupanja študentov.

Kljub prednostim pa ostajajo omejitve in izzivi. Kompleksna ali čustveno občutljiva vprašanja pogosto zahtevajo človeško interakcijo, ki jo avtomatizirani sistemi ne morejo v celoti nadomestiti. Za optimalne rezultate je zato ključno, da visokošolski zavodi združijo z UI podprte sistem in procese s človeškimi komunikacijskimi kanali in pri tem upoštevajo etične ter kulturne raznolikosti.

Visokošolski zavodi, ki uspešno implementirajo UI v svoje komunikacijske strategije, pridobijo konkurenčno prednost na globalnem trgu visokošolskega izobraževanja. Njihova sposobnost zagotavljanja hitre, jasne in prilagojene komunikacije ne le izboljšuje izkušnjo tujih študentov, temveč tudi krepi njihov ugled in pritegne nove generacije mednarodnih študentov.

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# UMETNA INTELIGENCA V INTEGRIRANEM SISTEMU MANAGEMENTA V LETALSTVU

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Članek preučuje vpliv umetne inteligence (UI) na integriran sistem managementa (ISM) v letalski industriji. Raziskava poudarja ključne prednosti UI, kot so prediktivno vzdrževanje, avtomatizacija procesov in izboljšanje varnosti prek analize podatkov v realnem času. Hkrati pa izpostavlja pomembne izzive, vključno z omejitvami razložljivosti UI sistemov, njihovimi omejitvami v nepredvidljivih situacijah ter etičnimi in pravnimi vprašanji, kot so odgovornost in varstvo podatkov. Priporočena je sinergija med UI in človeško inteligenco, kjer UI podpira operativne procese, vendar ostaja človeški nadzor ključen za kritično odločanje. Raziskava prispeva k boljšemu razumevanju izzivov in priložnosti, ki jih prinaša UI, ter nudi smernice za varno in učinkovito implementacijo v letalski sektor.

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# ARTIFICIAL INTELLIGENCE IN AN INTEGRATED MANAGEMENT SYSTEM IN AVIATION

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## Keywords:

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automation,  
ethics,  
explainability,  
human intelligence.

This paper examines the impact of artificial intelligence (AI) on the integrated management system (IMS) in the aviation industry. The study highlights key advantages of AI, such as predictive maintenance, process automation, and enhanced safety through real-time data analysis. It also addresses significant challenges, including the explainability limitations of AI systems, their constraints in unpredictable situations, and ethical and legal issues such as accountability and data protection. The study recommends a synergy between AI and human intelligence, where AI supports operational processes while human oversight remains essential for critical decision-making. This research contributes to a better understanding of the challenges and opportunities brought by AI and provides guidance for its safe and effective implementation in the aviation sector.



## **1 Uvod**

Sodobna družba je zaznamovana z izjemno hitrim tehnološkim razvojem, ki pomembno vpliva na vse vidike našega življenja in delovanja organizacij. Ena izmed ključnih silnic teh sprememb je umetna inteligenca (UI), ki prinaša nove priložnosti za optimizacijo in avtomatizacijo kompleksnih procesov. Letalska industrija, kot eden najbolj reguliranih in varnostno občutljivih sektorjev, ni izjema. Uvedba naprednih tehnologij, vključno z UI, postaja nujna za zagotavljanje konkurenčnosti, varnosti in učinkovitosti.

Integriran sistem managementa (ISM) je v letalski industriji ključno orodje za zagotavljanje skladnosti s predpisi ter za učinkovito obvladovanje tveganj, povezanih z varnostjo, kakovostjo, okoljem in delovanjem organizacije. Tradicionalni pristopi k upravljanju teh sistemov so se sicer izkazali za uspešne, vendar se z rastjo kompleksnosti letalskih operacij pojavlja potreba po naprednejših rešitvah, ki lahko združujejo velike količine podatkov in zagotavljajo hitre ter natančne analize. Tukaj vstopa UI, ki s svojimi sposobnostmi obdelave podatkov, napovedovanja in prilagajanja odpira nove dimenzije za upravljanje v letalstvu.

Kljub vsem prednostim pa uvajanje UI v ISM prinaša tudi določene izzive in tveganja. Med najpomembnejšimi so vprašanja zanesljivosti, transparentnosti in etične odgovornosti. Poleg tega se poraja tudi vprašanje, kje UI lahko preseže sposobnosti človeške inteligence in kje ostaja človek nepogrešljiv. Letalska industrija se pri tem sooča z dvema ključnima izzivoma: prvič, kako implementirati UI na način, ki bo izboljšal procese, ne da bi ogrozil varnost; in drugič, kako zagotoviti, da človeški dejavnik ostane v središču odločanja tam, kjer je to najpomembnejše.

### **1.1 Problematika**

V letalski industriji je varnost absolutna prioriteta. Zato vsaka nova tehnologija, ki se uvaja v operativne procese, zahteva natančno oceno njenih vplivov in zmožnosti. UI ima potencial, da z analizo podatkov iz različnih virov, kot so senzorji v letalih, zgodovinski podatki o vzdrževanju ter vremenski in operativni podatki, izboljša procese odločanja ter omogoči prediktivne analize. Na primer, prediktivno vzdrževanje na podlagi algoritmov UI lahko zmanjša število nepredvidenih okvar in s tem izboljša operativno učinkovitost.

Po drugi strani pa se pri uporabi UI pojavljajo tudi tveganja, povezana z zanesljivostjo sistemov in njihovimi omejitvami. Algoritmi so lahko dovzetni za napake, če se soočijo z nepredvidenimi situacijami, ki niso bile zajete v njihovem procesu učenja. Poleg tega je pomembno zagotoviti, da ostane odločanje v kritičnih trenutkih še vedno v rokah človeka, saj so sposobnosti intuicije in hitro prilagajanje človeškega uma v določenih okoliščinah nenadomestljive.

## **1.2 Namen in cilji raziskave**

Namen tega članka je raziskati, kako UI vpliva na integriran sistem managementa v letalstvu, ter identificirati ključne priložnosti in izzive, ki jih prinaša. Konkretno se osredotočamo na naslednje cilje:

Analizirati, kako lahko UI izboljša procese v ISM, zlasti na področjih varnosti, kakovosti in vzdrževanja.

Ugotoviti, kako lahko UI prispeva k zmanjšanju operativnih tveganj in izboljšanju skladnosti z mednarodnimi standardi in predpisi.

Preučiti omejitve UI v primerjavi s človeško inteligenco in določiti meje, kjer ostaja človekova vloga ključna.

Proučiti etične in pravne vidike uporabe UI v letalstvu, vključno z vprašanji odgovornosti in transparentnosti.

## **1.3 Relevanca raziskave**

Raziskava je pomembna iz več vidikov. Prvič, letalska industrija je globalno povezana, zato ima vsak napredek pri upravljanju sistemov potencial za širok vpliv. Drugič, UI je v zadnjih letih postala eden ključnih elementov digitalne transformacije, zato je razumevanje njenih vplivov na varnostno občutljive sektorje, kot je letalstvo, nujno za njeno učinkovito implementacijo. Nazadnje, prispevek k razpravi o sinergiji med človeško in umetno inteligenco lahko vodi do boljše integracije obeh v praksi ter k večjemu zaupanju v nove tehnologije.

## **1.4 Struktura članka**

Članek je strukturiran na naslednji način. V drugem poglavju predstavimo teoretična izhodišča, kjer preučimo ključne koncepte, povezane z UI in ISM, ter njihovo vlogo v letalski industriji. Tretje poglavje opisuje uporabljen metodologijo, vključno z analiziranimi podatki in metodami zbiranja informacij. Četrto poglavje se osredotoča na rezultate raziskave in razpravo, kjer analiziramo ugotovitve ter razpravljamo o njihovem pomenu za prakso. V zaključnem poglavju povzamemo ključne ugotovitve, izpostavimo omejitve raziskave ter predlagamo smernice za nadaljnje raziskave.

## **2 Teoretična izhodišča**

Umetna inteligenca (UI) v letalski industriji in njen vpliv na integriran sistem managementa (ISM) sta kompleksna fenomena, ki zahtevata celovito razumevanje tako tehnoloških kot organizacijskih vidikov. V tem poglavju bomo najprej opredelili temeljne pojme, povezane z UI in ISM, nato pa raziskali njuno prepletanje v kontekstu letalske industrije.

### **2.1 Umetna inteligenca: Opredelitev in ključne tehnologije**

Umetna inteligenca je širok pojem, ki vključuje razvoj algoritmov in sistemov, ki posnemajo kognitivne funkcije človeškega uma, kot so učenje, razumevanje, odločanje in prilagajanje (Russell & Norvig, 2020). Ključne tehnologije, ki podpirajo razvoj UI, vključujejo strojno učenje (ML), globoko učenje (DL), obdelavo naravnega jezika (NLP) in računalniški vid.

Strojno učenje je podmnožica UI, ki temelji na analizi podatkov in omogoča računalniškim sistemom, da se izboljšujejo brez eksplicitnega programiranja (Goodfellow, Bengio, & Courville, 2016). V letalskem kontekstu se ML uporablja za prediktivno vzdrževanje letal in analizo podatkov iz letalskih operacij (Airbus, 2021). Globoko učenje, kot ena izmed naprednejših tehnik ML, omogoča analizo kompleksnih vzorcev, kar je ključno za napovedovanje in odločanje v realnem času.

Obdelava naravnega jezika omogoča komunikacijo med UI in človeškimi operaterji, kar je ključno za izboljšanje uporabniške izkušnje v letalskih sistemih, kot so sistemi za podporo odločanju. Računalniški vid se uporablja za analizo vizualnih podatkov, na primer pri pregledih letal z uporabo dronov (Chowdhury et al., 2022).

## **2.2 Integriran sistem managementa: Opredelitev in vloga v letalstvu**

Integriran sistem managementa (ISM) združuje različne sisteme za upravljanje, vključno s sistemom za upravljanje kakovosti (QMS), sistemom za upravljanje varnosti (SMS), sistemom za upravljanje skladnosti (CMS), sistemom za okoljsko upravljanje (EMS) in sistemom za upravljanje delovnih pogojev (OHSMS) (ISO, 2018). ISM omogoča celovit pristop k obvladovanju tveganj in izboljšanju operativne učinkovitosti.

V letalski industriji ISM temelji na mednarodnih standardih in regulativah, kot sta ICAO Annex 19, ki se osredotoča na varnostno upravljanje, in EASA Part-OPS, ki določa operativne zahteve za letalske družbe (ICAO, 2020; EASA, 2021). Glavni cilj ISM v letalstvu je zagotavljanje skladnosti z regulativami in neprekinjeno izboljševanje varnosti ter učinkovitosti operacij.

## **2.3 Vloga umetne inteligence v integriranem sistemu managementa**

Umetna inteligenca prinaša številne priložnosti za izboljšanje ISM v letalstvu. Ena izmed ključnih prednosti UI je njena sposobnost obdelave velikih količin podatkov v realnem času, kar omogoča boljše odločanje in napovedovanje tveganj (Zhou et al., 2021). Prediktivna analitika, ki temelji na UI, lahko zazna vzorce v podatkih o letalskih operacijah in vzdrževanju, kar omogoča pravočasno prepoznavanje potencialnih težav ter preprečevanje incidentov.

Sistemi UI lahko na primer analizirajo podatke iz senzorjev v letalih in predlagajo optimalne termine za vzdrževanje, kar zmanjšuje tveganje za nepredvidene okvare in povečuje zanesljivost letalskih operacij (Boeing, 2022). Poleg tega UI omogoča avtomatizacijo določenih procesov v ISM, kot so pregledi skladnosti in analiziranje poročil o incidentih.



## **2.4 Omejitve in izzivi umetne inteligence v letalskem ISM**

Kljub številnim prednostim pa uporaba UI v ISM ni brez izzivov. Eden izmed glavnih problemov je zanesljivost algoritmov v nepredvidljivih situacijah. UI sistemi so namreč pogosto trenirani na osnovi zgodovinskih podatkov in lahko delujejo slabše, ko se soočijo s situacijami, ki niso bile zajete v učnih podatkih (Amershi et al., 2019).

Drug pomemben izziv je vprašanje transparentnosti in razložljivosti odločitev UI sistemov. V kritičnih industrijah, kot je letalstvo, je nujno, da lahko operaterji in regulatorji razumejo, kako so sistemi prišli do določenih odločitev, kar pa pri kompleksnih modelih, kot so globoke nevronske mreže, pogosto ni preprosto (Doshi-Velez & Kim, 2017).

Poleg tehničnih izzivov so prisotni tudi etični in pravni izzivi, kot so vprašanja odgovornosti in pravice do zasebnosti. V primeru nesreč ali incidentov, pri katerih so sodelovali sistemi UI, se pojavlja vprašanje, kdo je odgovoren – razvijalec algoritma, operater ali letalska družba? (Cath et al., 2018).

## **2.5 Sinergija med umetno in človeško inteligenco**

Pomemben vidik implementacije UI v ISM je iskanje ravnotežja med avtomatizacijo in človeškim nadzorom. Medtem ko UI omogoča učinkovitejšo obdelavo podatkov in avtomatizacijo ponavljajočih se nalog, človeška inteligenca ostaja ključna za reševanje kompleksnih in nepredvidljivih situacij. Raziskave kažejo, da najboljše rezultate dosegajo sistemi, ki omogočajo sinergijo med UI in človekom, pri čemer UI podpira odločanje, medtem ko človek prevzame nadzor v kritičnih trenutkih (Endsley, 2018).

## **3 Metodologija**

V raziskavi smo uporabili analitično metodologijo, osredotočeno na poglobljeno pregledovanje in sintezo obstoječe relevantne literature. Metodološki pristop temelji na sekundarnih podatkih, pridobljenih iz znanstvenih člankov, industrijskih poročil, tehničnih publikacij ter regulatornih dokumentov, ki se nanašajo na uporabo umetne inteligence (UI) v integriranem sistemu managementa (ISM) v letalski industriji. Ta

pristop omogoča celovit in sistematičen pregled trenutnega stanja znanja ter identifikacijo ključnih priložnosti in izzivov.

### **3.1 Raziskovalni dizajn**

Raziskovalni dizajn temelji na sistematičnem pregledu literature (angl. systematic literature review - SLR). SLR je metoda, ki omogoča identifikacijo, analizo in sintetično predstavitev relevantnih virov, pri čemer se osredotočamo na jasno definirana raziskovalna vprašanja in uporabo ponovljivih postopkov za iskanje in izbiro literature (Kitchenham et al., 2009). Cilj tega pristopa je pridobiti celovit vpogled v področje raziskave ter zagotoviti trdne temelje za razpravo o vplivu UI na ISM.

### **3.2 Iskanje in izbor literature**

Iskanje literature je bilo izvedeno v več fazah. Najprej smo opredelili ključne iskalne pojme, kot so "umetna inteligenca v letalstvu", "integriran sistem managementa", "varnost v letalstvu", "prediktivna analitika" in "avtomatizacija procesov". Iskalne pojme smo kombinirali z uporabo logičnih operatorjev (AND, OR) za širjenje in zoženje iskanja.

Literaturo smo iskali v uglednih znanstvenih podatkovnih bazah, kot so Scopus, Web of Science in IEEE Xplore, ter v industrijskih publikacijah, ki jih zagotavljajo organizacije, kot sta Mednarodna organizacija za civilno letalstvo (ICAO) in Evropska agencija za varnost v letalstvu (EASA). Upoštevali smo literaturo, objavljeno v zadnjih desetih letih (2013–2023), da bi zajeli najnovejše raziskave in tehnološke napredke.

Za izbor literature smo uporabili naslednje kriterije:

- Vključitev le recenziranih člankov in tehničnih poročil.
- Literatura, ki neposredno obravnava uporabo UI v letalskem sektorju ali podobnih varnostno občutljivih panogah.
- Poročila regulatornih organov in industrijskih akterjev, ki podajajo smernice ali analize vpliva UI na ISM.

Izbor smo izvedli v treh korakih:

- Preliminarni pregled naslovov in povzetkov.
- Pregled celotnih besedil za relevantne študije.
- Izločitev virov, ki niso ustrezno naslavljali raziskovalnih vprašanj.

### **3.3 Metode analize podatkov**

Za analizo izbranih virov smo uporabili kvalitativno vsebinsko analizo (angl. qualitative content analysis). Ta metoda omogoča identifikacijo ključnih tem, vzorcev in konceptov, ki so relevantni za raziskovalno vprašanje (Krippendorff, 2018). Analizo smo izvedli v več korakih:

Kodiranje: Opredelili smo ključne teme, kot so prednosti UI v ISM, omejitve in tveganja, ter etični vidiki.

Tematska analiza: Identificirane teme smo združili v širše kategorije, ki omogočajo poglobljeno razumevanje vpliva UI na ISM.

Primerjalna analiza: Primerjali smo ugotovitve iz različnih virov, da bi identificirali skupne trende in razhajanja.

Poleg kvalitativne analize smo izvedli tudi kvantitativno analizo pogostosti pojavljanja ključnih tem v literaturi. S tem smo lahko ocenili, katerim vidikom implementacije UI se raziskovalci in strokovnjaki posvečajo največ pozornosti.

### **3.4 Zanesljivost in veljavnost**

Zanesljivost in veljavnost raziskave smo zagotovili z uporabo standardiziranih metod za iskanje, izbiro in analizo literature. Sistematičnost SLR zagotavlja, da so vključeni viri ustrezni in da analize temeljijo na zanesljivih podatkih (Tranfield, Denyer, & Smart, 2003). Poleg tega smo v procesu analize uporabili večkratno preverjanje kodiranja in interpretacije, kar zmanjšuje možnost napak ali subjektivnosti.

### 3.5 Omejitve metodologije

Metodološki pristop ima nekatere omejitve. Sistematični pregled literature temelji na dostopnih podatkih in objavljenih raziskavah, kar pomeni, da so lahko določeni vidiki implementacije UI v ISM, zlasti specifični primeri iz prakse, premalo zastopani. Poleg tega so bile nekatere študije omejene na specifične geografske regije ali vrste letalskih operacij, kar lahko vpliva na širšo posplošljivost ugotovitev. Kljub temu pa obsežen pregled obstoječih virov omogoča trdne temelje za razpravo in prihodnje raziskave.

## 4 Rezultati

V tem poglavju predstavljamo rezultate sistematičnega pregleda literature in analize relevantnih virov, povezanih z implementacijo umetne inteligence (UI) v integriranem sistemu managementa (ISM) v letalski industriji. Rezultati so razdeljeni na štiri glavne teme: (1) prednosti UI v ISM, (2) omejitve in izzivi implementacije, (3) etični in pravni vidiki, ter (4) sinergija med UI in človeško inteligenco. Sledi razprava o teh ugotovitvah in njihova primerjava z obstoječimi raziskavami.

### 4.1 Prednosti umetne inteligence v integriranem sistemu managementa

UI ima velik potencial za izboljšanje procesov znotraj ISM v letalski industriji. Ena ključnih prednosti je sposobnost obdelave velikih količin podatkov v realnem času, kar omogoča boljše odločanje in proaktivno upravljanje tveganj (Zhou, Huang, & Lin, 2021). UI lahko analizira podatke iz različnih virov, kot so senzorji v letalih, poročila o incidentih ter vremenski podatki, in s tem omogoča prediktivno vzdrževanje ter optimizacijo operativnih procesov.

Prediktivna analitika, ki temelji na UI, lahko zmanjša število nepredvidenih okvar in posledično izboljša zanesljivost letalskih operacij. Na primer, Boeing (2022) poroča, da uporaba prediktivnega vzdrževanja z uporabo algoritmov UI zmanjšuje čas nepredvidenih servisov za do 30 %. Poleg tega UI omogoča avtomatizacijo rutinskih nalog, kot so pregledi skladnosti, kar zmanjšuje obremenitev človeških operaterjev in izboljšuje učinkovitost (ICAO, 2020).

Dodatno UI izboljšuje varnost z naprednimi sistemi za odkrivanje anomalij, ki lahko zaznajo nepravilnosti v operativnih podatkih, preden postanejo kritične. To vključuje prepoznavanje vzorcev, ki bi lahko vodili do incidentov, in zagotavljanje opozoril operaterjem v realnem času (Russell & Norvig, 2020).

## **4.2 Omejitve in izzivi implementacije umetne inteligence**

Kljub številnim prednostim obstajajo pomembne omejitve in izzivi pri implementaciji UI v ISM. Prvi izziv je zanesljivost algoritmov, zlasti v nepredvidljivih situacijah. UI sistemi so pogosto trenirani na zgodovinskih podatkih, kar pomeni, da lahko naletijo na težave, ko se soočijo s situacijami, ki niso bile zajete v učnih podatkih (Amershi et al., 2019).

Poleg tega se pojavijo tudi izzivi, povezani z razložljivostjo odločitev UI. Kompleksne nevronske mreže, ki so temelj mnogih UI sistemov, delujejo kot t. i. »črne skrinjice«, kjer je težko razumeti, kako so sistemi prišli do določenih odločitev. V letalski industriji, kjer so varnost in skladnost ključnega pomena, je razložljivost ključna za zagotavljanje zaupanja v UI sisteme (Doshi-Velez & Kim, 2017).

Drugi pomemben izziv je odpornost UI sistemov na kibernetiske napade. Letalska industrija je že danes tarča sofisticiranih kibernetiskih groženj, implementacija UI pa lahko te grožnje še poveča, če sistemi niso ustrezno zaščiteni (Chowdhury et al., 2022).

## **4.3 Etični in pravni vidiki**

Implementacija UI v letalstvu odpira pomembna etična in pravna vprašanja. Eno izmed ključnih vprašanj je odgovornost v primeru, ko pride do napake ali incidenta zaradi napačne odločitve UI sistema. V takih primerih se postavlja vprašanje, kdo je odgovoren – razvijalec algoritma, operater ali organizacija? (Cath et al., 2018).

Prav tako je pomembna zasebnost podatkov. UI sistemi temeljijo na obsežnih podatkovnih zbirkah, kar pomeni, da je treba zagotavljati skladnost z zakonodajo, kot je Splošna uredba o varstvu podatkov (GDPR). To vključuje omejitev dostopa do osebnih podatkov ter zagotavljanje transparentnosti v obdelavi podatkov (European Parliament, 2016).

Poleg tega se pojavljajo tudi vprašanja etične uporabe UI, zlasti pri avtomatiziranem odločanju, ki lahko neposredno vpliva na varnost in pravice posameznikov. Organizacije morajo pri implementaciji UI upoštevati načela pravičnosti, odgovornosti in transparentnosti (Floridi et al., 2018).

#### **4.4 Sinergija med umetno in človeško inteligenco**

Pomembno spoznanje iz pregleda literature je, da je optimalna uporaba UI v ISM dosežena, ko UI deluje v sinergiji s človeško inteligenco. Medtem ko UI omogoča hitrejša in natančnejša analiza, je človeški dejavnik ključen za interpretacijo podatkov in sprejemanje končnih odločitev, zlasti v kritičnih situacijah (Endsley, 2018).

Raziskave kažejo, da kombinacija avtomatiziranih sistemov in človeškega nadzora vodi do boljših rezultatov, saj se zmanjšajo možnosti za napake, ki bi lahko nastale bodisi zaradi človeških bodisi strojnih omejitev (Boeing, 2022). UI sistemi lahko služijo kot podpora človeškim operaterjem, tako da jim zagotavljajo ključne informacije in predloge, medtem ko imajo ljudje še vedno končno besedo pri odločitvah.

## **5 Razprava**

Ugotovitve iz literature potrjujejo, da ima UI velik potencial za izboljšanje ISM v letalstvu, vendar je njena implementacija zahtevna in zahteva preiščljeno strategijo. Prednosti UI, kot so prediktivno vzdrževanje, izboljšana varnost in avtomatizacija, lahko močno prispevajo k učinkovitosti in zanesljivosti letalskih operacij. Vendar pa omejitve, kot so razložljivost, zanesljivost in kibernetna varnost, zahtevajo nadaljnjo raziskavo in razvoj.

Implementacija UI mora upoštevati tudi etične in pravne okvirje, saj nepravilno upravljanje lahko vodi do resnih posledic. Razprava poudarja potrebo po vzpostavitvi jasnih smernic in regulativ za uporabo UI v letalstvu ter po razvoju tehnologij, ki bodo zagotavljale večjo transparentnost in zanesljivost.

## **5.1 Prednosti in vpliv umetne inteligence na ISM v letalstvu**

Rezultati analize potrjujejo, da ima UI pomembno vlogo pri izboljšanju učinkovitosti in zanesljivosti ISM v letalski industriji. Ena od ključnih prednosti je prediktivno vzdrževanje, ki omogoča pravočasno odkrivanje potencialnih okvar na podlagi analize podatkov iz senzorjev in zgodovinskih vzdrževanj (Boeing, 2022). S tem se zmanjšajo stroški nepredvidenih popravil, poveča se zanesljivost letalskih operacij, kar je ključnega pomena za varnost in poslovno učinkovitost.

Poleg tega UI omogoča avtomatizacijo procesov, kot so analize tveganj in pregledi skladnosti, kar razbremeni človeške operaterje in omogoča hitrejše ter natančnejše odločitve (ICAO, 2020). Napredni algoritmi za obdelavo podatkov lahko v realnem času zaznavajo nepravilnosti in anomalije, kar pripomore k večji varnosti (Zhou, Huang, & Lin, 2021). To je še posebej pomembno v kontekstu dinamičnega in kompleksnega okolja letalskih operacij, kjer je potrebna hitra prilagoditev na spremembe.

## **5.2 Omejitve in izzivi implementacije UI**

Kljub jasnim prednostim UI se organizacije soočajo z več izzivi. Prvi izziv je zanesljivost UI sistemov v nepredvidljivih situacijah. Algoritmi UI se učijo na podlagi zgodovinskih podatkov in lahko naletijo na težave, ko se soočijo z novimi, nepredvidenimi situacijami (Amershi et al., 2019). To je še posebej problematično v letalski industriji, kjer lahko napačna odločitev privede do resnih posledic.

Drug izziv je povezan z razložljivostjo oziroma interpretabilnostjo UI sistemov. Kompleksni modeli, kot so globoke nevronske mreže, pogosto delujejo kot »črne skrinjice«, kar pomeni, da je težko razumeti, kako je sistem prišel do določene odločitve (Doshi-Velez & Kim, 2017). V letalski industriji, kjer je transparentnost odločanja ključna, ta pomanjkljivost zmanjšuje zaupanje operaterjev in regulatorjev v UI sisteme.

Dodatno je implementacija UI povezana z visokimi stroški, tako pri razvoju kot pri vzdrževanju sistemov. Organizacije morajo investirati v infrastrukturo, kot so podatkovni centri, ter v izobraževanje kadrov, kar lahko predstavlja oviro za širšo

implementacijo, zlasti v manjših letalskih družbah (Chowdhury, Kabir, & Rahman, 2022).

### **5.3 Etični in pravni vidiki**

Etični in pravni vidiki so ključni pri implementaciji UI v letalstvu. Eden izmed najpomembnejših izzivov je vprašanje odgovornosti v primeru napake ali incidenta. Če UI sistem sprejme napačno odločitev, je treba jasno določiti, kdo nosi odgovornost – razvijalec sistema, operater ali letalska organizacija? (Cath et al., 2018). Ta vprašanja so trenutno še vedno predmet razprav in pravnih nejasnosti.

Poleg tega uporaba UI vključuje obdelavo velikih količin podatkov, kar postavlja zahteve glede varovanja zasebnosti in skladnosti z zakonodajo, kot je Splošna uredba o varstvu podatkov (GDPR). Zagotoviti je treba, da se osebni in operativni podatki uporabljajo transparentno in odgovorno (European Parliament, 2016).

UI odpira tudi širša etična vprašanja, kot so pravičnost in preprečevanje pristranskosti v avtomatiziranem odločanju. Na primer, sistemi UI, ki temeljijo na pristranskih podatkih, lahko sprejmejo odločitve, ki so nepravične ali diskriminatorne, kar bi lahko imelo resne posledice za delovanje in ugled letalske organizacije (Floridi et al., 2018).

### **5.4 Sinergija med UI in človeško inteligenco**

Kot kažejo rezultati analize, je optimalna uporaba UI dosežena, ko sistemi delujejo v sinergiji s človeško inteligenco. UI lahko učinkovito podpira človeške operaterje, na primer z analizo podatkov in predlogi za ukrepanje, vendar mora človek ohraniti ključno vlogo pri sprejemanju končnih odločitev, zlasti v kritičnih situacijah (Endsley, 2018).

Raziskave kažejo, da je kombinacija UI in človeškega nadzora učinkovita strategija za zmanjšanje napak in izboljšanje učinkovitosti. Na primer, medtem ko UI sistemi omogočajo hitro analizo velikih količin podatkov, človeški operaterji dodajajo vrednost z intuicijo, izkušnjami in sposobnostjo interpretacije rezultatov v širšem kontekstu (Russell & Norvig, 2020).



Poleg tega sinergija med UI in človeško inteligenco prispeva k večjemu zaupanju operaterjev v sisteme. Ko UI deluje kot orodje za podporo, ne pa kot popolni nadomestek za človeško odločanje, je manj verjetno, da bodo operaterji razvili občutek odvisnosti od tehnologije ali se soočili s t. i. avtoriteto avtomatizacije (Endsley, 2018).

### **5.5 Primerjava z obstoječimi raziskavami**

Ugotovitve te raziskave so skladne z obstoječo literaturo, ki poudarja prednosti in izzive UI v ISM. Na primer, študije, kot je tista od Zhou, Huang in Lin (2021), potrjujejo, da UI bistveno prispeva k prediktivnemu vzdrževanju in analizi tveganj. Hkrati pa raziskave, kot so tiste od Doshi-Velez in Kim (2017), opozarjajo na težave z razložljivostjo in potrebo po razvoju bolj transparentnih sistemov.

Razprava tudi potrjuje, da je letalska industrija specifična v svojih zahtevah, kar pomeni, da morajo biti UI sistemi prilagojeni potrebam varnostno občutljivih okolij. To razlikuje letalsko industrijo od drugih sektorjev, kjer so tveganja in posledice napačnih odločitev manj kritična.

### **5.6 Priporočila za nadaljnje raziskave in prakso**

Na podlagi rezultatov in razprave predlagamo naslednje:

- Razvoj bolj razložljivih in transparentnih UI sistemov, ki bodo omogočali večje zaupanje in lažjo implementacijo v varnostno občutljivih panogah.
- Poudarek na razvoju robustnih UI sistemov, ki bodo lahko učinkovito delovali tudi v nepredvidljivih situacijah.
- Nadaljnje raziskave na področju etičnih in pravnih vprašanj, zlasti glede odgovornosti in skladnosti z zakonodajo o varstvu podatkov.
- Spodbujanje sinergije med UI in človeško inteligenco z usposabljanjem operaterjev za učinkovito uporabo UI orodij kot podpornih sistemov.

## 6 Zaključek

Raziskava o implementaciji umetne inteligence (UI) v integriranem sistemu managementa (ISM) v letalski industriji je pokazala, da ima UI potencial za bistveno preoblikovanje načinov upravljanja z varnostjo, kakovostjo, okoljem in drugimi ključnimi vidiki operacij. UI omogoča napredne analitične zmogljivosti, prediktivno vzdrževanje ter izboljšano upravljanje tveganj, kar neposredno prispeva k večji učinkovitosti in zanesljivosti letalskih operacij. Kljub tem prednostim pa obstajajo pomembni izzivi, ki jih je treba nasloviti, da bi UI v polnosti izkoristili njen potencial.

### 6.1 Ključne ugotovitve

Med glavnimi ugotovitvami raziskave je, da UI že prinaša pomembne koristi v letalskem ISM, zlasti na področju avtomatizacije procesov in analize podatkov. Prediktivno vzdrževanje, podprto z algoritmi UI, je eden najbolj obetavnih primerov uporabe, saj omogoča pravočasno prepoznavanje potencialnih tehničnih težav, kar zmanjšuje operativne motnje in povečuje varnost (Boeing, 2022).

Poleg tega UI prispeva k izboljšanju procesov odločanja, saj omogoča hitro in natančno analizo velikih količin podatkov iz različnih virov. To pripomore k boljši prilagoditvi na spremembe v operativnem okolju in povečuje proaktivnost pri obvladovanju tveganj (Zhou, Huang, & Lin, 2021).

Kljub navedenim prednostim ostajajo omejitve, kot so razločljivost algoritmov, zanesljivost v nepredvidljivih situacijah in kibernetika varnost. Problematika »črnih skrinjic« pri naprednih UI sistemih poudarja potrebo po razvoju transparentnejših modelov, ki bodo omogočali večje zaupanje in lažje uvajanje v reguliranih sektorjih, kot je letalstvo (Doshi-Velez & Kim, 2017).

### 6.2 Prispevek raziskave

Prispevek te raziskave je v celoviti sintezi trenutnega stanja znanja o implementaciji UI v ISM v letalski industriji. Raziskava ne ponuja le pregleda prednosti in izzivov, temveč tudi razpravlja o etičnih in pravnih vidikih, kot so odgovornost, varstvo podatkov in pravičnost v avtomatiziranem odločanju (Cath et al., 2018; European

Parliament, 2016). S tem nudi izhodišče za nadaljnje raziskave in razvoj strategij, ki bodo pripomogle k bolj učinkoviti in etični uporabi UI v letalskem sektorju.

### **6.3 Praktične implikacije**

Letalske organizacije se morajo osredotočiti na razvoj strategij za integracijo UI, ki vključujejo ustrezno usposabljanje osebja, investicije v robustne in varne sisteme ter sodelovanje z regulatornimi organi za oblikovanje standardov, ki bodo podpirali varno in učinkovito uporabo UI (ICAO, 2020). Poleg tega je pomembno vzpostaviti mehanizme za stalno ocenjevanje in izboljševanje UI sistemov, zlasti glede njihove zanesljivosti in razložljivosti.

### **6.4 Omejitve raziskave**

Kljub širokemu pregledu literature raziskava vsebuje nekatere omejitve. Sistematični pregled temelji na sekundarnih podatkih, kar pomeni, da specifični praktični primeri niso bili podrobno analizirani. Poleg tega so bili zajeti le viri, objavljeni v angleščini, kar lahko omeji vpogled v širšo mednarodno perspektivo.

### **6.5 Priporočila za nadaljnje raziskave**

Nadaljnje raziskave bi morale vključevati empirične študije, ki bi temeljile na praktičnih primerih implementacije UI v različnih vrstah letalskih organizacij. Prav tako bi bilo smiselno raziskati možnosti za razvoj bolj transparentnih in razložljivih algoritmov ter proučiti vpliv UI na organizacijsko kulturo in vlogo človeških operaterjev v letalski industriji.

### **6.6 Sklep**

Umetna inteligenca predstavlja pomembno orodje za prihodnost letalske industrije, zlasti pri izboljševanju integriranega sistema managementa. Čeprav njena implementacija prinaša določene izzive, so njene prednosti prevelike, da bi jih prezrli. Z ustreznimi strategijami in podporo regulatornih organov lahko UI postane ključni dejavnik za nadaljnjo rast in razvoj varnejših, učinkovitejših ter trajnostnih letalskih operacij.

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# TAX FRAUD IN FINANCIAL STATEMENT – IDENTIFYING AND MEASURING TAX EVASION FACTORS (A LITERATURE AND METHODOLOGICAL REVIEW)

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The purpose of this article is to present the first part of the doctoral thesis “Tax Fraud in Financial Statement in Albania”, where tax fraud is considered as a form of tax evasion done with purpose. To the best of our knowledge there is no study who summarizes the tax evasion determinants and the methodological used to identify and measure these variables. Specifically, this study adopted a systematic review of 53 articles published in the past 15 years, summarising the methodologies used for identifying and measuring tax evasion determinants. Our findings show that many studies have measure economic and individual factors and there is less study focused on technology, competition between businesses, business expansion, corporate social services and failure to not receive reimbursement from the government. Additionally, it looks like there is no widely accepted method for measuring tax evasion factors. This research paper contributes in tax literature by regrouping the tax evasion factors in new categories.

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## 1 Introduction

Historically, financial statement fraud has been studied because of very large monetary losses. Even in Albania there are cases of fraud schemes that create opportunities for tax evasion and consequently irregularities in the presentation of financial statements. VAT reimbursement schemes, false expense claims of employees, understating of income, overstating of expenses are most typical financial statement fraud. To prevent these losses, it is important for the government identifying and measuring the factors of tax evasion. In this paper, tax fraud is considered as mentioned in Albanian Tax Dictionary. According with this definition, are summarised all factors of tax evasion analysed in previous literature published since 2010 to 2024. Notably, the authors who have categorised the tax evasion factors in recent years are Sritharan, Sahari and Sharon (2022), Shuid S., Zazili A., Basri S. (2021) and Alm et al.

According to Alm et al. (2019), the instances of tax evasion strategies are understating revenue, overstating expenses, and manipulating financial documents. In their literature review, Sritharan, Sahari and Sharon (2022) revealed that studies investigating tax evasion began evolving only in recent years. Studies have continuously explored factors related to individual and tax authorities but synthesising past studies on tax evasion has not been widely carried out. However, the latest studies evolving from the western part of the world look at a different perspective. They have found that institutional factors are under testing to measure the impact on tax evasion. In this paper are reviewed articles published in the period between 2010 to 2023, roughly a decade. It is because in 2010, the Organisation for Economic Co-operation and Development (OECD) established the Convention on Mutual Administrative Assistance in Tax Matters, which allows 130 countries to exchange of information related tax issues (OECD, 2021). In their study they grouped the studies into theoretical and empirical studies. According to them, theoretical studies identify tax evasion factors as individual factors, economic factors and other factors, where:

- ***Individual factors*** include morality, trust, attitudes, perceptions, intentionality, awareness, culture, religiosity, knowledge, and education.
- ***Economic factors*** include tax rate, financial constraints, income level, tax burden, corruption, economic structure, audit, penalty, and unemployment.

- **Other factors** are the digitalisation of government services, corporate social responsibility (CSR), and whistleblowing

On the other hand, they have found that empirical studies on tax evasion take two approaches: the simulation/experimental approach and the survey approach as follows:

- *Simulation/experimental approaches* includes laboratory experiments conducted in different countries to observe the compliance behaviour of people.
- **Survey approaches** includes the empirical model who allows the investigator to consider a wider range of factors, which can be classified into four types: factors related to the degree of sanctions, administrative capabilities, fiscal inequity, and social norms.

In a literature review, Shuid S., Zazili A., Basri S. (2021) reported that there are four main categories of determinant factors that influence tax evasion:

- **Demographic factors** such as age, gender, level of income, source of income, and tax return forms completed by tax practitioners;
- **Cultural and behaviour factors** such as attitudes, perceived behavioural control, fairness perceptions, social exchange, and moral obligations.
- **Legal and institutional factors** such as higher tax rates, ambiguity of the tax policy, frequent changes in tax law, size of the government, favours and cronyism, and lack of enforcement
- **Economic factors** such as inflation, trade openness, the extent to which the economy has developed and is organised, and the degree of market and business organisation.

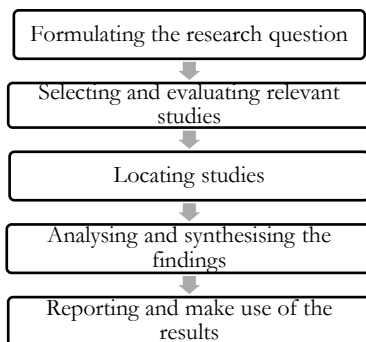
In contrast to the previous literature review, this article reviews the literature and methodologies, for the period after the agreement was formed by the OECD to help narrowing the gap in identifying and measuring the tax evasion factors. Therefore, the objectives of this systematic review are as follows:

- To synthesis the existing literature on the subject of tax evasion (from 2010 to 2024),

- To explore the methodology and variables of tax evasion.

## 2 Methodology

This study adopted a systematic literature and methodology review to summarise and analyse articles related to corporate tax evasion for the years 2010-2024. The systematic process applied is according to Denyer and Tranfield (2009), following the steps below:



**Figure 1: Research methodology for systematic literature review**

Source: Denyer and Tranfield (2009)

The literature research was conducted using the database of Scopus, Web of Science and other databases for studies that met the following criteria: (1) studies examining tax evasion determinants; (2) studies that used tax evasion as the dependent variable and (3) studies that used an empirical approach from 2010 - 2024. Table 1 below, lists all the articles used in this research, detailed by the authors, the year of publication, the journal, the research database and the country of the study.

Most studies belong to the years 2021 (7 studies) and 2011 (7 studies), most of them are collected from the Web of Science and Scopus databases (18 studies) and the research countries are Malaysia (14 studies), Ethiopia (6 studies), Albania (4 studies), Indonesia (4 studies), Turkey (3 studies), Serbia (2 studies), Ghana (2 studies), Iran and other countries by 1 study. The following table lists the number of studies that are indexed in Scopus and Web of Science (both of them), in Google Scholar and others that have been found in ResearchGate professional network:



**Table 1: Reviewed articles on tax evasion factors**

Nr.	Authors	Year	Journal	Research Database	Country
1	Anjarwi A., et al	2024	Deviant Behavior	Web of Science, Scopus	Indonesia
2	Gjoni, A., et al	2024	Journal of Governance & Regulation	ResearchGate	Albania
3	Chayati N., et al	2024	Media Riset Akuntansi, Auditing & Informasi	Google Scholar	Indonesia
4	Kassaw M.	2023	International journal of development and economic sustainability	Google Scholar	Ethiopia
5	Allam, A. et al	2023	Journal of International Accounting, Auditing and Taxation	Web of Science, Scopus	EU Countries
6	Hayat N., et al	2022	Sage Open	Web of Science, Scopus	Malaysia
7	Hoxhaj, M., Kamolli E.,	2022	European Journal of Economics and Business Studies	Google Scholar	Albania
8	Sritharan, N et al	2022	International Journal of Academic Research in Accounting Finance and Management Sciences	Human Resource Management Academic Research Society	-
9	Kaulu, B.	2021	Fudan Journal of the Humanities and Social Sciences	Web of Science, Scopus	Zambia
10	Shuid S., et al	2021	Global Business and Management Research: An International Journal	ResearchGate	Malaysia
11	Todorović, J., et al	2021	Economics. Information technologies	Google Scholar	Serbia
12	Kassa E.,	2021	Journal of Innovation and Entrepreneurship	Google Scholar	Ethiopia
13	Abdella, M., et al	2021	Research Journal of Finance and Accounting	ResearchGate	Ethiopia
14	Erul, R., et al	2021	İzmir Journal of Economics	Science publishing group	24 EU Countries
15	Irawan F., Utama A	2021	International Journal of Business and Society	Web of Science, Scopus	47 Countries
16	Shiferaw, N., & Tesfaye, B.	2020	International Journal of Scientific and Research Publications	ResearchGate	Ethiopia
17	Kemme D., et al	2020	Journal of World Business	Web of Science, Scopus	OECD countries
18	Golmezerji R., et al	2019	Journal of Economic Behavior & Organization	Web of Science, Scopus	Iran
19	Sebhat W., and Assfaw A.,	2019	Journal of Accounting, finance and Auditing Studies	ResearchGate	Ethiopia
20	Todorović, J., et al	2018	Proceedings of the Faculty of Economics in East Sarajevo	ResearchGate	Serbia

Nr.	Authors	Year	Journal	Research Database	Country
21	Rantelangi, C. and N. Majid.	2018	Proceedings of the Mulawarman International Conference on Economics and Business (MICEB 2017)	Google Scholar	Indonesia
22	Yee, C., et al	2017	International Journal of Law and Management	Web of Science, Scopus	Malaysia
23	Andoni M., et al	2017	European Journal of Business, Economics and Accountancy	Progressive Academic Publishing	Albania
24	Abdixhiku, L., et al	2017	Economic Systems	Web of Science, Scopus	26 transition economies
25	Vousinas, G.,	2017	Journal of Money Laundering Control	Web of Science, Scopus	Greece
26	Palil; M et al	2016	Gadjah Mada International Journal of Business	Web of Science, Scopus	Malaysia
27	Dulleck U., et al	2016	Journal of Public Economics	Web of Science, Scopus	Australia
28	Kiri N.,	2016	International Journal of Economics, Commerce & Management	Scientific Journals	Albania
29	Alasfour F., et al	2016	Advances in Taxation	Emerald	Jordan
30	Ameyaw, B. and Dzaka D.	2016	Modern Economy	Scientific Research Publishing	Ghana
31	Khlif, H., and Achek I	2015	International Journal of Law and Management	Web of Science, Scopus	-
32	Marandu E., et al	2015	International Journal of Economics and Finance	ResearchGate	-
33	Engida T.,	2014	EJOURNAL OF TAX RESEARCH	Web of Science, Scopus	Ethiopia
34	Awan A, and Hannan A.	2014	International Journal of Development and Economic Sustainability	European Centre for Research Training and Development UK	Pakistan
35	Kong, F., & Wang, C.	2014	Gdańskie Studia Azji Wschodniej	Gdańskie Studia Azji Wschodniej	-
36	Palil M., et al	2013	Jurnal Pengurusan	ResearchGate	Malaysia
37	Yalama G., and Gumus E.	2013	International Business and Management	CSCanada	Turkey
38	Betty A., et al	2013	International Journal of Economic Sciences and Applied Research	EconStore	Ghana
39	Tabandeh R, et al	2013	Jurnal Ekonomi Malaysia	ResearchGate	Malaysia
40	Noor R., et al	2012	Malaysian Accounting Review	UiTM Institutional Repository	Malaysia
41	Damayanti, T.	2012	Journal of Arts, Science & Commerce	Academia.edu	Indonesia

Nr.	Authors	Year	Journal	Research Database	Country
42	Maciejovsky, B., et al	2012	Journal of Business Ethics	Web of Science, Scopus	Vienna
43	Tabandeh R, et al	2012	PROSIDING PERKEM VII, JILID 2	Universiti Kebangsaan Malaysia	Malaysia
44	Benk, S., et al	2011	European Journal of Economics, Finance and Administrative Sciences,	Web of Science, Scopus	Turkey
45	Palil, M., & Mustapha, A	2011	European Journal of Social Sciences	Google Scholar	Malaysia
46	Hai, O., & See, L.	2011	Centre for Promoting Ideas	Google Scholar	Malaysia
47	Hai, O., & See, L.	2011	International Journal of Business and Social Science	International Journal of Business and Social Science	Malaysia
48	Bame-Aldred, C., et al	2011	Journal of Business Research	Web of Science, Scopus	EU Countries
49	Demir.I.,	2011	Isc Young Scientists	ResearchGate	Turkey
50	Ross, A.M., & McGee, R.M.	2011	Asian Journal of Law and Economics	Web of Science	Malaysia
51	Fagbemi, T., et al	2010	European Journal of Social Science	Academia.edu	Nigeria
52	Nor, J., et al	2010	Journal of Financial Reporting and Accounting,	Web of Science, Scopus	Malaysia
53	Palil M.,	2010	The University of Birmingham Journal	Google Scholar	Malaysia

Source: Authors (2024)

**Table 2: Number of studies indexed in most known journal database by research country**

Nr.	Web of Science and Scopus	No of articles	Research Gate	No of articles
1	26 transition economies	1	Albania	1
2	47 Countries	1	Ethiopia	3
3	Australia	1	Iran	1
4	Ethiopia	1	Literature review	2
5	EU Countries	2	Malaysia	2
6	Greece	1	Serbia	1
7	Indonesia	1	<b>Total</b>	<b>10</b>
8	Iran	1	<b>Google Scholar</b>	<b>No. of articles</b>
9	Literature review	1	Albania	1
10	Malaysia	4	Ethiopia	2
11	OECD countries	1	Indonesia	2
12	Turkey	1	Malaysia	3
13	Vienna	1	Serbia	1
14	Zambia	1	<b>Total</b>	<b>9</b>
	<b>Total</b>	<b>18</b>	<b>Other database</b>	<b>16</b>

Source: Authors (2025)

Evidently, there are different countries where data are collected and by summarising their findings, it can be said that tax evasion factors vary from country to country. According to Marandu E., et al (2015), it is useful to do a comparison of their findings despite the diversity among the studies because is valuable for future research and is helpful from a practical tax management point of view.

### 3 Results

According to Hassan (2024), there are two types of data collection methods: (1) Quantitative Data Collection that includes surveys, experiments, and other structured data collection method and (2) Qualitative Data Collection includes interviews, focus groups, observations, and document analysis. As shown in Table 3 below, previous studies have used questionnaires as a data collection method, but many authors have used secondary such as government data and World Yearbook Reports to measure tax evasion factors between years.

Another significant topic is the method used by these authors for data analysing. These methods are identified in Table 4, where the most commonly used method seems to be multiple regression analysis but there are authors who do not use a statistical method but use the Artificial Neural Network (AI) method.

The third topic and more difficult one is identifying the tax evasion factors used as an independent variable by every author in their research paper. While summarising the articles, in this research paper the variables are grouped in 7 categories: tax system factors (126 in total), demographic factors (45 in total), political factors (43 in total), social factors (30 in total), economic factors (27 in total), business factors (17 in total) and other factors (7 in total). Table 5 lists all of them, where the most commonly used variable, by over 10 authors, are tax audit (14 authors), tax penalties (14 authors), tax rate (13 authors), tax fairness (12 authors). Additionally, the most used category of tax evasion factors is tax system factors (analysed by 126 authors), followed by demographic factors, political factors, social factors and

**Table 3: Summary of data collection methods in articles used in this research**

Methods of data collection	Approach type	No of articles
<b>Quantitative Data Collection</b>	Business Environment and Enterprise Performance Survey (BEEPS) database	1
	Cross-sectional survey	1
	explanatory type of research	1
	Questionnaire	27
	Empirical analysis	1
	Laboratory experiments	1
	<b>Total</b>	<b>32</b>
<b>Qualitative Data Collection Total</b>	Data on audited companies	1
	financial ratio analysis	1
	Government Data from 1963-2010	1
	Government Data from 1963-2011	1
	Government data from 1985-2016.	1
	literature review	7
	observations	1
	panel data analysis	1
	data on Malaysia taken from the World Values database	1
	EU Data	1
	Structural equation modeling	1
	theoretical and empirical review, a recent survey of the Economic Chamber of Greece on “Measurement of Tax Consciousness”,	1
	time series data	1
World Competitiveness Yearbook, and Tax Administration Comparative Report, data from the period of 2002 to 2015	1	
	<b>Total</b>	<b>20</b>
<b>Mix method</b>	Questionnaire, Interview	1
	<b>Total</b>	<b>53</b>

Source: Authors (2025)

**Table 4: Summary of data analysing methods in articles used in this research**

Data analysing method	Statistical method	No of articles
<b>Regression methods</b>	basic regression model	2
	binary logistic regression	1
	chi-square test on SPSS	1
	ordered logistic regression analysis	1
	Ordered logit regression model	1
	ordered probit regression	1
	ordinal logistic regression	1
	Ordinary Least Square (OLS) and Partial Least Square (PLS)	1
	multiple linear regression analysis, Moderated Regression Analysis (MRA)	1

Data analysing method	Statistical method	No of articles
	multiple regression analysis	9
	linear multiple regression analysis	1
	Linear Regressions analysis	1
	Pearson correlation and multiple regression analysis	1
	PLS (Partial Least Square) approach	1
	Regression analysis	2
	Tobit regression analysis	1
	structural equation modelling	1
	a panel data regression method	1
	Factor analysis and multiple regression	1
<b>Total</b>	<b>29</b>	
<b>Artificial Intelligence</b>	Artificial Neural Network methodology	3
	dual-stage methods of partial least squares structural equation modelling (PLS-SEM) and artificial neural network (ANN).	1
	Cross-country empirical studies	1
	data for the European Union	1
	<b>Total</b>	<b>5</b>
<b>Descriptive analysis</b>	Descriptive analysis	1
	literature review without statistical methodology	5
	descriptive and inferential statistics.	1
	<b>Total</b>	<b>7</b>
<b>Other statistical techniques</b>	multivariate tests procedure	1
	Univariate and multivariate statistical techniques, the ordinary least square model	1
	arithmetic mean, percentages, standard deviation, t-tests, ANOVA etc.	1
	dummy and multinomial econometric models	1
	analysis of variance (ANOVA)	1
	MIMIC model	1
	Mediation analysis	1
<b>Total</b>	<b>7</b>	
<b>Other techniques</b>	heart rate variability	1
	Empirical data	1
	meta-analysis	1
	short-run model	1
	<b>Total</b>	<b>4</b>
<b>All methods</b>	<b>Total</b>	<b>53</b>

Source: Authors (2025)

**Table 5: Summary of tax evasion factors (variables) in articles used in this research**

Tax evasion factors (variables)	No of Authors	Tax evasion factors (variables)	No of Authors
<b>Tax system factors</b>	<b>(126)</b>	<b>Social factors</b>	<b>(30)</b>
Tax audit	14	Psychic stress	1
Tax penalties	14	Psychology	1
Tax rate	13	Reference groups influences	1
Tax fairness	12	Restraint	1
Probability of Controls	1	Social capital	1
Tax knowledge	7	Social exchange	1
Tax morale	7	Social factors	1
Complex Tax System and Procedures	6	Social responsibility	1
Simplicity of the tax system	1	Social security (SS) and health insurance contributions (HIC))	1
Tax burden	5	Attitude	4
Enforcement	5	Behaviour factors	4
Tax affordability	1	Perceived behavioural control	3
Tax authority role	1	Subjective norms	3
Tax deduction and sanctions	1	Anti-Tax Culture & Feeling of No Responsibility from Religious Point of View.	1
Tax education	1	Moral reasoning	1
Strength of tax auditing and reporting standards	1	National culture	1
Sustainability of the tax legislation	1	Female population	1
Tax preparers	1	Ethics	1
Tax compliance	4	Normative expectations	1
Tax equity	4	Equality and justice	1
The role of the tax authority	4	<b>Economic factors</b>	<b>(27)</b>
Taxation and fiscal factors	1	Agriculture as a percentage of the GDP	1
Technical controls	1	Shadows of Exempted Incomes	1
Tax awareness	3	Economic factors	5
Tax complexity	3	Income	7
The rate of value added tax	1	Inflation	4
Unapproved tax preparer	1	Financial restriction	3
Unfavourable tax system	1	Unemployment	1
Tax information	2	Imports of goods and services	1
Value Added Tax and Social Contribution Rate	1	Trade openness	3
Opportunity to evade tax	1	Economic quality	1
Level of taxpayers' awareness	1	<b>Political factors</b>	<b>(43)</b>
Amnesties and Incentives for Tax Evaders nothing for Tax Compliers	1	Changes in actual government politics	3
Awareness of taxpayers	1	Trust in Government	6
Number of controls	1	Corruption	5
Capabilities of the tax administration	1	Institutional factors	4

Tax evasion factors (variables)	No of Authors	Tax evasion factors (variables)	No of Authors
The ease with which information is retrieved	1	Size of governments	3
Uncertainty avoidance	1	The size of the government	1
<b>Business factors</b>	<b>(17)</b>	Government expenditure perception	7
The period of operation of the firm in the market	1	Undocumented Economy and No Role Model from Political Leadership	1
Type of ownership	1	Unproductive use and Unequal Distribution of Funds by Government.	1
The turnout of company	1	Urbanization	1
The size of business	3	Perceived power of authority	1
Working capital over total assets	1	Political Influence and Lack of Political Will for Tax Enforcement	1
Sales divided by total assets	1	Power of Authority	1
Account receivables divided by total sales	1	Collectivism	1
Other taxpayers	1	Rewarding scheme for loyal taxpayers.	1
Per capita income	1	Lack of Education and Lack of Counselling for Govt. Services Provided through Taxes	1
Business's ability to pay	1	Administrative factors	2
Inventory divided by sales	1	Accountability and transparency of public institution	1
Financial situation of the company	1	Service quality	2
Compliance costs	1	<b>Demographic factors</b>	<b>(45)</b>
Financial Constraint	1	Demographic factors	25
Financial leverage measured by total liabilities divided by total assets	1	Gender	6
<b>Other factors</b>	<b>(7)</b>	Age	7
Year dummies (TIME)	1	Education	2
Power distance	1	Legal status	1
Referent group	2	Marital status	1
Literature review	2	Ethnicity	1
Additional factors	1	Location	1
		EU membership	1
<b>Total = 295 factors of tax evasion (variables)</b>			

Source: Authors (2025)

## 4 Conclusion

Numerous studies have been conducted to examine the determinant factors of tax evasion, tax compliance, and individuals' intentions in relation to these activities. In order to accomplish the first objective of this article, it was found that in recent years there are few articles who have categorised the tax evasion factors in groups. Additionally, by synthesis 53 articles published from 2010 to 2024, exploring the



methodologies and variables used to measure tax evasion fraud, it was revealed that many studies have measure economic and individual factors while few of them have focused on other tax evasion factors such as technology, competition between businesses, business expansion, corporate social services and failure to receive reimbursement from the government. A significant conclusion is that there is no widely accepted method for measuring tax evasion factor. The researches paper has contribute in tax literature by regrouping the tax evasion factors in new categories and it is recommended that following papers should analyse if there is a relation between the country of the study and the methodology applied by previous literature review.

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# VPLIV SLUŠNE DISFUNKCIJE STAREJŠIH ZAPOSLENIH NA ERGONOMSKE SMERNICE OBLIKOVANJA DELOVNIH MEST

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Raziskava se osredotoča na vse večjo prisotnost starejših zaposlenih na trgu dela, ki so zaradi naravnih sprememb in dolgotrajne izpostavljenosti hrupu še posebej občutljivi na težave s sluhom. Hrup na delovnem mestu lahko pomembno vpliva na zdravje in produktivnost, zato smo razvili model za ocenjevanje in razvrščanje delovnih mest glede na ergonomske okvire obremenitve sluha. Model vključuje analizo ključnih dejavnikov, kot so frekvence zvokov, trajanje izpostavljenosti hrupu in merjenje slušnih sposobnosti zaposlenih. Cilj raziskave je omogočiti delodajalcem in ergonomskim strokovnjakom prilagoditev delovnih mest starejšim zaposlenim, kar bo prispevalo k večjemu zadovoljstvu, boljši delovni učinkovitosti in kakovosti življenja. Rezultati prinašajo praktične smernice za izboljšanje delovnega okolja in so uporabni tako za delodajalce kot raziskovalce na področju ergonomije in varnosti pri delu.

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# THE IMPACT OF HEARING DYSFUNCTION IN OLDER WORKERS ON ERGONOMIC GUIDELINES FOR WORKPLACE DESIGN

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**Keywords:**

hearing dysfunction,  
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noise

The research focuses on the growing presence of older workers in the labour market, who are particularly susceptible to hearing problems due to natural changes and long-term exposure to noise. Workplace noise greatly affects health and productivity, so we have created a model to evaluate and categorize workplaces based on ergonomic aspects of hearing exposure.. The model involves analysing key factors such as sound frequencies, duration of noise exposure and measuring employees' hearing ability. The research should enable employers and ergonomics experts to adapt workplaces to older workers, contributing to higher job satisfaction, better work performance and quality of life. The results offer practical guidelines for enhancing the work environment and are valuable to both employers and researchers in ergonomics and occupational safety.



## 1 Uvod

V sodobnem svetu se življenjski pogoji izboljšujejo, kar je tudi posledica osveščenosti o bolj zdravem načinu življenja. Pri daljšanju pričakovane življenjske dobe igra eno glavnih vlog tudi izjemen napredek v medicini. Če vsem tem dejstvom prištejemo še upad rodnosti in migracije, zelo hitro ugotovimo, da se povprečna starost prebivalstva v Evropi zanesljivo dviguje (Galof & Balantič, 2021).

Staranje prebivalstva je globalni trend, zaradi katerega se število starejših zaposlenih na trgu dela stalno povečuje. (Vertot, 2010; Balantič, Z., 2010). Ta demografska sprememba predstavlja poseben izziv, saj staranje pogosto prinaša naravne spremembe, med katerimi je izguba sluha ena najpogostejših (Balantič, Polajnar, & Jevšnik, *Ergonomija v teoriji in praksi*, 2016). Sluh je ključen dejavnik za kakovost življenja, zanesljivo komunikacijo in socialno vključenost starejših zaposlenih. Izguba sluha ne vpliva zgolj na posameznika, temveč ima tudi širše posledice za organizacije in družbo (Loeb, M., 1986).

S staranjem se pojavi naravna izguba sluha, ki je posledica degenerativnih sprememb v slušnem sistemu. S starostjo se pogosteje srečamo tudi s kroničnimi boleznimi (diabetes, visok krvni tlak), ki še dodatno vplivajo na sluh. Vemo, da je sluh odvisen tudi od časa izpostavljenosti hrupu, kar še intenzivneje doživimo vzporedno s staranjem. Kot ugotavljajo raziskave, "starostna izguba sluha in kronična bolezen pogosto tvorita negativen krog, kjer sta slabšanje sluha in slabo zdravje pogosto tesno povezana" (Gopinath et al., 2020). Ko človek slabše sliši se pogosto samoizolira in zapade v depresijo. Raziskave so pokazale, da "izpostavljenost hrupu, skupaj z napredovanjem starosti, lahko vodi do poslabšanja kakovosti življenja, saj vpliva na komunikacijo, socialne interakcije in duševno zdravje" (Shargorodsky et al., 2019).

Izpostavljenost hrupu na delovnem mestu dodatno prispeva k naglušnosti, kar vodi do težav pri delu, povečane izolacije in zmanjšane produktivnosti. S tem so povezani tudi večji socialni stroški, kot so zdravstvena oskrba, rehabilitacija sluha in zgodnejše upokojevanje, kar dolgoročno vpliva na delovno populacijo in gospodarstvo.

V raziskavi smo se osredotočili na delovno aktivne starejše zaposlene z diagnosticirano naglušnostjo, potrjeno s strani otorinolaringologa, ki pri svojem delu uporabljajo slušne aparate. Cilj raziskave je bil preučiti vpliv izpostavljenosti hrupu

ter razviti rešitve za prilagoditev delovnih mest. Zanima nas, kako hrup v delovnem okolju vpliva na sluh starejših zaposlenih ter kako organizacije in delodajalci izboljšujejo delovne pogoje in zagotavljajo varnost v zvezi s hrupom.

Ker je pri izgubi sluha mogoče uporabiti tehnične pripomočke, smo želeli ugotoviti, ali uporaba slušnih aparatov pri starejših zaposlenih izboljša njihove komunikacijske sposobnosti in delovno produktivnost v primerjavi z obdobjem, ko teh pripomočkov ne uporabljajo. Prav tako nas je zanimal vpliv sprememb v delovnem okolju, kot sta izolacija hrupa in uporaba zaščitnih slušalk, na počutje in produktivnost zaposlenih ter na njihovo sposobnost komuniciranja s strankami, sodelavci in nadrejenimi.

Uporaba slušnih aparatov je bila večkrat raziskana v kontekstu izboljšanja komunikacijskih sposobnosti in zmanjšanja socialne izolacije. Raziskave so pokazale, da slušni aparati pomembno prispevajo k večji vključitvi starejših v socialne in delovne interakcije, kar posledično povečuje delovno produktivnost in kakovost življenja (Kochkin, 2019). Predvidevamo, da bodo rezultati omogočili boljše razumevanje potreb starejših zaposlenih in pripomogli k oblikovanju delovnih mest, ki zagotavljajo varno, učinkovito in zdravo delovno okolje za vse generacije.

## 2 Metode

Raziskava združuje teoretični in empirični pristop k raziskovanju vpliva hrupa na delovna mesta starejših zaposlenih.

V teoretičnem delu so bili s pomočjo deskriptivne metode in metode analize zbrani podatki iz obstoječe literature, ki obravnavajo teme, kot so starejši zaposleni, sluh, slušni aparati in delovni pogoji v hrupnih okoljih.

Empirični del raziskave temelji na dveh ključnih metodah: izvedbi ankete in merjenju slušnih sposobnosti anketirancev. Anketa je bila izvedena tako v fizični kot spletni obliki, pri čemer jo je izpolnilo 50 starejših zaposlenih z diagnosticirano izgubo sluha (40 % žensk in 60 % moških). Raziskava je potekala z uporabo anketnega vprašalnika in interne analize podatkov anketirancev v programu NOAH podjetja AUDIO BM d.o.o.

Anketa je bila izvedena preko spletnega portala 1ka, nekateri starejši anketiranci pa so jo izpolnili v poslovalnici AUDIO BM Kranj. Dosežena je bila 100-odstotna odzivnost. Pred izvedbo so se vsi anketiranci pogovorili z raziskovalno ekipo, ki jim je pojasnila namen raziskave in jih prosila za dovoljenje za uporabo njihovega avdiograma (meritev sluha) v raziskovalne namene. Anketni vprašalnik je vključeval 32 vprašanj, pri čemer so bili vprašalnik in podatki meritev sluha neposredno povezani z osebniimi podatki respondentov.

V raziskavi so sodelovali izbrani starejši zaposleni z izgubo sluha, ki so jim to diagnozo potrdili specialisti otorinolaringologije. Analizirali smo meritve sluha anketirancev, izvedene s strani zdravnika specialista, pri čemer smo za povezovanje različnih podatkov uporabili šifrirano identifikacijo respondentov.

### **3 Rezultati**

Analiza meritev sluha, prikazana na sliki 1, je pri vseh anketirancih pokazala izrazito obojestransko izgubo sluha, pri čemer prevladuje sensorineuralna izguba sluha, ki je tudi najpogostejša oblika izgube sluha.

Zaznali smo ne le sensorineuralno, temveč tudi prevodno in kombinirano izgubo sluha, kar nakazuje na raznolike patološke mehanizme, ki vplivajo na sluh anketirancev.

Izračunali smo povprečno izgubo sluha anketirancev na govornih frekvencah, ki so ključne za zaznavanje govora in drugih zvokov iz okolja. Ugotovili smo rahlo razliko med povprečno izgubo sluha na levem in desnem ušesu, pri čemer je izguba na levem ušesu v povprečju višja za 2 dB. Čeprav je razlika minimalna, lahko vpliva na zaznavanje zvokov in komunikacijo v vsakdanjem življenju.

Nadalje smo izvedli izračun izgube sluha po metodi Fowler, ki temelji na rezultatih prazne tonske avdiometrije pri govornih frekvencah in omogoča kvantitativno oceno izgube sluha v odstotkih. Povprečna izguba sluha pri anketirancih je znašala 38,4 dB, kar zagotavlja celovit vpogled v stopnjo okvare njihovega slušnega sistema. Najvišja ugotovljena izguba sluha po Fowlerju je bila 91,10 %, najnižja pa 10,80 %, kar prikazuje razpon izgub sluha med anketiranci.

**Slika 1: Analiza meritev govornih frekvenc (rdeča barva označuje desno uho, modra pa levo uho)**

Ime in priimek	500 Hz	1000 Hz	2000 Hz	4000 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	izguba sluha po FOWLERIU
O1	60	70	70	65	70	70	65	80	81,90%
O2	15	30	40	55	10	40	45	55	29,60%
O3	10	15	35	100	10	20	55	115	28,00%
O4	35	55	80	100	25	55	75	100	70,30%
O5	15	15	50	45	15	15	50	40	29,00%
O6	35	35	35	75	30	30	35	55	28,50%
O7	30	45	55	75	30	45	55	70	54,00%
O8	25	35	40	75	20	35	40	85	36,80%
O9	30	35	65	65	25	35	65	65	52,30%
O10	35	45	50	55	30	40	55	60	48,90%
O11	45	40	40	25	50	45	45	35	32,50%
O12	25	35	45	55	30	35	45	55	36,60%
O13	30	40	45	45	25	35	35	40	26,20%
O14	45	50	65	60	25	25	30	40	23,40%
O15	20	35	65	65	20	40	65	60	51,70%
O16	35	20	20	40	25	20	15	45	10,80%
O17	25	45	70	85	20	45	65	110	59,60%
O18	15	15	25	75	10	15	45	70	21,90%
O19	30	35	50	65	40	50	50	75	46,70%
O20	55	60	55	65	60	65	60	65	70,10%
O21	35	40	35	65	55	65	70	80	41,70%
O22	20	35	55	45	15	25	40	50	27,00%
O23	15	50	65	70	20	35	50	80	47,40%
O24	15	25	30	60	20	25	40	70	23,70%
O25	10	10	45	65	10	10	10	60	14,40%
O26	10	10	30	65	10	10	25	55	15,80%
O27	20	25	35	65	15	15	25	95	22,00%
O28	35	45	65	105	15	20	45	95	38,30%
O29	20	35	45	55	10	25	30	50	21,20%
O30	15	20	60	65	5	20	65	65	43,30%
O31	50	50	45	75	45	50	60	55	55,70%
O32	15	30	45	60	20	30	45	55	33,60%
O33	10	30	50	60	15	30	45	50	31,60%
O34	35	30	20	30	35	30	30	30	15,30%
O35	40	70	70	60	45	70	65	65	73,90%
O36	25	45	50	50	30	50	55	50	46,10%
O37	10	20	35	50	10	20	30	40	14,80%
O38	10	20	50	65	10	20	50	75	37,40%
O39	10	10	25	60	10	10	40	60	17,60%
O40	20	35	50	60	30	40	60	65	43,80%
O41	50	40	55	50	10	15	45	40	27,00%
O42	85	90	120	120	65	55	75	90	83,10%
O43	50	50	75	90	15	35	55	90	51,80%
O44	20	25	35	65	20	30	40	65	27,60%
O45	30	50	40	40	20	30	35	45	24,40%
O46	5	5	30	75	15	35	65	70	25,30%
O47	100	100	120	120	40	90	110	120	91,10%
O48	20	20	30	70	90	85	85	90	33,20%
O49	30	35	40	50	25	30	45	55	31,60%
O50	5	5	35	50	20	15	55	70	20,70%
<b>povprečna vrednost v Db</b>	<b>28,6</b>	<b>36,2</b>	<b>49,7</b>	<b>65</b>	<b>26,3</b>	<b>35,6</b>	<b>49,7</b>	<b>66</b>	<b>38,38%</b>

Izračun izgube sluha po Fowlerju posameznikom, ki izpolnjujejo določene pogoje, omogoča pridobitev tehničnih pripomočkov, kot so vibracijske budilke, induktivne zanke in telefoni za naglušne.

Za nadaljnjo analizo podatkov smo v programu SPSS izvedli T-teste in binomske teste. Namen obdelave podatkov je bil preveriti, ali obstajajo statistično značilne razlike med dvema skupinama glede na povprečje določene spremenljivke in ali se



porazdelitev opazovanj med dvema kategorijama ujema s pričakovano porazdelitvijo.

V nadaljevanju (Tabela 1) so prikazani rezultati t-testa za neodvisne vzorce, kjer smo preverjali statistično pomembne razlike v povprečni vrednosti dveh neodvisnih skupin. Anketirance smo razdelili v dve skupini na podlagi mediane izračuna izgube sluha po Fowlerju. Rezultati analize kažejo, da na 5 % ravni značilnosti ( $p > 0,05$ ) ničelne domneve ( $H_0$ ) ne moremo zavrniti, kar pomeni, da nimamo dokazov o statistično pomembnih razlikah med povprečnimi vrednostmi obeh skupin.

Tabela 1 prikazuje rezultate t-testa za posamezne frekvence (500 Hz, 1000 Hz, 2000 Hz in 4000 Hz), ki so ključne za razumevanje govora – desno uho.

**Tabela 1: Rezultati t-testa za posamezne frekvence (500 Hz, 1000 Hz, 2000 Hz in 4000 Hz), ki so ključne za razumevanje govora – desno uho**

Frekvenca	Skupina	Velikost vzorca (N)	Povprečje (M)	Standardni odklon (SD)	Standardna napaka (SEM)	t(p) vrednost
4000 Hz	2	19	61,05	19,48	4,47	
4000 Hz	1	22	68,18	18,87	4,02	1,189 (0,242)
2000 Hz	2	19	46,32	15,08	3,46	
2000 Hz	1	22	50,45	21,65	4,62	0,699 (0,489)
1000 Hz	2	19	36,84	10,17	2,33	
1000 Hz	1	22	33,18	22,86	4,87	-0,644 (0,523)
500 Hz	2	19	27,63	11,59	2,66	
500 Hz	1	22	25,23	20,67	4,41	-0,449 (0,656)

Opomba: N predstavlja velikost vzorca, M označuje aritmetično sredino, SD pomeni standardni odklon, SEM pa standardno napako aritmetične sredine. Simbol 1 označuje vrednost kazalnika izgube sluha po Fowlerju, ki je nižja od referenčne mediane, medtem ko simbol 2 označuje vrednost, ki presega referenčno mediano.

Tabela 2 prikazuje rezultate t-testa za neodvisne vzorce, kjer smo preverjali, ali obstajajo statistično pomembne razlike v povprečnih vrednostih dveh neodvisnih skupin za levo uho. Rezultati analize kažejo, da, podobno kot pri desnem ušesu, na 5 % ravni značilnosti ničelne domneve ( $H_0$ ) ne moremo zavrniti. To pomeni, da nimamo dokazov, da bi se povprečne vrednosti obeh skupin statistično značilno razlikovale ( $p > 0,05$ ).

V nadaljevanju so predstavljeni rezultati Binomskega testa, s katerim smo preverjali deleže dihotomne spremenljivke, povezane z vprašanjem: »Ali menite, da se vam je sluh poslabšal od začetka zaposlitve v podjetju, kjer ste preživeli večino vaše delovne kariere?« (Tabela 3). Test primerja teoretične rezultate (izračunane s pomočjo binomske porazdelitve) z empiričnimi, pridobljenimi iz opazovanih podatkov vzorca. Glede na teoretične predpostavke predvidevamo, da bo delež tistih, ki se strinjajo z navedeno trditvijo, večji od 0,5. Kljub temu, da je opazovani delež tistih, ki podpirajo trditev (0,66), visoko, pa rezultati binomskega testa tega ne potrjujejo, saj je p-vrednost eksaktnega binomskega testa višja od 0,05.

**Tabela 2: Rezultati t-testa za posamezne frekvence, ki so ključne za razumevanje govora (500Hz, 1000Hz, 2000Hz in 4000Hz) – levo uho**

Frekvenca	Skupina	Velikost vzorca (N)	Povprečje (M)	Standardni odklon (SD)	Standardna napaka (SEM)	t(p) vrednost
4000 Hz	2	19	63,42	23,69	5,44	
4000 Hz	1	22	68,18	19,91	4,25	0,699 (0,489)
2000 Hz	2	19	49,47	14,42	3,31	
2000 Hz	1	22	52,05	18,49	3,94	0,491 (0,626)
1000 Hz	2	19	37,89	14,07	3,23	
1000 Hz	1	22	33,64	21,22	4,52	-0,744 (0,461)
500 Hz	2	19	27,89	18,51	4,25	
500 Hz	1	22	21,82	13,23	2,82	-1,221 (0,229)

Opomba: N predstavlja velikost vzorca, M označuje aritmetično sredino, SD pomeni standardni odklon, SEM pa standardno napako aritmetične sredine. Simbol 1 označuje vrednost kazalnika izgube sluha po Fowlerju, ki je nižja od referenčne mediane, medtem ko simbol 2 označuje vrednost, ki presega referenčno mediano.

**Tabela 3: Rezultati binomskega testa za vprašanje »Ali menite, da se vam je sluh poslabšal od začetka zaposlitve v podjetju, kjer ste večino svoje delovne kariere preživeli?«**

Skupina	Kategorija	Vzorec (N)	Delež v vzorcu	Pričakovani delež	P-vrednost (dvostranska)
Skupina 1	1,00	27	66 %	50 %	0,060
Skupina 2	2,00	14	34 %	50 %	
Skupaj		41	100 %		

Opomba: Skupina 1 – strinjanje z vprašanjem; skupina 2 – nestrinjanje z vprašanjem.

Rezultati binomskega testa (Tabela 4) kažejo, da je statistično značilen večji delež tistih anketirancev, ki so navedli, da na njihovem delovnem mestu niso bili izvedeni ergonomski ukrepi (opazovani delež je 0,73;  $p = 0,014$ ).

**Tabela 4: Rezultati binomskega testa za trditev »Ali so bili na vašem delovnem mestu izvedeni kakšni ergonomski ukrepi - prilagoditve delovnega okolja z zmanjševanjem motenj zaradi hrupa?«**

Skupina	Kategorija	Vzorec (N)	Delež v vzorcu	Pričakovani delež	P-vrednost (dvostranska)
Skupina 1	2,00	24	73 %	50 %	0,014
Skupina 2	1,00	9	27 %	50 %	
Skupaj		33	100 %		

Opomba: Skupina 1 – ukrepi niso bili izvedeni; skupina 2 – ukrepi so bili izvedeni.

## 4 Diskusija

Rezultati raziskave so pokazali, da je večina starejših zaposlenih redno izpostavljena hrupu na delovnem mestu, kar ima dolgoročne negativne posledice za njihov sluh. To izpostavlja potrebo po uvedbi ustreznih zaščitnih ukrepov, kot so uporaba osebne varovalne opreme, izolacija hrupnih virov in ozaveščanje o nevarnostih hrupa. Delodajalci in organizacije morajo izboljšati delovne pogoje ter varnost starejših zaposlenih, predvsem z izobraževanjem o zaščiti sluha in pravilni uporabi osebnih zaščitnih sredstev. Prav tako bi morali pogosteje izvajati ukrepe, kot so prilagoditve delovnih mest, da bi zmanjšali izpostavljenost hrupu.

Naša raziskava je prav tako pokazala, da uporaba slušnih aparatov med starejšimi zaposlenimi občutno izboljša njihove komunikacijske sposobnosti in delovno produktivnost. Slušni aparati omogočajo boljšo komunikacijo s strankami, sodelavci in nadrejenimi, kar pozitivno vpliva na delovno izkušnjo.

Na podlagi teh ugotovitev je jasno, da je potrebno okrepiti prizadevanja za izboljšanje delovnih pogojev za starejše zaposlene. Ključnega pomena je uvedba trajnostnih in učinkovitih zaščitnih ukrepov, ki bodo zmanjšali tveganje za izgubo sluha ter izboljšali delovno izkušnjo teh zaposlenih. Celovit pristop, ki vključuje tudi sodelovanje z zunanjimi organizacijami, je nujen za zagotovitev varnega in zdravega delovnega okolja za starejše zaposlene.

Študije, kot je poročilo Evropske agencije za varnost in zdravje pri delu (EU-OSHA, 2005), že dolgo opozarjajo na škodljive učinke hrupa na sluh in psihosocialno počutje. Naša raziskava dodatno potrjuje, da hrup ni le neposreden vzrok za poslabšanje sluha, temveč tudi negativno vpliva na kakovost življenja in produktivnost zaposlenih.

Večina anketirancev je poročala o dolgotrajni izpostavljenosti hrupu, pri čemer jih je 56 % ocenilo raven hrupa kot srednjo ali višjo. Kljub temu je presenetljivo velik delež tistih, ki nikoli niso podali pritožbe nadrejenim, kar odpira vprašanja o pomanjkanju ozaveščenosti ali zaupanja v delovne procese za zmanjševanje hrupa. To je v skladu s študijami, ki ugotavljajo, da delavci pogosto ne prepoznajo svojih pravic glede varnosti pri delu (Mikeln, 2000).

Rezultati so tudi pokazali, da največji delež izgube sluha izhaja iz izpostavljenosti hrupu in starostnih sprememb, kar nakazuje potrebo po izboljšani preventivi, vključno z uporabo osebne zaščitne opreme in tehničnimi ukrepi, kot so akustična izolacija. Poleg tega je pomembno vključiti redne zdravstvene preglede in usposabljanje zaposlenih, kar je v skladu z načeli Direktive 2003/10/ES (UL Evropske unije, 2003).

Zanimivo je, da je uporaba slušnih aparatov izkazala pozitivne učinke na komunikacijske sposobnosti in produktivnost zaposlenih, kar potrjujejo tudi ugotovitve Lin et al. (Lin et al., 2011). Vendar pa se soočamo z izzivi pri uvajanju teh rešitev, saj je sprejemanje tehnologij pogosto počasno zaradi stigmatizacije in pomanjkanja informacij.

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# THE CONCEPT OF GREEN ECONOMY AS A CHALLENGE AND DEVELOPMENT GUIDELINE OF GORSKI KOTAR

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The passage of time brings a pronounced trend of population decline but also prolongation of life span. The share of the third age population is increasing, and the gap between the rich and the poor is growing. There is also the problem of rural areas lagging urban areas and depopulation, which is not only a problem of the hilly and mountainous region of Gorski Kotar (GK) but is also present in the most developed countries of the European Union (EU). The current socio-economic model is not sustainable in the long term and innovative / different solutions are needed. One of these solutions is the application of the green economy (GE) concept, which links the stimulation of economic growth and job creation with increased care for environmental protection and equality, efficient use of resources and social inclusion. The paper explains the basic determinants, principles, and goals of the GE, as well as the most important challenges in the field of energy transition and establishing a circular economy. The authors analyze needs and potential in the field of sustainable environmental management in GK. Thematic areas were identified as key development challenges. The authors explain the advantages of green construction and emphasize the importance of regional connectivity and mobility. The presentation of the research results is summarized in the SWOT analysis.

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## 1 Introduction

The rural areas of the EU are crucial for green transition, and represent a significant opportunity for job creation, the fight against the abandonment of rural areas and the mitigation of depopulation. This includes harnessing the potential of the bio and circular economy to stimulate economic diversification and create quality jobs, especially in the transition to a carbon-neutral and sustainable bioeconomy.

The GK microregion is in the western part of Croatia and is one of the three microregions of the Primorje-Gorski Kotar County (PGC). According to the Law it is an area of interest and under special national protection to encourage demographic renewal, settlement and the creation of assumptions so that natural and other economic resources can be used as efficiently as possible for economic development while preserving biological and landscape diversity. Negative demographic trends in GK represent a threat to the local economy and in the long run can become a significant limiting factor in the County's economic and social progress. In this sense, the application of the GE concept offers solutions that contribute to low-carbon development, with the aim of efficient use of resources. The authors especially emphasize social justice and social inclusion, with increased concern for environmental protection.

This paper will provide an overview of GK with elaboration of potential development challenges and implementation of the GE measures in different sectors to boost the microregions' economic potential and retain people.

## 2 Conceptual Framework of Green Economy

In recent decades, along with the blue economy, green development, GE, and green growth have been emphasized (Neusteurer, 2016; Gavrić et al, 2019; Denona Bogović, et al 2000. Kovačić et al, 2021) as synonyms of the transition towards sustainability. It is one of the directions of development that is often promoted and emphasized as desirable and necessary. The GE offers a solution to certain problems that have been caused throughout the century. Namely, a great dependence on fossil fuels that has been created. However, the GE sometimes does not fulfill its ultimate purpose since it uses economic and business models that promote profit maximization at any cost, and the rule of money over product and person. The above



includes projects that are economically and energetically self-sustaining, while trying to shift the focus from large utility projects (for example, high-power wind farms or photovoltaic systems) that often bring profit to private investors. However, the emphasis is and should be on projects of the same or smaller scale, but which creates a greater economic benefit for the local community. Therefore, it is important to make responsible (political) decisions that will support the transition to technologies and activities with less carbon emissions and pollution.

As early as the eighties of the last century, awareness about the need to change the existing model of economic development, with a more rational use of limited, non-renewable resources, with the aim of reducing harmful effects on the environment began to develop. It became evident that economic development cannot be stopped, but it was necessary to change direction and move to sustainable models of development and lifestyle. The well-known concept of sustainable development, at the time a new development model, emphasized the importance of parallel consideration of economic, social and environmental requirements in order to ensure "meeting the needs of the present generation without jeopardizing the ability of future generations to meet their needs". (Bruntland Report, 1987).

The term GE also appears in the 1980s. According to Neusteurer (2016), the term was mentioned for the first time in the Blueprint for a GE report prepared in 1989 for the needs of the British government. The use of the term grows slowly until the global economic crisis of 2008, when its more intensive use begins. The United Nations Environment Program (UNEP) then promotes the so-called green stimulus packages to avoid a global recession. At the same time, the Global Green New Deal, a planning document of the UN Department of Economic and Social Relations (UNDESA) for climate, energy and development in 2009, brings the first comprehensive presentation of the concept of the GE as a new model of economic development based on the principles of sustainable development.

In the conclusions of the UN Earth Summit conference from Rio in 2012, it is stated that member states should find their own GE models and create long-term plans with clearly defined priorities (which may differ from richer to less rich countries). At the same time, 15 goals for the GE were adopted at the conference. It is clear that the world is dealing with an economy that should generate increasing prosperity, but at the same time maintain natural systems that serve humans. Historically, green

growth has not been a priority. Economic expansion has imposed unsustainable demands on natural systems - both in terms of the amount of resources that are extracted or harvested, and the amount of emissions and waste that the environment is expected to absorb and neutralize. The results come from the fact that growth based on such a form of management cannot continue indefinitely, that is, that the environment has its natural limits related to absorption.

Growth and development are often used as synonyms, even though they denote different processes that usually run parallel to each other. According to the author (Jackson, 2009), growth always means a shift in quantity, a quantitative change. On the other hand, development is a new state to be aspired to, with its positive and negative meanings. However, the fact is that growth ignores the importance that the environment has for people's well-being, while development also includes an environmental component. The goals of the GE can meet the needs of food, transportation, energy and more, in a sustainable and fairer way. The EEA's main report, *The European Environment: State and Outlook 2010 (SOER 2010)*, states that there is a need to ensure a fair distribution of benefits (as well as costs) in the transition to a GE. In this context, the GE can be considered an alternative vision for growth and development, as it can generate growth and improvements in people's lives in ways that are consistent with sustainable development. The GE represents a breakthrough in thinking about growth and development, the production of goods and services, and consumer habits, through well-being, justice, the limits of resource use, efficiency and sufficiency, and a holistic approach to resource management.

It is obvious that the current socio-economic model is not sustainable in the long term and that some new solutions are needed, and one of them is precisely the concept of the GE. One of the tools available to achieve the goals of the GE is the circular economy, which promotes practices such as sharing, renting, reusing, repairing and recycling, in order to extend the life cycle of products and reduce the amount of waste. The circular economy is an important segment of the economic recovery of the EU. The European Commission (EC) adopted the Action Plan for the Circular Economy, which is one of the main components of the new European Green Plan, which aims to prepare the economy for a green future, strengthen competitiveness, protect the environment and give new rights to consumers.

### **3 Microregion Gorski Kotar Analysis**

The analysis of the GK microregion contains a general description of the area, location and population, as well as a development index. Development needs and potentials are explained and the most important development determinants in the field of sustainable environmental management and circular economy, sustainable transport and green mobility, energy transition and low-carbon development and green construction are highlighted. The future development of tourism in the context of a holistic approach is also considered. Special emphasis is placed on social innovations and smart development as support and implementation of technological solutions in function of the quality of life of the population.

#### **3.1 Location, population, development index**

According to the NUTS 2<sup>1</sup> classification, GK belongs to Adriatic Croatia, and according to the NUTS 3 classification to PGC. Administratively, it is divided into 6 municipalities (Mrkopalj, Lokve, Brod Moravice, Skrad, Ravna Gora and Fužine) and 3 cities (Delnice, Čabar and Vrbovsko). According to the data of the Geoportal (2024), GK has an area of 1,273.1 km<sup>2</sup>, which is 35.5 % of the land territory of the County. According to the 2021 Census, 265,419 inhabitants lived in PGC, of which 19,032 (7.42 %) inhabitants lived in the microregion of GK. The decrease in the number of the County in the past decade (2011/2021) was 9.91 %. In the same period, the decline in the population of GK amounted to 17.29 %. The percentage decrease in the number of inhabitants in the County was greater than the percentage decrease in the County's population, which reduced the share of the County's population in the total population from 7.77 % to 7.14 %. The microregions' population density in 2021 was 14.95 inhabitants per km<sup>2</sup>, while in the County it was 74.28 inhabitants per km<sup>2</sup>. It follows that the GK district is 5 times less populated than the county average. Compared to the base year of 1991, the number of inhabitants in the municipality of Mrkopalj and the town of Vrbovsko decreased by 50 % over the 30 years, while the smallest decrease of 25 % was recorded in the town of Delnice.

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<sup>1</sup> The nomenclature of spatial units for statistics, known under the acronym NUTS, is a statistical classification that serves for the collection, processing, analysis and publication of statistical spatial data at the level of the European Union.

All local units from the GK area belong to the hilly-mountainous area, of which the municipalities of Lokve, Mrkopalj, Skrad, Brod Moravice and the cities Čabar and Vrbovsko belong to assisted area, while the others are in the group that according to the value of the Development Index are in the third and the fourth quarter of above-average ranked local self-government units. The Development Index is a composite indicator calculated as an adjusted average of standardized values of socio-economic indicators for measuring the development level of local and regional self-government units in each period.

**Table 1: Development Index for the local self-government units in Gorski Kotar**

National rank of 556	Local self-government unit	Development group	Development index 2024
138	Fužine	6	104,069
153	Delnice	6	103,588
267	Skrad	5	100,036
268	Ravna Gora	5	100,034
285	Čabar	4	99,542
304	Lokve	4	98,864
333	Mrkopalj	4	97,860
393	Vrbovsko	3	95,716
463	Brod Moravice	2	93,459

Source: Adjusted by authors according to the Ministry of the Regional Development and Funds of the European Union of the Republic of Croatia

All cities and municipalities of GK have recorded a decline in the development index compared to the period 2016-2018, except for Skrad which now belongs to 5<sup>th</sup> development rank. Fužine, Delnice, Ravna Gora, and Mrkopalj have retained their development status, while Čabar and Lokve became assisted area. Vrbovsko decreased to rank 3 of the assisted area, while Brod Moravice significantly decreased status from 4 to rank 2 of the assisted area. Almost all local units of GK, except Delnice and Fužine are assisted areas while Ravna Gora and Skrad are clearly on the edge of becoming one. Therefore, this data just underlines the fragility of the microregion which it is essential to identify the potential and needs and deliver the concrete actions. The evident development trends in the microregion have already been identified since 2014 in the Declaration on the Existence of Gorski Kotar, bearing in mind that active domestic and international measures must ensure the balanced progress of GK. Declaration emphasized all relevant actions from the

regional legislator perspective to be done in order to boost the equal development and prosperity. However, not much since then on the national level has been done.

### **3.2 Development needs and potential**

Development needs and potential in GK are recognized through sustainable environmental management, sustainable transport and mobility, energy transition towards low-carbon development and green construction, green/sustainable tourism, smart villages and social innovations.

#### **Sustainable environmental management / circular economy**

Sustainable management of the environment and green areas includes the management of forests and waters, protected areas, sustainable agriculture, rural tourism and circular economy, especially in waste management. The maintenance of green areas is of great importance for GK, which contributes to the social and recreational function of the development, which is important for the health and quality of life of the residents. Analysis of the potential of GK in the context of the GE indicates that despite numerous resource opportunities, there are almost no green investments that focus on production processes and technologies based on improving energy efficiency as well as on efficient waste management and recycling. The above points to the importance of greater employment of the working population in secondary sector activities, namely, processing industry, waste management, electricity supply, water supply, air conditioning, and environmental rehabilitation and construction. Innovative design, construction and production of low-energy / green buildings and houses can be drivers of economic activities. The fact is that the possibilities of modular construction with wooden elements allow flexibility in the use of residential spaces, which can easily be converted into business or other spaces. All these activities have many direct and indirect effects, through employment, taxes and others. A significant role is also played by the tertiary sector, namely green/rural tourism, which has all the prerequisites to contribute to the protection of the natural resources of Croatia.

### **Sustainable transport / green mobility**

Of all the forms of the transport system, road and rail transport are the most common form of transport infrastructure in hilly and mountainous areas. In the area of GK, due to the insufficient number of intercity bus lines, the distance and the dispersion of the settlements, road traffic is mostly carried out by private car. Public transport is provided only by bus, mostly for the purpose of children education and mostly for the local population who do not own a vehicle. The process is two-way, so there is an emigration of the population from smaller, remote settlements, and some bus lines are canceled due to economic unprofitability. The lack of transport offer in the context of railway transport is correlated with the distance of the line route from the settlement, the low frequency of departures and the weak transport offer especially in the afternoon, which makes it impossible to transport children and young people to extracurricular activities. Increasing train traffic compared to road traffic would indirectly contribute to less pollution, which, as is known, rail traffic compared to other forms of transport has on the environment. There is great potential in sustainable transport, both in terms of infrastructure and more energy-efficient vehicles.

### **Energy transition towards low-carbon development / Green construction**

The transition of the energy sector in GK still insufficiently includes increasing energy efficiency, developing the energy market, increasing the use of renewable energy sources (RES), especially water and wind, and increasing the quality of energy management. At the same time, with the use of new (smart) technologies, it is important to raise the level of information of the population and entrepreneurs/economy. Energy efficiency, as the first component of the energy transition with the aim of reducing the need for energy, can significantly contribute to the reduction of production and CO<sub>2</sub> emissions. Renewable energy sources (RES) in GK are still an underutilized potential, from the use of energy from the sun, wind, biomass and small watercourses. The installed production capacities of renewable energy sources and cogeneration are modest, and the total installed power is low. Wood, as the main source of biomass, has its limitations, since it is a renewable source of energy only as long as it is used within the limits of the annual cutting mass, which is approximately 569,000 m<sup>3</sup>. However, considering the current production, there is still room for encouraging the use of wood-based cogeneration

plants (given the available raw material). A plant to produce pellets is operative in the business zone, products are mostly exported.

In order to increase the use of renewable energy sources, the possibilities for development of small hydropower plants (up to 10 MW) in the area of GK is great. Planned locations for the construction of small, mini and micro hydropower plants have already been determined in the entire water supply system managed by the utility company. In the transition from non-renewable to the use of renewable energy sources, in consumption patterns and the use of recyclable materials, technology and energy efficiency are significant drivers. However, the challenge will be the development of the necessary expertise, implementation of knowledge and influencing changes in the population's behavior and habits, given that there is a long-term practice of unsustainable energy use.

### **Green construction**

Although a green building is a building that, through its design, construction or operation, reduces or eliminates negative impacts and can create positive impacts on the climate and natural environment (Ying et al, 2021, Yin et al, 2024). The authors Bungau et al. (2022) emphasize that green buildings preserve precious natural resources and improve the quality of life. There are several features that can make a building, green. According to the authors (Ying et al, 2021, Bungau et al, 2022) this includes: efficient use of energy, water, wind or sun, good indoor air quality, use of materials that are non-toxic, ethical and sustainable, consideration of environmental issues in design, construction and production, consideration of the quality of life in design, construction and operation, design that enables adaptation to a changing environment. The wealth of wood raw material, its accessibility and the knowledge and skills of wood processing make wood the original building material in GK. Requirements for reducing greenhouse gas emissions in industry also apply to construction as a sector that contributes greatly to environmental pollution. Wood processing requires less cost and energy compared to concrete and steel and creates residues that are used to produce heat and sound insulation and as firewood. The tradition and culture of the manufacturer would certainly contribute to the functionality, reliability, quality and promotion of such products. This is precisely the opportunity for innovative projects and employment of young people in jobs where smart/technological, innovative and functional solutions are sought.

## **Green/rural tourism**

Croatian Institute for Tourism created the Action Plan for the Development of Green Tourism (2016), which states that green tourism is not a special type of tourism, but a concept of green development, which should be included in all levels of tourism planning and tourism development of GK (2016). Green tourism is rapidly developing under the influence of the growing tourism industry's great pressure on the environment, but also the increasing demand for green tourist destinations. The development of green tourism depends on various stakeholders in the area of GK, decision-makers and GK Tourist Board. Destination management should look at the development of green tourism in terms of creating a stimulating environment that will provide support to all stakeholders in the greening of tourism. The negative implications of tourism for the environment and the connection between environmental elements and tourism development are known. The development of green tourism should be defined by certification of tourist facilities or the destination as a whole. Green certificate (Dias et al, 2024) is confirmation that the destination or business entity behaves responsibly towards the ecological, economic and social environment and invests financial and non-financial resources in reducing its own negative impacts on the environment, as well as in meeting the needs of tourists. Gorski Kotar tourism development master plan issued in 2020 is an important document for the development of green tourism. However, each destination is unique, so it is necessary to consider the specifics and challenges in order to create an environment for the development of green tourism in the area of GK.

## **Development of smart villages**

The initiative to develop smart villages in the EU was launched with the aim of improving the quality of rural life and solving the problem of depopulation and an aging rural population. The standard of living is on average lower in rural than in urban areas. The level and quality of education and healthcare is also lower, and economic activity is weaker. The idea is to enable the local population, which is best acquainted with the possibilities and needs of their community, to self-initiatively join and direct their own social and economic development with the use of innovative solutions and digital technologies. According to the definition in the EU Action For Smart Villages (European Commission, 2019), Smart villages are rural



areas and communities that develop based on their own advantages and territorial wealth, using new opportunities to create added value. Communities in which traditional and new networking is supported by means of digital technologies, innovations and smart use of available knowledge for the benefit of its residents. According to the authors (Guzal-Dec et al, 2018, Emerllahu et al, 2024) this implies: the fact that the community is managed by the residents jointly and on their own initiative, innovative use of technology with the aim of improving services and quality of life, long-term development consideration, creation of new forms of cooperation and partnerships, reflection on the development of one's own environment.

In 2019, the EU Parliament accepted Smart Villages as a new concept for the development of rural areas in the EU Multiannual Financial Framework 2021-2027. and decided on this concept financing. Respecting the fundamental determinants of this concept in GK, the following effects can be achieved:

- better access to public services,
- digitization and diversification of local entrepreneurship, creation of sectoral, innovation and development centers, creation of new quality jobs and remote work opportunities,
- development of short food supply chains and innovative agricultural models,
- better use of renewable energy sources and greater energy efficiency,
- development of the GE,
- preservation of the environment and biological diversity and better adaptation to climate change,
- better daily connectivity within the microregion and surrounding urban areas,
- greater participation of residents in the adoption and implementation of development plans.

Rural areas across Europe are undergoing strong changes. The challenges are great, but at the same time it is an opportunity for rural areas to participate almost equally in business and other activities like urban areas. For the residents of GK, it is an opportunity to improve the quality of life and business and retain young residents.

## Social innovation / smart development

In the context of green public administration, efficiency and effectiveness are important from the aspect of the speed of implementation of administrative procedures and the capacity to attract investments. However, the introduction of green practices in business, as well as responsible reporting, are of particular importance to GK. Technological and social innovations according to the authors (Raworth et al, 2014, Moulaert, 2017, Broughel et al, 2019, Selvakkumaran, 2021) are important from the aspect of improving and improving public and other services, with the purpose of improving people's quality of life.

Technological innovations in the field of GK have not yet taken root, in such a way that they offer practical and immediately applicable solutions, and the ecological and social aspect is also often missing. Social innovations should result in meeting the social needs and demands of residents and improving the quality of life. They should also contribute to the efficient use of resources (human, financial and other) and encourage more individuals and communities to act as co-creators and solve problems. In this sense, social innovations can have a positive effect on employment, mitigating the aging of the population, access based on social needs (health, education, transport, public availability of services and others).

## 4 Development challenges

Summarizing the development needs and potential in GK, thematic areas set as key development challenges were defined. The above includes functional settlements and sustainable lifestyle, solutions based on nature, circular and GE, and inclusive city / region, emphasize green construction, and social and other connectivity and more efficient mobility. There are many challenges, but the transformation towards sustainability and a higher quality of life for the residents of GK has already begun with the implementation of certain green policies.

**Functional settlements are not just a modern concept**, they are policies and interventions that encourage the development of local settlements and connected neighbourhoods in the populated area. The challenge for the residents of GK is reflected in the fact that it is necessary to improve a functional community where people can live, work and access basic services without having to travel long

distances. The availability of smaller offices, co-working and business spaces can offer proximity to workplaces or the possibility of working remotely. Better understanding and management of spatial plans, energy communities and care for green areas are important development determinants for GK.

**Sustainable lifestyles** appear for the first time in the sustainable development goals of the United Nations program, through goal 4. Education and goal 12. sustainable production and consumption. Everyday behavior patterns that reduce the negative impact on the environment and support the quality of life are present through three levels. For the residents of GK, the above means improving the way of life by being aware of the influence of the choice of homes and their construction, food and clothing, means of transportation and free time organization. The public administration is faced with making decisions and improving the infrastructure that supports changes in citizens' habits and acceptance of innovations. A sustainable lifestyle for residents of GK includes self-sufficiency in food production through incentives for sustainable agriculture development, use of eco products, movement/recreational and other activities of the population, quality of life (environment, age of the population, health, housing, income).

**A connected city / region as a concept** implies the introduction of technologies for data collection and their networking in order to make decisions that will contribute to direct and indirect effects and savings. Considering the size of the cities and municipalities of GK and the number of inhabitants, better connectivity would enable residents to more easily integrate into the community, better communication, saving resources and more efficient use of public services. In doing so, digital tools can be used to improve communication with residents and contribute to efficiency in the management of infrastructure and public services.

**Mobility is of great importance and should be people-centered**, especially in areas of low population density, dispersed workplaces and services where private car transport is the only means of most travel. In the area of GK, public transport is expensive and economically unsustainable, walking and using bicycles are limited by long distances and weather conditions. Better mobility is the biggest challenge for GK residents. It is important to improve the quality of public transport / connection of local government units, activate on-demand transport, start activities on appropriate rail connections, increase the use of digital infrastructure, etc.

By implementing **the principle of clean construction** in GK, the use of local materials with low carbon content and biomaterials such as wood will be promoted. One of the challenges in the transition to clean construction is encouraging the reuse of construction materials in construction and renovation works.

**Green buildings and energy** make it possible to reduce the low-carbon footprint on the natural environment. Gorski Kotar is facing a big challenge in how to better implement measures of energy efficiency, water conservation and air quality. The starting point is a holistic approach to facility planning, design, construction and maintenance. It is known that practices, technologies and materials that reduce its negative impact are available for all phases of the object's life cycle. As an example, collected rainwater and filtered gray water can be used to irrigate gardens and flower beds. The economic benefits of implementing green construction are also manifested through a higher property value, which is achieved through optimized use of resources and better building quality.

**Circular resources** represent a transition to the use-reuse-renewal paradigm, which is the basis for ensuring a sustainable future of GK. According to the authors (Velenturf et al, 2021, Ristić Trajković, et al, 2024) the introduction of the circular model begins with raising awareness and public communication about the circular economy, educations with the cooperation of educational and research institutions, the media and civil society. It continues at the level of households that actively participate in the recovery of materials. The transition from a linear to a circular process can be/will be encouraged by presenting new construction technologies, providing subsidies for energy efficiency measures in residential buildings, and more. Public administration in GK is expected to be open to testing and experimenting with new circular concepts, approaches and business models.

As stated by the authors in their research (Sowińska-Świerkosz et al, 2022, Ristić Trajković, et al, 2024, Dunlop et al, 2024), **nature-based solutions** are activities that serve to protect, sustainably manage and restore natural or modified ecosystems that are effectively and adaptively dealing with social challenges, while simultaneously benefiting people and biodiversity. They are supported by the benefits of healthy ecosystems and address major challenges such as climate change, disaster risk reduction, food and water security, and health are crucial for economic development. The challenge and purpose of the policy „a place for all“ for GK

assumes the creation of a safe, attractive and healthy area for living. The policy of a place for everyone is important for the revitalization of underutilized areas of GK. By conducting a greater number of activities and creating new, innovative content, public space must provide equal access and equal opportunities for everyone.

Having in mind that GK is truly rich of natural resources and has a huge potential for clean growth, the microregion still lags behind regarding the infrastructure and industry, while industry is focused mainly on processing industry (mainly wood). In order to reach environmental first preservation, and secondly goals, one of the potential solutions could lead to **green taxation**, often referred to as environmental taxation, which according to Thanasas (2024) involves the imposition of taxes on environmentally harmful activities such as carbon emissions, pollution, and resource extraction. This form of taxation is designed to provide economic incentives for individuals and businesses to adopt more sustainable practices and reduce their environmental impact. However, the grand question still remains should (green) taxation be an appropriate measure to tax the pollutants in the fragile environment or should the absence of any taxation deliver results regarding the growth and development of the microregion. Scholars (Hu in Thanasas, 2024) found that green taxation can enhance a country's total factor productivity by encouraging cleaner technologies and more efficient resource use, while at the same time boosting innovation and research that can deliver progress financed by pollutants. However, that policy would perform the full effect for the microregion such as GK, in case of broader fiscal decentralization, where the local communities or local administration could redistribute this revenue to support other policy areas or according to Murauskaite-Bull and Caramizaru (2021) re-invest it social schemes. The revenues from income tax in Croatia are distributed in such a way that the share of the municipality or city is 72%, the share of the county is 16%, and the share for decentralized functions is 12%. However, those requirements have not been met.

## **5 SWOT analysis of Gorski Kotar**

According to many studies, the GE has grown from a trend to an indispensable part of economic development planning. As the authors (Raworth et al, 2014) emphasize, it becomes a structural element that offers a fairer distribution of funds and resources, while at the same time ensuring equality in society and responsible behavior towards the entire community. It redefines the concept of wealth in such

a way that the economic evaluation should also include the values of health and the environment. It also includes the development of human resources, i.e. staff training in the direction of the green economy. GK residents, thanks to their experience and education, can initiate and achieve many changes. Some of the challenges in this sense are sustainable / green tourism, establishment of a green market with indigenous products, green jobs and implementation of new skills, lifelong learning / center for the development of green competences and skills, transformation of business entities / enterprises, attracting entrepreneurs and craftsmen to green jobs and another. The existence of several EU, national and regional funding opportunities and financing mechanisms represents the solid base for the development of the microregion. However, the impact of those investments remains to be evaluated. The absorption rate of each and the obstacles preventing GK local units to fully implement those resources present the high risk. Therefore, the need for adjusting the grants to the real territorial needs and the stronger fiscal decentralization, should be considered for future actions. However, the balance between preserving natural resources, and investments that create added value jobs still remain high priority and should not be discouraging factor for the private investments in economic development, but smartly stimulated by smart and green taxation policy that would attract potential investors in the future.

**Table 2 : SWOT analysis of Gorski Kotar**

	<b>STRENGTH</b>	<b>WEAKNESSES</b>
<b>Location and natural features</b>	<ul style="list-style-type: none"> <li>- Good traffic (railway and road) connection of the area with the rest of the Republic of Croatia as well as abroad</li> </ul>	<ul style="list-style-type: none"> <li>- Underutilized geographic position of the microregion</li> <li>- Insufficient valorization and economic use of natural heritage</li> </ul>
<b>Population and human resources</b>	<ul style="list-style-type: none"> <li>- Experience and competencies in traditional occupations of GK - forestry, wood industry and eco-agriculture</li> <li>- Active civil sector</li> </ul>	<ul style="list-style-type: none"> <li>- Unfavorable demographic trends and age structure of the population</li> <li>- Negative migration balance</li> <li>- Average net wages below the county average</li> </ul>
<b>Economy</b>	<ul style="list-style-type: none"> <li>- Excursion tourism related to natural resources</li> <li>- The tradition of forestry and wood processing industry</li> <li>- Export-oriented industry, integrated into global value chains</li> <li>- Membership in the Local Action Group</li> </ul>	<ul style="list-style-type: none"> <li>- Below average economic development</li> <li>- Unattractiveness of business zones</li> <li>- Technological lag (industry at the level of industrial revolution 2.0 and 3.0)</li> <li>- Insufficient focus of entrepreneurs on technology and innovation and research</li> </ul>

	<b>STRENGTH</b>	<b>WEAKNESSES</b>
<b>Infrastructure</b>	<ul style="list-style-type: none"> <li>- Road and railway infrastructure</li> <li>- The infrastructure of the protection and rescue system</li> <li>- Recreational and sports infrastructure</li> <li>- Adequate energy infrastructure</li> <li>- Business infrastructure (availability of business zones)</li> </ul>	<ul style="list-style-type: none"> <li>- Insufficiently developed network of water supply systems and drainage and purification system</li> <li>- Insufficient telecommunication infrastructure (there is no optical infrastructure)</li> <li>- Insufficient availability of public transport</li> </ul>
	<b>OPPORTUNITIES</b>	<b>THREATS</b>
<b>Location and natural features</b>	<ul style="list-style-type: none"> <li>- Great biological and landscape diversity and wealth</li> <li>- Forest and water wealth</li> </ul>	<ul style="list-style-type: none"> <li>- Climate changes</li> <li>- Inability to manage resources due to centralization (forests, water, state agricultural land)</li> </ul>
<b>Population and human resources</b>	<ul style="list-style-type: none"> <li>- New work opportunities - work from home;</li> <li>- The new generation of traditional occupations is based on advanced technologies, it is an opportunity for the young and highly educated population of GK</li> </ul>	<ul style="list-style-type: none"> <li>- Unwillingness to change and lifelong learning;</li> <li>- Further urbanization of the Republic of Croatia</li> </ul>
<b>Education of the population</b>	<ul style="list-style-type: none"> <li>- Lifelong education through modern communication tools</li> <li>- School in nature as a new educational trend</li> </ul>	<ul style="list-style-type: none"> <li>- Mismatch between the education system and the needs of the economy</li> </ul>
<b>Economy</b>	<ul style="list-style-type: none"> <li>- Proximity to the sea and tourist destinations</li> <li>- Growing popularity of outdoor and eco-tourism</li> <li>- New trends that connect forests, medicine and health tourism</li> <li>- Growth in demand for eco-agricultural products</li> <li>- Potentials for the development of renewable energy sources</li> <li>- The trend of using wood in construction</li> <li>- Green Taxation</li> <li>- Availability of EU, national and regional funds to boost development</li> </ul>	<ul style="list-style-type: none"> <li>- Unfavorable business environment compared to neighboring Slovenia and coast</li> <li>- Insufficient degree of fiscal and functional decentralization and overemphasized role of the central state</li> </ul>
<b>Infrastructure</b>	<ul style="list-style-type: none"> <li>- Global development of MaaS mobility systems</li> </ul>	<ul style="list-style-type: none"> <li>- High costs of maintaining communal infrastructure in areas with low population density</li> </ul>

It is evident that there are numerous challenges and opportunities for the further development of GK. At the same time, it is necessary to work on limitations and weaknesses, to implement new solutions and policies that will bring direct and indirect benefits to the entire community. Only through the joint forms of action of

all stakeholders, the development of GK can go in the direction of increasing the quality of life of residents, mitigating negative demographic trends and social progress.

## 5 Conclusion

Population and depopulation are the most important challenges that calls for a comprehensive approach to the future development of GK. Regions that, like GK, record a significant decrease in the number of inhabitants have a large gap in the provision of social services (health care, cultural events), physical (transportation) and information technology connectivity, education and employment opportunities. Therefore, it is necessary to stop the negative trend mentioned in order to minimize the consequences for the economy, social life and social standard. The implementation of green policies and the concept of GE in the area of GK can reduce negative trends and at the same time stimulate development. It is known that a region cannot be successful if it loses its population. A more developed transport network and better-quality mobility can significantly reduce depopulation by strengthening the connection between rural and urban areas. Rural / eco-tourism and remote work are only some solutions that can play an important role in the economic and demographic revitalization of the GK area.

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# PROCESNI MANAGEMENT KOT KLJUČNI DEJAVNIK DOLGOROČNEGA OBSTOJA POSLOVNIH SISTEMOV

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V sodobnem poslovnem okolju, ki ga zaznamujejo hitre tehnološke spremembe in globalna konkurenca, je nujno, da poslovni sistemi za svoj dolgoročni obstoj neprestano optimizirajo svoje delovanje. Dolgoročni obstoj poslovnih sistemov se nanaša na njegovo zmožnost preživetja in rasti v dinamičnih tržnih pogojih skozi daljše časovno obdobje. Na to zmožnost lahko vplivajo različni notranji in zunanji dejavniki. Namen prispevka je identificirati ključne dejavnike, ki vplivajo na dolgoročni obstoj poslovnih sistemov. Prav tako želimo ugotoviti pomen procesnega managementa skozi njegovo umestitev na seznamu zbranih dejavnikov. V ta namen je pregledana multidisciplinarna zbirka SCOPUS. Na podlagi teoretičnega pregleda smo oblikovali nabor ključnih dejavnikov dolgoročnega obstoja poslovnih sistemov. Pripravljen pregledni prispevek lahko služi kot izhodišče za nadaljnje raziskave usmerjene v poglobljeno analizo posameznih ključnih dejavnikov in njihovo medsebojno povezanost. Identificiran nabor predstavlja tudi osnovo za oblikovanje modela najpomembnejših dejavnikov dolgoročnega obstoja poslovnih sistemov. Le ta bo imel tudi praktično vrednost za različne poslovne sisteme.

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# PROCESS MANAGEMENT AS A KEY FACTOR IN THE LONG-TERM VIABILITY OF BUSINESS SYSTEMS

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In the modern business environment characterized by rapid technological changes and global competition, business systems need to optimize their operations to ensure long-term viability continuously. The long-term viability of business systems refers to their ability to survive and grow under dynamic market conditions over an extended period. Various internal and external factors can influence this ability. This paper aims to identify the key factors that affect the long-term viability of business systems. Additionally, we aim to determine the importance of process management by positioning it within the list of identified factors. To achieve this, a multidisciplinary SCOPUS database was reviewed. Based on the theoretical review, we compiled a set of key factors contributing to the long-term viability of business systems. The prepared review article can serve as a starting point for further research focused on an in-depth analysis of individual key factors and their interconnections. The identified set also serves as a foundation for developing a model of the most important factors influencing the long-term viability of business systems, which will have practical value for various business systems.



## 1 Uvod

Dolgoročni obstoj poslovnih sistemov predstavlja ključen izziv v sodobnem poslovnem okolju, kjer globalna konkurenca in hitre tehnološke spremembe zahtevajo stalno prilagajanje in inovacije (Kremsar, 2021). Sposobnost poslovnih sistemov, da vzdržujejo svojo konkurenčnost skozi daljše časovno obdobje, ni le vprašanje preživetja, temveč tudi strateškega razvoja, ki omogoča trajnostno rast in prilagodljivost. V takšnih razmerah se dolgoročni obstoj poslovnih sistemov pogosto povezuje z njihovo zmožnostjo odzivanja na zunanje spremembe ter izkoriščanjem notranjih virov in zmogljivosti (Felin et al., 2015).

Pri tem procesni management predstavlja enega izmed osrednjih pristopov, ki poslovnim sistemom omogoča doseganje strateških ciljev skozi optimizacijo in usklajevanje poslovnih procesov. S poudarkom na izboljšavah operativne učinkovitosti in prilagodljivosti je procesni management postal ključen dejavnik za doseganje trajnostne konkurenčne prednosti. Njegova vloga pri dolgoročnem obstoju poslovnih sistemov je še posebej pomembna v hitro spreminjajočem se poslovnem okolju, kjer sta agilnost in inovativnost bistvenega pomena (Dumas et al., 2013).

Namen prispevka je identificirati ključne dejavnike, ki vplivajo na dolgoročni obstoj poslovnih sistemov in analizirati pomen procesnega managementa v tem kontekstu. Poleg omenjenega, prispevek raziskuje vpliv procesnega managementa na dolgoročno stabilnost in prilagodljivost poslovnih sistemov. Namen je ponuditi teoretično osnovo za razumevanje ključnih dejavnikov, ki prispevajo k trajnostni konkurenčni prednosti in dolgoročnem obstoju poslovnih sistemov. S tem se postavlja temelj za razvoj praktičnih strategij in modelov, ki lahko poslovnim sistemom pomagajo pri soočanju z dinamičnimi izzivi sodobnega poslovnega okolja.

V nadaljevanju sledi pregled teoretičnih izhodišč iz obravnavane tematike, predstavitev uporabljene metodologije, analiza identificiranih dejavnikov ter razprava o njihovem vplivu na dolgoročni obstoj poslovnih sistemov. Prispevek zaključujemo z diskusijo o praktični vrednosti ugotovitev in predlogi za nadaljnje raziskave.

## 2 Teoretična izhodišča

### 2.1 Dolgoročni obstoj poslovnih sistemov

Dolgoročni obstoj poslovnih sistemov se nanaša na njihovo sposobnost preživetja, stabilnosti in rasti skozi daljša časovna obdobja. Gre za koncept, ki vključuje ne le odpornost na zunanje pritiske in tržne spremembe, temveč tudi proaktivno prilagajanje, inovacije ter ustvarjanje trajnostne vrednosti za deležnike. Po definiciji je dolgoročni obstoj tesno povezan z vzdrževanjem konkurenčne prednosti, ki poslovnim sistemom omogoča trajno uspešnost (Barney in Hesterly, 2015).

Ključni elementi, ki določajo dolgoročni obstoj, vključujejo strateško načrtovanje, učinkovito upravljanje virov in sposobnost prilagajanja spreminjajočim se tržnim razmeram. Poslovni sistem, ki uspejo razviti agilne organizacijske strukture in kulturo nenehnega učenja, so boljše pripravljena na soočanje z izzivi globalne konkurence in tehnoloških sprememb (McEvily et al., 2004).

Pomen dolgoročnega obstoja se v današnjem hitro spreminjajočem se poslovnem okolju le še povečuje, kjer poslovni sistemi pogosto delujejo pod močnimi pritiski globalizacije in digitalizacije. Dolgoročni obstoj omogoča poslovnim sistemom ne le preživetje, temveč tudi izkoriščanje novih priložnosti, ki nastajajo zaradi tehnoloških inovacij in sprememb v potrebah potrošnikov. Tako predstavlja temelj za trajnostni razvoj in stabilnost tako na mikro kot makroekonomski ravni (Lăzăroiu et al., 2020).

Na dolgoročni obstoj poslovnih sistemov vplivajo tako notranji kot tudi zunanji dejavniki. Notranji dejavniki so tisti, ki izvirajo iz notranje organizacije poslovnih sistemov, medtem ko zunanji dejavniki izhajajo iz širšega gospodarskega, tehnološkega in družbenega okolja (Bukovšek, 2017).

Notranji dejavniki, ki vplivajo na dolgoročni obstoj poslovnih sistemov, vključujejo predvsem organizacijsko kulturo, strukturo poslovnih sistemov, kakovost vodenja in sposobnost inoviranja (Hove et al., 2013). Močna organizacijska kultura, ki temelji na vrednotah, kot so sodelovanje, inovativnost in odgovornost, ustvarja okolje, kjer zaposleni aktivno prispevajo k trajnostnemu razvoju poslovnega sistema. Poleg tega ima ustrezna struktura poslovnega sistema ključno vlogo pri prilagajanju spremembam v poslovnem okolju ter omogoča učinkovito alokacijo virov in hitro



odzivanje na tržne priložnosti. Vodstvo poslovnega sistema je prav tako ključni notranji dejavnik, saj odločitve vodilnih vplivajo na vse ravni poslovanja (Srimulyani et al., 2023). Voditelji, ki spodbujajo transparentnost, komunikacijo in sodelovanje med oddelki, lahko bistveno pripomorejo k dolgoročni stabilnosti poslovnega sistema (Hughes, 2016). Inovacijska sposobnost poslovnega sistema pa ima ključno vlogo pri ustvarjanju novih izdelkov, storitev in procesov, kar poslovnim sistemom omogoča ohranjanje konkurenčne prednosti na dolgi rok (Shatilo, 2019).

Z druge strani zunanji dejavniki vključujejo predvsem spremembe v regulativnem okviru, gospodarske trende, tehnološki napredek in vedenje potrošnikov (Daily et al., 2001). Globalizacija in digitalizacija prinašata nove izzive in priložnosti, pri čemer poslovni sistemi potrebujejo sposobnost hitrega prilagajanja spremembam na trgu. Gospodarski trendi, kot so inflacija, recesije ali rasti trga, neposredno vplivajo na delovanje poslovnih sistemov in zahtevajo premišljeno strateško načrtovanje (Xue, Shen in Hsieh, 2019). Tehnološki napredek, kot so umetna inteligenca, avtomatizacija in digitalizacija, ustvarja priložnosti za povečanje operativne učinkovitosti, vendar hkrati zahteva tudi visoko stopnjo prilagodljivosti in pripravljenosti na spremembe. Na vedenje potrošnikov vplivajo številni dejavniki, vključno z družbenimi trendi, demografskimi spremembami in tehnološkimi inovacijami, kar poslovne sisteme sili k nenehnemu prilagajanju svojih izdelkov in storitev (Dubitskaya in Tcukanova, 2018).

## **2.1 Pomen procesnega managementa v poslovnih sistemih**

Procesni management (angl. Business Process Management, v nadaljevanju BPM) predstavlja ključen element pri zagotavljanju dolgoročnega obstoja poslovnih sistemov, saj omogoča strukturiran pristop k obvladovanju in optimizaciji poslovnih procesov (Ahmad in Van Looy, 2020). S prilagoditvijo poslovnih procesov hitrim spremembam na trgu lahko poslovni sistemi ohranijo konkurenčno prednost ter hkrati zagotavljajo skladnost z regulativnimi zahtevami. BPM prav tako spodbuja boljšo izrabo virov in zmanjšuje nepotrebne stroške, kar povečuje operativno učinkovitost (Van Looy et al., 2014).

Poleg operativnih koristi ima BPM tudi strateško vrednost. Z integracijo procesov in novih tehnologij, kot so umetna inteligenca in avtomatizacija, lahko poslovni sistemi izboljšajo izkušnje strank ter hkrati povečajo svojo odpornost na zunanje

izzive. To omogoča dolgoročno stabilnost in trajnostni razvoj poslovnih sistemov (Bakotic in Krnic, 2017).

Procesni management ima neposreden vpliv na izboljšanje učinkovitosti poslovnega sistema, saj omogoča identifikacijo in odpravo neučinkovitosti v poslovnih procesih. S poenostavitvijo procesov poslovni sistemi zmanjšujejo nepotrebne stroške, povečujejo produktivnost in izboljšujejo kakovost svojih izdelkov ali storitev (Urh et al., 2019). Poleg tega sistematična uporaba BPM podpira hitrejšo implementacijo novih poslovnih modelov in tehnologij, kar je ključnega pomena za rast poslovnega sistema (Fischer et al., 2020).

### 3 Metodologija

Sistematični pregled razpoložljive znanstvene literature je bil izveden s pomočjo podatkovne zbirke SCOPUS. V pregledu smo se osredotočili predvsem na raziskave, ki so preučevale dejavnike dolgoročnega obstoja poslovnih sistemov. Literaturo smo iskali med članki, objavljenimi do / vključno z 20.01.2025. Pri iskanju smo uporabili naslednja dva iskalna niza v angleškem jeziku:

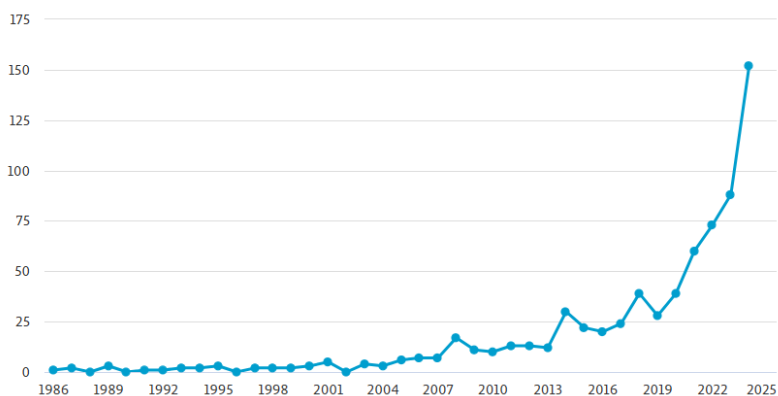
- "success factor" OR "success indicator" OR "critical factor" OR "critical indicator" OR "key factor" OR "key indicator" AND "organization" OR "company" OR "enterprise" OR "business\*" AND "resilience" OR "longevity" OR "long term survival" OR "long term existence" OR "viability";
- prvi sklop besednih zvez smo zamenjali s "process management" OR "business process" OR "business process management".

V obeh primerih poizvedovanja smo se, z namenom zagotavljanja natančnosti raziskave in pridobivanja relevantnih virov, pri iskanju osredotočili na naslednja področja: Business, Management and Accounting; Social Sciences; Engineering; Economics, Econometrics and Finance; Decision Sciences. Pri prvem iskalnem nizu smo tako izluščili 722 virov in pri drugem iskalnem nizu 348 virov.

## 4 Rezultati raziskave

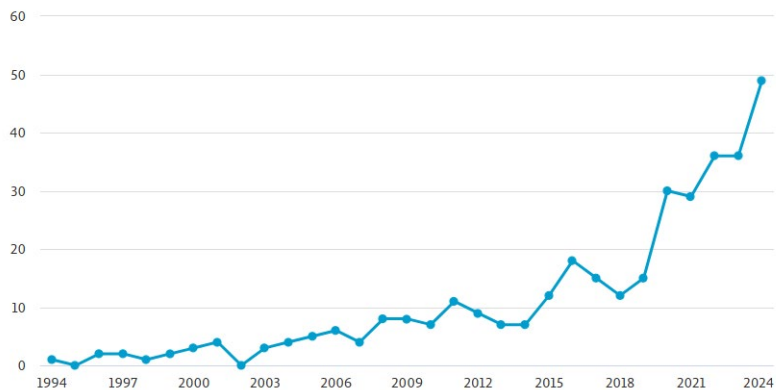
### 4.1 Bibliometrična analiza pridobljenih virov

Na samem začetku bibliometrične analize pridobljenih virov najprej prilagamo grafa razporeditve virov po letih, kjer je tako za prvi iskalni niz (slika 1) kakor tudi za drugi iskalni niz (slika 2) razvidno, da raziskave iz obravnavane tematike v zadnjih petih letih močno naraščajo.



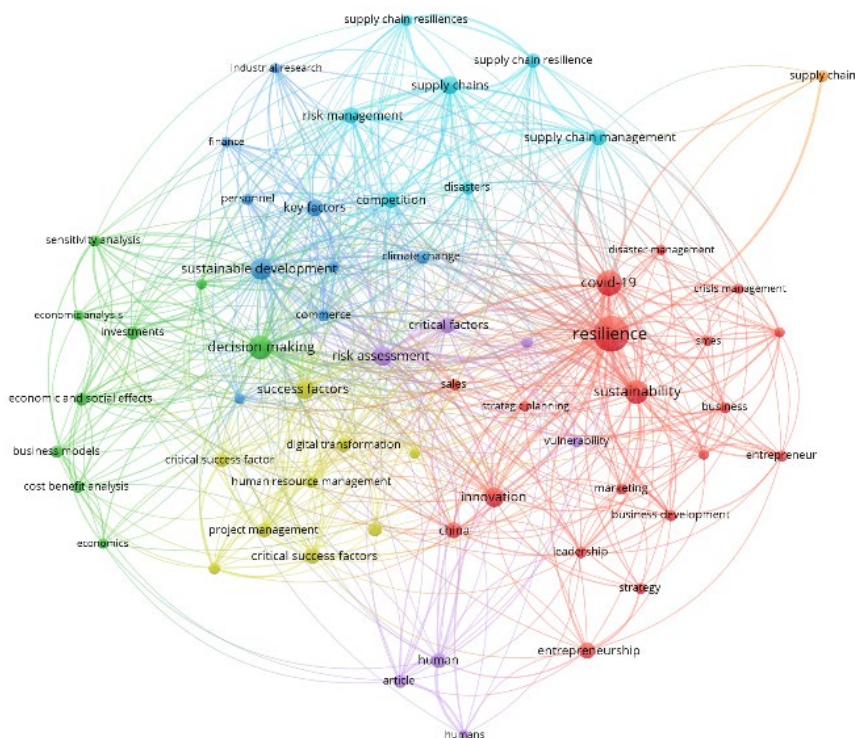
Slika 1: Razporeditev virov po letih za prvi iskalni niz

Vir. Lasten



Slika 2: Razporeditev virov po letih za drugi iskalni niz

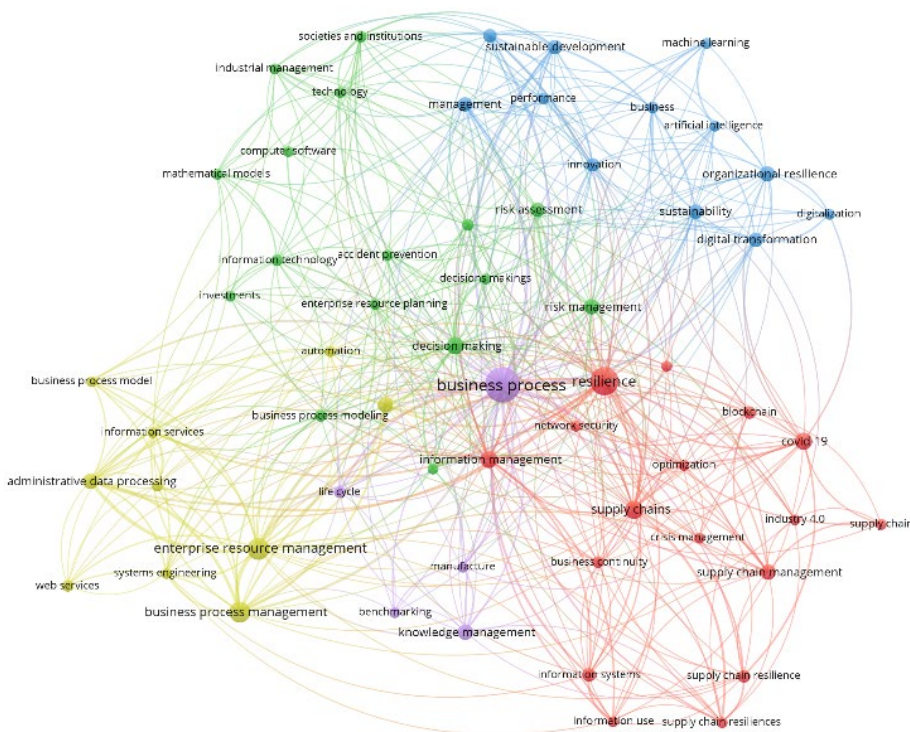
Vir. Lasten



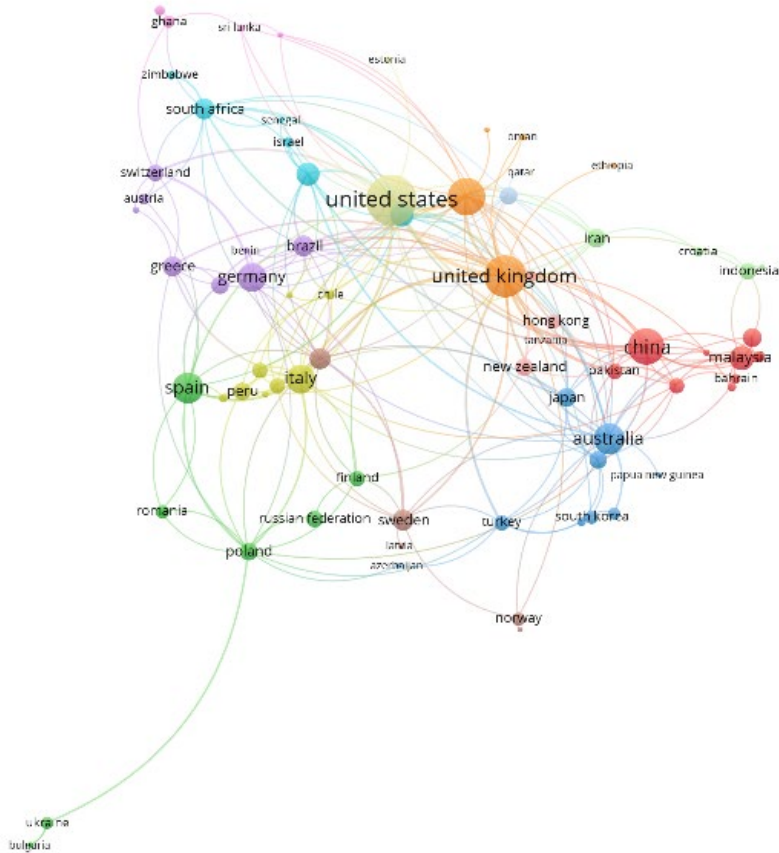
**Slika 3: Zemljevid vizualizacije omrežja ključnih besed za prvi iskalni niz**

Slika 3 predstavlja bibliometrično mrežo, ki se osredotoča na dolgotrajni obstoj poslovnih sistemov. Največje vozlišče je odpornost (angl. Resilience), ki predstavlja osrednjo temo mreže. Okoli vozlišča odpornost se zgostijo ključni koncepti, kot so covid-19, trajnost (angl. Sustainability) in inovacija (angl. Innovation), kar kaže na večplastnost izzivov, s katerimi se poslovni sistemi soočajo pri zagotavljanju dolgoročnega obstoja. Med večjimi vozlišči, ki jih velja izpostaviti zaradi njihovega vpliva na dolgoročni obstoj poslovnih sistemov, so še odločanje (angl. Decision Making), ocena tveganja (angl. Risk Assessment), dejavniki uspeha (angl. Success Factors) ter dobavne verige (angl. Supply Chains). Ta vozlišča se močno navezujejo na ključne notranje in zunanje dejavnike, ki jih izpostavljamo v nadaljevanju: na primer inovacijske sposobnosti (angl. Innovation), kakovost vodenja (angl. Leadership), operativno učinkovitost, ocena tveganja (angl. Risk Assessment), projektni management (angl. Project Management) in makroekonomske pogoje (ekonomska analiza (angl. Economic Analysis), finance, naložbe (angl.

Investments)). Opazna je tudi povezanost s področji, ki se nanašajo na organizacijsko kulturo in strukturo (upravljanje človeških virov (angl. Human Resource Management) in poslovni modeli (angl. Business Models), saj so ravno ti vidiki pogosto povezani s procesnim managementom in strateškim razvojem kadrov. Pri tem je procesni management ključnega pomena za optimizacijo poslovnih procesov, izboljšanje operativne učinkovitosti ter podporo inovacijam, kar pojasnjuje, zakaj se pojavlja tako v kontekstu notranjih dejavnikov (npr. obvladovanje resursov, komunikacija, zavzetost zaposlenih) kot tudi zunanjih (npr. prilagajanje zahtevam trga, tehnološki napredek in upravljanje tveganj). V ospredju ostaja ideja, da je prav proaktivno upravljanje procesov eden od temeljev, ki organizaciji omogoča dolgoročno uspešno soočanje z izzivi, razvidnimi iz bibliometrične mreže.



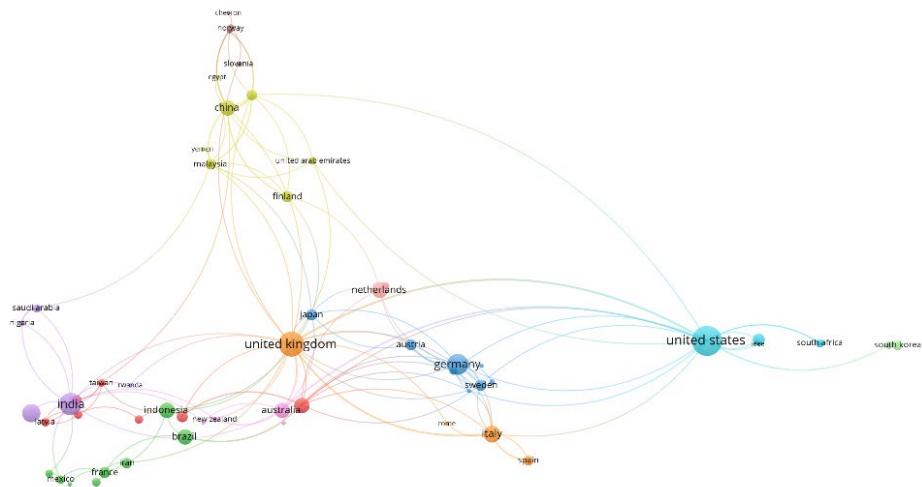
Slika 4: Zemljevid vizualizacije omrežja ključnih besed za drugi iskalni niz



**Slika 5: Zemljevid vizualizacije omrežja soavtorstva držav za prvi iskalni niz**

Slika 4 predstavlja bibliometrično mrežo drugega iskalnega niza. V središču mreže izstopa vozlišče poslovni proces (angl. Business Process), ki se prek številnih povezav navezuje na odpornost (angl. Resilience), upravljanje podjetniških virov (angl. Enterprise Resource Management), upravljanje poslovnih procesov (angl. Business Process Management) in dobavne verige (angl. Supply Chains). Ti poudarki kažejo na pomembno vlogo procesnega managementa pri zagotavljanju organizacijske odpornosti, saj ravno usklajenost poslovnih procesov, učinkovito načrtovanje virov ter obvladovanje dobavnih verig tvorijo temelje za dolgotrajni obstoj poslovnih sistemov. V zgornjem delu mreže opazimo močno zastopana področja, kot so trajnost (angl. Sustainability), organizacijska odpornost

(Organizational Resilience), digitalna transformacija (angl. Digital Transformation), strojno učenje (angl. Machine Learning) in umetna inteligenca (angl. Artificial Intelligence), kar potrjuje pomen inovacijskih sposobnosti ter tehnološkega napredka pri krepitvi odpornosti poslovnih procesov. Poleg tega se med večjimi vozlišči znajdejo še upravljanje tveganj (angl. Risk Management), odločanje (angl. Decision Making) in covid-19, ki poudarjajo potrebo po pravočasnem odzivanju na tržne spremembe in nepredvidene okoliščine, vključujoč krizno upravljanje in prilagajanje makroekonomskim razmeram. Na spodnjem delu mreže se izrisuje vozlišče, ki med drugim vključuje upravljanje znanja (angl. Knowledge Management), primerjalno analizo (angl. Benchmarking), informacijske sisteme (angl. Information Systems) ter inženiring sistemov (angl. Systems Engineering). Ti izrazi nakazujejo, da sta sistematično upravljanje znanja in stalno nadgrajevanje internih procesov izjemno pomembna dejavnika vzdrževanja konkurenčne prednosti. Na ta način se Slika 4 jasno navezuje na ključne notranje in zunanje dejavnike (npr. inovacijske sposobnosti, upravljanje tveganj, tehnološki napredek, globalni tržni trendi), ki jih izpostavljamo kot bistvene za dolgoročni obstoj poslovnih sistemov.



Slika 6: Zemljevid vizualizacije omrežja soavtorstva držav za drugi iskalni niz

Zemljevida vizualizacije omrežja prikazana na slikah 5 in 6 sta razvita za prikaz odnosov med državami na podlagi ugotovitev raziskav in povezav citiranja. Vsako vozlišče predstavlja posamezno državo, pri tem pa večja vozlišča označujejo večjo količino virov iz posamezne države. Države, kot so Združene države Amerike, Združeno kraljestvo in Kitajska (prvi iskalni niz) oz. Indija (drugi iskalni niz), imajo večja vozlišča, kar jasno kaže na njihov pomemben doprinos v raziskavah obravnavanega področja. Različne barve vozlišč ponazorijo različne skupine držav s podobnimi raziskovalnimi interesi. Povezave držav medtem pokažejo, da se raziskovalci teh državah sklicujejo na delo svojih mednarodnih kolegov.

## 4.2 Ključni dejavniki dolgotrajnega obstoja poslovnih sistemov

Po pregledu literature smo uspešno identificirali ključne notranje in zunanje dejavnike, ki pomembno vplivajo na dolgoročni obstoj poslovnih sistemov.

Med notranje dejavnike spadajo:

- Organizacijska kultura (Shveda et al., 2024; Kirchmer, 2008);
- Struktura poslovnega sistema (Viaene & Van den Bergh, 2018; Jakoubi et al., 2007);
- Kakovost vodenja (Rubakha et al., 2024; Macuzić et al., 2016);
- Inovacijske sposobnosti (Shveda et al., 2024; Kirchmer, 2008);
- Finančna stabilnost (Rubakha et al., 2024);
- Operativna učinkovitost (Kirchmer, 2008; Macuzić et al., 2016);
- Zavzetost zaposlenih (Viaene & Van den Bergh, 2018);
- Tehnološke zmožnosti (Shveda et al., 2024; Belesiotti et al., 2021);
- Sistematično upravljanje znanja (Shveda et al., 2024; Kirchmer, 2008).

Organizacijska kultura poudarja spodbujanje inovacij, sodelovanja ter transparentnost (Shveda et al., 2024; Kirchmer, 2008). Struktura poslovnega sistema je ključnega pomena, saj vključuje fleksibilnost, jasno določene vloge in odgovornosti ter učinkovito komunikacijo med oddelki (Viaene & Van den Bergh, 2018; Jakoubi et al., 2007). Kakovost vodenja je tesno povezana z vodstvenimi kompetencami, strateškim razmišljanjem ter podporo ekipnemu delu in razvoju zaposlenih (Rubakha et al., 2024; Macuzić et al., 2016). Poleg tega imajo pomembno



vlogo tudi inovacijske sposobnosti, ki vključujejo uporabo novih tehnologij, razvoj izdelkov in storitev ter prilagajanje tržnim spremembam (Shveda et al., 2024; Kirchmer, 2008). Finančna stabilnost omogoča učinkovito upravljanje sredstev, nizko stopnjo dolga in dolgoročne investicije v rast (Rubakha et al., 2024). Operativna učinkovitost je ključna za optimizacijo poslovnih procesov in zmanjševanje stroškov ter omogoča uporabo kazalnikov učinkovitosti in uspešnosti (Kirchmer, 2008; Macuzić et al., 2016). Zavzetost zaposlenih, ki vključuje njihovo motivacijo in zadovoljstvo, vpliva na ohranjanje talentov in priložnosti za napredovanje (Viaene & Van den Bergh, 2018). Tehnološke zmožnosti, kot so digitalizacija procesov, upravljanje podatkov ter kibernetška varnost, zagotavljajo konkurenčno prednost (Shveda et al., 2024; Belesioti et al., 2021). Nenazadnje pa je za dolgoročni uspeh podjetij ključno tudi sistematično upravljanje znanja, ki vključuje deljenje znanja, nenehno izobraževanje in gradnjo intelektualnega kapitala (Shveda et al., 2024; Kirchmer, 2008).

Med zunanje dejavnike spadajo:

- Makroekonomski pogoji (Rubakha et al., 2024);
- Regulativni okvir (Shveda et al., 2024);
- Tehnološki napredek (Shveda et al., 2024; Belesioti et al., 2021);
- Tržni trendi (Viaene & Van den Bergh, 2018);
- Vedenje potrošnikov (Evans, 2001);
- Globalizacija (Rubakha et al., 2024; Macuzić et al., 2016);
- Okoljski dejavniki (Vedula et al., 2024);
- Geopolitični vplivi (Belesioti et al., 2021);
- Družbeni dejavniki (Evans, 2001);
- Okolje za inovacije (Shveda et al., 2024; Kirchmer, 2008);
- Logistični dejavniki (Vedula et al., 2024);
- Tveganja in nepredvideni dogodki (Rubakha et al., 2024).

Makroekonomski pogoji, kot so gospodarska rast, inflacija in obrestne mere ter nihanje valut, lahko pomembno vplivajo na poslovne modele podjetij (Rubakha et al., 2024). Regulativni okvir, ki vključuje zakonodajne prilagoditve, okoljske standarde in davčno politiko, določa operativne možnosti podjetij (Shveda et al., 2024). Tehnološki napredek, predvsem v obliki umetne inteligence in avtomatizacije

ter novih tehnoloških trendov, podjetjem omogoča digitalno transformacijo in inovacije (Shveda et al., 2024; Belesioti et al., 2021). Tržni trendi, ki vključujejo spreminjajoče se preference potrošnikov, rast nišnih trgov ter konkurenčno dinamiko, zahtevajo stalno prilagajanje podjetij (Viaene & Van den Bergh, 2018). Poleg tega vedenje potrošnikov, ki ga oblikujejo družbeni vplivi, demografske spremembe in povečana pričakovanja glede trajnostnosti, igra ključno vlogo pri oblikovanju izdelkov in storitev (Evans, 2001). Globalizacija odpira dostop do mednarodnih trgov, hkrati pa povečuje tveganja, povezana z globalnimi dobavnimi verigami in geopolitičnimi izzivi (Rubakha et al., 2024; Macuzić et al., 2016). Okoljski dejavniki, kot so podnebne spremembe in pritiski za trajnostni ter zeleni razvoj, so vedno bolj pomembni za podjetja, ki želijo dolgoročno obstati (Vedula et al., 2024). Geopolitični vplivi, vključno s politično stabilnostjo regij, sankcijami, konflikti in trgovinskimi vojnami, lahko povzročijo velike motnje v poslovanju (Belesioti et al., 2021). Družbeni dejavniki, kot so izobraževalni sistemi in kulturne razlike, določajo razpoložljivost kvalificirane delovne sile in sodelovanja na globalnem trgu (Evans, 2001). Okolje za inovacije, ki vključuje dostop do raziskovalnih središč in subvencije za inovacije ter partnerstva z akademskimi ustanovami spodbuja razvoj novih tehnologij in procesov (Shveda et al., 2024; Kirchmer, 2008). Logistični dejavniki, kot so stabilnost dobavnih verig, stroški prevoza in razpoložljivost surovin, pa ostajajo ključni za nemoteno delovanje podjetij (Vedula et al., 2024). Nenazadnje so tveganja in nepredvideni dogodki, kot so naravne nesreče, finančne krize in pandemije, pomembni dejavniki, ki vplivajo na odpornost poslovnih sistemov (Rubakha et al., 2024).

### 4.3 Procesni management kot ključni dejavnik

Iz pregledanih člankov ugotavljamo, da je procesni management pogosto predstavljen kot ključni dejavnik vpliva na dolgoročni obstoj poslovnih sistemov. Številne raziskave (Kirchmer, 2008; Viaene & Van den Bergh, 2018; Jakoubi et al., 2007; Shveda et al., 2024; Macuzić et al., 2016; Rubakha et al., 2024) poudarjajo njegovo vlogo pri izboljševanju operativne učinkovitosti in sposobnosti poslovnih sistemov, da se odzovejo na spremembe v dinamičnem poslovnem okolju.

Kirchmer (2008) je v svoji raziskavi ugotovil, da inovacije v poslovnih procesih ne prispevajo le k stabilnosti podjetja, temveč omogočajo njegovo rast in dolgoročno konkurenčnost. Viaene in Van den Bergh (2018) sta pokazala, kako je prilagoditev

poslovnih procesov skozi transformacijo organizacije omogočila preživetje podjetja Autogrill v izjemno konkurenčnih pogojih. Podobno so Jakoubi et al. (2007) razvili metodologijo, ki povezuje obvladovanje tveganj s procesnim managementom, kar krepi odpornost poslovnih sistemov na nepredvidene dogodke.

Poleg tega Shveda et al. (2024) poudarjajo, da digitalna transformacija poslovnih procesov ni le konkurenčna prednost, ampak nujnost za dolgoročno obstojnost v dinamičnih okoljih. Raziskava Macuzić et al. (2016) se osredotoča na ocenjevanje dejavnikov odpornosti v poslovnih procesih, pri čemer ugotavlja, da optimizacija in prilagodljivost procesov igrata ključno vlogo pri odzivu na krizne razmere. Rubakha et al. (2024) pa poudarjajo pomen finančne stabilnosti in strateške odpornosti poslovnih sistemov, kar vključuje tudi krepitev procesnega managementa za uspešno spoprijemanje z zunanjimi izzivi.

## **5 Diskusija in zaključek**

Rezultati raziskave jasno kažejo, da na dolgoročni obstoj poslovnih sistemov vpliva kombinacija notranjih in zunanjih dejavnikov. Notranji dejavniki, kot so organizacijska kultura, struktura poslovnega sistema, kakovost vodenja, inovacijske sposobnosti in finančna stabilnost, omogočajo prilagodljivost, razvoj in trajnostno rast (Kirchmer, 2008; Rubakha et al., 2024; Shveda et al., 2024). Zunanji dejavniki, kot so makroekonomski pogoji, regulativni okvir, tehnološki napredek, tržni trendi in vedenje potrošnikov, pa poslovne sisteme postavljajo pred nenehne izzive (Shveda et al., 2024; Evans, 2001; Vedula et al., 2024).

Procesni management je v raziskavi identificiran kot eden od ključnih dejavnikov. Pomembno je poudariti, da se v literaturi ne obravnava le kot tehnični ali podporni mehanizem, temveč kot osrednji pristop, ki podpira dolgoročno uspešnost in obstoj poslovnih sistemov (Kirchmer, 2008; Viaene & Van den Bergh, 2018). Njegova implementacija namreč omogoča vzpostavitev ravnovesja med notranjimi možnostmi in zahtevami zunanjega okolja. Na notranji ravni procesni management (BPM) omogoča strukturiran pristop k obvladovanju in optimizaciji procesov, kar zmanjšuje stroške in izboljšuje produktivnost (Macuzić et al., 2016; Rubakha et al., 2024). Prav tako omogoča prilagodljivost, saj poslovnim sistemom pomaga hitreje odzivati na tržne in tehnološke spremembe (Shveda et al., 2024; Kirchmer, 2008). Na zunanji ravni BPM poslovnim sistemom omogoča boljše prilagajanje

regulativnim zahtevam ter učinkovito odzivanje na tehnološke in tržne pritiske (Jakoubi et al., 2007; Belesioti et al., 2021).

Ena ključnih prednosti BPM je tudi integracija naprednih tehnologij, kot so umetna inteligenca in avtomatizacija, kar spodbuja trajnostno konkurenčno prednost in dolgoročno rast. Vloga BPM je še posebej izrazita v hitro spreminjajočem se poslovnem okolju, kjer agilnost in inovativnost odločilno vplivata na konkurenčnost (Shveda et al., 2024; Belesioti et al., 2021). Njegov pomen je primerljiv z drugimi ključnimi notranjimi dejavniki, kot so inovacijske sposobnosti in kakovost vodenja (Rubakha et al., 2024; Kirchmer, 2008).

Pregled literature je bil omejen na multidisciplinarno bazo podatkov SCOPUS. Posledično je mogoče, da so bili nekateri relevantni viri izključeni. Poleg tega raziskava temelji na teoretičnih pregledih in ni vključevala empiričnih podatkov, kar omejuje njeno neposredno uporabnost v specifičnih poslovnih kontekstih. Vendar prispevek ponuja pregled ključnih dejavnikov dolgoročnega obstoja in izpostavlja pomen procesnega managementa na podlagi celovitega pregleda do sedaj dostopnih podatkov.

Raziskava ima pomembno praktično vrednost, saj so identificirani dejavniki temelj za razvoj strategij, ki omogočajo večjo stabilnost, prilagodljivost in konkurenčnost poslovnih sistemov. Njene ugotovitve predstavljajo teoretični okvir za nadaljnje raziskave in praktično vodilo za poslovne sisteme, ki želijo doseči dolgoročno uspešnost v dinamičnem okolju.

Za nadaljnje raziskave priporočamo empirične študije, ki bi podrobneje analizirale vpliv posameznih dejavnikov na dolgoročni obstoj poslovnih sistemov. Koristno bi bilo tudi raziskati medsebojno povezanost notranjih in zunanjih dejavnikov ter razviti celovit model, ki bi omogočili boljše razumevanje kompleksnosti dolgoročnega obstoja glede na najpomembnejše dejavnike.

Le z ustreznim ravnotežjem med notranjimi zmogljivostmi in prilagoditvijo na zunanje izzive lahko poslovni sistemi ohranijo konkurenčnost in relevantnost v hitro spreminjajočem se gospodarskem okolju.

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# FAKE NEWS IN THE DIGITAL AGE: THE ROLE OF SCIENCE AND MEDIA LITERACY IN IDENTIFYING TRUTH

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In the digital age, called the post-truth era, emotions and beliefs frequently overshadow objective facts. The concept of "post-truth," Oxford Dictionary's Word of the Year in 2016, underscores the influence of fake news, conspiracy theories, and opinion-driven narratives in distorting perceptions of reality. The 2024 oooScience! project study, conducted as part of the European Researchers' Night and Researchers at Schools initiative of the Marie Skłodowska-Curie Actions (MSCA) & Citizens examined the ability of 921 respondents to distinguish fake news from credible information. The research, involving diverse groups such as the general public, educators, high school students, and event attendees, revealed the critical role of science and media literacy in combating misinformation. Accessible scientific communication emerged as a key tool for fostering trust in science and bridging gaps between experts and the public. These findings highlight the importance of collaborative educational strategies to enhance media literacy, build resilience against fake news, and empower individuals to make informed decisions in the digital age.

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## 1 Introduction

In the digital age, commonly called the post-truth era, information appealing to emotions, beliefs, and desires often precedes objective facts. The term "post-truth," declared the Word of the Year by the Oxford Dictionary in 2016, captures the growing influence of fake news, conspiracy theories, and opinion-driven narratives in shaping perceptions of reality that frequently diverge from factual truth. Although fake news is not a new phenomenon, the internet and social media have dramatically expanded the reach and impact of misinformation and disinformation. Fake news may arise unintentionally through the spread of unchecked information (*misinformation*), be deliberately created to deceive or harm (*disinformation*), or consist of accurate information shared with the intent to cause damage (*malinformation*) (Christian, 2020).

### 1.1 A Short Review of the Literature on Fake News

Fake news has emerged as a pressing concern across multiple domains, including science, health, politics, and media. Scholars have explored its causes, mechanisms of spread, and impacts while proposing strategies for mitigation. This review synthesises these insights, establishing connections between studies to provide a cohesive understanding of fake news. Harper et al. (2020) highlight its detrimental effects, particularly in science and health. Defined as fabricated information mimicking credible content without editorial rigour, fake news includes misinformation (unintentional inaccuracies) and disinformation (deliberately deceptive content). On social media it spreads faster than truthful information, appealing to novelty and leveraging biases like confirmation and desirability bias. This rapid dissemination undermines public health and trust in science. Harper et al. (2020) advocate for reliable sources, critical thinking, and evidence-based platforms to combat these issues.

Wu et al. (2022) broaden the analysis, revealing that fake news often emerges during significant events driven by financial, ideological, or sensational motives. Amplified by platform algorithms, echo chambers, and emotional triggers, fake news exacerbates political polarisation and erodes trust in institutions. They propose regulatory frameworks and technological innovations to counteract these challenges, aligning with Harper et al.'s (2020) findings. Lazer et al. (2018) examine fake news'



proliferation through declining trust in traditional media and increasing polarisation. They emphasise the role of social media algorithms and bots in amplifying misinformation, particularly in politics. Cognitive biases, such as repeated exposure increasing perceived credibility, pose significant challenges. Authors call for global efforts integrating education, platform accountability, and collaboration between governments and researchers. Similarly, Tandoc (2019) underscores audience susceptibility to fake news, highlighting the role of media literacy in addressing cognitive biases and emotional appeals. However, he notes limitations in fact-checking and algorithmic interventions.

Mann (2018) situates fake news in the "post-truth" era, where emotional appeals often override factual information, challenging scientific integrity. His focus on fostering transparency complements Harper et al.'s (2020) emphasis on rebuilding trust in science. Taddicken and Wolff (2020) explore disinformation's emotional and cognitive dimensions, advocating media literacy and emotional awareness to build resilience against misinformation. Field-Fote (2019) highlights misinformation in scientific research, stressing rigorous standards to preserve credibility. Baissa et al. (2024) analyse how fake news combines traditional and novel narrative strategies to influence public discourse on critical issues. Zhang (2024) and Patel and Surati (2024) emphasise multimodal detection methods, integrating text, images, and videos for greater accuracy while acknowledging challenges like scalability and dataset diversity.

The literature underscores the multifaceted nature of fake news and its societal consequences. Interdisciplinary approaches are essential, integrating technological advancements, media literacy education, platform accountability, and robust scientific standards. Collaboration among academia, policymakers, and media organisations is vital to fostering an informed, resilient public.

The 2024 ooScience! project study, conducted as part of the European Researchers' Night and Researchers at Schools initiative under MSCA & Citizens, aimed to evaluate individuals' ability to differentiate between fake news and factual information and examine their media consumption habits. It surveyed diverse groups, including the general population, educators, high school students, and European Researchers' Night event attendees across Slovenian cities. The research highlighted the vital role of science and research in addressing misinformation in a

digital society. By focusing on critical thinking and scientific literacy, the study sought to identify how scientific inquiry can combat the spread of fake news and equip individuals—especially young people—with the skills needed to discern credible information, ultimately fostering a fact-based society resilient to misinformation.

## 2 Description of Methodology, Instrumentation, and Sample

The European Researchers' Night and Researchers at Schools under the auspices of the European Union aim at science engagement with society, inspiring young people to embark on scientific careers, raising public awareness of the importance of science, enforcing researchers' public recognition by illuminating their key role and impact in society. In 2024 and 2025, the European Researchers' Night, which is the largest science outreach event in Europe, occurs simultaneously in 23 countries and over 400 cities across Europe and beyond (European Research Council, n.d.). As part of the project titled *Fake news and conspiracy theories? Let's empower (ourselves for) science!* (oooScience!) (*Lažne novice in teorije zarote? Opolnomočimo (se za) znanost!*" - oooZnanost!), we conducted a study to explore how various stakeholders perceive science and research activities. For this purpose, we developed five distinct questionnaires tailored to different population groups: high school students, teachers and professors, university researchers, participants in the European Researchers' Night event, and the general public. The questionnaires were available on the online platform *1ka-arnes*, while a physical version was provided to participants of the European Researchers' Night event (held on the last Friday of September 2024). Participation in the study was voluntary, and respondents were guaranteed complete anonymity. Consent for data collection, processing, and storage was obtained from all participants. Data collection took place between June and December 2024.

The questionnaire included a five-item scale on fake news and conspiracy theories rated on a five-point Likert scale, ranging from 1 ("strongly disagree") to 5 ("strongly agree"). The scale's reliability, as measured by Cronbach's alpha, was 0.756, indicating good internal consistency. In social science research, values above 0.7 are generally considered acceptable, suggesting that the scale is suitable for further analysis. Factor analysis revealed that all items contribute to a single underlying construct. Based on the content of the items, the scale measures perceived ability

and the importance of identifying fake news and attitudes toward this issue. All items relate to the theme of recognising, understanding, and addressing the problem of fake news and misinformation. The construct can be summarised as *Perceived competence and awareness of the fake news problem*. The factor analysis results showed that all items loaded well on a single factor, confirming that the scale measures a unified concept. The items capture multiple dimensions of this construct, including self-confidence and skills, social and democratic impact, and the importance of scientific communication. Teachers in primary and secondary schools and university researchers responded to two additional items on teachers' and high school students' perceptions of knowledge and skills for communicating scientific findings and distinguishing fake news. Demographic data, including gender, age, employment status, and education level, were collected for all respondents.

The study included 921 participants. The sample consisted of diverse individuals differing in age, gender, education, and participant type. 68.0% were women, 29.8% were men, and 2.2% chose "prefer not to answer" or "other." The gender distribution was slightly negatively skewed, with women predominating. Participants ranged in age from 15 to 89 years, with an average age of 32.18 (SD = 16.53). The largest age group was 15–19 years (40.8%), followed by 41–60 years (29.4%). Other age groups included 20–30 years (12.5%), 31–40 years (12.7%), and 61 years and older (4.6%). The age distribution was slightly positively skewed, indicating a higher proportion of younger respondents. The sample included a mix of participant types: 50.8% European Researchers' Night participants, 18.9% teachers in primary and secondary schools, 15.4% high school students, 5.6% university staff, and 9.2% general public. Most respondents had secondary education or were enrolled in secondary school (44.2%). Other education levels included (a) primary education: 3.4%, (b) higher vocational education: 5.3%, (c) bachelor's degree (first Bologna cycle): 18.9%, (d) master's degree, specialisation, or old university degree (second Bologna cycle): 17.4%, and (e) master's in science or Ph.D.: 10.9%.

### 3 Results

We asked respondents to evaluate several statements regarding news that distort reality or are even false, with the following prompt: "*Below are some statements about the nature of news and the quality of information we encounter through various channels. For each statement, please assess the extent to which you agree or disagree. Use a scale from 1 (strongly*

*disagree*) to 5 (*strongly agree*). Select 'I don't know' if you cannot decide or evaluate." Table 1 provides insights into respondents' perceptions of news that distorts reality or is false, focusing on their ability to recognise such information, their knowledge and skills to differentiate credible news, and their views on the broader implications of false information.

**Table 1: Respondents' Evaluation of Statements on News that Distort Reality or Contain False Information**

	N		Mean	S.D.	I disagree (1+2)	Neutral 3	I agree (3+4)	I don't know
	Valid	Missing						
I believe I can recognise news or information that distorts reality or is even false.	841	80	3,70	,96	9,0 %	25,2 %	58,9 %	6,9 %
I believe I have enough knowledge and skills to distinguish credible news from fake news.	874	47	3,80	,95	9,4 %	21,3 %	65,7 %	3,6 %
I believe that news or information that distorts reality or is even false is a problem in Slovenia.	829	92	3,86	,97	8,0 %	21,3 %	62,4 %	8,3 %
I believe that news or information that distorts reality or is even false is a problem for democracy in general.	834	87	4,16	,97	6,0 %	13,5 %	73,5 %	7,0 %
I believe that clearly communicated scientific results would personally help me distinguish between fake news and verified facts.	835	86	3,96	1,01	7,2 %	20,2 %	65,7 %	6,9 %

Respondents generally believe they can recognise news or information that distorts reality, with a mean score of 3.70. A majority (58.9%) agree with this statement, while 25.2% are neutral and 9.0% disagree. A small percentage (6.9%) were undecided. Confidence in distinguishing credible from fake news scored slightly higher, with a mean of 3.80. A significant majority (65.7%) agree, and only 9.4% disagree, indicating higher self-assessed competence in this area. Neutral responses accounted for 21.3%, and only 3.6% chose "I don't know."

The belief that distorted or false news is a problem in Slovenia yielded a mean score of 3.86. Most respondents (62.4%) agree with this statement, 21.3% are neutral, and 8.0% disagree. An additional 8.3% selected "I don't know." The strongest agreement was on the statement that false information is a problem for democracy, with a mean of 4.16. A substantial majority (73.5%) agree, while only 6.0% disagree and 13.5% are neutral. Those undecided accounted for 7.0%. Respondents also agree that clearly communicated scientific findings would help distinguish between fake news and verified facts, with a mean of 3.96. The agreement stands at 65.7%, with 20.2% neutral and 7.2% disagreeing. A small portion (6.9%) expressed indecision.

In the following analysis, we conducted additional statistical tests to determine whether any of the socio-demographic factors of respondents are associated with opinions about the nature of fake news. We identified significant relationships involving education and the recognition of fake news. Education is statistically significantly and positively associated with the perceived ability to recognise fake news ( $r=0.089$ ;  $p=0.016$ ), indicating that individuals with higher levels of education are more likely to believe they can identify false information. Education was also linked to the perception of fake news as a societal problem in Slovenia and globally. A statistically significant and positive correlation ( $r=0.118$ ;  $p=0.002$ ) indicates that more educated individuals are more likely to perceive fake news as a problem in Slovenia. Similarly, a positive and statistically significant correlation ( $r=0.146$ ;  $p<0.001$ ) with the perception of fake news as a threat to democracy highlights that individuals with higher education levels are more likely to view fake news as a danger to democratic systems. Furthermore, education is significantly and positively associated with recognising the benefits of clear communication of scientific results ( $r=0.112$ ;  $p=0.003$ ). This suggests that more educated individuals value scientific communication more in distinguishing fake news from verified facts.

We also identified two statistically significant and positive correlations involving age and the perception of fake news as a societal problem. A positive correlation ( $r=0.130$ ;  $p<0.001$ ) indicates that older individuals are likelier to perceive fake news as a problem in Slovenia. Additionally, a weak but statistically significant correlation ( $r=0.083$ ;  $p=0.017$ ) shows that older respondents are more inclined to view fake news as threatening democracy. The t-test results revealed a statistically significant difference between genders for the statement: *"I believe that clearly communicated scientific results would personally help me distinguish between fake news and verified facts."* ( $t=-1.986$ ;  $p=0.024$ ). Women ( $M=4.01$ ;  $SD=0.97$ ) agreed with this statement more strongly than men ( $M=3.86$ ;  $SD=1.08$ ).

In summary, higher education levels and older age significantly influence the perception of fake news as a societal issue. Educated individuals are more confident in identifying fake news and perceiving it as a more significant threat to Slovenia and its democracy. They also value clear and accessible communication of scientific findings as a key tool in distinguishing fake news from verified information. Similarly, older respondents are more likely to view fake news as a societal problem, particularly its impact on democratic processes. These findings underline the necessity of targeted educational initiatives and tailored scientific communication to address the needs of diverse demographic groups.

In addition to the statements about fake news presented in Table 1, we posed two additional statements to teachers and high school students, focusing on teachers' and high school students' perceptions of knowledge and skills for communicating scientific findings and distinguishing fake news. This approach allows for a comparison between the opinions of teachers and students. The results (Table 2) highlight differences in perceptions between teachers (elementary school, high school, university) and high school students regarding their own and their professors' ability to communicate and emphasise knowledge and skills necessary for distinguishing between fake news and verified facts. Regarding sufficient knowledge and skills to communicate scientific findings, teachers rated their ability to effectively communicate scientific findings with a mean score of 3.54, with 12.0% disagreeing and 58.1% agreeing. High school students evaluated their professors' ability to communicate these findings slightly higher, with a mean score of 3.71, where 10.9% disagreed, and 68.1% agreed. The t-test result shows no statistically significant difference between the two groups. The effect size suggests a small

negative effect, indicating that students view their professors' skills somewhat more favourably than teachers view their own.

In terms of emphasis on knowledge and skills to distinguish fake news from verified facts, teachers reported emphasising these skills in their work with students, with a mean score of 3.74. Only 9.3% disagreed, while 68.4% agreed with the statement. High school students rated their professors' emphasis on these skills lower, with a mean score of 3.27. Among students, 21.9% disagreed, and only 40.9% agreed. The t-test result indicates a statistically significant difference between the two groups. The effect size ( $d=0.486$ ) suggests a moderate positive effect, highlighting that teachers believe they emphasise these skills more than how students perceive their professors' efforts.

**Table 2: Comparison of Teachers' and High School Students' Perceptions of Knowledge and Skills for Communicating Scientific Findings and Distinguishing Fake News**

Teachers (elementary school, high school, university)				Students (high school)				t-test Cohen's d
	M	S.D.	I agree (3+4)		M	S.D.	I agree (3+4)	
I believe that I have sufficient knowledge and skills to effectively communicate scientific findings, which would help distinguish between fake news and verified facts. (n=217)	3,54	,84	58,1%	I believe that my professors have sufficient knowledge and skills to effectively communicate scientific findings, which help us distinguish between fake news and verified facts. (n=138)	3,71	,94	68,1%	t=-1,86 p=,064 d= -,20
In my work with pupils, high school students, or university students, I specifically emphasise knowledge and skills that would help them distinguish between fake news and verified facts. (n=215)	3,74	,92	68,4%	My professors specifically emphasise knowledge and skills during lectures that would help us distinguish between fake news and verified facts. (n=137)	3,27	1,03	40,9%	t=4,33 p=,001 d=0,49

While both groups recognise the importance of knowledge and skills for distinguishing fake news, students perceive their professors' communication efforts more favourably but see less emphasis on these skills during lectures. This discrepancy suggests a potential gap in communicating the importance of these skills during teaching. Educators may need to address this gap better to align students' perceptions with their intended teaching efforts.

#### **4 Discussion**

The recognition and understanding of fake news present a significant societal challenge in the digital age. As confirmed by the findings of this study, a majority of respondents believe they can identify news that distorts reality or is outright false. Even greater confidence is expressed regarding distinguishing credible news from fake news. However, a notable proportion of neutral responses indicates that many individuals remain uncertain about their abilities, underscoring the need for targeted interventions to improve these skills. Awareness of the societal impact of fake news is similarly high, with 62.4% of respondents identifying fake news as a problem in Slovenia and 73.5% recognising its broader threat to democracy. This awareness highlights the pervasive nature of misinformation and its potential to undermine trust in democratic processes. Respondents also strongly agree that clearly communicated scientific findings can aid in distinguishing fake news from verified information, emphasising the critical role of accessible and reliable scientific communication in combating misinformation. The findings reveal some demographic variations in perceptions of fake news. Higher education is positively associated with greater confidence in recognising fake news and perceiving it as a societal problem in Slovenia and globally. Educated individuals also place greater value on clear and comprehensible scientific communication. Similarly, older respondents are more likely than younger ones to view fake news as a serious societal issue and a threat to democracy. Gender differences further emerge, with women placing higher importance on scientific communication clarity than men.

A notable gap exists between teachers and students regarding their perceptions of knowledge and skills in combating misinformation. Students tend to rate their professors' ability to communicate scientific findings more favourably than teachers rate themselves. However, students also report that insufficient emphasis is placed on teaching the skills to distinguish fake news from credible information. This



discrepancy highlights a need for educators to communicate their efforts better and to integrate media literacy into their teaching practices more effectively.

Conspiracy theories often attribute events to covert actions by malicious and powerful actors, typically with political motives. These theories rely on circular reasoning, where evidence against the conspiracy or the lack of supporting evidence is interpreted as proof of its validity. As a result, conspiracy theories become matters of belief rather than empirical verification (Christian, 2020). Fake news similarly exploits cognitive and emotional mechanisms to manipulate public opinion. By leveraging anger and other emotions, which strongly motivate action (Posner et al., 2005), creators of fake news focus on popular topics and design content to prompt engagement—clicking, reading, and commenting—which generates profit.

Media literacy is essential for combating fake news (Deuze & Prenger, 2019). Competent individuals critically evaluate sources, distinguish clickbait tactics, and verify information using multiple outlets (Kiely & Robertson, 2016). Steps such as checking the credibility of sources, verifying authorship, and confirming publication dates can help identify false information. While journalistic ethics demand accuracy, public scepticism is necessary, given the varying interests of media organisations. As Chan (2019) and Christian (2020) emphasise, fostering critical thinking, media literacy, and awareness of personal biases can empower individuals to resist misinformation and make informed decisions in the digital age. The findings of this study emphasise that combating fake news in the digital age requires a multifaceted approach that integrates media literacy, critical thinking, and scientific communication. The role of science in identifying truth is indispensable; clear, accessible, and reliable communication of scientific findings can serve as a cornerstone in distinguishing verified information from misinformation.

Educators, policymakers, and media organisations must collaborate to design educational initiatives that address the diverse needs of demographic groups, especially those most vulnerable to misinformation. Events such as the European Researchers' Night promote public understanding of science, foster research trust, and bridge the gap between experts and the general public. By building public resilience against fake news and conspiracy theories, societies can strengthen their democratic foundations and empower individuals to navigate the complexities of the digital age with confidence and discernment. The interplay between science and

media literacy holds the key to preserving the integrity of information in a world increasingly dominated by digital media.

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# POMEN VARNOSTNE KULTURE ZA VARNO IN KAKOVOSTNO OBRAVNAVO

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Kakovost v socialnovarstvenih zavodih je povezana z varnostjo stanovalcev, pozitivnimi izidi ter uspešnostjo obravnave. Namen raziskave je bil ugotoviti, kakšna je stopnja varnostne kulture med zaposleni. Rezultati raziskave kažejo, da zapleni v socialnovarstvenih zavodih najvišje ocenjujejo usposobljenost za delo, zagotavljanje potreb pacientov med izmenami in upoštevanje uveljavljenih standardov. Najnižje so bile ocenjene trditve o pomanjkanju zaposlenih in težavah pri zagotavljanju varnosti pacientov. Varnostna kultura je ocenjena kot dobra ali zelo dobra, pri čemer ni bilo statistično pomembnih razlik glede na državo, spol ali delovno dobo zaposlenih v zdravstveni negi v socialnovarstvenih zavodih. Prav tako je komunikacija med zaposlenimi v socialnovarstvenih zavodih zelo dobra, tudi mnenja zaposlenih upoštevajo. Za kakovostno in varno obravnavo je pomembno timsko sodelovanje zaposlenih, odprta komunikacija in podpora nadrejenih.

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# THE IMPORTANCE OF SAFETY CULTURE FOR SAFE AND QUALITY CARE

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Quality in social care institutions is closely linked to resident safety, positive outcomes, and the effectiveness of care. The purpose of the study was to determine the level of safety culture among employees. The results show that employees in social care institutions rate their work competence, meeting patient needs during shifts, and adherence to established standards the highest. The lowest-rated statements relate to staff shortages and challenges in ensuring patient safety. The safety culture is evaluated as good or very good, with no statistically significant differences based on country, gender, or length of service among nursing staff in social care institutions. Communication among employees in social care institutions is also rated as very good, and employee opinions are taken into account. For quality and safe care, teamwork among employees, open communication, and supervisory support are crucial.



## 1 Uvod

Varnostna kultura je osrednjega pomena za zagotavljanje varnosti in kakovosti v različnih organizacijskih okoljih, še posebej v sektorjih, kjer so tveganja za napake, nesreče ali škodo velika, na primer v zdravstvu, letalstvu, energetiki in industriji. Gre za skupek vrednot, prepričanj, norm in vedenj, ki dajejo varnosti osrednje mesto v delovanju organizacije (Cooper, 2000). Organizacije z močno varnostno kulturo, ne le zmanjšujejo tveganja za napake, temveč tudi izboljšujejo kakovost obravnave, krepijo zaupanje zaposlenih ter zagotavljajo trajnostno odličnost (Reason, 1997; Mistri et al., 2023).

V zdravstvenem sektorju varnostna kultura neposredno vpliva na kakovost in varnost obravnave pacientov. Dobro razvita varnostna kultura omogoča odprto komunikacijo (Dietl et al., 2023), dobro počutje (Lorber & Dobnik, 2022), učinkovito poročanje o incidentih in preprečevanje sistemskih napak (Kohn, Corrigan & Donaldson, 2000). Obvladovanje varnostnih tveganj je povezano z izgradnjo kulture na vrhu in je predpogoj za kakovostno in celovito obravnavo (Gabrovec, 2024). Ključno je, da zaposleni zaznavajo varnost kot skupno odgovornost in so spodbujeni k aktivnemu sodelovanju pri prepoznavanju tveganj ter sprejemanju ukrepov za njihovo obvladovanje. Organizacije, ki vlagajo v vzpostavljanje in vzdrževanje varnostne kulture, ustvarjajo okolje, kjer se napake prepoznavajo kot priložnosti za učenje, ne pa kot razlog za kaznovanje (Pronovost et al., 2006). Kakovostna in varna zdravstvena obravnava preprečuje škodo za pacienta tako v zvezi z zdravljenjem kot glede fizične varnosti bivanja ali zadrževanja pri izvajalcu zdravstvene dejavnosti (ZPacP, 2020).

Pomen kakovostne obravnave je tesno povezan z varnostno kulturo, saj visoka stopnja varnosti v procesih omogoča zanesljivo, natančno in k posamezniku osredotočeno oskrbo. Kakovostna obravnava zajema ne le tehnično brezhibnost zdravstvenih posegov, temveč tudi empatijo, spoštovanje in komunikacijo s pacienti (Guidi & Traversa, 2021; Sharkiya, 2023), kar neposredno vpliva na njihove izkušnje in zadovoljstvo (Donabedian, 1988). Raziskave kažejo, da usklajeno delovanje varnostne kulture in kakovostne obravnave zmanjšuje število zdravstvenih zapletov, povečuje zaupanje v zdravstvene storitve ter izboljšuje dolgoročno zdravje populacije. Na primer, študija Singerja in sodelavcev (2009) je pokazala, da imajo bolnišnice z višjo stopnjo varnostne kulture manj napak pri zdravljenih in operacijskih

zapletov (Elliot et al., 2021). Poudarili so tudi, da vključevanje vodij v krepitev varnostne kulture, spodbujanje transparentnosti in nenehno izobraževanje zaposlenih prispevajo k dolgoročnemu izboljšanju kakovosti oskrbe. Svetovna zdravstvena organizacija je poročala, da eden od desetih pacientov v bolnišnični obravnavi utрпи varnostni odklon, kar poudarja pomen razvoja kulture varnosti za izboljšanje kakovosti in varnosti pacientov (WHO, 2019).

Poleg tega je pomembno, da se varnostna kultura prilagaja potrebam in kompleksnosti organizacije. Po mnenju Manserja (2009) je v dinamičnih okoljih ključnega pomena hitra prilagoditev praks in struktur, ki omogočajo obvladovanje nepredvidljivih situacij. V teh kontekstih varnostna kultura deluje kot okvir za učinkovito sodelovanje med interdisciplinarnimi ekipami, kar neposredno vpliva na uspešnost zdravljenja in zadovoljstvo pacientov.

Ker je varnostna kultura temeljni dejavnik za zagotavljanje varne in kakovostne obravnave, s poudarkom na ključnih dejavnikih, strategijah in izzivih, ki so povezani z njeno implementacijo in vzdrževanjem v sodobnih organizacijah je bil naš namen ugotoviti, kakšna je stopnja varnostne kulture med zaposlenimi v zdravstveni negi v socialnovarstvenih zavodih..

## 2 Metodologija

Izvedena je bila presečna raziskava, v katero so bili vključeni zaposleni v zdravstveni negi iz štirih socialnovarstvenih zavodov.

### 2.1 Opis vzorca

V raziskavo je bilo vključenih 125 zaposlenih v zdravstveni negi in oskrbi v vseh štirih sodelujočih socialnovarstvenih zavodov, od tega sta bila dva sodelujoča socialnovarstvena zavoda iz Avstrije in dva iz Slovenije. Vrnjenih in v celoti izpolnjenih je bilo 106 vprašalnikov, kar predstavlja 85 % odziv. 70 % sodelujočih je bilo bolničarjev in tehnikov zdravstvene nege ter 30 % diplomiranih medicinskih sester. Kar 45 % je bilo med zaposlenimi tistih z delovno dobo 3 do 5 let, sledili so zaposleni z delovno dobo 11 let in več. Med sodelujočimi je bilo 48 % tistih, ki so zaposleni v Sloveniji in 52 % tistih, ki so zaposleni v Avstriji.



## 2.2 Zbiranje podatkov

Kot raziskovalni instrument je bil uporabljen vprašalnik, ki je poleg demografskih podatkov vključeval še trditve iz vprašalnika za merjenje varnostne kulture (AHRQ, 2010), in sicer sklop trditve, ki so se nanašale na delo v socialnovarstvenem zavodu (18 trditve), komunikacijo (10 trditve), vodenje (3 trditve) ter varnostno kulturo (10 trditve). Anketiranci so se do zastavljenih trditve opredeljevali na 5-stopenjski Likertovi lestvici, kjer 1 pomeni Se nikakor ne strinjam, 2 pomeni Se ne strinjam, 3 pomeni Se ne morem odločiti, 4 pomeni Se strinjam in 5 pomeni Se popolnoma strinjam. Cronbach alfa koeficient uporabljenega vprašalnika je znašal 0,796.

## 2.3 Statistična analiza

Narejena je bila deskriptivna analiza za oceno varnostne kulture med zaposlenimi v zdravstveni negi v socialnovarstvenih zavodih. Za ugotavljanje razlik med državama je bil uporabljen Mann-Whitney test. Za raven statistične pomembnosti smo uporabili  $p < 0,05$ . Statistična analiza je bila izvedena s programom SPSS 28.0 (IBM Corp, ZDA).

## 3 Rezultati

V nadaljevanju so predstavljene povprečne vrednosti ocene dela, komunikacije, vodenja ter varnostne kulture s strani zaposlenih v socialnovarstvenih zavodih.

Iz tabele 1 je razvidno, da so bile najvišje ocenjene (ocena  $> 4$ ) trditve, da so zaposleni v sodelujočih socialnovarstvenih zavodih dobro usposobljeni za svoje delo, da je med izmenami dobro poskrbljeno za potrebe pacientov in da zaposleni pri delu upoštevajo uveljavljene standarde za delo. Najnižje (ocena  $< 3$ ) pa so bile ocenjene trditve, da zaposlene obtožujejo za poškodbe pacientov, da zaposleni težko poskrbijo za varnost pacientov, da zaposleni pogosto ignorirajo postopke, da imajo dovolj zaposlenih za nudenje zdravstvene nege in da se zaposleni bojijo poročati o svojih napakah. Ugotovili smo statistično pomembne razlike v ocenah med zaposlenimi v socialnovarstvenih zavodih v Avstriji in Sloveniji le pri trditvah, ki se nanašajo na to, da imajo dovolj zaposlenih za izvajanje zdravstvene nege ( $Z=2,853$ ,  $p=0,005$ ), da so zaposleni dobro usposobljeni za svoje delo ( $Z=2,631$ ,  $p=0,011$ ), da

so dovolj usposobljeni za delo s težavnimi pacienti ( $Z=2.552$ ,  $p=0,014$ ) in da razumejo namen usposabljanja na delovnem mestu ( $Z=2.334$ ,  $p=0.023$ ).

**Tabela 1: Rezultati trditev za oceno dela**

Trditve	$\bar{x} \pm s$
Zaposleni se spoštujemo.	3,92±0,80
Zaposleni drug drugemu nudimo podporo.	3,73±0,78
Imamo dovolj zaposlenih za nudenje zdravstvene nege.	2,51±1,22
Zaposleni pri delu upoštevamo uveljavljene standarde.	4,03±0,61
Zaposleni se počutimo enakovredne med člani tima.	3,95±0,78
Zaposleni pri svojem delu ubiramo bližnjice.	3,21±1,10
Zaposleni smo dobro usposobljeni za svoje delo.	4,17±0,90
Zaposleni moramo pri delu hiteti zaradi preveč dela.	3,99±0,92
Kadar ima kdo preveč dela, mu drugi pomagajo.	3,84±0,75
Zaposlene obtožujejo za poškodbe pacientov.	2,31±1,21
Zaposleni smo dovolj usposobljeni za težavne paciente.	3,70±1,06
Zaposleni se bojimo poročati o svojih napakah.	2,77±1,11
Zaposleni razumemo namen usposabljanj pri delu.	3,93±0,83
Zaposleni pogodto ignorirajo postopke.	2,45±1,10
Zaposlene se pravično obravnava ob pojavu napake.	3,12±1,23
Med izmenami je poskrbljeno za potrebe pacientov.	4,07±0,95
Zaposleni težko poskrbimo za varnost pacientov.	2,34±1,10
Zaposleni se počutimo varno, ko sporočamo napake.	3,10±1,04

**Tabela 2: Rezultati trditev za oceno komunikacije**

Trditve	$\bar{x} \pm s$
Zaposleni vemo, kakšno znanje in veščine potrebujemo.	4,1±0,9
Zaposleni smo seznanjeni z vsemi spremembami oskrbe.	4,1±0,9
Posredovane so nam vse informacije ob sprejemu.	3,7±0,9
Zaposleni ukrepamo, če bi lahko kaj škodovalo pacientu.	4,0±1,1
Zaposleni se pogovarjamo, kako zagotoviti kakovost.	4,2±0,8
Ideje in predloge zaposlenih spodbujajo.	3,5±0,9
Zaposleni se pogovarjamo o načinih zagotavljanja varnosti.	4,3±0,8
Mnenja zaposlenih se upoštevajo.	2,6±0,9
Zaposleni imamo vse potrebne informacije.	4,1±0,8
Zaposleni brez težav govorijo o problemih in težavah.	3,6±1,0

Iz Tabele 2 je razvidno, da so najvišje ocenjene trditve ( $>4$ ), ki se nanašajo, da se zaposleni pogovarjajo kako zagotoviti varnost, o načinih zagotavljanja kakovosti, da zaposleni ukrepajo, kadar bi lahko kaj škodovalo pacientu, da zaposleni vedo, kakšno znanje in veščine potrebujejo ter da so zaposleni seznanjeni z vsemi spremembami v okviru oskrbe pacienta. Najnižje ( $<3$ ) je bila ocenjena trditev, da se mnenja

zaposlenih ne upoštevajo. Med zaposleni v socialnovarstvenih zavodih v Avstriji in Sloveniji nismo našli statistično pomembnih razlik pri nobeni izmed trditev, ki so se nanašale na komunikacijo.

Za oceno vodenja sta bili dve trditvi ocenjeni z oceno  $> 4$ , in sicer, da vodja upošteva predloge zaposlenih glede varnosti pacientov ( $4,1 \pm 0,9$ ) in da vodja posveča veliko pozornosti težavam glede varnosti ( $4,1 \pm 0,8$ ), medtem, ko je bila trditev, ki se je nanašala na pohvalo vodje, kadar zaposleni pri delu upoštevajo ustrezne postopke ocenjena z oceno ( $3,8 \pm 1,0$ ). Pri omenjenih trditvah, ki so se nanašale na vodjo prav tako nismo ugotovili statistično pomembnih razlik glede na državo zaposlitve.

Iz Tabele 3 je razvidno, da so bile najvišje (ocena  $> 4$ ) ocenjene trditve, da v sodelujoči organizaciji za paciente dobro poskrbijo, zagotavljajo varno okolje za paciente, da jim uspeva ohranjati varnost pacientov ter da skrbijo za varnost pacientov. Najnižje (ocena  $< 2$ ) je bila ocenjena trditev, da se dopušča, da se iste napake ponavljajo. Med zaposleni v socialnovarstvenih zavodih v Avstriji in Sloveniji nismo našli statistično pomembnih razlik pri nobeni izmed trditev, ki so se nanašale na komunikacijo. Na vprašanje o samooceni varnosti jih je 54 % odgovorilo, da je le ta zelo dobra, 15 % jih je odgovorilo, da je varnostna kultura odlična, 22 %, da je dobra in 9 %, da je primerna.

**Tabela 3: Rezultati trditev za oceno varnostne kulture**

Trditve	$\bar{x} \pm s$
V naši organizaciji je za paciente dobro poskrbljeno.	$4,4 \pm 0,8$
Naša organizacija zagotavlja varno okolje za paciente.	$4,2 \pm 0,7$
V organizaciji nam uspeva ohranjati varnost pacientov.	$4,1 \pm 0,7$
V naši organizaciji skrbimo za varnost pacientov.	$4,1 \pm 0,8$
Ko uvedemo spremembe jih preverjamo.	$3,8 \pm 0,9$
Vodstvo pogosto preverja oskrbo pacientov.	$3,8 \pm 0,8$
Vodstvo prisluhne idejam za izboljšanje varnosti pacientov.	$3,8 \pm 0,9$
Pri nas z lahkoto uvajamo spremembe izboljšanja varnosti.	$3,6 \pm 1,0$
Vodstvo vključuje zaposlene za izboljšanje varnosti.	$3,4 \pm 0,9$
Dopušča se, da se iste napake ponavljajo.	$1,9 \pm 1,0$

Nihče ni ocenil varnostne kulture v socialnovarstvenem zavodu kot slabe. Tudi pri samooceni varnostne kulture nismo zasledili statistično pomembnih razlik med zaposlenimi v Avstriji in Sloveniji. Prav tako ni bilo ugotovljenih statistično pomembnih razlik v oceni varnostne kulture glede na spol in delovno dobo.

## 4 Razprava

Iz rezultatov raziskave je razvidno, da so zaposleni v socialnovarstvenih zavodih na splošno visoko ocenili kompetence in kakovost dela, pri čemer so bile najvišje ocenjene trditve, ki se nanašajo na usposobljenost za delo, upoštevanje uveljavljenih standardov ter zagotavljanje potreb pacientov med izmenami. To nakazuje na močno strokovno osnovo in dobro delovno prakso, ki sta ključni za kakovostno oskrbo pacientov. Podobno so raziskave na področju zdravstvene oskrbe pokazale, da dobro usposobljeni zaposleni in dosledno spoštovanje standardov pomembno prispevata k večji varnosti pacientov in boljši kakovosti oskrbe (Carayon et al., 2014; Vincent et al., 2013). Organizacijska politika zagotovo vpliva na vidik kulture, vendar dnevne interakcije, ki jih imajo zaposleni med seboj in z vodji, tako imenovana življenjska sila kulture organizacije. V zdravstvenih organizacijah kultura varnosti pacientov in zaposlenih temelji na tem, kako dobro ekipe sodelujejo, kako vodstvo in vodje podpirajo varnost pacientov in delavcev, kako osebje poroča o dogodkih in skorajšnjih nesrečah ter kako se ekipe in vodje odzivajo na dogodke (Murray et al., 2024).

Kljub temu pa nizke ocene pri trditvi, kot je pomanjkanje osebja za nudenje zdravstvene nege kaže na pomembne izzive, s katerimi se soočajo zaposleni. Pomanjkanje kadra je pogost problem v socialnovarstvenih in zdravstvenih zavodih, ki vodi do povečanega stresa, izgorelosti ter negativnega vpliva na kakovost oskrbe (Aiken et al., 2008; Garcia et al., 2019; Sipos et al., 2024). Spodbudno je, da je trditev, ki se nanaša na strah pred poročanjem napak ocenjena nizko, saj kot je navedel že Edmondson (1999) je strah pred poročanjem napak lahko posledica kulture obtoževanja, ki zmanjšuje pripravljenost zaposlenih za odkrit pogovor o napakah in njihovem preprečevanju.

Na področju komunikacije so zaposleni visoko ocenili razprave o načinih zagotavljanja varnosti in kakovosti ter njihovo poznavanje potrebnih znanj in sprememb v oskrbi. To nakazuje na dobro informiranost in pripravljenost zaposlenih, kar je ključnega pomena za učinkovito delo. Kljub temu pa nižja ocena glede upoštevanja mnenj zaposlenih kaže na potrebo po večjem vključevanju osebja v odločanje in oblikovanje procesov. Študije potrjujejo, da večje vključevanje zaposlenih povečuje njihovo zadovoljstvo ter izboljšuje komunikacijo in organizacijsko kulturo (Gittel et al., 2010; Lorber & Dobnik, 2022).

Pri vodenju so bile pozitivno ocenjene trditve, ki se nanašajo na vodje in njihovo skrb za varnost pacientov ter upoštevanje predlogov zaposlenih. Nižje ocene, kot je na primer pomanjkanje pohval za upoštevanje postopkov, nakazujejo priložnosti za izboljšave v smislu priznavanja in motivacije zaposlenih. Raziskave kažejo, da pohvale in priznanje pomembno vplivajo na motivacijo, zavzetost in zadrževanje kadra (Deci & Ryan, 2000; Kouzes & Posner, 2017; Manzoor et al., 2021; Cairns & Kelloway, 2025).

Rezultati, povezani z varnostno kulturo, kažejo na močno osredotočenost organizacij na varnost pacientov. Trditve, da je dobro poskrbljeno za paciente in da se ohranja varno okolje, so bile visoko ocenjene, kar potrjuje zavezanost kakovosti. Spodbudna je nizka ocena pri ponavljanju napak, saj je s tem poudarjena potreba po sistematičnih pristopih k učenju iz napak in vzpostavitvi okolja brez obtoževanja. Že zgodnje raziskave so pokazale, da t. i. "varnostna kultura brez obtoževanja" izboljša pripravljenost zaposlenih za poročanje napak in s tem preprečevanje ponavljanja (Frankel et al., 2008). Zagotavljanje kakovosti in varnosti zdravstvene obravnave ter upravljanje kakovosti nista izziv le v Republiki Sloveniji, ampak tudi v številnih drugih državah, ki na primer opisujejo vrzeli pri zagotavljanju kakovosti, varnosti in kontinuirane obravnave ob prehajanju uporabnikov med sistemom institucionalnega varstva starejših in bolnišnično obravnavo (Ministrstvo za zdravje, 2021).

Analiza razlik med zaposlenimi v Avstriji in Sloveniji je pokazala statistično pomembne razlike pri trditvah, povezanih s kadrovske zasedbo, usposobljenostjo za delo in namenom usposabljanj. To kaže na razlike v delovnih pogojih in praksah, ki bi jih bilo smiselno nadalje raziskati za identifikacijo najboljših praks in njihovo implementacijo v obeh okoljih. Takšne primerjave so pomembne za razumevanje, kako različni sistemi vplivajo na uspešnost dela in zadovoljstvo zaposlenih, kar potrjujejo tudi rezultati raziskav, ki primerjajo delovne pogoje v mednarodnih okoljih (Schneider et al., 2013; Cairns & Kelloway, 2025).

Na splošno rezultati raziskave potrjujejo visoko stopnjo zavzetosti in strokovnosti zaposlenih v socialnovarstvenih zavodih, vendar izpostavljajo tudi ključne izzive, predvsem na področjih kadrovske politike, podpore zaposlenim in izboljšanja procesov za učenje iz napak. Te ugotovitve lahko služijo kot izhodišče za razvoj strategij za izboljšanje delovnih pogojev, varnosti pacientov in zadovoljstva zaposlenih.

## 5 Zaključek

Raziskava je pokazala, da so zaposleni v socialnovarstvenih zavodih na splošno zadovoljni s kakovostjo dela, komunikacijo, vodenjem in varnostno kulturo. Visoke ocene pri usposobljenosti zaposlenih in zagotavljanju kakovostne oskrbe pacientov odražajo močne temelje za varno in učinkovito delo. Vendar nizke ocene, povezane s pomanjkanjem kadra in težavami pri zagotavljanju varnosti, opozarjajo na ključne izzive, ki jih je treba nasloviti.

Pri komunikaciji in vodenju je pomembno okrepiti sodelovanje in prepoznavanje prispevkov zaposlenih. Razlike med Avstrijo in Slovenijo glede kadrovskega razmerja in usposobljenosti kažejo na potrebo po medsebojnem učenju in implementaciji najboljših praks.

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# POVPREČNO EKONOMSKO BREME DEMENCE V SLOVENIJI IN NA OSEBO V OBDOBJU 2019-2023

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Demenca je splošno prepoznana javnozdravstvena prioriteta. Število ljudi z demenco bo v prihodnje povsod v svetu naraščalo, vzporedno z demografskimi spremembami se podaljšuje življenjska doba in hkrati se s staranjem povečuje tveganje za demenco. Demenca ima velik ekonomski učinek na obolelega, njegove svojce in družbo kot celoto. Metode: Opravili smo pregled literature glede ekonomskih stroškov demence in glede ocen prevalence demence. Rezultati: Na osnovi izbrane metodologije smo izračunali stopnjo prevalence demence v Sloveniji za obdobje 2019-2023, standardizirano na starost in spol, ter stroške demence v obdobju 2019-2023 in na osebo z demenco. Razprava: Breme demence predstavlja pomemben delež BDP in z leti narašča, kljub visoki presežni umrljivosti v obdobju pandemije covid 19. Osebe z demenco, njihovi svojci in oskrbovalci potrebujejo boljšo podporo ter financiranje storitev. Leta 2019 se je vrh G20 z deklaracijo zavezal k skupnemu pristopu za obvladovanje demence. V Sloveniji je bila sprejeta Strategija obvladovanja demence v Sloveniji do leta 2030 in dvoletni Akcijski načrt, ki predstavljata specifične strateške dokumente za izvajanje aktivnosti in programov na področju demence. Navedene ekonomske in epidemiološke ocene bodo v pomoč raziskovalcem, političnim odločevalcem, zdravstvenim delavcem in drugim ključnim deležnikom, da bi bolje razumeli in obravnavali spremembe v okolju zdravstvenega in socialnega varstva.

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# AVERAGE ECONOMIC BURDEN OF DEMENTIA IN SLOVENIA AND PER PERSON IN THE PERIOD 2019-2023

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Dementia is a widely recognized public health priority. The number of people with dementia will increase worldwide in the future, in parallel with demographic changes, life expectancy is increasing, and at the same time, the risk of dementia increases with aging. Dementia has a major economic impact on the patient, their relatives and society as a whole. Methods: We conducted a literature review regarding the economic costs of dementia and estimates of dementia prevalence. Results: Based on the selected methodology, we calculated the prevalence rate of dementia in Slovenia for the period 2019-2023, standardized by age and gender, and the costs of dementia in the period 2019-2023 and per person with dementia. Discussion: The burden of dementia represents a significant share of GDP and is increasing over the years, despite the high excess mortality during the COVID-19 pandemic. People with dementia, their relatives and caregivers need better support and financing of services. In 2019, the G20 summit committed to a common approach to dementia management with a declaration. Slovenia has adopted the Dementia Management Strategy in Slovenia until 2030 and a two-year Action Plan, which represent specific strategic documents for the implementation of activities and programs in the field of dementia. The economic and epidemiological assessments provided will help researchers, policymakers, healthcare professionals and other key stakeholders to better understand and address changes in the healthcare and social care environment.



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## 1 Uvod

Demenca ni normalen proces staranja temveč gre za bolezen možganov, njena pojavnost je povsod po svetu v porastu. Najpomembnejši neodvisen dejavnik tveganja za demenco je starost, z naraščanjem starosti in s podaljševanjem življenjske dobe se pojavnost demence strmo povečuje, še posebej po 65. letu starosti (WHO, 2021). Demenca predstavlja javnozdravstveno prioriteto. Stroški zdravstvenega varstva in dolgotrajne oskrbe oseb z Alzheimerjevo boleznijo in drugimi demencami so visoki, demenca se uvršča med najdražje kronične bolezni (Hurd et. al., 2013; 2023 Alzheimer's disease facts and figures, 2023).

Leta 2019 smo, po ocenah, v svetu imeli 57 milijonov ljudi z demenco (GBD 2019, 2022), medtem, ko so bili stroški demence za leto 2019 ocenjeni na 1300 milijard US\$, do 2030 bodo po napovedih narasli na 2000 milijard US\$ dolarjev (WHO, 2023). Najvišji delež stroškov, do 70%, pripada Evropi in Severni Ameriki (Wimo et. Al, 2013). Okrog polovice stroškov predstavlja neformalna oskrba, ki jo zagotavljajo svojci (v povprečju 5 ur nege ali nadzora dnevno) (WHO, 2023). Do leta 2050 naj bi se število ljudi z demenco v svetu potrojilo na več kot 150 milijonov vzporedno se bodo poveševali tudi stroški (WHO, 2023; GBD 2019, 2022).

V EU (EU27) je leta 2018 živel 7,9 milijonov ljudi z demenco, do leta 2050 naj bi se število podvojilo na 14,3 milijona (Alzheimer Europe). Jönsson in sod. (2023) so ocenjevali letne stroške demence na osebo v Evropi, ki so se razlikovali med državami in regijami ter znašali od najvišjih 73.712 € do najnižjih 7.938 €.

Izračuni stroškov demence najpogosteje vključujejo direktne stroške zdravstva in stroške socialnega varstva ter stroške neformalne oskrbe. Direktni stroški zdravstva vključujejo stroške zdravstvenega varstva, kot so stroški bolnišničnega zdravljenja, zdravil in ambulantni pregledi. Direktni stroški socialnega varstva se nanašajo na formalne storitve, ki se izvajajo zunaj sistema zdravstvene oskrbe in vključujejo skupnostne storitve, kot so nega na domu, oskrba s hrano in prevoz ter oskrba v socialnovarstvenem zavodu. Neformalna oskrba vključuje ocenjen čas, ki ga družinski oskrbovalci porabijo za oskrbo, pomoč pri vsakodnevnih aktivnostih in nadzora nad osebo (Alzheimer's Disease International, 2010; Alzheimer's Disease International, 2015; World Health Organization, 2021; Wimo et al., 2011).

Slovenija se po številu ljudi z demenco na 1000 prebivalcev uvršča v sam vrh držav. Leta 2011 se je uvrstila takoj za Japonsko, Italijo in Nemčijo (z več kot 15-timi ljudmi z demenco na 1000 prebivalcev), do leta 2040 bo po napovedih z 32-timi ljudmi z demenco na 1000 prebivalcev Slovenija na drugem mestu, takoj za Japonsko (OECD, 2023).

Vlada RS je v juliju 2023 sprejela Strategijo obvladovanja demence v Sloveniji do leta 2030 in januarja 2024 Akcijski načrt (Ministrstvo za zdravje, 2023). Za načrtovanje, izvedbo in implementacijo javnozdravstvenih in drugih ukrepov za obvladovanje demence ter za oceno učinkovitosti ukrepov je smiselno poznavanje stroškov demence in njihove dinamike.

V prispevku smo prvič pri nas ocenjevali trend skupnih stroškov demence po strukturi stroškov v obdobju 2019-2023, povprečje za isto obdobje, hkrati smo s pomočjo izračunov standardiziranih stopenj demence po spolu in po starosti za posamezna leta od 2019 do 2023 izračunali oceno stroškov po strukturi na osebo z demenco v Sloveniji v posameznem letu in v povprečju za obdobje 2019-2023.

## 2 Metode

Na osnovi predhodnega pregleda literature (Lovrečič in Lovrečič, 2024b) in izbrane metodologije smo izračunali skupne stroške demence po posamezni postavki, izhajajoč iz BDP za Slovenijo za vsako posamezno izbrano leto v obdobju od 2019 do 2023 ter povprečje izbranega obdobja (SURS. SiStat (a)).

Izračunali smo število prebivalcev Slovenije, moških in žensk v vsaki od izbranih starostnih skupin, 60–64, 65–69, 70–74, 75–79, 80–84, 85–89 ter v starosti 90 in več let za vsako leto 2019, 2020, 2021, 2022 in 2023, pri čemer smo uporabili podatke prebivalstva Slovenije ((SURS. SiStat (c)) za izbrana leta.

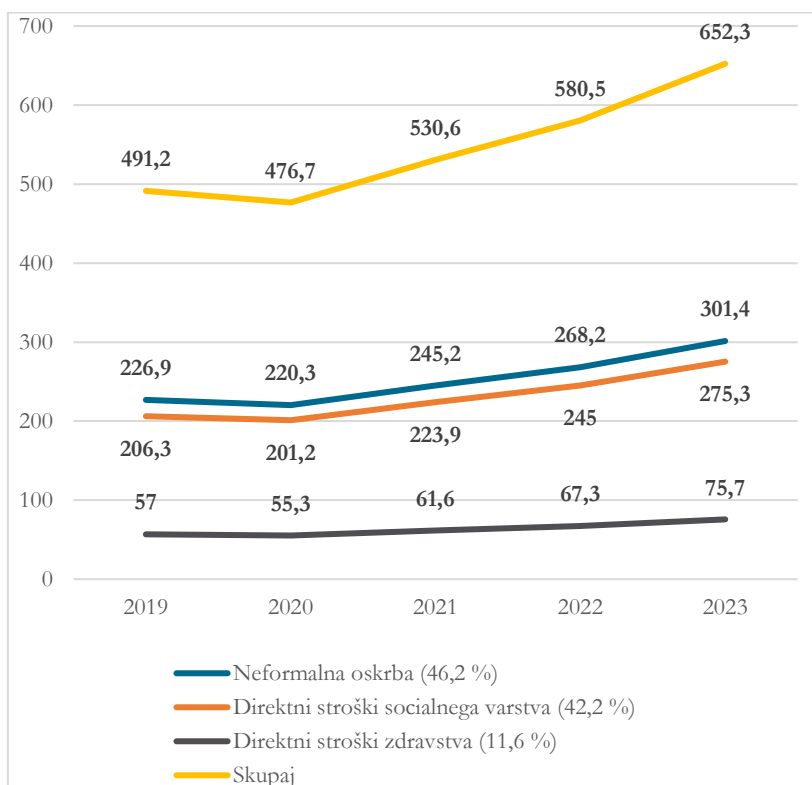
Število oseb z demenco za Slovenijo na nacionalni ravni je bilo izračunano za vsako posamezno leto za obdobje 2019-2023 in na osnovi stopenj prevalence za demenco, standardiziranih na starost in spol, ki so bile izdelane v okviru evropskega projekta European Collaboration on Dementia (EuroCoDe) (Alzheimer Europe, 2019), ki je najpogosteje uporabljena in priporočena metoda za izračun prevalence demence, ter na osnovi predhodno izračunanih podatkov prebivalstva v starosti 60 let in več, po

starostnih skupinah in po spolu ter skupno. Starostno/po spolu specifične stopnje prevalece za demenco smo aplicirali za izračune za vsako skupino po spolu in starosti od starostne skupine 60-64 let naprej.

Izračunali smo letne stroške demence glede na delež BDP v Sloveniji po posameznih letih v obdobju 2019-2023, glede na strukturo stroškov ter stroške glede na osebo z demenco.

### 3 Rezultati

Trendi stroškov v Sloveniji po strukturi in skupno za obdobje 2019-2023 so prikazani na Sliki 1.



Slika 1: Trendi izračunanih skupnih stroškov demence v Sloveniji po strukturi stroškov in skupno (v milijonih €) po posameznih letih v obdobju 2019 in 2023

Vir: Lastni izračuni

V obdobju od 2019 do 2023 so ocenjeni skupni stroški demence v Sloveniji v povprečju znašali 546,3 milijonov evrov letno, od najnižje vrednosti v letu 2020, ko so znašali 476,7 milijonov evrov, do najvišje leta 2023, ko so znašali 652,3 milijonov evrov. V istem obdobju so neformalni stroški demence v povprečju znašali 252,4 milijonov evrov letno, najmanj leta 2019 in sicer 226,9 milijonov evrov, največ leta 2023, ko so znašali 301,4 milijonov evrov. Za enako obdobje so direktni stroški socialnega varstva v povprečju znašali 230,4 milijonov evrov letno, od najnižje vrednosti v letu 2020, ko so znašali 201,2 milijonov evrov, do najvišje leta 2023, ko so znašali 275,3 milijonov evrov. V obdobju od 2019 do 2023 so direktni stroški zdravstvenega varstva za demenco na leto v Sloveniji v povprečju znašali 63,4 milijonov evrov, od najnižje vrednosti v letu 2020, ko so znašali 55,3 milijonov evrov, do najvišje leta 2023, ko so znašali 75,7 milijonov evrov.

V tabeli 1. so prikazi ocen števila oseb z demenco med prebivalci Slovenije v starosti 60 let in več v obdobju 2019-2023, tako moških kot žensk po posameznih letih in skupno.

**Tabela 1: Ocenjeno število oseb z demenco glede na stopnjo demence standardizirane po starosti in po spolu med prebivalci Slovenije v starosti 60 let in več, Slovenija, 2019-2023**

	Ženske z demenco (število)	Moški z demenco (število)	Skupaj prebivalci z demenco (število)
2019	24916	10827	35743
2020	25331	11195	36526
2021	25431	11438	36869
2022	25829	11799	37628
2023	26325	12203	38528

Vir: Lastni izračuni

V tabeli 2. so prikazani ocenjeni stroški demence na osebo letno.

**Tabela 2: Ocenjeni stroški demence po strukturi in skupno na osebo z demenco, Slovenija, 2019-2023**

	Število oseb z demenco letno	Skupni stroški demence/ leto (milijoni €)	Eurov na osebo z demenco na leto (tisoči €)	Neformalna oskrba (delež 46,2%) (tisoči €)	Direktni stroški socialnega varstva (delež 42,2%) (tisoči €)	Direktni stroški zdravstva (delež 11,6%) (tisoči €)
2019	35743	491,2	13.742,5	6.349,0	5.799,3	1.594,1
2020	36526	476,7	13.051	6.029,6	5.507,5	1.513,9
2021	36869	530,6	14.391,5	6.648,9	6.073,2	1.669,4
2022	37628	580,5	15.427,3	7.127,4	6.510,3	1.789,6
2023	38528	652,3	16.930,5	7.821,9	7.144,7	1.963,9
Povprečje 2019-2023	37059	546,3	14.708,6	6.795,4	6.207	1.706,2

Vir: lastni izračuni

## Razprava z zaključki

Ocene tujih strokovnjakov kažejo, da letni stroški demence z leti naraščajo povsod po svetu (Alzheimer's Disease International, 2010; Wimo et al., 2011; Hurd et al., 2013; Alzheimer's Disease International, 2015; GBD 2019, 2022; WHO, 2021; Jönsson et al., 2023; 2023 Alzheimer's disease facts and figures, 2023; WHO, 2023). Tudi naši izračuni stroškov in trend nakazujejo, da so ocenjeni stroški demence v obdobju 2019-2023 v porastu. Izjema je leto 2020, ko so bili stroški nižji v primerjavi z letom prej, kar sovпада z negativnim učinkom COVID-19 na rast BDP v Sloveniji (Banka Slovenije, 2020). Vzporedno s tem je imela Slovenija visoko pozitivno presežno umrljivost. Novembra 2020 je umrlo 92 % več ljudi kot v novembru v obdobju 2015-2019 (SURS). Na to je vplivala pandemija covid 19, v Sloveniji je prihajalo do vdora SARS-CoV-2 in hitrega širjenja okužb predvsem med varovanci domov starejših občanov (DSO). Enako so ugotavljali tudi drugod po svetu, kjer so DSO predstavljali epicentre okužb, bolezni in umrljivosti (Ryoo et al., 2020; Trabucchi & De Leo, 2020; Seshadri et al., 2021). Navkljub visoki presežni umrljivosti v letu 2020 zaradi pandemije covid 19 med starejšimi osebami, je

prevalenca demence v Sloveniji v obdobju 2019-2023 bila v porastu po posameznih letih in za celotno obdobje, tako pri ženskah kot moških ter skupno.

Podatki za svet, Evropo in Slovenijo nedvomno kažejo, da so ženske povsod po svetu pogosteje prizadete zaradi demence v primerjavi z moškimi, razmerje ženske z demenco proti moškim z demenco, je pred in po obdobju pandemije covid 19, navadno med 2 in 3 (Alzheimer Europe, 2019; GBD 2019, 2022; Lovrečič et al., 2020; Lovrečič in Lovrečič, 2022; Lovrečič et al., 2021). Starejše ženske z demenco v Sloveniji so bile glede umrljivosti med pandemijo bolj prizadete v primerjavi z moškimi, saj se je razmerje npr. v obdobju 2020-2021 obrnilo v prid moškim. Pri ženskah je bilo v obdobju 2020-2021 za 82% ali 5,5-krat manj primerov demence kot v primerjavi z 2018-2019, v enakem obdobju je bilo pri moških za 37% ali 1,59-krat manj primerov demence kot v primerjavi z 2018-2019 (Lovrečič in Lovrečič, 2024).

Zaradi podaljševanja življenjske dobe in vzporedno s tem večjega tveganja za demenco, še posebej po 65-tem letu starosti, lahko upravičeno pričakujemo naraščanje deleža starejšega prebivalstva z demenco. Demografske spremembe kažejo, da smo leta 2021 v Sloveniji imeli petino prebivalcev Slovenije starih 65 let ali več, starejših od 80 let je bilo 5%. Do leta 2030 bo po projekcijah starih 65 let in več že četrtnina, stari 80 let in več bodo predstavljali 7% prebivalcev (SURs). Projekcije za leto 2030 kažejo, da bo med prebivalstvom naraščal tudi delež ljudi z demenco in bo po napovedih dosegel 2,15% celotne populacije pri nas (Lovrečič in Lovrečič, 2024). Podobno ugotavljajo drugod po svetu (2023 Alzheimer's disease facts and figures, 2023).

Glede na navedeno lahko utemeljeno pričakujemo porast stroškov za demenco, tako v svetu kot pri nas, saj se demenca že sedaj uvršča med najdražje kronične bolezni (Hurd et. al., 2013; 2023 Alzheimer's disease facts and figures, 2023).

Naše ocene stroškov za obdobje 2019-2023 so v povprečju znašale 14.708,6 € letno, kar je višje kot so bile predhodne ocene 74 €<sup>1</sup> za leto 2004 (Vodušek et al., 2008) in 9427 €<sup>2</sup> za leto 2010 (Bon et al., 2013). Naše ocene stroškov so primerljive z ocenjenimi letnimi stroški na osebo z demenco v svetu za leto 2019, ki so povprečno

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<sup>1</sup> /standard kupne moči

<sup>2</sup> prilagojenih na pariteto kupne moči (€ PKM)



znašali 23796 US \$ (Wimo et al., 2023; WHO, 2021) in z oceno za leto 2010 za Evropo v višini 24565 US \$ (Wimo, & Prince, 2010).

Po ocenah Svetovne zdravstvene organizacije so svetovni letni zdravstveni stroški ocenjeni na 3624 USD, stroški socialnega varstva 13.128 USD, neformalna oskrba pa 14.393 USD (WHO, 2021). Podobno strukturo stroškov so ugotavljali v največji metaanalizi ocen stroškov osebe z demenco v evropskih državah. Med državami obstajajo pomembne razlike v tem, kako je organizirana, financirana in zagotovljena oskrba pri demenci. Ključna razlika leži v ravnotežju med formalno (tj. plačano oskrbo, ki jo izvajajo strokovni delavci ali organizacije) in neformalno oskrbo (tj. neplačano oskrbo, ki jo nudi bolnikovo socialno omrežje), pri čemer je neformalna oskrba bolj izrazita v južnoevropskih državah, na kar vpliva tako kulturni kot institucionalni gradient. To vpliva na stroške in omejuje prenosljivost gospodarskih študij med državami in regijami (Jönsson et al., 2023).

V Sloveniji je bila sprejeta Strategija obvladovanja demence v Sloveniji do leta 2030 in dvoletni Akcijski načrt, ki predstavljata specifične strateške dokumente za izvajanje aktivnosti in programov na področju demence (Portal GOV SI., 2023). Za ustrezno dodeljevanje finančnih in drugih sredstev za obvladovanje demence je potrebno poznati stroške demence, zato so podatki pomembni za načrtovalce politike. Naši izsledki omogočajo trenutni vpogled v ocene letnih stroškov za demenco ter trendov. Slovenija ima tudi druge posebnosti: sooča se z velikim in naraščajočim deležem starajočega prebivalstva, omejenostjo kapacitet socialnovarstvenih nastanitev in storitev, pomanjkanjem strokovnega kadra v socialnovarstvenih zavodih, starejše ženske, ki živijo same imajo večje tveganje za revščino ipd). Slovenija se po številu ljudi z demenco na prebivalce uvršča v vrh držav in tudi po napovedih bo Slovenija vse bolj v vrhu držav. Na področju demence se soočamo z velikimi izzivi na področju diagnostike, zdravljenja in preprečevanja tveganj za demenco, kar vse lahko v prihodnje dodatno obremeni stroške.

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# UMETNA INTELIGENCA IN ORGANIZACIJA SISTEMA JAVNEGA ZDRAVSTVA

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Prispevek prikaže, kako je umetna inteligenca (UI) v finančni perspektivi 2021-2027 postala v Evropski Uniji tudi ena izmed silnic transformacije sistema javnega zdravja in spodbujanja raziskav, razvoja in inoviranja. Evropska Komisija (EK) je pravočasno pripravila ustrezno zakonodajo in instrumente. A aktivnosti v nekaterih državah (in ne le v kontekstu digitalne transformacije) zamujajo in s tem zmanjšujejo njihovo konkurenčnost. V konceptu trajnostnega razvoja ima zdravje državljana EU še posebno mesto: je vrednota in je gonilo produktivnosti. Le zdravi ljudje omogočajo produktivnost, kar pomeni realizacijo dodane vrednosti. Dodana vrednost je vodilno gonilo konkurenčnosti tudi v t.i. Draghijevem poročilu za EK, na katerem že temelji korekcija obstoječe strategije EU in priprava strategije za obdobje 2028-2034. Izpostavljen je pomen različnih dimenzij UI za sistem javnega zdravstva. V tem kontekstu so prikazani odzivi v Sloveniji na naslednja vprašanja, ki so strateškega pomena: Ali so v Sloveniji identificirani in s kapacitetami pokriti kritični izzivi na področju zdravstva? Ali politika ukrepanja postavlja v središče pozornosti zdravje in njegovo obvladovanje? Ali razvoj UI vpliva na krepitev institucij?

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# ARTIFICIAL INTELLIGENCE AND PUBLIC HEALTH SYSTEM

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The paper shows how artificial intelligence (AI) became a system transformation driver of public health system in European Union in the financial perspective 2021-2027. As AI drives research, development and innovation. European Commission (EC) has in time prepared proper regulation and instruments. However, AI activities delay in some countries (not only in the context of digital transformation, but in the framework of multiple dimensions), what diminishes the country competitiveness. Following the sustainable development concept, the health of a citizen has a special notion: it is a value and a productivity driver. Only healthy people are productive and perform added value. Added value is a leading driver of growth also in the EC Draghi Report; based on this report, the corections of 2021-2027 strategy is performing and strategy and measures for next financial perspective 2028-2034 will be prepared. That is why this paper is exposing the meaning and AI dimensions of digitisation and AI in the public care system. In this context, activities in Slovenia are described following three strategic questions, as: Are critical challenges of health system in Slovenia identified and capacities for them developed? Does politics put health in the centre of action and its governance? Does the development of AI impact institutional capacities?



## 1 Uvod

Umetna inteligenca (UI) obljublja korenito preoblikovanje ekonomij držav, spreminjanje pristopa, načina in organizacije dela v podjetjih in javnih institucijah. Zaradi priložnosti, ki jih prinaša umetna inteligenca, za spodbujanje digitalne preobrazbe in oblikovanje javnih politik, je postalo ključnega pomena razumeti dimenzije in potencial umetne inteligence. Potrebno je aktivno vključevanje vseh deležnikov, njihovo vertikalno in horizontalno aktivno povezovanje za širjenje znanj in aplikacijo know-how-a, tako v podjetjih kot v sektorjih javne uprave.

Ker je zdravje temeljna pravica zagotovljena z Ustavo, hkrati pa je zdravo prebivalstvo predpogoj ustvarjanja dodane vrednosti v družbi, je pomembno razvijati tako kapacitete posameznika kot kapacitete sistema kot kapacitete institucij, da se uveljavi načeli »Zdravje v vseh politikah« in da so »Storitve javnega zdravstva naravnane na pacienta« (Ollila E., et al., 2005, str. 1). Z novimi vrednotami in pristopi pa so potrebne strukturne spremembe, ki terjajo sistemski pristop in krepitev kapacitet, da se razpravlja o skupnem javnem dobrem in o vlogi javne politike pri spodbujanju uporabe umetne inteligence. Razvojni problemi in potenciali UI so različno razumljeni, pa tudi (ne)videni. Če aktivnosti zamujajo, slabi konkurenčnost, v primeru zdravja so ogroženi dobrobit, varstvo državljanov in celo po Ustavi RS jamčene pravice do zdravja. V korist trga dela in ščitenja socialnih pravic posameznika je bil leta 2017 uveden EU steber socialnih pravic ([https://employment-social-affairs.ec.europa.eu/policies-and-activities/european-pillar-social-rights-building-fairer-and-more-inclusive-european-union\\_en](https://employment-social-affairs.ec.europa.eu/policies-and-activities/european-pillar-social-rights-building-fairer-and-more-inclusive-european-union_en), 15. 1. 2025). Evropska Komisija je potrdila, da bo tudi upoštevala vrednote in cilje trajnostnega razvoja (SDG, 2015) Združenih narodov. Zdravje je tako pravica v stebru kot je tudi tretji cilj SDG, ki zavezuje vlade »da zagotovijo zdravo življenje in spodbujajo dobrobit za vse in v vseh obdobjih« (<https://www.un.org/sustainabledevelopment/health/>, 2. 12. 2023). Pristop »Eno zdravje« napotuje, da zdravja ljudi, živali, rastlin in okolja ni mogoče obravnavati ločeno, ampak je treba ukrepati celostno za „eno zdravje“ ([https://www.who.int/health-topics/one-health#tab=tab\\_1](https://www.who.int/health-topics/one-health#tab=tab_1), 13.12.2023).

Marca 2024 je Parlament EU sprejel Zakon Evropske unije o umetni inteligenci (The Artificial Intelligence Act, 2024). Umetna inteligenca je za zdravstvene sisteme pomemben instrument obvladovanja vse večjih stroškov, reagiranja na zahteve

staranja prebivalstva, usklajuje ponudbo in povpraševanje po zdravstvenih storitvah in delovni sili. OECD in zdravstveni ministri njenih držav so leta 2024 opredelili akcijski načrt (Artificial Intelligence and the Health Workforce Perspective from Medical Associations on all AI in Health), da omogoči in uveljavi odgovornost za uvedbo umetne inteligence v zdravstvu. Ker je uresničitev celotnega potenciala umetne inteligence v zdravstvu po institucijah in državah zahtevna, so priporočene vsebine, metodologije in sam pristop k urejanju in nadzoru. Treba je vzpostaviti javno-zasebna partnerstva in partnerstva med osebami in ponudniki, izboljšati je treba upravljanja zdravstvenih podatkov ter se vključevati v mednarodno sodelovanje tako s strokovnimi aktivnostmi, kot vodenjem in managementom. Vzpostavljajo s organizacijski, sistemski in institucionalni digitalni temelji, ki morajo podpirati optimalno upravljanje in management, sicer se zavira napredek. Gre ne le za tehnološki, ampak tudi za napredek družbe kot celote. Zaupanje in razumevanje rešitev umetne inteligence prinaša tudi napredek natančne medicine kar vnaša v javni sistem zdravstva in preventive milenijske spremembe.

Ne le Zakon o UI, tudi nova zakonodaja na področju digitalnega zdravja in Evropski digitalni prostor zdravstvenih podatkov (EHDS, European Health Data System) povezuje države v tematsko mrežo in v izmenjavo dosežkov raziskav (System State of Health in the EU Synthesis Report 2023, str. 22). Za področja javnega zdravja je pomembno delo vrhunskih strokovnjakov, ki v tem razvoju sodelujejo in pripravljajo pomembne dokumente - t.i. skupne izjave (ang. Joint Statement), kot so: »Napredek natančne medicine za evropske bolnike z rakom s slikanjem na podlagi umetne inteligence«, "Globalni kontinuum za zdrave generacije", "Obdelava naravnega jezika za genetiko raka", "Proti načrtu EU za usklajevanje možganov"[https://hadea.ec.europa.eu/news/unlocking-impact-discover-how-four-eu-funded-joint-actions-are-contributing-healthier-europe-2023-12-04\\_en](https://hadea.ec.europa.eu/news/unlocking-impact-discover-how-four-eu-funded-joint-actions-are-contributing-healthier-europe-2023-12-04_en), 15.1.2025). Sodelovanja pri njihovi izdelavi in raba UI vodijo v nove strategije, diagnostične metode, rabo novih instrumentov in takšne obdelave podatkov, ki vpeljujejo v klinično zdravljenje integrirano diagnostiko.

Sodelovanje pri vseh teh aktivnostih pa za državne programe in strategije lahko pomeni njihovo polno realizacijo: n.pr. na področju raka v Sloveniji Državnega programa obvladovanje raka. Vlada RS je 23.12.2021 sprejela Državni program obvladovanja raka 2022–2026 (DPOR; <https://www.dpor.si/drzavni-program/>), katerega cilji in aktivnosti v DPOR so povezani tudi z drugimi pomembnimi



področji. Na nivoju EU je sprejet (po zgledu iz Slovenije) Evropski program spopada z rakom (Europe's Beating Cancer plan, [https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/promoting-our-european-way-life/european-health-union/cancer-plan-europe\\_en](https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/promoting-our-european-way-life/european-health-union/cancer-plan-europe_en), 15.1.2025).

Za spopad z največjimi problemi trajnostnega razvoja pa je za to finančno perspektivo 2021-2027 EK razglasila in priporočila v rabo državam članicam nov instrument, kar so Misije [https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe\\_en](https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe_en), 15.1.2025).

Pet misij je zamišljeni kot ukrep tako na nivoju EU kot po državah za pet najbolj problematičnih področij zelenega prehoda: misija za prilagajanje na klimatske spremembe, vključno z družbenimi spremembami, misija za borbo proti raku, misija zdrava zemlja in hrana, misija za klimatsko nevtralna in pametna mesta ter misija zdravi oceani, morja, obale in notranje vode.

Poročilo Svetovne zdravstvene organizacije poudarja potrebo po trdnih finančnih reformah in strogi ureditvi za omejitev moči industrije. S strategijo zaščite javnega zdravja lahko država pospeši napredek pri doseganju globalnih ciljev trajnostnega razvoja do leta 2030 in vse bolj opozarja na »vpliv komercialnih determinant na nenalezljive bolezni v evropski regiji. Skoraj 7500 smrti na dan ali 25% smrti v regiji je pripisanih komercialnim dejavnikom, kot so tobak, alkohol, predelana hrana, fosilna goriva in poklicne prakse. « (Poročilo WHO Commercial Determinants of Noncommunicable Diseases in the WHO European Region, 2024). 40% resursov za zdravje je v svetu izgubljenih zato, ker se ne ukrepa ne strateško, premalo je preventive in preveč je slabosti pri operativnih rešitvah (UNICEF Increasing access to health products for children and families, 2024, str. 4).

Digitalne determinante zdravja (OECD Invest, str. 74) pa so študijah OECD, WHO in London School of Economics (OECD Invest, s. 74) usodne za zdravstvene rezultate, ker jih je treba res razumeti. V 21. stoletju namreč tudi dostop do interneta, digitalna pismenost, algoritemska validacija in upravljanje podatkov tudi sooblikujejo zdravstvene rezultate. Pomembne so podrobnosti, načini obdelave pa so postali kompleksni.

Digitalni okvir celostne politike za vključujočo in uspešno digitalno prihodnost (OECD, Going Digital Integrated Policy Framework) je z letom 2019 začrtal pot vladam, ljudem, podjetjem in deležnikom, da ga uporabijo pri oblikovanju politik ukrepanja. Pri tem je treba vključiti v digitalno transformacijo številna in različna področja politik (OECD, 2019), predvideti in načrtovati medsebojno vplivanje sedem med seboj povezanih razsežnosti politike: 1) dostop; 2) uporaba; 3) inovativnost; 4) delovna mesta; 5) socialna blaginja; 6) zaupanje; in 7) odprtost trga. Okvir izpostavlja, da so tehnologije, podatki in poslovni modeli gonilne sile obstoja in razvoja. Zato digitalna transformacija ne pomeni le integracije digitalnih tehnologij v poslovanje in javne storitve, ampak gre za pomemben vpliv tehnologij na družbo, za trdnost in odpornost njenih sistemov.

## 2 Kontekst umetne inteligence v zdravstvu v okolju EU

Zakon EU o umetni inteligenci (Regulation (EU) 2024/1689) v okviru digitalne strategije ureja razvoj, komercializacijo, implementacijo in uporabo sistemov UI. Regulacija UI pa je potrebna zaradi:

1. Varnosti in temeljnih pravic: treba je zagotoviti, da so sistemi umetne inteligence na trgu EU varni in skladni z obstoječo zakonodajo o temeljnih pravicah.
2. Pravne varnosti: Olajšati gre naložbe in inovacije v UI, da se zagotovi jasen pravni regulativni okvir.
3. Izboljšanega upravljanja in managementa: Zagotoviti je treba učinkovito sistemsko izvajanje UI, pri čemer so vključeni različni akterji nacionalni ravni in EU.
4. Razvoja enotnega trga: Aplikacije UI morajo biti zakonite, varne in zanesljive ter preprečiti drobitev trga.

Sistem UI je kategoriziran v štiri ravni: nesprejemljivo, visoko, omejeno in minimalno. Ta kategorizacija določa raven nadzora in zahteve, ki jih morajo izpolnjevati razvijalci in upravljalci teh sistemov. Pomembno je, da se tehnologije razvijajo in uporabljajo na način, ki spoštuje temeljne pravice in spodbuja dobro počutje državljanov. Za sisteme umetne inteligence se od pristojnih nacionalni organov pričakuje, da vzpostavijo sistem upravljanja na ravni držav članic in mehanizem sodelovanja na ravni EU.

Priporočilo Sveta OECD o umetni inteligenci (OECD Recommendation of the Council on Artificial Intelligence, 2019) je standard, ki so ga sprejele vlade za odgovorno upravljanje z UI. Njegovih pet načel izpostavlja vrednote: 1) UI naj spodbuja vključujoče rasti, trajnostni razvoj in blaginjo, 2) sistemi umetne inteligence spoštujejo pravno državo, človekove pravice, demokratične vrednote in raznolikost ter bi morali vključevati ustrezne zaščitne ukrepe, 3) za sisteme UI mora obstajati preglednost in razkritja, 4) sistemi UI morajo delovati robustno, zaščitno in varno in 5) organizacije in posamezniki, ki razvijajo, uvajajo ali upravljajo sisteme umetne inteligence so odgovorni za njihovo delovanje v skladu s pravili. Navedenih je še pet priporočil za oblikovalce politik v zvezi z nacionalnimi politikami in mednarodnim sodelovanjem za zaupanja vredne sisteme UI. Toda »umetna inteligenca v zdravstvu predstavlja tveganje za ponudnike zdravstvenih storitev zlasti zaradi morebitnih motenj v ponudbi delovne sile: spreminjajo se vloge, kompetence in veščine. Zato je nujno najti ravnotežje med inovacijami in zaščitnimi ukrepi« (Almyranti, M. et al. 2024).

Kršitve zasebnosti so veliko tveganje, saj gre za »povpraševanje« po osebnih podatkih. Druga skrb je zanesljivost informacij, ki jih ustvarijo sistemi UI. Kar pa daje vse večje upanje za uspešno zdravljenje n.pr. raka, je eksponentna rast podatkov. UI lahko pridobi pomembne in integralne vpogleda iz ogromnih količin informacij. Raziskave lahko odkrijejo vzorce in odnose, ki so bili prej prikriti, s čimer se pospeši tempo odkrivanja etiologije, diagnostike, napredovanja in zdravljenja raka. Aplikacije segajo od označevanja genetskih variant do pridobivanja povezav med genom in boleznijo tudi iz znanstvenih publikacij. Metode omogočajo hitro analizo milijonov raziskovalnih člankov, kliničnih poročil in baz podatkov. Zato je vse hitrejši razvoj modelov, natančnejša so prognostična orodja in realizira se osebi prilagojen načrt zdravljenja. Izdelujejo se genetski profili, aplikacije genetike raka, prilagojene strategije zdravljenja na podlagi profilov tumorjev, identificirajo se gonilne mutacije in potencialne terapevtske tarče, spremljajo se vplivi na odpornost na zdravljenje, napredovanje bolezni in odziv v realnem času. Treba je ravnati v skladu s spremenjeno realnostjo, da ne gre zgolj za tehnološki napredek, ampak za fundamentalne in kompleksne spremembe. Zato ima UI številne dimenzije, posega v različne panoge, predvsem pa terja krepitev sistema javnega zdravstva. Da postaja s prihodnostjo sistem javnega zdravstva potreben, pa je za države EU pokazala že analiza pandemije COVID-19 (Yang, K. et al., 2022).

### 3 Metodologija

Uporabljena metoda je razlagalno-raziskovalna. Ta metoda izpostavi pomembne dokumente v kontekstu UI, EU in Slovenije ter z njihovimi določili, ugotovitvami in priporočili povezuje ukrepanja javnega zdravstva R Sloveniji. S sledenjem teh vsebin razkrije najpomembnejše probleme in izzive obravnavanega področja. Ker pa je metoda pojasnjevalnega značaja uvodoma obrazloži, zakaj je tematika pomembna, na kakšen način se priporoča ukrepati, raziskovati in inovirati. Na osnovi analiziranih in prikazanih primerov literature R Slovenije, OECD, EuropeHealthNet in EK, na ugotovitvah pristojnih organov in institucij, temeljijo podatki, ki omogočajo odgovore na zastavljena tri strateška vprašanja: Ali so v Sloveniji identificirani in s kapacitetami pokriti kritični izzivi na področju zdravstva? Ali politika ukrepanja postavlja v središče pozornosti zdravje in njegovo obvladovanje (ang. governance)? Ali razvoj UI vpliva na krepitev institucij?

### 4 UI in vplivi na sistem javnega zdravstva v Sloveniji: odgovori na tri strateška vprašanja

*1 Ali so v Sloveniji identificirani in s kapacitetami pokriti kritični izzivi na področju zdravstva?*

Revizije Računskega sodišča in OECD dokumenti kažejo, da so ukrepi za delovanje sistema javnega zdravstva premalo upoštevani tako v ukrepanju za razvoj kot v krepitvi odpornosti. Obstoječe stanje - več kot 140 000 ljudi brez zdravnika v primarnem varstvu, čakalne vrste, 1000 postelj v domovih za starejše nezasedenih zaradi pomanjkanje kadra (medicinskih sester, socialnih delavk, bolničarjev, itd.), več kot tri četrt zavarovancev ni deležnih zobozdravstvenih storitev javnega zdravstva – vse to so alarm nakopičenih problemov javnega zdravstva. Praksa kaže, da se sistemsko ukrepanje odlaga, da se posveča več pozornosti blaženju posledic kot odpravljanju vzrokov.

Slovenija je sicer upoštevala priporočilo EK za Nacionalne programe za okrevanje in odpornost in za prehod v zeleno družbo namenila maksimalnih 42% ali 712 mio EUR, za digitalno transformacijo pa 20% ali 345 mio EUR (www.eu-skladi.si, 1.4.2021), vendar ni osredotočenosti in ukrepanja za največje probleme povezane z zdravjem, ki pa morajo biti sistemski. Nacionalni načrt za okrevanje in odpornost je načrtoval le 9% za zdravje (za digitalizacijo, dostopnost sistemov in usposabljanje)

od skupne vsote za obdobje 2021-2026 225 mio EUR. EU kohezijska politika bo za obdobje 2021-2027 financirala zdravje z 103 mio EUR, od tega z regionalnim skladom 28 mio za opremo, ostalo Evropski socialni sklad (80% za dostopnost, uspešnost in pripravljenost zdravstvenega sistema, 20% za digitalizacijo).

Slovenija tudi ni vzpostavila ukrepa ali instrumenta, ki je Misija Rak, da ni priporočene strateške horizontalne osredotočenosti različnih panog za zdravje, njegovo preventivo in v spopadu z rakom. Institucije, ki delujejo v borbi proti raku bi se lahko veliko bolj povezovale, tudi v skupnih prijavah na projekte in kliničnih raziskavah, kar je tudi posledica dejstva, da je Ministrstvo za zdravje delegiralo ali preneslo odgovornost za Državni program obvladovanja raka na Onkološki institut.

Medtem ko so na nivoju EU v novembru 2023 zaključili prvo fazo trije projekti Misije Rak financirani s programom Horizon Europe: Uncan.EU, Vozlišče za raziskavo raka in Evropski digitalni center za bolnike z rakom, je Slovenija edina med državami članicami EU, ki nima vzpostavljenega vozlišča. T. i. Hub pa ima pomembno vlogo za razvoj in inoviranje za organiziranje in komuniciranje. Z letom 2024 se je v okolju EU nadaljevala druga faza: za R&I so se aktivirali deležniki eko sistema zdravstva/raka. V državah, kjer se niso, ali pa premalo intenzivno, ostajajo izven mrež in sistemov ter možnosti črpanja dodatnih sredstev krepitev sistemov in kapacitet, digitalizacijo, infrastrukturo, zaposlitve in dostopa do know-how-a.

Hiter razvoj umetne inteligence predstavlja priložnosti in velike izzive: upravljanje podatkov, razvoj zdravil sirot, učinkovito osredotočenost na bolnika, ki terjajo najvišjo koordinacijo in institucionalno podporo. Zato je bil v letu 2024 tako pomemben precedenčni primer, ko je Vlada financirala izdelavo in komercializacijo zdravila sirote, vložila v proceduro ustrezno dopolnitev zakonodaje, ki je do tedaj preprečevala investiranja javnega sektorja; pomembno je, da štiti komercializacijo domicilno razvitega zdravil in z njim povezan know-how, ki dejansko predstavlja neopredmeteno premoženje države. V letu 2025 se bo možno prijaviti na EK razpis za zdravila sirote, k skupnemu raziskovalnemu in inovativnemu delu (HORIZON-HLTH-2025-01-IND-03: Facilitating the conduct of multinational clinical studies of orphan devices), a vendar treba je poskrbeti za takšne kapacitete, da se prevzame koordinacijo projekta, saj koordinator postane lastnik razvitih produktov v projektu. Upoštevati je treba, da v EU od 12. januarja 2025 veljajo nova pravila za pridobitev dovoljenja za promet z novim zdravilom proti raku ali zdravilom za napredno

zdravljenje in da bodo z letom 2028 ta pravila veljala tudi za zdravila sirote, od leta 2030 bodo nova pravila veljala za vsa nova zdravila. Vedno znova se odpirajo nove potrebe po kapacitetah različnih branž, do različnih profilov managementa, pravnikov in ne le naravoslovno-tehničnih profilov, pri čemer ne gre pozabiti zelo pomembnih aktivnosti prenosa in prevajanja znanja (ang. knowledge translation) zaradi učinkovitega sodelovanja in sploh delovanja posameznih strok.

## *2 Ali politika ukrepanja postavlja zdravje v središče pozornosti?*

Ob strukturnih reformah in strategijah tranzicije je postalo pomembno tudi krepiti sisteme in odpornost. Ne ukrepa se celostno in pristopa se tehnično-tehnološko: n.pr. za okrevanje in odpornost se 43% sredstev usmerja neposredno v tehnološko investiranje, ne glede na škodljive determinante zdravja in brez predhodnega ugotavljanja potreb prebivalstva.

»Za napredek blaginje, za socialne, zdravstvene in okoljske ciljeve, so izboljšave še potrebne zato, ker do zdaj niso bile deležne enake pozornosti kot so to bili fiskalni in politično-ekonomski cilji« (EuroHealthNet Assessment, 2024). Tudi Evropski semester (institucija EK, ki analizira kakovost ukrepanja in bdi nad pripravljenostjo sistemov socialnega varnosti, vključno z zdravjem in dolgotrajno oskrbo) za Slovenijo vedno znova izpostavlja potrebo po reformah in večji intenzivnosti sprememb ([https://commission.europa.eu/system/files/2022-05/2022-european-semester-csr-slovenia\\_en.pdf](https://commission.europa.eu/system/files/2022-05/2022-european-semester-csr-slovenia_en.pdf)).

Člen 152 Pogodbe Evropske Skupnosti (EC Treaty) določa vlogo Skupnosti na področju javnega zdravja, pri čemer navaja, da so »dejavnosti Skupnosti usmerjene v izboljšanje javnega zdravja, preprečevanje bolezni in bolezni ljudi ter odpravljanje virov nevarnosti za zdravje ljudi«. Ti ukrepi Skupnosti morajo dopolnjevati ukrepe, sprejete na nacionalni ravni, odgovornost držav članic pa je za organizacijo in izvajanje zdravstvenih storitev in zdravstvene oskrbe. V tem okviru Evropsko računsko sodišče in Računsko sodišče RS (Special Report, 2005) ugotavljata številne neučinkovitosti: podana so bila negativna mnenja v povezavi z javnimi naročili, plačami, slabim planiranjem, itn. Navedeno pomeni slabo izvajanje funkcij managementa v javnem sektorju; to pa lahko zavira delovanje stroke, kar je velika škoda glede na dosežke sistema javnega zdravstva. Računsko sodišče je v reviziji učinkovitosti vstopa zdravnikov na trg dela za obdobje od 1. 1. 2008 do 30. 9. 2019

podalo mnenje, da »Ministrstvo za zdravje in Zdravniška zbornica Slovenije nista bila učinkovita pri skrbi za učinkovit vstop zdravnikov na trg dela, da nista poskrbela za ugotavljanje dejanskih potreb po zdravnikih niti za ugotavljanje razlogov za morebitno pomanjkanje zdravnikov v okviru posameznih specialnosti. Zaradi tega tudi nista mogla poskrbeti za to, da bi se razlogi za domnevno pomanjkanje zdravnikov uspešno odpravljali. Podatki o tem, koliko je vsak posamezni zdravnik dejansko aktiviran v zdravniški službi, ne obstajajo. Na res številne pomanjkljivosti pa je že leta 2017 opozorila revizija Organizacijski in kadrovski izzivi zdravstvenega varstva v Republiki Sloveniji.

Republika Slovenija ima tradicijo zdravljenja in raziskovanja raka. Onkološki inštitut (OI) od leta 1950 vodi Register raka. Nacionalni inštitut za javno zdravje, NIJZ, OI, Klinični centri, Bolnica Golnik in številne nevladne organizacije so in delujejo na mednarodnih projektih. NIJZ že desetletje koordinira EU projekte skupnega ukrepanja. Tudi sektor civilne družbe deluje profesionalno, organizirano, je v veliko pomoč obolelim, preživelim in njihovim družinam, sodeluje s stroko in zbirajo denar za raziskovanje. Za projekt Obzorje 2020 EU-TOPIA, ki je pričel v letu 2022, je bila izbrana Slovenija zato, ker je edina imela na voljo vse potrebne podatke Statističnega urada RS, Centralnega registra prebivalstva, Registra raka RS ter Registrov presejalnih programov Zora, Dora in Svit, v letu 2025 pa še Peter. Zdaj, ko bi se morale povezovati in globalno skupaj organizacije še bolj povezovati in se vključevati razne panoge, se pojavljajo vrzeli predvsem zato, ker organizacije in institucije na razpolagajo z ustreznimi kapacitetami.

### *3 Ali razvoj UI vpliva na krepitev institucij?*

Intervencija vlade je učinkovita samo takrat, ko ima država na voljo ustrezne kapacitete, da ukrepa. Poleg kapacitete vladanja pa je management ena ključnih struktur in je odgovoren za operacionalizacijo strategij, programov, projektov, optimalno izrabo različnih resursov.

»Potenciali UI v R Sloveniji še zdaleč niso izkoriščeni: treba bi bilo optimizirati procese, pospešiti razvoj programske opreme, preprogramirati programe v odprtokodne« (Letos je padlo kar nekaj statističnih rekordov, Delo, 30. december 2024, str. 2) izpostavlja Statistični urad RS, institucija z največjimi izkušnjami glede

uporabnikov, ki bi kot vizionar na področju uvajanja umetne inteligence lahko v državni upravi lahko za UI že intenzivno delovala.

Misije bi lahko pomenile nov celosten pristop politik ukrepanja, ki je zaradi razvoja UI pomembna strateško oporo, ker »misije in z njimi povezane usmeritve, tudi njihovo financiranje, terjajo poglobljanje, na kakšen način naj javne organizacije dizajnirajo programe, izpeljujejo in vrednotijo politike ukrepanja« (Mazzucato, *Governing Missions*, 2019, str. 14). V Sloveniji ni Misij, ki bi vzpostavile strateški portfolio pristop in hkrati nadgradile obstoječo strategijo pametne specializacije, ki je bila tudi za zdravstvo zasnovana v pretekli finančni perspektivi. V kontekstu zdravja je tveganje, da bodo izgubljene priložnosti, saj misija Rak prinaša potencial, ki ga gre izkoristiti (t.j. da se na novo redefinira pomen zdravja, sistem zdravstva. Ne nazadnje, da se Slovenija trdno postavi na zemljevid kot referenčni center. Pomembno je, da se organizirajo in sprožijo v akcijo potenciali, ki so dolgoročno v ljudskem interesu, da se poveže civilizacija z naravo. Zato so potrebne zadostne upravne, akademske in politične zmogljivosti, da prenesejo pritiske, ki bi ogrožali sistem javnega zdravstva in zdravje ljudi.

Management mora učinkovito delovati v vseh svojih petih funkcijah, ki so: vodenje, programirano vsebinsko in finančno načrtovanje, organiziranje in koordiniranje, obvladovati potenciale, ki so v ljudeh, in nadzirati poslovanje. Danes so potrebni sistemski nadzori (monitoring, revizije in evalvacije); evalvacij, ki pomenijo nadzor nad kakovostjo (ali se delajo prave stvari in ali se delajo na pravi način) pa skoraj ni.

Država in sistem zdravstva terjata vzpostavljen sistem javnih institucij in učinkovito vladanje, strokovno administracijo in javni management. Vladanje mora obvladovati politike ukrepanja in pripravo instrumentov (ang. policy and policy-making), kar je več kot priprava zakonodaje. Gre za strategijo zdravstva, pa tudi za strategijo UI in premišljene pristope, na strategijah temelječe akcijske programe, ki pa razumejo potrebe in izzive konteksta okolja in časa.

## 5 Zaključki

Prispevek je izpostavil tri pomembne vidike vezane na zastavljena tri vprašanja, ki so strateškega pomena. Najprej je bila v prispevku prikazana teorija. Sprejeta zakonska ureditev v okolju EU je bila pravočasno narejena, a v državi so na



posameznih področjih zamude. Prikazani so tudi izsledki pomembnih analiz, za R Slovenijo še posebej pomembnih revizij Računskega sodišča, OECD, EuroHealthNet, Evropskega semestra. Priložnosti razvoja UI ostajajo neizkoriščene. Največkrat zato, ker na najvišjem nivoju vladanja in v javnem managementu ni poskrbljeno za krepitev kapacitet. Več je potrebnih premikov v novem konteksta razmišljanja in ukrepanja za trajnostni razvoj, treba je intenzivno delati na strateških in sistemskih spremembah, predvsem pa uveljaviti odgovornost za izpeljavo načela zdravja v vseh politikah in da se aktivnosti resnično osredotočijo na pacienta.

Ker so klimatske spremembe vezane na vprašanja zdravja, ker se povečujejo smrti, bolezni, širijo infekcije in respiratorne bolezni, v naravi pa je vse več požarov, neviht, prahu in peska, so slaba kakovost zraka, zemlje in vode največja grožnja naravi in ljudem. Zato morajo biti sistemi zdravstva javni, vladanje pa mora okrepiti politike ukrepanja in zdravstveno infrastrukturo.

Številne raziskave, revizije, evalvacije in analize ostajajo neopažene, še bolj pa neuporabljene za krepitev sistema odgovornosti, izgradnjo sistema javnega zdravstva in krepitev politik ukrepanja. Lahko rečemo, da ima strategija prilagajanja zdravja in skrbi za zdravje in nego v klimatskih spremembah nizko prioriteto, kar se ne dogaja ne le v Sloveniji. So vrzeli med zakonodajo, opredelitvami politik in ukrepov ter dejanskim stanjem. Vse preveč energije se izgublja v teoretičnem razglabljanju, namesto bi ukrepi politik predstavljali izbrane strokovne predloge v prakso. Še zlasti je pomembna vloga visokega šolstva ali akademije, ki naj prevzame vlogo povezovanja različnih akterjev.

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### **O avtorici**

Neva Maher je izredna profesorica, diplomirala, magistrirala in doktorirala iz poslovnih ved na Univerzi v Ljubljani, na Ekonomski fakulteti. Rojena leta 1951, je upokojena dekanja Fakultete za poslovne in uravne vede Univerze v Novem mestu. Je evalvatorica programov Erasmus+ in evalvatorica kakovosti študijskih programov in potrjevanja akreditacij. Med 2015-2017 je bila članica Visoke skupine Evropske Komisije the European Commission (High Level Group on maximizing the impact of EU Research and Innovation programmes), od leta 2022 je članica Odbora Misije Rak (Cancer Mission Board).

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# COMMUNICATION STRATEGIES AS KEY OF CHANGE LEADERSHIP

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The purpose of this study is to investigate the impact of internal marketing communication strategies and employer branding approaches on strategic human resource management, as well as their effect on organizational change management. This will be achieved using a holistic narrative approach to research, examining current market trends, relevant and available scientific literature, and a case study on acquisitions of retail chains. The aim of the study is to develop a conceptual model of organizational change management based on communication strategies. The findings suggest that the developed conceptual model creates the necessary prerequisites and significantly influences the encouragement of effective leadership during changes, as well as reducing employee resistance in the process of implementing organizational changes. Also, this study offers a deeper understanding and supports decision-makers, while encouraging further research by scholars. However, it is limited by the descriptive approach, the limited availability of literature, and the small sample size.

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## 1 Introduction

The management of organizational changes, as both a scientific and practical field, has gained significant attention in recent years, considering the dynamics of innovation, technological advancements, and the challenges of implementing digital business models. A key component in existing organizational change models is the efficient and effective communication of the vision, goals, and values of change. This is crucial for increasing the level of employee engagement, reducing the level of resistance to change, and fostering resilience to new situations (Collins, D. 1998). According to numerous authors and statistical data, Kotter's change management model (1998, 2014) is the most used in practice today. The purpose of this study is to examine the impact of communication strategies on strategic human resource management and their effect on organizational change management and change leadership, through internal marketing communication and employer branding. The aim of the study is to develop a conceptual model of organizational change management based on communication strategies. This will be accomplished through a holistic narrative research approach, which examines current market trends, relevant scientific literature, and a case study on retail chain transformations. Accordingly, the study hypothesizes that internal marketing communication strategies and employer brand development have a positive impact on employee resilience and successful change management. These aspects are analyzed and elaborated in this paper using a theoretical, qualitative research approach, based on prior knowledge, practical experience, and available literature collected via the Google Scholar platform, as well as secondary statistical data gathered from statistical report platforms. The limitations of this study are narrative, theoretical research approach, the use of secondary data, the small sample size, and the limited availability of literature. The first chapter introduces the subject matter and provides a literature review used in the study, framed within the integrated multidimensional framework of human resource marketing and communication. After outlining the methodology, a systematic review of the literature and a case study were used to identify the key factors that influence the level of readiness for change. The discussion further presents strategies and conceptual frameworks for organizational change management model, with a focus on leadership development, human resource development, and creative communication strategies. The study also includes an integration of the conceptual framework for human resource development and knowledge management.

## 2 Literature Review

Considering the subject of the study, and literature, the impact of internal marketing communication and employer branding on organizational change management, can be elaborated from the following aspects:

- Primarily in relation to the aforementioned management of organizational changes, since nearly all models emphasize the importance of communication in spreading awareness of changes, evaluation, and feedback (Collins, D., 1998; Dulanović, Jaško O., 2008; Kotter J. P., 1998; Kotter J.P., 2014; Anderson D., Anderson, L.A. 2010; Lauer T., 2021).
- As part of strategic human resource management, with respect to employee motivation strategies, where employee recognition plays a key role in further encouraging changes through marketing communications and employer branding, via integrated communications and internal communication (Filipović V., Kostić-Stanković M., 2007; Barjaktarović S., Cicvarić Kostić S., Kostić-Stanković M., 2021; Štavljanin V., 2005; Barrow S., Mosley R., 2005; Figurska I., Matuska E., 2013.; Marjanović M., 2024.; Shanmuga Priya G., UmaRaman M., 2021; Reis I., Sousa M.J., Dionísio A., 2021.; Stanković J., Živković R., Gajić J., Brdar I., 2017; Radošević T. B., 2019); and post-acquisition and post-marger period and employee readiness for change (Devenport J., Barrow S., 2009; Khana Z., Soundararajan V., Wood G., Ahammadd M. F., 2020).
- In processes that impact key performance indicators of human resource management strategies, such as: talent acquisition, recruitment, selection, employment, evaluation, employee development, and promotion (Orlić R., 2005), especially the development of new models of human resource management that emphasize the leadership role compared to traditional models (Ulrich D., Grochowski J., 2018), and the proposal of the economic, functional, and psychological value of the employer (Barjaktarović S., Cicvarić Kostić S., Kostić-Stanković M., 2021; Stanojević S., Kostić-Stanković M., Štavljanin V., 2023; Lievens F., Slaughter J. E., 2016; Fernandez-Lores S., Gavilan D., Avello M., Blasco F., 2016; Caputo A., Molino M., Cerato B., Cortese C.G., 2023; Della Corte V., Mangia G., Micera R., Zamparelli G., 2008)), through human resources development.

### 3 Methodology

Secondary data used in this study were collected through keyword searches on the Google Scholar platform, including scientific journals, articles, books (in full or available sections and chapters), and consulting materials. The case study was conducted based on semi-structured interviews held during July 2024, lasting 45 to 60 minutes, with leaders in change management in mergers, acquisitions, and digitalization of retail chains. The roughly formulated questions focused on processes, strategies, factors, and the interrelation of human resource management and organizational change management. Conceptual models were analyzed and elaborated from the perspective of change leaders.

### 4 Case Study

These case studies focus on organizational change and the impact of human resource strategies, specifically within the context of organizational transformation, such as mergers, acquisitions, and digitalizations in Central and Southeast Europe, and present a development of a conceptual model of organizational change management. Elaboration is based on processes, strategies, factors, and the interrelationship between human resource management and organizational change management, and multidimensional frame of change leadership.

#### 4.1 Communication as Driver of Change

In the literature and case studies, there is a large number of different drivers of change, both internal and external. This study examines one segment of these drivers from both an internal and external perspective, specifically internal communication, as it is highlighted in the case study for its importance in creating the strategy for implementing organizational changes, as well as in implementation and change leadership. According to Eurostat (2024), employment statistics focusing on communication skills show that internal communication within organizations occupies about 50% of the working time of employed people. The case study analyzed and elaborated in this paper, through the examination of organizational change management models and human resource management strategies during company transformations, also points to the high level of influence and significance of internal communication as a key factor for the success of organizational change



implementation. This is achieved through effective leadership, which primarily involves:

- continuous communication and
- just-in-time responses to received feedback

This creates the opportunity for the:

- exchange of ideas,
- developing good interpersonal relations,
- human resource development,
- activities in developing and implementing strategies, and
- thus foundational sustainable business practices.

#### **4.2 Human Resource as Internal and External Drivers of Change**

According to data from the Republic Institute of Statistics of Serbia (2024), the past decade has seen an increase in employment levels, as well as a rise in wages, economic stability, and the security of the workforce and human capital. In the considered case study, the availability of labor and workforce for new business ventures, organizational development, and expansion through the development of distribution networks and communication channels, is one of the key internal and external factors for driving and managing organizational changes, such as acquisitions and business transformations. Special attention is given to the labor market's condition in relation to the required qualifications. In cases of a shortage of necessary qualifications, human resource management strategies focus on talent retention strategies, as well as on attracting and developing new talent. This contributes to increasing employment levels and the value of human capital, effective and efficient knowledge management, and economic and social security, stability, and growth.

### **4.3 Impact of Human Resource Communication on Change Readiness**

Key elements of organizational change management, according to numerous authors and research studies, and elaborated case studies, include the resistance of employees and their level of readiness for change. Resistance has a significant impact on the failure of organizational change implementation, with the failure rate of organizational changes reaching as high as 70%, according to several studies. At the same time, resistance is considered an expected factor during the implementation of changes. Therefore, this paper and case study elaborate the potential of human resources and methods for human resource development, thereby impacting organizational change management. Opportunities for additional development and knowledge, qualifications, skills, and the further development of human resource, aiming to fully utilize the local workforce, which ensures stable and sustainable growth and development. Additionally, during company transformations, attracting and retaining talent also implies the need to adapt to new circumstances, such as technological transformations, digitalization, and changes in organizational systems and business models. From the perspective of human resource development, in this case studies, motivation can be viewed through the conceptual frameworks of developing employee potentials and talents, which are linked to the level of motivation and the desire for specific professional achievements. Therefore, employees' developmental potential primarily depends on their professional and personal characteristics, as well as their level of motivation. Talent development and knowledge management, as a broader scientific field, represents the development potential of a company and a predictive factor for the success of implementing organizational changes, aligning with strategic human resource management. Human resource development during organizational transformations can be considered from two perspectives: the development of employees and talents and the attracting talents. Employee development during organizational transformations can be analyzed through the following frameworks: the development of new generations of employees; integrated communication systems, talent acquisition; the importance of employer branding and human resource internal communications. In order to foster readiness for change and thus increase the success rate of managing organizational changes, internal communication plays a crucial role in leadership and human resource management.

## 5 Discussion

Communication, elaborated in this paper, especially in terms of feedback and timely response, can significantly contribute to reducing level of resistant, and burnout of employees during the implementation of organizational changes. Technological innovations and increasingly frequent and comprehensive digital transformations, during organizational transformations, mergers, and acquisitions, based on strategies for implementing organizational changes make conditions for successful implementation, based on strategies with a focus on the human factor, mutual interaction, and the use of new technological and digital solutions. Furthermore, based on the development of human resource internal communication, the establishment of trust and good interpersonal relationships fosters the development of teams and human resources, particularly in terms of knowledge management. This enables more efficient knowledge exchange within teams, as well as the acquisition of new knowledge through the implementation and adaptation to new systems and the use of digital solutions. According to statistical data from The Strategic Human Resources Management (SHRM, 2025), communication is a key factor for the success of organizational change management and leadership. In fact, 65% of leaders and managers consider communication the most important aspect. Deloitte's concept (2023) of organizational change management through transformation strategies that strengthen creativity in organizations views transformation management through the lens of employee creativity. Therefore, based on strategies, methods, and techniques for fostering employee creativity and their implementation, the success rate of company transformations increases.

When comparing communication approaches, as well as change management models approaches: top-down, bottom-up, and linear, open dialogue proves to be the more efficient and effective approach, which are elaborated in this paper, especially in terms of human resource development and leadership of organizational change management. According to KPMG (2023), employee experience and organizational culture influence employee behavior and actions, which in turn impacts the outcomes of organizational change management. According to a Deloitte (2023) study, the positive impact of creativity on business development and growth contributes increase level of annual revenue for 10%. Research from Deloitte Digital and LIONS on the overall creativity in business and its impact on transformation success highlights that key elements are employees, as well as other

stakeholders and internal communication. Internal communication as the foundation for further business development and growth based on creative strategy development, and consequently the success of implementing various types of organizational change transformations, can be considered as key factor in successful leadership.

Taking into account the assumption about the key factor of organizational change management, which in the context of integrating marketing strategies and human resources refers to communication strategies, the literature highlights the significant influence of internal communication and the employer's brand on the growth of employee performance. According to numerous authors in recent literature, the influence of internal communication and the employer's brand leads to the growth of employee levels of: performance, satisfaction, motivation, loyalty, productivity, attachment, engagement (Lievens F., Slaughter J. E., 2016; Fernandez-Lores S., Gavilan D., Avello M., Blasco F., 2016; Caputo A., Molino M., Cerato B., Cortese C.G., 2023; Della Corte V., Mangia G., Micera R., Zamparelli G., 2008; Monteiro B., Santos V., Reis I., Sousa B., Sousa M.J., Au-Yong-Oliveira M., 2020; Fernandez-Lores S., Gavilan D., Avello M., Blasco F., 2016). Additionally, the influence of internal communication and the employer's brand results in a positive employee perception through: reduced levels of resistance and increased resilience (Eger L., Micik M., Gangur M., Rehor P., 2019; Almacika E., Eratb S., Akcinb K., 2012; Samoliuk N., Mishchuk V., 2022; Kotter J.P., 1998; Kotter J.P. 2014). Leadership, along with managerial competencies, synergized with leadership elements such as professional and personal characteristics, leadership styles, and authenticity, significantly contribute to and influence the effectiveness and efficiency of organizational change implementation, thus impacting the overall success of organizational transformations and change management.

## 6 Conclusion

The essential factor of communication, is the establishment of good interpersonal relations as a prerequisite for successful leadership and business. Communication strategies play a crucial role in change management, particularly in shaping and communicating the company's vision and values, which are essential for both employers and employees. Change leaders focus on creating meaningful employee experiences, implementing human resource management strategies, and

emphasizing practices that enhance employee engagement, motivation, and safety during organizational change. These factors are vital for strengthening employee resilience and overcoming resistance to change, where the human factor of the organization plays a significant role. To achieve the desired impact on employees and ensure the effective management of organizational changes, communication strategies must be carefully planned, designed, and executed.

Conceptual model of organizational change management based on communication strategies, which is developed, based on organizational development and change management include: communication strategies, leadership development; human resources development, and can be further developed through a knowledge management system. Within this context, inspiration, creativity development, and motivation are key drivers. Recognition as one of the most significant motivational factors, largely contributing to increased employee satisfaction and engagement.

The contributions of this developed concept are evident both academically and practically. Academically, it advances the field of leadership and change management studies, while practically, it provides a deeper understanding of organizational change management and the impact of marketing communication strategies on the efficiency and effectiveness of implementing organizational changes.

The limitations of this research lie in the small sample size, limited literature, and the narrative approach used.

Future research will adopt a Grounded Theory methodology, focusing on a larger sample of change leaders, human resource managers, and decision-makers. Data collected through semi-structured interviews will be analyzed using open coding techniques.

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# ASSESSING THE IMPACT OF PAID MEDIA ON STUDENT ENROLLMENT DECISIONS IN CROATIAN HIGHER EDUCATION: A COMPARATIVE ANALYSIS OF MEDIA TYPES

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Communication is essential in marketing, connecting organizations with their target audiences. However, not all media types hold equal value in customer decision-making. This exploratory study examines the relevance and frequency of use of paid, owned, and earned media in higher education from students' perspectives. The focus is on paid media due to its high costs and its role in influencing prospective students' choices. The findings show that owned media are the primary source of information, while paid and earned media play lesser roles. These insights can guide higher education institutions in optimizing communication expenses and improving audience engagement.

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## 1 Introduction

As a peacock displays its beautiful tail to impress its mate, companies use promotional tools to capture the attention of their target audiences. A fair deduction would be that those who fail in their promotional efforts risk fading into obscurity in the eyes of their customers. However, promotion is an expensive activity. Even in the past, reaching customers was neither easy nor inexpensive, as John Wanamaker famously attested, saying, “I know that half of my advertising is wasted, but I don’t know which half” (Kotler et al., 2022, p. 293).

Recent studies reveal a declining trend in the quality of consumer attention, leading companies to intensify their efforts to capture the interest of their audiences by ramping up advertising, resulting in costs rising by as much as nine times (Teixeira, 2014). Statistics also indicate that advertising spending continues to grow year by year. It is projected that global advertising spending will increase by 2.37 times by 2029 compared to 2017 (Statista, 2023). Therefore, promotion will remain a cost-driven issue in the future.

The problem organizations face in the market is how to communicate effectively with consumers, as marketing communication becomes increasingly demanding and challenging. Organizations must focus on quality communication and find creative ways to communicate efficiently, while also balancing business costs.

This paper aims to identify the importance and usage of different types of media—namely, paid, owned, and earned media—in higher education from students’ perspectives. The results will shed light on how to balance these types of media to effectively communicate with prospective students and influence their decision-making process in a cost-effective manner.

## 2 Literature review

Marketing is a relevant and essential tool for achieving a competitive advantage in the market, and it requires a deep understanding of consumer behavior to be effective. Achieving effectiveness is particularly challenging for higher education institutions (HEIs) because their services are classified as high credence services, students are perceived as both consumers and co-creators of these services, and

student choice is influenced by numerous variables (Chauhan, 2022). As HEIs increasingly adopt business-like strategies to attract diverse student populations, including domestic and international students, the need for effective marketing also arises. Consequently, the importance of promotion for HEIs in a competitive and globalized marketplace continues to grow (Camilleri, 2020). Competition and the ongoing decline in the number of university-aged students, particularly in developed countries, have led, and will continue to lead, to decreased enrollment, driving many HEIs to adopt aggressive marketing and promotional strategies (Wu & Naidoo, 2016).

Promotion, as an organization's communication tool, is an expensive resource that needs to be wisely planned and implemented. Fill and Turnbull (2016) identify three key elements of planned marketing communication: tools, media, and content (messages). The main communication tools include advertising, sales promotion, public relations, direct marketing, personal selling, and value-added approaches such as sponsorships, exhibitions, and field marketing. Content can be primarily informational or emotional but is typically a subtle blend of both. Examples of media include magazines, websites, and television programs.

When classifying media by sources, Fill and Turnbull (2016) introduce the POEM classification, which includes three types of media:

1. **Paid Media:** Involves renting time or space on external platforms to deliver targeted messages, with a planned and measured approach to audience reach, costs, and scheduling.
2. **Owned Media:** Leverages an organization's assets, such as websites, vehicle branding, and other branded displays, to convey messages and foster conversations without incurring rental costs.
3. **Earned Media:** Encompasses unplanned, organic discussions and mentions about a brand, both online and offline, which may arise naturally or be stimulated by marketing efforts.

The media relevant to this research are those most commonly used by prospective students in their decision-making process.

1. **Paid Media:** Includes TV, radio, web ads/banners, paid advertisements on social media, and articles in the media about higher education.
2. **Owned Media:** Encompasses HEI websites, open days, HEI emails, HEI telephone contact, presentations in schools, posters and flyers in schools, posters in public places, and posts on platforms such as Twitter, YouTube, Instagram, and Facebook. It also includes visibility through Google search.
3. **Earned Media:** Covers recommendations from high school teachers/HEI professors, family recommendations, and good reputation or word-of-mouth endorsements from colleagues, friends, and others.

In Table 1, a list of communication channels along with relevant supporting sources is presented.

**Table 1: Communication channels with sources**

Media type	Media	Country	Authors
Paid media	TV	N/A	(Hossler, 1990, as cited in Mehboob et al., 2012)
		Italy	(Pinna et al., 2018)
	Radio	N/A	(Hossler, 1990, as cited in Mehboob et al., 2012)
		Italy	(Pinna et al., 2018)
	Web advertisements/ banners	Canada	(Angulo-Ruiz et al., 2016)
		Cameroon	(Noël, 2023)
	Paid advertisements on social media	N/A	(Huebner, 2021)
		Lebanon	(Ismail, 2021)
Media articles about the HEI	UK	(McNicholas & Marcella, 2022)	
	Uganda	(Muhangi, 2020)	
Owned media	HEI's website	Portugal	(Soares & Simões, 2015)
		Croatia	(Meštrović et al., 2019)
		USA	(Burdett, 2013)
	Open days	Hong Kong	(Ho & Law, 2022)
		Scotland	(Briggs & Wilson, 2007)
	HEI's email	UK	(Moogan, 2020)
		UK, EU,	(Towers & Towers, 2020)
N/A		(Harahap et al., 2017)	

Media type	Media	Country	Authors
	HEI's phone	UK	(Šola & Zia, 2021)
		Italy	(Pinna et al., 2018)
	Presentation in high schools	Bosnia	(Babović, 2014)
		USA	(Cai et al., 2015)
	Posters and flyers in high schools	Portugal	(Dias & Meneses, 2022)
		Portugal	(Simões & Soares, 2010)
	Posters in public places	N/A	(Chauhan, 2022).
		N/A	(Ziyadin & Serikbek, 2020)
	HEI's social media	Portugal	(Dias & Meneses, 2022)
		N/A	(Kusumawati, 2014)
		Vietnam	(Le et al., 2020)
	Google search	UK	(McNicholas & Marcella, 2022)
UK		(Šola & Zia, 2021)	
Earned media	High school teacher recommendations	Finland	(Herold et al., 2016)
		Kyrgyzstan	(Najimudinova et al., 2022)
		Canada	(Pizarro Milian & Rizk, 2018)
	HEI professor recommendations	UK	(McNicholas & Marcella, 2022)
		Kenya, India	(Nyaribo et al., 2012)
	Family recommendations	USA	(Dial, 2014).
		Indonesia	(Kusumawati, 2013)
		China	(Liu & Zhu, 2019)
	Recommendations from other relevant persons (colleagues, friends, employers)	Germany	(Dumitrașcu & Șerban, 2013)
		Vietnam	(Le et al., 2020)
		Poland	(Sojkin et al., 2012)

Source: Authors from multiple sources

Table 1 presents a comprehensive list of all the media channels utilized in this analysis, each accompanied by relevant research findings that demonstrate the significance and impact of these media in the context of HEIs.

However, communication should also be considered from the perspective of the decision-making process. For complex decision-making—particularly applicable to the purchase of expensive or high-risk products—communication must align with each phase of that process. The complex decision-making model identifies the stages

consumers go through as follows: need recognition, information search, evaluation of alternatives, final purchase, and post-purchase behavior (Kotler et al., 2022).

This paper analyzes the three types of media in relation to the student decision-making phases, aiming to provide valuable insights specifically relevant to HEI communication managers in their efforts to effectively engage with target audiences.

### **3 Methodology**

The aim of this study is to assess the relevance and frequency of use of different types of media employed by higher education institutions in their communication with target audiences. The three types of media analyzed are paid, owned, and earned media.

The analysis was conducted with respect to the decision-making phases of prospective students. The survey included a list of 20 communication channels/media that respondents utilized when deciding where to study. Among these, five channels were classified as paid media, twelve as owned media, and three as earned media. To calculate the percentage distribution of media usage, the total usage across all media types was summed, and the proportion of each type (paid, owned, or earned) was calculated relative to this total.

The research sample consisted of 50 respondents, both undergraduate and graduate students, from various Croatian higher education institutions. Data analysis was performed using MS Excel.

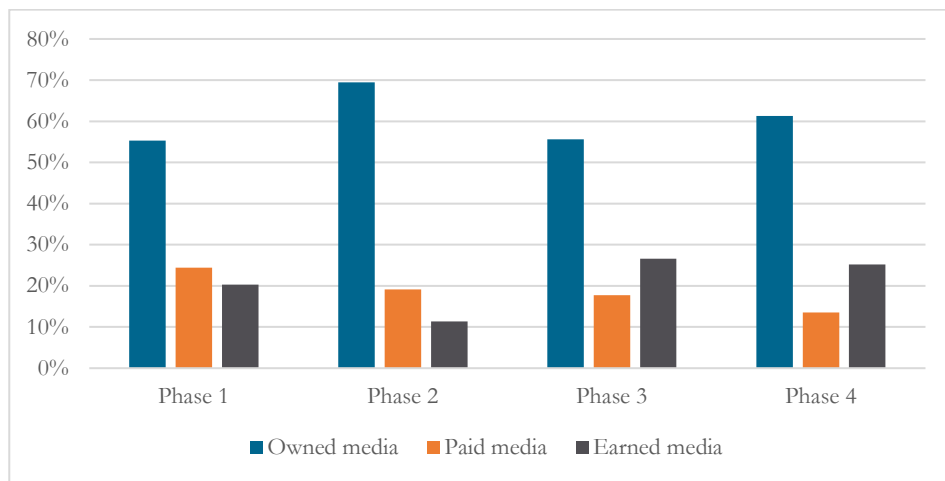
### **4 Data analysis and results**

The analysis explores how prospective students engage with three types of media—paid, owned, and earned—during each phase of their decision-making process when selecting a HEI. The focus is on the first four phases of the decision-making process: need recognition, information search, evaluation of alternatives, and final purchase. The study presents the percentage distribution of each media type within its respective category across the entire sample. The findings are summarized in Table 2, which offers a detailed breakdown in percentage points, and visually represented in Figure 1 for a clearer comparison of media usage patterns.

**Table 2: Frequency of media types across decision-making phases**

	Phase 1	Phase 2	Phase 3	Phase 4
Owned media	55%	69%	56%	61%
Paid media	24%	19%	18%	14%
Earned media	20%	11%	27%	25%

Source: authors



**Figure 1: Graphical representation of the frequency of media types across decision-making phases**

Source: Authors

The data in the table highlights the varying importance of media types across the four decision-making phases when prospective students choose a higher education institution. Owned media consistently dominates throughout all phases, reaching its peak influence in Phase 2 (Information Search) at 69%. Paid media demonstrates a declining trend, starting at 24% in Phase 1 (Need Recognition) and gradually decreasing to 14% by Phase 4 (Final Purchase), indicating its diminishing impact as students move closer to their final decision. Conversely, earned media shows a notable rise in significance from 20% in Phase 1 to 27% in Phase 3 (Evaluation of Alternatives) and maintains a strong presence at 25% in Phase 4, emphasizing the growing importance of recommendations as students finalize their choices. This distribution underscores the importance of strategic focus on owned and earned media throughout the decision-making process.

The most frequently used specific media across each group and decision-making phase reveal distinct patterns. In Phase 1 (Need Recognition), owned media is evenly distributed, with a particular emphasis on presentations in high schools, while paid media is evenly spread across channels. Earned media is also evenly distributed but highlights teacher recommendations as a key source. During Phase 2 (Information Search), owned media dominates with HEI websites, open days, and internet searches being the most prominent. Paid media in this phase focuses more on media articles about the HEI, whereas earned media remains evenly distributed. In Phase 3 (Evaluation of Alternatives), owned media continues to dominate, particularly through HEI websites and internet searches. Paid media maintains an even distribution, while earned media is also evenly spread but places emphasis on recommendations from other relevant individuals. Finally, in Phase 4 (Final Purchase), owned media is strongly led by HEI websites, paid media primarily features media articles, and earned media is dominated by recommendations from other relevant individuals.

## 5 Discussion and conclusion

This exploratory study highlights several key points worth considering. These findings provide valuable insights into the decision-making process of prospective students and the role of media in influencing their choices.

*Media Allocation by Decision-Making Phases:* The key question arises: why is there a difference in the media types used across decision-making phases, and what accounts for this distribution? At the beginning of the process, the consumer does not have established criteria for evaluating specific brands. They require a significant amount of information to develop a set of criteria for assessing brands. Additionally, they need more information about the individual brands they will consider for evaluating alternatives (Mihart, 2012).

The most prominent media type used by prospective students in all decision-making phases is owned media. This may be because prospective students, as consumers of educational services, base their purchasing decisions primarily on information received from higher education institutions (Helmsley-Brown, 1999, cited in Maringe & Gibbs, 2009).



Paid media decreases across the phases. One possible explanation is that its purpose is to attract attention, and generate a positive attitude. Paid media is more focused on informing and creating awareness (Fill & Turnbull, 2016). Over the course of the phases, its role in attracting attention and creating awareness becomes less dominant as these goals are typically achieved in the early stages.

Advocacy and conversations often rely on earned media, with many campaigns aiming to generate strong word-of-mouth communication (Fill & Turnbull, 2016). Earned media becomes dominant in the later phases of decision-making, while it is weaker in the information-gathering phase. This is because, in the information-gathering phase, prospective students primarily seek technical information about offerings and are less likely to seek advice. However, in the final decision-making stage, the risk of purchasing is highest, and advice or positive word-of-mouth becomes crucial. Earned media is often seen as more reliable and trustworthy than paid media because it comes from independent sources (Jain & Pandey, 2023).

*Most Prominent Specific Media Used:* Each prospective student utilizes different communication channels. Therefore, to achieve optimal communication and reach potential students, it is necessary to use the appropriate communication channels (Maringe & Gibbs, 2009).

In the initial phases, owned media dominates, with HEI websites, open days, and internet searches being the most prominent sources. Websites and internet searches are particularly relevant for gathering technical information about the offerings. Presentations in high schools and open days represent personal contact with prospective students, which is most effective due to the role of personal selling. Personal selling is important for information dissemination and persuasion, as it helps inform, persuade, and provoke purchase decisions through tailored messages (Fill & Turnbull, 2016).

Paid media, such as advertising, can be used to raise awareness (Fill & Turnbull, 2016). Accordingly, paid media, through mass communication channels, is evenly distributed and consumed by prospective students, with an emphasis on media articles in phases 2 and 4. Newspapers and magazines play a key role in influencing students' higher education choices by providing essential information about education, facilities, and contact details (Muhangi, 2020).

Earned media, such as teacher recommendations and advice from other relevant individuals, becomes more prominent in the later phases of the decision-making process. As emphasized earlier, the final decision is riskier, so high school teachers, regarded as experts in the field, are considered reliable sources. Prospective students may follow recommendations from these expert sources because the information is perceived as relevant and consistent with their values (Herold et al., 2016).

*Costs and time-based media allocation:* Effective communication and optimal budget distribution are crucial, given the high costs of paid media (Teixeira, 2014). The process of purchasing higher education services is strictly defined, with decisions being made once a year. The phases of the decision-making process are clearly predetermined and follow a defined course. Strategically utilizing relevant media in each phase can significantly contribute to the efficient allocation of limited resources, as opposed to blindly investing in various media throughout the year. Blind investments often result in the use of unreliable or unattractive media sources, which fail to produce a positive effect, regardless of the message's content and validity (Veloutsou et al., 2005). The study indicates that specific phases of the process favor particular media.

In conclusion, this exploratory study provides valuable insights into the decision-making process of prospective students and the role of various media types in shaping their choices. Owned media plays a dominant role in the early phases, while paid media decreases as attention and awareness are already established. Earned media gains prominence in the later stages, especially when decision-making risks are higher, as students rely on recommendations from trusted sources. The study emphasizes the importance of strategically allocating resources across media types to optimize communication and effectively guide students through the decision-making process.

## **5.1 Scientific and practical contribution**

This exploratory study contributes scientifically by exploring how different media types—owned, paid, and earned—affect prospective students' decision-making at various stages. It provides insights into effective media allocation strategies in higher education marketing. Practically, it offers recommendations for higher education institutions to optimize their communication channels and marketing budgets,

improving engagement and increasing enrollment rates by targeting the right media at each decision-making phase.

## 5.2 Limitations and future research

A limitation of this study is the relatively small sample size of 50 respondents. Future research could expand the sample size for more comprehensive findings and explore not only the frequency of media usage but also the significance and strength of the influence each media type has on prospective students' decision-making processes. This could provide deeper insights into how media affects students' choices beyond mere exposure.

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# LEARNING ANALYTICS AMONG UNIVERSITY TEACHERS: PRELIMINARY FINDINGS

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This study investigates the use of learning analytics among university teachers. A survey, developed based on a literature review, was distributed to faculty members at the University of Maribor, Slovenia, and the University of Rijeka, Croatia. The preliminary findings show that university teachers primarily use learning management systems to collect data, but rarely combine data from different sources or use advanced analytics techniques such as machine learning. The study also reveals scepticism around ease of use, confidence in analytics and social impact, highlighting the importance of facilitating conditions for adoption. Despite these challenges, participants recognise the benefits of learning analytics to make informed decisions and improve teaching effectiveness. The study underscores the need for further research to develop better tools and support for widespread adoption.

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## 1 Introduction

The increasing accessibility and use of digital technology leaves behind extensive data trails that form a basis for meaningful analyses and predictions of user behaviour. In areas such as marketing, customer data is used to predict interest in future products; Netflix curates movie recommendations based on individual viewing habits and Amazon anticipates book preferences to drive engagement and sales. The vast potential of data analytics has also spread to academia, where similar methods are being used to improve learning experiences and outcomes. Studies examining learning analytics in higher education have shown promising results in identifying student needs, improving academic outcomes and supporting student retention (Cobo-Rendon et al., 2021; Denley, 2014; Gašević et al., 2016; Kaliisa et al., 2022).

Learning analytics, broadly defined, provides educators with insights into student learning behaviour through the analysis of data patterns, enabling more informed decisions about targeted interventions. At the course level, these insights can significantly improve the quality of pedagogical support by revealing barriers to learning and enabling timely feedback. The notion that learning analytics can drive meaningful improvements in educational practise has gained widespread acceptance in recent years. In this study, we adopt the widely accepted definition of the Society for Learning Analytics Research (SoLAR), established at the first International Conference on Learning Analytics and Knowledge and cited by (Siemens & Long, 2011, p. 34): “Learning analytics is the measurement, collection, analysis, and reporting of data about learners and their contexts for the purpose of understanding and optimising learning and the environments in which it takes place.”

Learning analytics can generally be divided into two main categories: descriptive and diagnostic analytics, which focus on the analysis of past data, and predictive and prescriptive analytics, which aim to predict learner behaviour or outcomes and guide appropriate interventions. While descriptive and diagnostic analyses help to understand students’ past performance and identify patterns, predictive and prescriptive analyses enable the development of strategies to support individual learning trajectories and predict likely educational outcomes (Bamiah et al., 2018). For educators, particularly in higher education, this ability to both understand and



predict learners' needs represents a major opportunity to improve academic support and promote learning success.

However, despite this potential, the full scope of learning analytics is not yet being fully utilised, even by universities with significant investment in this area, such as The Open University UK (Olney et al., 2021). There is a growing awareness of the opportunities and limitations associated with these tools. Critics argue that learning analytics should not only be considered as a tool to promote the digital transformation of education, but must also take into account the human element, as outcomes depend on the interaction between the analytics tools and the various stakeholders, including students, lecturers and administrators (Ferguson et al., 2019; Olney et al., 2021). Considering these human factors is critical to understanding the real-world application of learning analytics and fostering a supportive, data-driven academic environment.

This study aims to broaden our understanding of the practical use of learning analytics from the perspective of university teachers and academic staff. Using a quantitative approach, we aim to investigate how teachers use learning analytics, what challenges they face and what benefits they see. By focusing on these stakeholders, we fill a critical gap in the literature that often emphasises technological capabilities over the nuanced, human-centred challenges of integrating data analytics in education. The findings of this study contribute to the ongoing discourse on optimising learning environments by providing initial insight into the factors that facilitate or hinder teachers' use of learning analytics. The findings are valuable not only for academic institutions, but also for educational technology developers who want to design and implement analytics tools that truly support teaching and learning. This paper presents the preliminary results of this research and highlights the current situation in higher education in Slovenia and Croatia.

## **2 Theoretical background**

In the pre-digital era, educational data was rarely collected or used, and learning technologies were mainly developed based on behaviourist principles. Although behaviourism appears to be disconnected from learning analytics, Rodriguez (2013) has noted that large online education platforms such as MOOCs like Udacity, EdX and Coursera apply behaviourist principles by relying on traditional methods such

as skill learning and reinforcement of concepts through interactive exercises. Clearly defined, measurable learning objectives make it possible to assess certain levels of learning outcomes even by digital technology (Ye, 2022).

In educational research, a distinction is made between assessment and evaluation in the educational context. Formative assessment aims to improve a learning product during its development, while summative assessment assesses the effectiveness of the final version. Initially, only quantitative data was collected, but later qualitative data was added, allowing researchers to observe student behaviour using rubrics and checklists. Today, both assessment and evaluation are fundamental to pedagogical practise as researchers seek to utilise all relevant data to improve both teaching and learning.

Although digital technology had already found its way into education at the beginning of the 20th century, it was not until the 1990s that online learning became widely accepted (Ye, 2022). The introduction of learning management systems (LMS) created a multi-channel platform where students could participate and share information. Lecturers were able to share lectures, assign tasks, make exams and promote online discussions that supported collaborative learning. LMSs also enabled efficient data collection and recording, creating a rich repository of information about student engagement and performance. Data from LMS platforms capture interaction traces and link key stakeholders (such as students and instructors) to course content (e.g., videos, web pages, quizzes, and discussion forums) and actions (e.g., clicks, responses, and views). This automatic data collection is a fundamental element for the development of learning analyses.

Despite the increasing use of LMS, content creation and course delivery still largely depend on the intuition of teachers. Since many LMSs still offer only basic analyses, deeper data analysis is essential to unlock the full potential of this information to improve teaching and learning practises. Advanced techniques — such as social network analysis, sentiment analysis, impact analysis and predictive modelling of learning outcomes — are particularly valuable (Siemens & Baker, 2012). Hoppe (2017) proposes a triad of methodological approaches in learning analytics: (1) social network analysis, which focuses on the relationships between actors and artefacts; (2) process-oriented analysis, which includes action pattern detection and sequence analysis; and (3) content analysis, which uses techniques such as text mining to

analyse student-generated artefacts. These overlapping approaches can create valuable synergies and provide a more nuanced view of learning behaviour and outcomes.

Advanced analytics require specialised expertise, facilitating the creation of dashboards that visualise data to help educators and administrators identify and address specific learning challenges. Despite their potential, these tools remain underutilised in education, revealing a notable implementation gap. To bridge this gap, more research and practical strategies are needed to seamlessly integrate learning analytics into daily educational practices, transforming raw data into actionable insights that enhance teaching quality and support student achievement.

### **3 Methodology**

To investigate the actual use of learning analytics among university teachers, as well as the drivers for adoption and perceived benefits, we conducted a quantitative survey drawing on established theoretical frameworks. We chose Unified Theory of Acceptance and Use of Technology (UTAUT) (Davis, 1989) as the primary framework for our study as it comprehensively covers the relevant acceptance factors identified in the literature. To elicit responses, we developed a structured questionnaire with a 5-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). This format allowed for a standardised approach to assessing teachers' perceptions, challenges and usage patterns of learning analytics. The questionnaire was designed and distributed via the online platform 1ka, which enabled secure data collection and allowed us to efficiently manage and analyse the responses.

We started distributing the questionnaire by contacting the deans of education at each faculty of the University of Maribor and the University of Rijeka. An introductory email was sent with a link to the survey and a request for further distribution, asking the vice deans to forward the survey to all faculty members involved in teaching. This approach was intended to capture a broad and representative sample from a range of disciplines and faculties, reflecting a range of views on the use and potential of learning analytics in higher education. Despite this approach, the initial response rate was lower than expected. We therefore extended the data collection period to improve the sample size and reliability of the data.

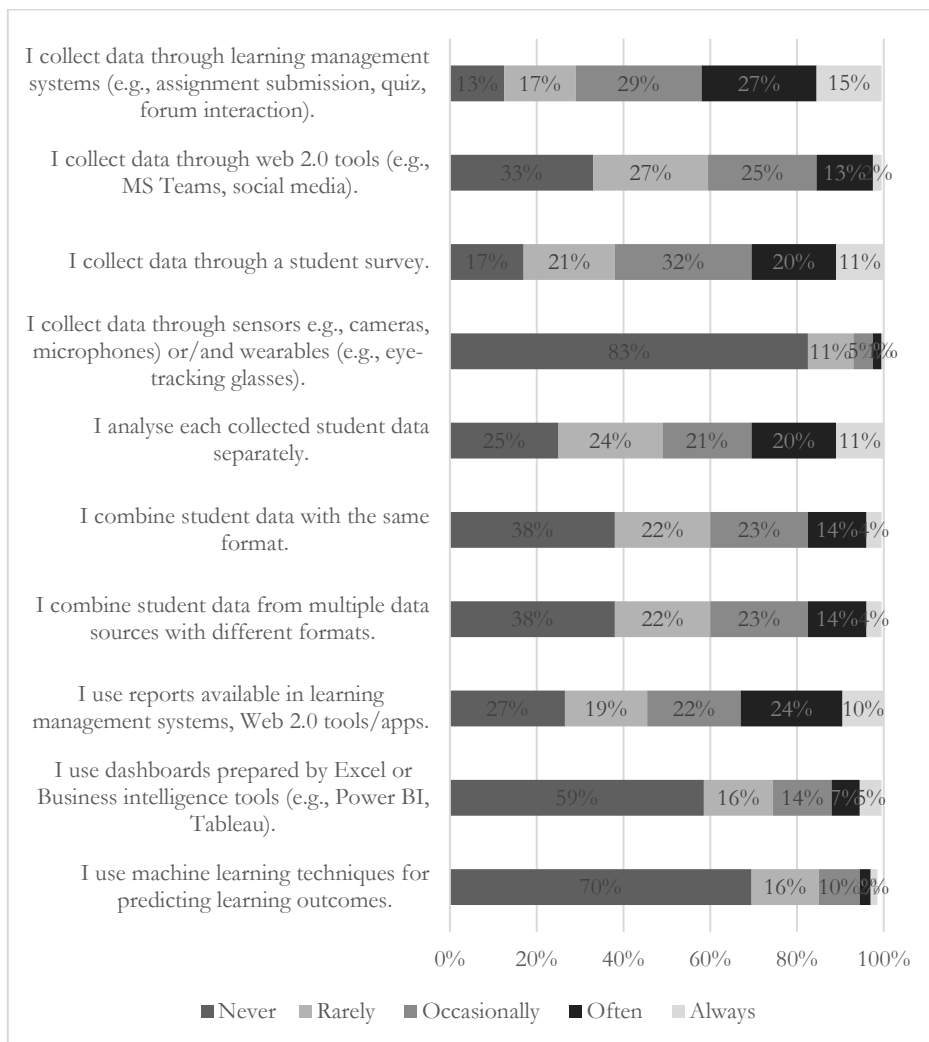
In this article, we present an initial analysis based on the collected responses. The data has been exported and analysed using Microsoft Excel. Future analyses will extend this preliminary assessment by examining correlations between demographic factors (such as teaching experience and subject specialism) and attitudes towards learning analytics.

## 4 Results

As part of the study, 154 university teachers were surveyed, with 148 participants completing the questionnaire in full; only these responses were included in our analysis. The respondents came from 14 faculties of the University of Maribor and 12 faculties of the University of Rijeka. The majority of respondents held the academic title of full professor (26%), associate professor (25%) and assistant professor (24%), followed by assistant (14%), lector (8%), senior lecturer (3%) and lecturer (1%).

56% of respondents had more than 15 years of professional experience, followed by those with 11-15 years (21%), 6-10 years (13%), 1-5 years (10%), and less than one year (1%) of experience. In terms of age distribution, respondents aged 45-54 years (36%) were predominant, followed by those aged 35-44 years (35%), 55-64 years (14%), 25-34 years (11%) and 65 years or older (3%).

The participating university teachers use learning analytics, albeit to a fairly limited extent. Mostly they use the functions of LMS and collect data from platforms, such as the submission of assignments and quizzes. They use available reports in LMS tools and occasionally other web applications, but data collection through student surveys or online tools such as MS Teams is less common. The use of sensors or wearable devices for data collection is rare. Data integration is also rare, with participants occasionally merging data of the same format and rarely combining data from multiple sources with different data types. Analytical functions within LMS tools are occasionally used, while dashboard analyses using Excel or business intelligence tools and machine learning to predict learning outcomes are rarely used (Figure 1).



**Figure 1: Use of learning analytics**

Source: Own

We also analysed the most important factors mentioned in the literature: perceived effort, social influence, perceived risks and facilitating conditions.

Perceived effort: Majority of the respondents (60%) neither disagreed nor agreed with the statement that using learning analytics is easy. 17% disagreed or strongly disagreed and 23% agreed or strongly agreed. Similar trends were observed for the statements about the ease of using learning analytics and acquiring the relevant skills.

Social influence: The results showed varying levels of agreement, suggesting that social influence is not a significant factor. Respondents most agreed with the statement that learning analytics is currently popular, followed by the statement that they know others who use it, and least agreed with the statement that influential people recommend it.

Perceived risks: Most respondents were neutral on perceived risks, although a greater proportion saw learning analytics as an opportunity. 45% of respondents were neutral on whether they trust the information provided by Learning Analytics. 38% agreed or strongly agreed and 1% disagreed or strongly disagreed. Similarly, 54% were neutral on the question of whether learning analytics provides accurate information for decision making, while 41% agreed and only 5% disagreed. The highest level of agreement was for the statement that learning analytics provides information in real time.

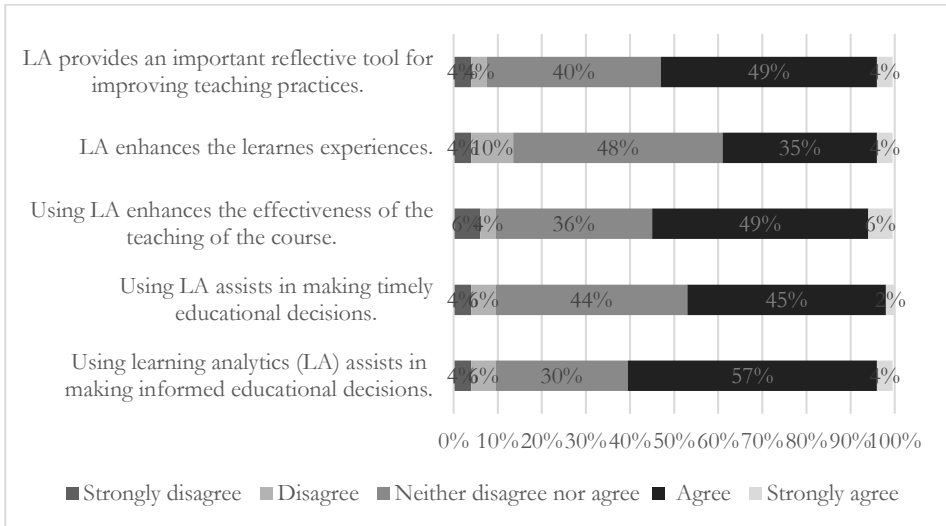


Figure 2: Benefits of using learning analytics

Source: Own

Facilitating conditions: Respondents mostly agreed that they have adequate tools to analyse data, but were less sure whether they have sufficient information and training on learning analytics. The lowest level of agreement was when asked about suitable guidelines for regulating data access.

Despite the limited use of learning analytics, respondents were largely in agreement about its benefits. Most agreed that learning analytics helps to make informed educational decisions, followed by the statement that it improves the effectiveness of the teaching of the course. They were less likely to agree that learning analytics contributes significantly to a better learner experience (Figure 2).

## **5 Conclusion**

Learning analytics is transforming from a purely research-driven field to one with practical and widespread applications. Its growth is enhancing the educational experience by providing actionable insights and promoting a more learner-centred approach. The main contributions of this paper lie in providing a cross-national perspective on the practical implementation of learning analytics, identifying context-specific challenges and opportunities faced by university teachers in Slovenia and Croatia.

The preliminary findings of the study show that the use of learning analytics is still in its infancy at both universities. Although more and more institutions and stakeholders are recognising the potential of learning analytics to improve learning outcomes, the analysis shows that university teachers are primarily using LMS features. Data is mostly collected through assignments, quizzes and other activities, but rarely integrated with other data sources or analysed using advanced techniques such as machine learning. Despite the limited use of learning analytics, university teachers recognise the benefits. There is the strongest support for the statement that learning analytics helps to make informed pedagogical decisions, increase teaching effectiveness and serve as an important tool for improving teaching methods.

University teachers at both universities face challenges when it comes to implementing learning analytics. The analysis of factors such as perceived effort, social influence, perceived risks and conducive conditions indicates that teachers are relatively sceptical about the user-friendliness of learning analytics. Social influence

does not play a major role in the introduction of these tools. In terms of perceived risks, teachers are rather cautious about the use of learning analytics. However, they generally agree that the framework conditions, such as appropriate tools and supportive environments, play a crucial role in promoting the use of learning analytics.

Although learning analytics has a positive impact on higher education, it is still only used to a limited extent by university teachers. To realise its full potential, it is important to create a supportive environment that includes advanced analytics tools, customised dashboards, access to relevant information and training, and clear guidelines for data usage. In addition, it is crucial to involve university teachers and other staff as active stakeholders in the development and implementation of learning analytics, as their direct engagement can lead to a better understanding and utilisation of these analytics tools.

As with most empirical research studies, it is necessary to point out certain limitations of this study. This study was conducted at a specific time and on a specific sample, which may limit the generalizability of the findings to other timeframes or populations. Testing on a larger sample group would contribute to a better reliability of the results and could provide more comprehensive insights into attitudes and perspectives on the practical implementation of learning analytics. It is also important to note that the study is limited as it was conducted on participants from only two universities, potentially limiting the diversity of perspectives and experiences within the sample. Additionally, the use of a rating scale (a Likert-type scale) can be seen as a limiting factor in conducting this study, as rating scales can influence the results of the study to some extent initially, potentially leading to biases in responses. Finally, the anonymity of the survey may hinder the researchers' ability to follow up or clarify responses, limiting the depth of understanding of participants' perspectives.

Future research should focus on more comprehensive and longitudinal studies that include different perspectives and stakeholders in the educational process. In addition, the development of improved methodological approaches is necessary to enable generalisable and transferable results. Learning analytics has the potential to become an important tool for improving pedagogical practise, but further research



and the development of a supportive environment is needed to ensure a successful transition from theory to practise.

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# OPTIMIZACIJA OCENE ERGONOMSKIH TVEGANJ Z UPORABO POSPEŠKOMEROV V 4D OKOLJU

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Zanesljiva ocena ergonomskih tveganj je ključna za izboljšanje varnosti in zdravja zaposlenih in za zmanjšanje pojava absentizma. Današnji inovativni pristopi oblikovanja ergonomske ocene povezujejo fizično, biološko in tehnološko okolje. Brezžični sledilniki gibanja (pospeškometri – inercialni senzorji) Movella Xsens, nameščeni na človeka, v realnem času natančno zajemajo vse premike v 3D prostoru in verodostojno beležijo tudi časovno dinamiko položajev telesnih segmentov (4D okolje). Modeliranje različnih morfoloških značilnosti zaposlenih in oblikovanje delovnega prostora izvedemo z Siemensovim računalniškim orodjem Tecnomatix Process Simulate Human. Senzorji za sledenje gibanju v 4D okolju so zagotovili bolj natančne meritve in s tem bolj objektivno oceno ergonomskih tveganj. Zajem podatkov je dosleden in omogoča pripravo še dodatnih ergonomskih ocen v kratkem času. Omogočeno je hitrejše in učinkovitejše prilagajanje delovnih mest in hitro izboljšanje delovnih pogojev. Na voljo je visoka odzivnost in hitro poseganje v produktivnost in zadovoljstvo zaposlenih. Dolgoročno bi se močno zmanjšalo število kostno-mišičnih obolenj, kar bi spodbudilo izrazito rast prispevka k bolj trajnostni in zdravi delovni praksi.

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# OPTIMISING ERGONOMIC RISK ASSESSMENT USING ACCELEROMETERS IN A 4D ENVIRONMENT

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accelerometers,  
4D environment

Reliable ergonomic risk assessment is the key to improving employee health and safety and reducing absenteeism. Today's innovative approaches to ergonomic assessment link the physical, biological and technological environment. The Movella Xsens wireless motion trackers (accelerometers – inertial sensors), which are attached to people, capture all movements in 3D space in real time and also reliably record the temporal dynamics of the positions of the body segments (4D environment). The computer tool from Siemens, Tecnomatix Process Simulate Human, is used to model the various morphological characteristics of employees and to design the workspace. The motion tracking sensors in the 4D environment have enabled more accurate measurements and therefore a more objective assessment of ergonomic risks. Consistent data collection enables fast and efficient ergonomic assessment. It enables faster and more efficient adaptation of workstations and rapid improvement of working conditions. A high level of responsiveness and rapid intervention in employee productivity and satisfaction are possible. In the long term, musculoskeletal disorders would be significantly reduced and the contribution to a more sustainable and healthier way of working significantly increased.



University of Maribor Press

## 1 Uvod

Vsakega človeka, ki vstopa na trg dela, čaka svojevrsten izziv, s katerim se sooča na mnogih nivojih. Srečuje se s pripravami na zaposlitev, izbornim postopkom, formalizacijo glede zaposlitve, prilagajanjem na delovno okolje in usposabljanjem za delo ter z zagotavljanjem varnosti in zdravja pri delu. Poudariti moramo, da je sklop izzivov tesno povezan z varnim in zdravim delovnim okoljem oziroma z ergonomijo, kjer se oblikuje jedro stalnega izboljševanja delovnega mesta. Organizacije so dolžne za svoje zaposlene poskrbeti tako, da preventivno skrbijo za njihovo zdravje. Če hoče organizacija doseči tak namen, potem mora dosegati celo vrsto vmesnih ciljev. V organizacijah se poveča produktivnost tudi zaradi zmanjšane števila telesnih poškodb, odsotnosti z dela (t. i. absentizem) in zmanjšanja števila napak zaradi nezbranosti ali zmanjšane telesne zmogljivosti zaradi bolnega zaposlenega na delovnem mestu (t. i. prezentizem). Če hočemo slediti temu namenu, moramo dosegati vmesne cilje in poskrbeti za to, da pravilno ocenimo in opredelimo možne nevarnosti pri oblikovanju določenega delovnega mesta in dela (Balantič et al., 2016).

Najboljše prakse za proučevanje ergonomije na delovnem mestu, vključujejo celovit pristop, ki upošteva različne vidike delovnega okolja in potrebe zaposlenih (Balantič et al., 2024). Prvi ukrep je običajno namenjen prilagoditvi delovnih mest, z vključevanjem telesnih značilnosti zaposlenih, kjer najpogosteje prilagodimo delovni nivo in naklon delovne površine. V tem sklopu uporabimo in optimiramo razne ergonomske pripomočke (opore, podloge, naslonjala ...). Pozorni moramo biti na ustrezne namestitve in na pravilno uporabo ergonomskih pripomočkov, z zavedanjem, da poskrbimo za nevtralizacijo telesnih obremenitev. Naslednji korak vključuje umestitev pravočasnih in zadostnih odmorov ter razgibavanje telesa, kar zmanjšuje utrujenost zaposlenega. Stalno moramo skrbeti za izobraževanje in usposabljanje o pravi uporabi ergonomske opreme. Zelo pomembno je periodično preverjanje stanja učinkovitosti ergonomskih ukrepov, kjer pa nam lahko izjemno pomaga uporaba senzorjev gibanja oziroma pospeškometerov oziroma inercialnih senzorjev. Prav ta merilna tehnologija nam omogoča natančno spremljanje in prilagajanje delovnih pogojev, saj z njihovo pomočjo lahko prepoznamo in odpravimo potencialna tveganja v realnem času. Vse te aktivnosti morajo vključevati zaposlene v nadaljnji proces oblikovanja in izboljševanja delovnih mest. Njihove povratne informacije in izkušnje so dragocene za prepoznavanje težav in za iskanje

učinkovitih rešitev. Prav zaradi zgoraj naštetih dejavnikov je dobra in zanesljiva ocena ergonomskih tveganj na delovnih mestih ključna za izboljšanje varnosti ter zdravja zaposlenih in za posledično zmanjšanje pojava absentizma. V sodobnem času vse bolj inovativni pristopi oblikovanja ergonomske ocene delovnega mesta tesno povezujejo fizično, biološko in tehnološko okolje (Castillo et al., 2022; Carnazzo et al., 2024)

Fizično okolje vključuje dejavnike, kot so delovna oprema, orodja, delovni prostori in telesna drža pri delu. Biološko okolje vključuje preučevanje vpliva delovnih pogojev na fiziološke in psihološke vidike delavcev, kot so stres, utrujenost in splošno počutje. Tehnološko okolje pa se osredotoča na uporabo naprednih tehnologij, kot so avtomatizacija, robotika, internet stvari in računalništvo v oblaku, ki lahko izboljšajo delovne procese in zmanjšajo obremenitve zaposlenih (Sangeethalakshmi et al., 2023).

Če hočemo objektivno oceniti delovne pogoje in prepoznati njihov vpliv na človeka, potem je potrebno uporabiti objektivno metodologijo za zajem in obdelavo pridobljenih podatkov. Integracija omenjenih treh ključnih dejavnikov omogoča celovito in natančno oceno ergonomskih tveganj, kar vodi k bolj učinkovitim rešitvam za izboljšanje delovnih pogojev. Na podlagi ocene tveganj je nato potrebno določiti prednostne naloge za obvladovanje tveganj. Pri tem imajo prednost tveganja, ki predstavljajo največjo grožnjo za zdravje in varnost zaposlenih (Rezvanizadeh et al., 2023).

Sodobna pametna okolja omogočajo uporabo najrazličnejših senzorjev za zbiranje podatkov, programsko opremo za analizo in obdelavo teh podatkov in seveda algoritme za pravilno presojo in interdisciplinarno povezavo zajetih in strojno obdelanih podatkov (Lind et al., 2020). Na ta način dobimo jasen objektivni in vsestranski vpogled v raznolikost ergonomskih rešitev, na podlagi katerih lahko sprejemamo bolj zanesljive poslovne odločitve in lažje modeliramo izboljšane delovne procese (Lind, 2024).

Uporaba inercialnih senzorjev oziroma pospeškomerov v 3D prostoru lahko pomaga spremljati telesno držo in gibanje zaposlenih tudi v četrti, časovni dimenziji – s tem ustvarimo t. i. 4D okolje. Na ta način lahko sistem zazna morebitne nevarnosti v realnem času. Napredna analitična orodja lahko strokovnjaku iz

področja ergonomije omogočajo takojšnjo podporo pri analizi zbranih podatkov za zmanjšanje tveganj na obravnavanih delovnih mestih (Greco et al., 2020; Kotowski & Gibson, 2023). S tem celostnim pristopom k ergonomiji se ne izboljšuje le varnost in zdravje zaposlenih, temveč se povečuje tudi njihova produktivnost in zadovoljstvo pri delu. Zaposleni so tako manj izpostavljeni poškodbam in boleznim, ki so posledica dela ter se počutijo bolj cenjene in motivirane.

## **2 Metode**

Brezžični sledilniki gibanja (pospeškometri) Movella Xsens omogočajo večkanalno zbiranje podatkov o dinamiki zaposlenega in to v realnem času in prostoru. Zbrani podatki tvorijo osnovo za podrobno analizo gibanja. Senzorji zajemajo podatke o hitrosti, pospešku in kotih sklepov, kar omogoča natančno spremljanje in analizo telesnih gibov med delom (Xsens Technologies, 2021). Meritve s senzorji za sledenje gibanju v 4D okolju se izvajajo v več korakih:

- namestitev senzorjev na telo zaposlenega in to na ključne točke, kot so zapestja, komolci, ramena, hrbet, boki, kolena in gležnji,
- kalibracija sistema, z določitvijo začetnih referenčnih točk, s čemer se zagotovi natančnost zajetih podatkov,
- zajem podatkov o gibih in položajih telesa v realnem času,
- analiza podatkov, ko se zbrani podatki analizirajo s pomočjo programske opreme, ki prepozna vzorce gibanja in drže ter identificira potencialna ergonomska tveganja,
- poročilo, ki vsebuje ugotovitve in priporočila za izboljšanje ergonomije na delovnem mestu,
- implementacija izboljšav s prilagoditvami delovnih postaj, z uvedbo ergonomskih pripomočkov in z usposabljanjem zaposlenih.

Uporabimo sistem s sedemnajstimi senzorji (Slika 1), in dvema posebnima rokavicama, kjer je na vsako od teh rokavic nameščeno po pet senzorjev na konceh prstov (Slika 2) (Manus, n.d.). Standardna postavitev torej vključuje 17 senzorjev ki so nameščeni na naslednjih mestih:

- glava,
- prsni koš,
- medenica,
- zgornji del hrbtenice (levo in desno),
- zgornji del rok (levo in desno),
- spodnji del rok (levo in desno),
- zapestje (levo in desno),
- stegna (levo in desno),
- spodnji del nog (levo in desno) in
- stopala (levo in desno).

Ta postavitev omogoča natančno spremljanje gibanja celotnega telesa.



**Slika 1: Zaposleni na delovnem mestu, z nameščenimi inercialnimi senzorji**

Vir: Lasten

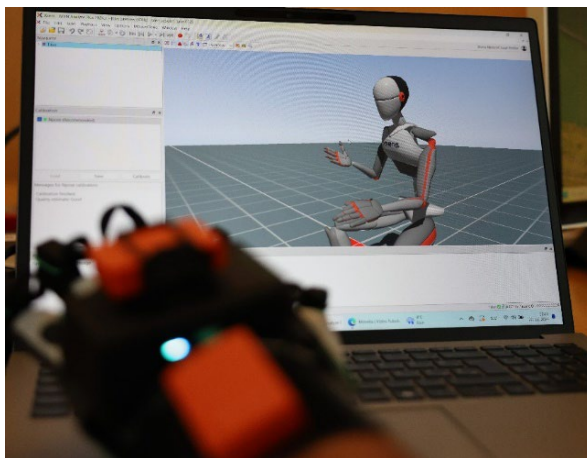




**Slika 2: Rokavica z inercialnimi senzorji**

Vir: Lasten

Premike v prostoru zajemamo z orodjem Xsens – MVN Analyze Plus v realnem času in pri tem verodostojno beležimo dinamiko položajev telesnih segmentov (Slika 3) (Xsens Technologies, 2021).



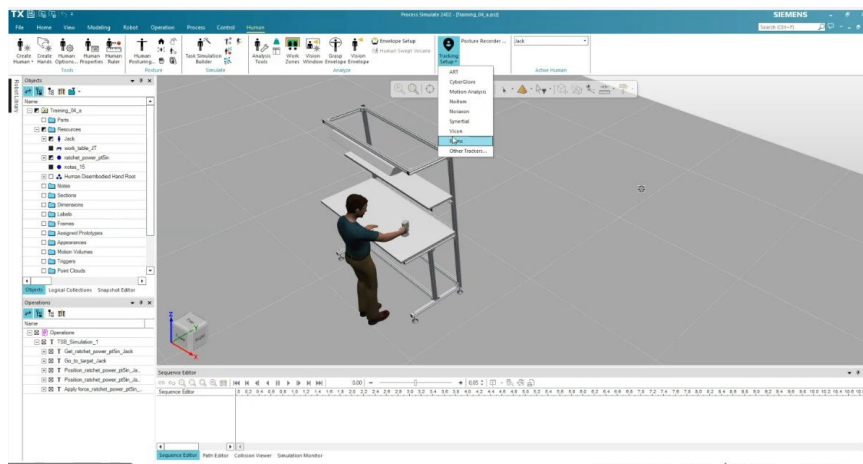
**Slika 3: Računalniško orodje Xsens – MVN Analyze Plus za zajem podatkov iz inercialnih senzorjev, ki so nameščeni na telo zaposlenega**

Vir: Lasten

Modeliranje različnih morfoloških značilnosti zaposlenih in oblikovanje delovnega prostora izvedemo z Siemensovim računalniškim orodjem Tecnomatix Process Simulate Human (Slika 4). To napredno orodje omogoča simulacijo in analizo

interakcij med delavci in njihovim delovnim okoljem. S pomočjo orodja lahko ustvarimo digitalne modele delovnih mest, ki upoštevajo različne telesne značilnosti zaposlenih, kot so višina, teža, razpon rok in druge antropometrične mere (Siemens, 2024). Pri tem lahko uporabimo širok nabor priporočenih ergonomskih analiz, ki vključujejo naslednje analize in simulacije:

- analiza drže: ocenjevanje telesne drže med različnimi delovnimi nalogami za prepoznavanje potencialnih tveganj za mišično-skeletne motnje,
- analiza obremenitev: merjenje in ocenjevanje fizičnih obremenitev, ki jih delavci doživljajo med dvigovanjem, potiskanjem, vlečenjem in med drugimi fizičnimi aktivnostmi,
- analiza gibanja: spremljanje in analiza gibanja telesnih segmentov za prepoznavanje neustreznih ali ponavljajočih se gibov, ki lahko vodijo do poškodb,
- analiza delovnega prostora: optimizacija postavitve delovnega prostora za zmanjšanje nepotrebnih gibov in izboljšanje dostopnosti orodij in materialov,
- simulacija delovnih nalog: uporaba simulacij za preizkušanje različnih scenarijev in prilagoditev delovnih nalog, da se zmanjšajo tveganja za poškodbe.



Slika 4: Modeliranje delovnega prostora z orodjem Tecnomatix Human

Vir: Lasten

### **3 Rezultati**

Tradicionalne metode, ki temeljijo na vizualnem opazovanju in subjektivnih ocenah, pogosto ne morejo zajeti vseh subtilnih gibov in položajev telesa, ki lahko prispevajo k ergonomskim tveganjem. Uporaba senzorjev za sledenje gibanju v 4D okolju predstavlja pomemben napredek na področju ergonomskih analiz. Senzorji omogočajo natančno sledenje vsakemu gibu zaposlenega, kar omogoča bolj podrobno analizo in identifikacijo potencialnih tveganj (Vox et al., 2021).

Poleg tega senzorji omogočajo zbiranje podatkov v realnem času, kar pomeni, da lahko analitiki takoj prepoznajo in obravnavajo morebitne težave. To je še posebej pomembno v dinamičnih delovnih okoljih, kjer se lahko pogoji dela hitro spreminjajo. S tradicionalnimi metodami bi bilo potrebno več časa za zbiranje in analizo podatkov, kar bi lahko pomenilo zamudo pri implementaciji potrebnih izboljšav.

Natančnost meritev, ki jo omogočajo senzorji, prav tako prispeva k boljši zanesljivosti ocen ergonomskih tveganj. To pomeni, da so priporočila za izboljšave delovnih pogojev bolj utemeljena in ciljno usmerjena. Če senzorji zaznajo, da se zaposleni pogosto nahaja v ergonomsko neugodnem položaju, se lahko delodajalec osredotoči na prilagoditev delovnega mesta ali uvedbo ergonomskih pripomočkov, ki bodo zmanjšali tveganje za poškodbe (Santos et al., 2024).

Dodatna prednost uporabe senzorjev je možnost dolgoročnega spremljanja in analize podatkov tudi pri ergonomskih metodah, kot je metoda OWAS, RULA ali REBA (Balantič et al., 2016). Ergonomska analiza delovnih mest po omenjenih metodah je pokazala, da so senzorji za sledenje gibanju v 4D okolju, v primerjavi s tradicionalnimi metodami, zagotovili bolj natančne meritve in s tem bolj zanesljivo in objektivno oceno ergonomskih tveganj. Zajem podatkov je dosleden in omogoča pripravo še dodatnih ergonomskih ocen v kratkem času.

Ročni zajem podatkov sicer lahko poteka z visoko frekvenco beleženja gibov zaposlenega, toda v tem primeru je analiza zamudna. Če to delo prepustimo senzorjem in avtomatskemu beleženju, lahko delo opravimo zanesljivo, učinkovito in zelo hitro. Prednost je v neprekinjenem spremljanju dela na delovnem mestu. Analiza na ta način postaja bolj poglobljena in bolj natančna. Lažje identificiramo

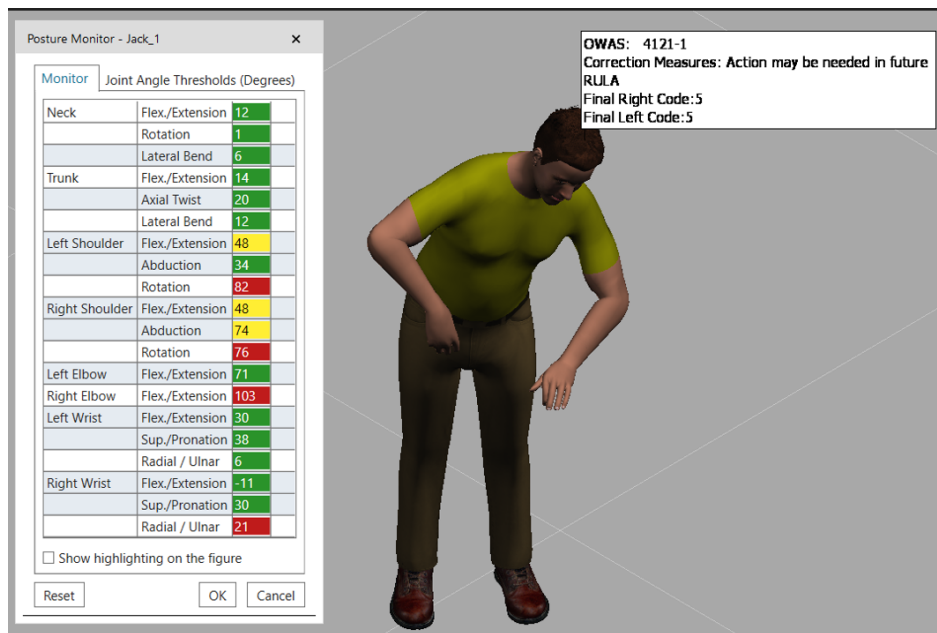
morebitna specifična tveganja. Ves čas omenjamo 4D okolje, kar je še dodatna prednost, saj na ta način dokaj enostavno lahko sledimo časovnim spremembam zaradi spreminjajočih se delovnih pogojev ali zaradi uvedbe ergonomskih ukrepov.

Študijo primera smo izvedli v kontroliranem laboratorijskem okolju, kjer je oseba moškega spola z baterijskim vijakom izvajala ponavljajočo se nalogo sestavljanja komponent. Delovni proces je vključeval pobiranje in pozicioniranje komponent, njihovo združevanje s privijanjem ter prestavljanje sestavljenega izdelka na odlagalno površino. Za spremljanje gibanja in drže udeleženca študije smo uporabili 17 inercialnih senzorjev, (15 nameščenih na ključne točke telesa ter 2 nameščena na rokavicah, ki zbirata podatke iz koncev prstov obeh zapestij).

Sistem inercialnih senzorjev smo pred začetkom meritev natančno kalibrirali z določanjem referenčnih točk, kar zagotavlja visoko natančnost zajetih podatkov. Med izvajanjem naloge smo v realnem času zbirali podatke o gibih in položajih telesa, ki smo jih nato analizirali s programsko opremo za prepoznavanje vzorcev gibanja in identifikacijo ergonomskih tveganj. Končna analiza je vključila kvantitativne podatke o obremenitvah mišičnih skupin, časovne vzorce delovnih položajev in ocene tveganj po priznanih metodah, kot sta na primer OWAS in RULA.

Uporaba senzorjev je omogočila bolj podrobno in natančno analizo ergonomskih tveganj v primerjavi s tradicionalnimi metodami. Vizualni prikazi, pridobljeni s pomočjo inercialnih senzorjev, so razkrili specifične drže in obremenitve telesa med delovnim procesom. Rezultate smo analizirali s pomočjo orodij, implementiranih v Tecnomatix Process Simulate. Analiza s pomočjo orodja »Posture Monitor« (Slika 5), ki vključuje analizo drže na podlagi OWAS in RULA sistemov, razkriva specifične točke tveganja in poudarja potrebo po ergonomskih prilagoditvah za zmanjšanje mišično-skeletnih obremenitev. OWAS ocena "4121-1" nakazuje, da trenutna drža ni urgentno problematična, vendar obstaja možnost za izboljšave v prihodnosti, zlasti v kontekstu dolgoročnega vpliva na delavčevo zdravje. Ocena RULA z rezultatom 5 na levi in desni strani telesa opozarja na srednje do visoko tveganje za poškodbe in poudarja potrebo po ukrepanju. Podrobnejša analiza sklepov kaže, da je trup v fleksiji (pripogib naprej) pod kotom 46°, kar presega priporočene vrednosti in kaže na znatno obremenitev hrbtnih mišic. Desna rama je abducirana za 48° (odmik roke od telesa), kar pomeni, da so mišice ramenskega sklepa in okoliških

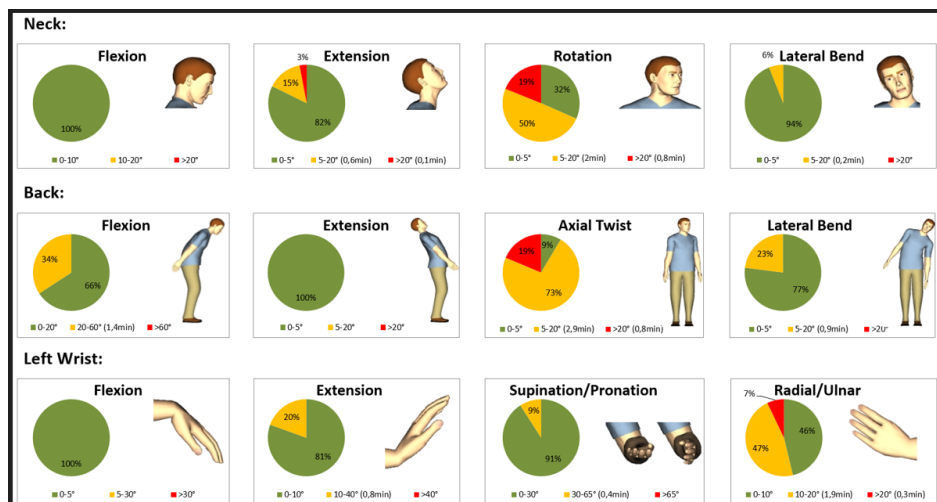
struktur izpostavljenosti zmerni obremenitvi. Desni komolec dosega kot fleksije/ekstenzije  $76^\circ$ , kar kaže na obremenitev, ki bi lahko povzročila utrujenost ali celo poškodbe pri daljši izpostavljenosti. Desno zapestje ima radialno (proti palcu)/ulnarno (proti mezinu) deviacijo  $31^\circ$ , kar je nad varnimi mejami in signalizira tveganje za prekomerno obremenitve zapestja.



Slika 5: Analiza drže in ergonomskih tveganj (OWAS, RULA)

Vir: Lasten

Podrobnejši vpogled v biomehانيčne parametre je zagotovilo programsko orodje »**Ergonomic Metrics**«, ki je analizirala premike vratu, hrbta in zapestja (Slika 6). Analiza kaže, da največje tveganje za obremenitev v vratu predstavlja iztegovanje, kjer je kot  $20^\circ$  presežen v 15 % časovnem deležu, rotacija pa presega  $20^\circ$  v 19 % časovnem deležu. Gibanje vratu v preostalih ravninah večinoma ostaja znotraj varnih območij. Pri hrbtu se večja obremenitev pojavlja pri upogibu naprej, kjer je pri 34 % časovnem deležu zabeležen kot med  $20^\circ$  in  $60^\circ$  ter pri zasukih, kjer 8 % časa presega vrednost  $20^\circ$ . Pri levem zapestju beležimo največje tveganje povezano z iztegovanjem, saj je kot  $40^\circ$  presežen 20 % časa. Pri zasukih zapestja 9 % časa presega vrednost  $65^\circ$ .

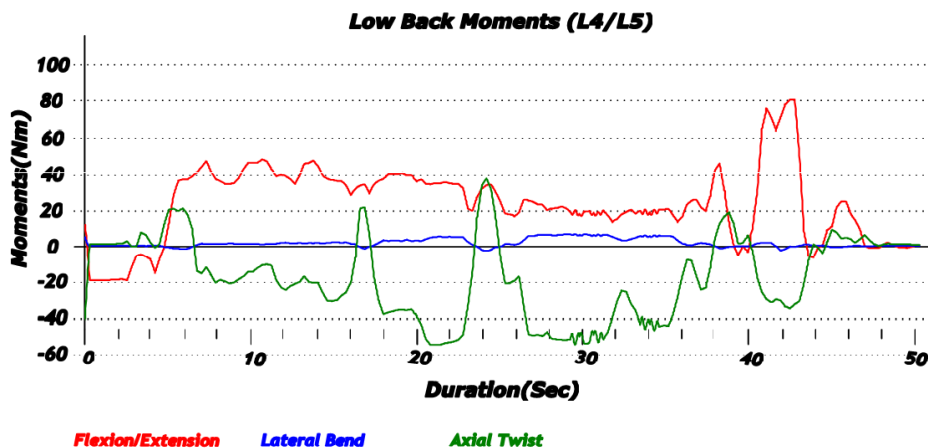


Slika 6: Analiza obremenitve vratu, hrbta in zapestja

Vir: Lasten

Pridobljeni podatki so prav tako ključni za prepoznavanje obremenitev spodnjega dela hrbta, ki so jih dodatno podprle meritve z orodjem »Low Back«. Graf na sliki 7 prikazuje časovno porazdelitev momentov sile na ledvenem delu hrbtenice (L4/L5) za tri različne gibalne komponente: fleksijo/ekstenzijo, stranski upogib (lateral bend) in aksialni zasuk (axial twist). Moment sile je izražen v Nm, čas trajanja pa v sekundah. Podrobna analiza kaže, da so najvišje vrednosti momenta pojavijo pri fleksiji/ekstenziji (rdeča linija) in jih dosegamo med približno 20. in 40. sekundo. Na tem časovnem odseku moment presega 60 Nm. Ta komponenta predstavlja ključni vir obremenitve na ledvenem delu, kar kaže na visoko intenzivnost gibanja naprej in nazaj. Moment v lateralni smeri povzroča stranski upogib (modra linija), ki v celotnem časovnem intervalu ostaja skoraj konstanten in blizu 0 Nm, kar predstavlja minimalne stranske obremenitve. Nasprotno pa aksialni zasuk (zelena linija) doseže pomembne vrhove pri približno 15., 25. in 40. sekundi, kjer vrednosti presegajo 40 Nm v pozitivni ali negativni smeri. To nakazuje ponavljajoče se obremenitve zaradi rotacijskega gibanja, ki lahko povečajo tveganje za poškodbe vretenc in diskov. Fleksija in ekstenzija v ledvenem delu hrbtenice sta zelo neugodni obremenitvi in sta tudi glavna dejavnika, ki prispevata k mehanskim pritiskom na segment L4/L5. Čeprav je stranski upogib zanemarljiv, je aksialni zasuk še vedno pomemben dejavnik tveganja zaradi pogostih in izrazitih vrhov aktivnih torzijskih momentov. Za zaščito ledvenega dela je vsekakor ključno zmanjšanje ekstremnih fleksijskih in

ekstenzijskih momentov, pri čemer je priporočljiva uporaba ergonomskih orodij, ki omejujejo pretirano gibanje v tej smeri. Prav tako je pomembno izogibanje ponavljajočim se zasukom ali zmanjšanje intenzivnosti rotacijskih gibov, saj lahko takšni ukrepi bistveno pripomorejo k preprečevanju poškodb.



Slika 7: Beleženje momentov v anteroposteriorni, lateralni in aksialni smeri med 4. in 5. ledvenim vretencem

Vir: Lasten

Študija je pokazala, da so meritve s senzorji omogočile hitrejšo analizo in bolj zanesljive rezultate, kot pri ročni izvedbi. Medtem ko tradicionalne metode pogosto zahtevajo daljši čas za zbiranje in obdelavo podatkov, je uporaba inercialnih senzorjev omogočila takojšnjo prepoznavo tveganj in pripravo ciljno usmerjenih izboljšav, kar povečuje učinkovitost ukrepov.

#### 4 Diskusija

Širok nabor ergonomskih ocen, daje strokovnjakom priložnost za optimalno pripravo zelo vsestranske ocene ergonomskih tveganj. Ugotovili smo, da je z uporabo inercialnih senzorjev oziroma pospeškometerov v 4D okolju možna hitrejša in učinkovitejša ergonomska ocena delovnega mesta. Analiza drže, gibov, uporabe sile in ponavljajočih se gibov, je vozlišče praktično vseh metod in ergonomskih ocen. Različne metode ocenjevanja omogočajo natančno prepoznavanje specifičnih

ergonomskih tveganj, ki so prisotna na različnih delovnih mestih v različnih panogah, kot so na primer:

- **V proizvodnih obratih** se senzorji uporabljajo predvsem za spremljanje gibanja zaposlenih, ki opravljajo ponavljajoče se naloge. S tem se lahko identificirajo neergonomski gibi in položaji, ki bi lahko vodili do poškodb zaradi ponavljajočih se obremenitev. Na podlagi teh podatkov se lahko prilagodijo delovni procesi in uvedejo ergonomski pripomočki, kot so prilagodljive delovne postaje in ergonomska orodja.
- **V zdravstvenih ustanovah** se inercialni senzorji uporabljajo za spremljanje gibanja medicinskega osebja, ki pogosto dviguje in premika paciente. Senzorji lahko pomagajo prepoznati tvegane gibe in položaje ter vodijo do izboljšav, kot so uporaba dvigal za paciente in ergonomske tehnike dvigovanja, s čimer se zmanjšajo tveganja za poškodbe hrbtenice in mišično-skeletnega sistema.
- **V pisarniških okoljih** se inercialni senzorji uporabljajo za spremljanje drže zaposlenih, ki večino časa preživijo v sedečem položaju za računalnikom. Senzorji lahko zaznajo slabo držo in tako lahko utemeljeno predlagamo prilagoditve, kot so ergonomski stoli, nastavljive mize in pogosti odmori za raztezanje, kar pripomore k zmanjšanju tveganja za bolečine v hrbtu in vratu.
- **Na gradbiščih** se inercialni senzorji uporabljajo za spremljanje gibanja delavcev, ki opravljajo fizično zahtevna dela. Senzorji lahko pomagajo prepoznati tvegane gibe in položaje na podlagi katerih predlagamo izboljšave, kot so uporaba ergonomskih orodij in tehnik dvigovanja, s čimer se zmanjšajo tveganja za poškodbe zaradi dvigovanja težkih bremen in drugih fizičnih obremenitev.

Na podlagi ugotovitev ergonomskih ocen je možno hitro in učinkovito prilagoditi delovna mesta, uvedbo ergonomskih pripomočkov in spremembe delovnih procesov, kar prispeva k izboljšanju delovnih pogojev. Z izboljšanjem ergonomije na delovnem mestu se povečuje produktivnost zaposlenih. Udobno in varno delovno okolje omogoča zaposlenim, da delajo bolj učinkovito in z manj napora, kar vodi do večje produktivnosti in boljših rezultatov. Ergonomsko urejena delovna mesta prispevajo k večjemu zadovoljstvu zaposlenih. Ko se zaposleni počutijo



udobno in varno, so bolj motivirani in zvesti podjetju, kar pozitivno vpliva na delovno klimo in zmanjšuje fluktuacijo zaposlenih.

Dolgoročno se z izboljšanjem ergonomije na delovnem mestu močno zmanjšuje število kostno-mišičnih obolenj. To vključuje zmanjšanje bolečin v hrbtu, vratu, ramenih in drugih delih telesa, kar prispeva k boljšemu zdravju zaposlenih. Izboljšanje ergonomskih pogojev spodbuja trajnostno in zdravo delovno prakso. Zmanjšanje poškodb in bolezni, povezanih z delom, prispeva k dolgoročni vzdržnosti delovne sile in zmanjšuje stroške, povezane z bolniškimi odsotnostmi in zdravstveno oskrbo. V tem trenutku je uporaba inercialnih senzorjev še dokaj draga in zahteva kar nekaj kompleksnega znanja iz področja ergonomije. V prihodnosti bi lahko uporaba teh senzorjev za sledenje gibanju v 4D okolju postala standardna praksa pri ergonomskih analizah. Z napredkom tehnologije se bodo senzori verjetno še izboljšali, kar bo omogočilo še bolj natančne in zanesljive meritve. Poleg tega bi lahko integracija teh senzorjev z drugimi tehnologijami, kot so umetna inteligenca in strojno učenje, omogočila še bolj celovite in prilagojene rešitve za izboljšanje ergonomije na delovnem mestu. Uporaba teh metod bo sčasoma verjetno postala bolj enostavna in cenena.

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# ERGONOMICS THROUGH THE LENS OF GAMIFICATION

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Our paper explores the connection between ergonomics and gamification in order to understand the relationship between the two areas and their impact on employee health, comfort and productivity. We outline the key ergonomic principles for creating an ergonomically designed work environment, such as maintaining a neutral posture, encouraging movement and stretching, and managing excessive workload. In addition, we look at gamification – a strategy that uses game-specific concepts, including badges, leaderboards and challenges – to motivate and engage employees. This paper provides use-case examples that enable organizations to integrate ergonomics through engaging, game-like elements by linking ergonomic principles with different gamification methods. With this approach, organizations can cultivate a proactive well-being culture that ultimately improves employee satisfaction and overall organizational performance.

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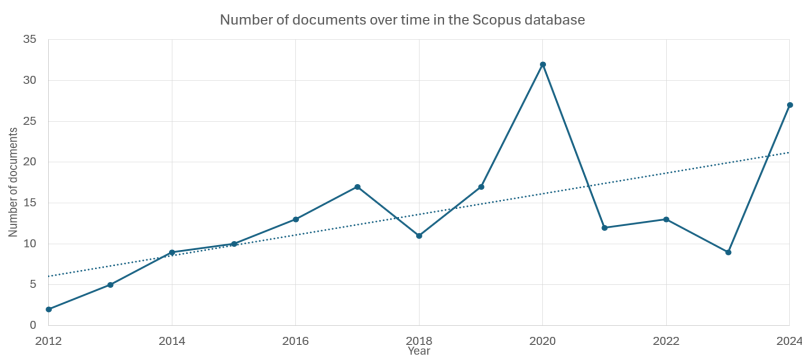


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## 1 Introduction

Nowadays, ergonomics plays an important role in workplace design, because the companies that invest in the right work experience for their employees are ahead of others. An ergonomically designed workplace increases the performance and efficiency of the organization. Poorly designed workplaces cause most of the employee health problems, which lead to absenteeism and presenteeism. In the long term, this leads to unnecessary costs for the company and employee dissatisfaction (Balantič et al., 2016). Appropriate ergonomic measures such as adapting the workplace, optimising work equipment and tailoring work processes have proven to be effective in reducing physical strain, minimising musculoskeletal disorders and promoting employee satisfaction. These adaptations not only ensure that workers avoid injury, but they also improve productivity and overall morale by meeting both the physical and cognitive demands of workers (Silva et al., 2024).

Teaching occupational health and safety in engineering is a challenge because it is a multidisciplinary subject, and it is difficult to reach workers using traditional methods. A study by Rodeghiero Neto & Amaral (2024) suggests that the use of active learning strategies: problem-based learning, project-based learning and gamification helps in introducing various ergonomic principles to employees who were previously unaware of their benefits. That is why the combination of ergonomics or human factors and gamification has gained popularity in recent years – Figure 1 shows the graph with the growth of the documents over the years.

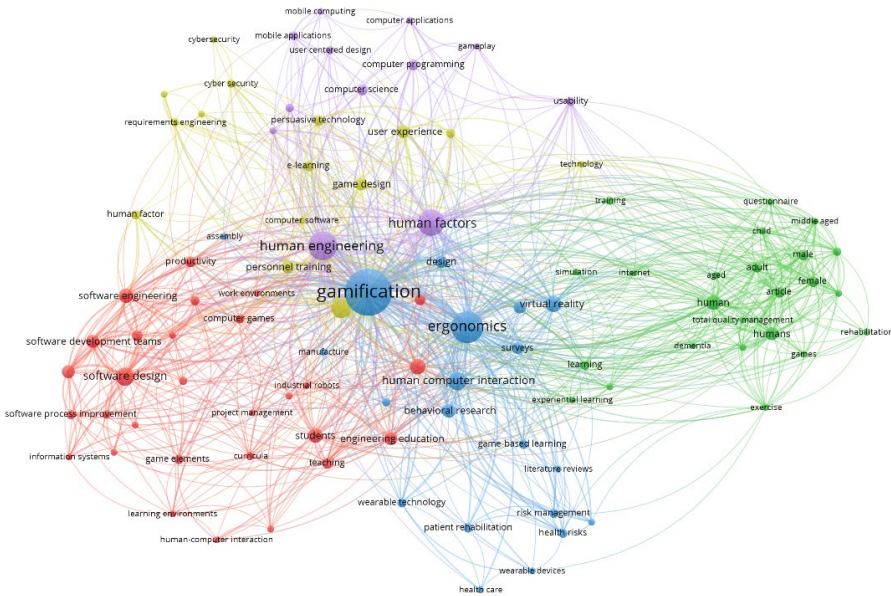


**Figure 1: Gamification of ergonomics over the last 12 years**

Source: Own

**Gamification** is usually described as the application of game-specific concepts of game design to a non-game context (Deterring et al., 2011b, 2011a). The primary purpose of gamification and its most potent observed effect is fostering, growing, and capturing the motivation of gamified systems' users, followed closely by encouraging engagement and participation. Gamification can be applied to various application domains, including but not limited to smart and sustainable mobility (Okreša Đurić, 2022), demand-responsive transportation systems (Martí et al., 2024), conducting surveys (Schatten et al., 2022), education (Khaldi et al., 2023), banking, trading, marketing, task facilitation (Antonaci et al., 2019).

We argue herein towards using gamification to encourage employee engagement, knowledge retention and ergonomic skill development. Using the VOSviewer programme (Van Eck & Waltman, 2023) and preliminary research, we found that the above areas are interlinked (Figure 2). We combine ergonomic principles with different gamification methods and provide guidelines and ideas for organizations to create a healthier, more productive, happier workforce.



**Figure 2: Network visualization map of the keywords for the fields of ergonomics and gamification made with VOSviewer**  
Source: Own

The rest of the paper is structured as follows: Section 2 provides a literature review on the topics of ergonomics and gamification, Section 3 presents the methodology used in the process of preparing this paper, Section 4 consists of the comparison of the sets of ergonomic principles and gamification methods to see how one can complement the other, followed by a discussion on use-case examples of gamification for ergonomics. The conclusion is given in Section 5.

## 2 Literature Review

### 2.1 Ergonomic Principles

Ergonomic principles are derived from the properties of the human body, and the environment should adapt according to them. New technologies are becoming cheaper and are being incorporated into the design of the various devices we use to operate and help ourselves at work. For example, the chairs we sit in nowadays are much more variable than they used to be, have become highly variable over the years, and adaptable to the physiological characteristics of the human being. The rigid seat bases have been replaced by flexible seating surfaces with a variety of adjustments and surface tilt resistances. Chairs aside, innovators around the world are taking ergonomic principles into account in all these solutions - below are eight of the most important principles when considering worker's health (Balantič et al., 2016).

**Maintaining a neutral posture** focuses on the proper arrangement of the environment where we stand or sit. A major problem nowadays is the high number of pain or injuries caused by inadequate loading on the spine. These problems are solved by a dynamic workplace and the correct choice of sitting height. They can be alleviated by lumbar and sacral support, and standing on an ergonomic mat. In addition to the spine, which is the most problematic in most cases, we also need to pay attention to the correct position of the joints, head and limbs. Sherman et al. (2024) discuss the importance of maintaining ergonomic principles, such as ideal working height and neutral postures, to reduce overuse injuries among orthotics and prosthetics practitioners in the U.S.

**Performing work in the area of maximum comfort** states that the loads we lift should be held as close to the body as possible. Objects that are farther away from us should be of lighter weight. If we do not follow the rules for lifting loads, we run the risk of musculoskeletal disorders. A study by Moradi & Barakat (2020) found that lifting heavy loads manually, especially when exceeding recommended weights or distances, significantly increases the risk of musculoskeletal disorders.

The human body is made to move, that's why it's important to **allow movement and stretching**. We can do that by providing breaks when doing static and repetitive work. The aim of breaks is to move the body to a neutral position for a while, or to the opposite of the stressed position at work. This relaxes certain muscles and allows better muscle coordination. Because of this static work, it is important to adapt the workplace to suit the majority of people or to consider adapting the work surfaces. A study by Vitoulas et al. (2022) demonstrates that active micro-breaks, including stretching and strengthening exercises, reduce pain and fatigue while improving mood in employees engaged in static and repetitive work.

The fourth ergonomic principle is the so-called **reduction of physical overload**. When designing workplaces, we need to pay attention to critical points where overloading can occur. We need to try to prevent such situations from happening, but if this is not possible, we can think about various tools or machines to help us with difficult tasks, such as in the case of Sarmiento-Ortiz et al. (2024). Their study highlights the implementation of a load elevator in workplaces, which significantly reduces the risk of musculoskeletal injuries by minimizing manual handling.

**Reducing the occurrence of inappropriate movements** is an important factor when we are trying to reduce fatigue, ill health, musculoskeletal disorders and other negative effects. The most common inappropriate movement type is repetitive movement, which is defined as repeating the same or a similar movement two or more times within a 30-second period. If these movements are problematic, they should be eliminated as soon as possible through automation or the use of machines and tools. When designing work activities, care must be taken to avoid these types of tasks or to ensure that frequent breaks are taken. One example we can give is from Chan et al. (2020): they developed a deep learning approach to classify risks associated with repetitive movements using 2D human pose estimation, enabling fast and accurate ergonomic evaluations.

We need to be aware of the direct physical pressure of various external elements when we are working and take the necessary precautions in order to **reduce point pressures on the body**. For example, sitting incorrectly, with the lower thigh resting too much on the edge of the chair, causes improper blood circulation. We should also beware of kneeling postures and too small working spaces. Antle et al. (2018) highlight that prolonged improper postures, like sitting with uneven pressure distribution, lead to poor blood circulation and discomfort in the lower limbs.

**Reduction of excessive vibration** is also an important principle employees need to follow, because vibration has a bad effect on blood flow, which in turn leads to pain, tendinitis or, for example, inflammation of the carpal tunnel. A study revealed that vascular disorders, nerve malfunctions, and musculoskeletal issues are also common with excessive vibration (Vihlborg et al., 2017). Such work activities should be avoided, at least reduced in the time a worker spends on them.

When carrying out work, most of the information a person obtains is through visual perception. That's why we need to pay attention to **ensuring adequate lightning**, as failure to do so will lead to more errors, headaches and reduced concentration, which directly affects productivity. Golmohammadi (2021) found that inadequate illumination and poor colour temperature contribute to visual discomfort, reduced concentration, and lower productivity.

## 2.2 Gamification Methods

One of the crucial points in keeping up with good practice examples of ergonomics and observing the beneficial effects of applying the mentioned principles of ergonomics is consistency. Consistency can be built in several manners, including through building habits, through repeated patterns of their use in everyday behaviour enforced by a third party, such as a manager or a human resources personnel, or by creating a positive motivational environment wherein the user wants to participate in upholding the standards of the workplace by keeping up to the standards and requirements of the employer wherein the requirements of ergonomic behaviour at one's workplace is included. The latter is an idea that aims at modelling and implementing a positive and encouraging environment that does not feel forced upon the employee but is solidified and steered by the user's motivation and



willingness to participate in the described system. Various ways can be used to foster motivation, one of which is the process of gamification.

The game-specific concepts that gamification applies to non-game contexts come from the domain of game design. Four fundamental elements of game design are usually considered to be the story, aesthetics, mechanics, and technology (Schell, 2019). The story is a concept that binds all the other concepts together, provides motivation for them, and gives them a specific place in the game. Aesthetics encompasses all aspects of the visual and audio experience the game aims to provide its players. Mechanics define how players interact with the in-game world, the implemented environment, and the game in general. Lastly, the technology element observes the game through the constraints, differences, and opportunities of technological requirements, abilities, and power. This element is responsible for modelling a game as a virtual reality (VR) system, a mobile experience, or a gaming console software.

Some of the concepts described above can be considered gamification-ready concepts already, e.g., the element of the story. Other fundamental game design elements described above motivate and encompass further concepts that can be used in a gamified system, such as point and leaderboards, badges, quests, grouping mechanisms (e.g. guilds), role-playing, etc. Although the technological element defines and constrains how to implement a gamified system, the element of mechanics is essential in containing actionable approaches towards a game or non-game systems. The most commonly used elements (Antonaci et al., 2019; Ertan Şevk & Arkün Kocadere, 2024; Zainuddin et al., 2020) and mechanics include but are not limited to, points, badges, achievements, rankings, virtual goods, quests, levels, avatars, rewards, narrative, competition, etc. Some researchers (Ndulue et al., 2022) show that the effect of gamification elements and mechanics varies regarding the application domain where they are implemented, even if the observed element remains mostly or entirely unchanged.

Some of the above-mentioned gamification elements and mechanics have been organised in frameworks for more straightforward mapping, planning and implementation of gamified systems (Denden et al., 2024). One of the modern ideas related to gamification is personalised gamification, which is used to exert additional motivation, engagement, and retention from the observed users. While personalised

gamification is somewhat of an umbrella term that subsumes all the others, exceptional cases of personalised gamification can be mapped to a position between a static and an environment.

Gamification is tightly tied to the concept of persuasive strategies – both share the primary goal of influencing the behaviour of users via eliciting user-driven change. Regarding persuasion, some of the most commonly used strategies in persuasive games and gamified systems include competition, rewards, and social comparison (Orji et al., 2017). Personalisation is another concept often related to gamification (Rodrigues et al., 2020). Personalised gamification is found to have a positive effect on users' motivation. Still, the impact of personalised gamification depends on various factors that define how a person reacts and behaves.

### 3 Methodology

We conducted a focused review of articles and reports on ergonomic principles and gamification methods. We searched online databases (for example, MDPI, IEEE, and ScienceDirect) using terms such as “ergonomic principles”, “workplace well-being” and “gamification methods”. We chose sources that gave clear guidance on improving health with different ergonomic principles, such as maintaining a neutral posture, reducing overload and providing adequate movement or stretching. We also looked at sources that explained how to use points, challenges, or other forms of gamification to motivate people to cooperate with positive changes to their everyday work environment.

### 4 Results and Discussion

This section presents use-case examples that show different gamification method combinations supporting a particular ergonomic principle. We base these examples on points in the reviewed literature about practicality and ease of use in a workplace setting. Only one example is provided per the ergonomic principle to illustrate the possibilities, although additional use cases may be developed.

To motivate employees to **maintain a neutral posture**, we propose a system that prompts employees to respond to a prompt to assess their current posture on a scale from bad posture to excellent posture, each level enriched by a description and a

visual cue of its features. The employee receives the prompt at random intervals during their working hours. Responding to the prompt should be easy and fast so as not to distract the employee from their job. The longer the posture is maintained in a good or better posture, an optionally publicly visible streak builds and motivates the employee to continue this good practice. Accruing *posture points* based on the employee's responses can be exchanged for elements of prestige based on the individual's perception, e.g. a spot on a list, a bragging right or similar.

To ensure **maximum comfort in their work area**, an employee is commonly expected to fulfil several expectations. A checklist is an obvious choice to streamline the setup to ensure maximum comfort and, therefore, productivity of an employee. A gamified checklist modelled as a quest comprising a set of tasks wrapped up in a narrative with automated status messages based on the level of quest completion might motivate the employee to ensure a comfortable work area, in addition to their intrinsic motivation. Some of the elements of the checklist may expire over time and need to be repeated in specified intervals to ensure continuous support.

A sedentary or stationary position is common nowadays, so providing a system for **promoting movement and stretching** is an intriguing prospect. Introducing the employees to a system that would alert them regularly, e.g. similar to the Pomodoro technique, to take a break and do some exercises or stretches could help them introduce healthy habits in their everyday jobs. Utilising role-playing, employees can choose a fictional character or the archetypes they identify with most from a set, where each has the most suitable exercises and stretches (e.g. Hercules from Disney's 1997 cartoon would differ from Elsa from Disney's 2013 cartoon). Special rewards may be unlocked by stretching in the company of other employees. Additionally, tracking step counts during working hours could be implemented to foster the healthy habit of walking. Providing incentives for all but scaling those based on the rolling average of a single employee and a group of them can entice healthy competition.

**Reducing physical overload** is advisable by utilising ergonomic tools (e.g. load elevators, rolling carts, lifting straps) when physical activity is necessary. In this less-is-more situation, the goal is to motivate employees to minimise physical labour whenever possible. A system that tracks employee activities and rewards them

inversely relative to the weight, distance, and occurrence of physical labour is argued to be able to reduce overload where ergonomic tools are available.

Education is often a good approach and is argued here to be the optimal approach to **reducing the occurrence of inappropriate movements**. Introducing employees to simple, informative, yet minimalistic training, serious games followed by quizzes, crosswords and puzzles enriched by a daily tournament in scoring points seems like a decent approach to fostering knowledge and awareness of inappropriate and repetitive movements.

Once set up, features of the ergonomic principle that **reduces point pressures on the body** are not expected to change soon. Maintaining those features and keeping the employees aware of their importance is crucial. Daily generated fictional short story narratives focussing on the features of this principle remind employees of the fundamental concepts related to this principle.

While the causes of **excessive vibrations** may be numerous, it is essential to rule out the machine itself as faulty equipment causing the vibrations. Providing simplified schematics with labelled key points and a list of tasks that must be performed in a defined sequence while related to each other by a generated story is argued here to make it easier for employees never to miss a step in configuring the machine and avoiding it being the cause of excessive vibrations.

Several features constitute **adequate lighting** in a work area. Employees replying to their colleagues' requests for information using predefined questions can help them ensure the proper working conditions based on this principle. Rewarding them relative to the number of requests received and replied to and optionally publishing the score is argued here to promote care about other employees and provide more focus on this principle. Furthermore, this approach can promote socialisation and inter-group dynamics as well.

Figure 3 represents a visualization of the eight use-case examples.

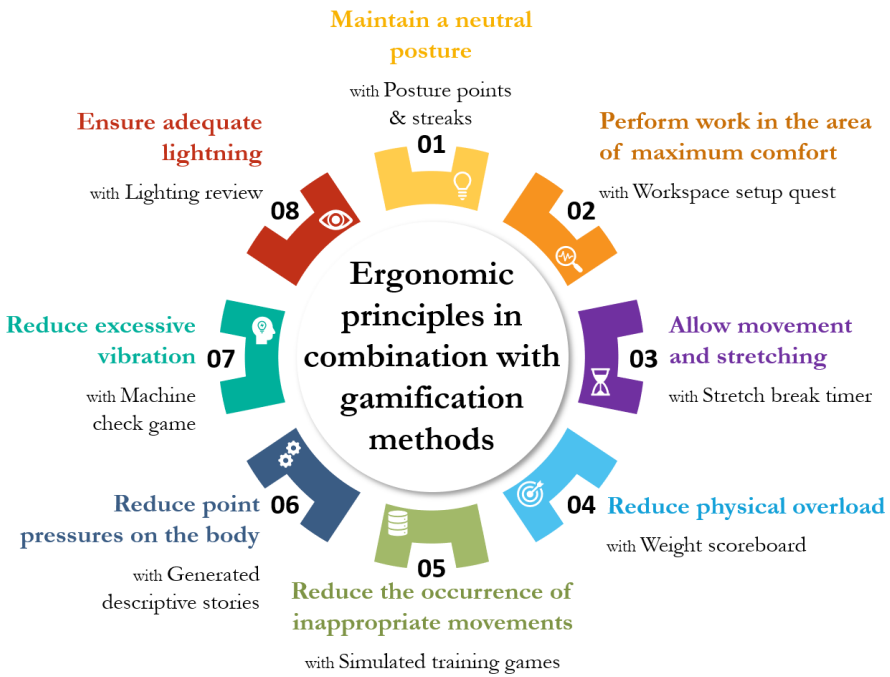


Figure 3: Gamified use-case examples per ergonomic principle

Source: Own

## 5 Conclusion

This paper presents a short overview of the main principles of ergonomics, followed by a quick look at the concept of gamification and the related methods. Based on the observations gained through the literature review, several use-case examples are provided, covering all the ergonomics principles, suggesting how gamification might be applied in an ergonomics context to promote healthy and safe behaviour.

While the examples provided in this paper are not numerous, the authors argue that game-related concepts should be used to promote and ensure a more satisfying and motivating working experience. Future work is foreseen as delving deeper into the possible combinations of gamification with each ergonomic principle, possibly ensuring a practical and measurable approach.

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# UPORABA UMETNE INTELIGENCE ZA IZBOLJŠANO ODLOČANJE V MANAGEMENTU

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Uporaba umetne inteligence (UI) bistveno preoblikuje procese odločanja v managementu. Prispevek preučuje uporabo sodobnih UI tehnologij v managerskih procesih in kako orodja UI lahko dopolnjujejo človeško inteligenco za izboljšanje kakovosti in učinkovitosti odločitev. S pregledom literature in analizo teme smo identificirali ključna področja in izzive pri uporabi UI v procesih managerskega odločanja. Rezultati študije kažejo, da so orodja UI managerjem v pomoč in lahko pomagajo pri zbiranju relevantnih in pravočasnih odločitvenih informacij. Vendar pa uporaba UI prinaša tudi izzive, vključno z etičnimi in pravnimi vidiki uporabe UI, predvsem glede zasebnosti podatkov ter potrebo, da managerji razvijejo nove veščine za učinkovito uporabo UI orodij. Študija predlaga tudi uvajanje celovitih programov usposabljanja, da bo management lahko izkoristil potencial UI ob hkratnem zmanjšanju tveganj. Ta prispevek prispeva k tekoči razpravi o vlogi UI v managementu, saj nudi uporabne vpoglede za raziskovalce in praktike, ki želijo izkoristiti UI v svojih procesih odločanja.

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# IMPACT OF ARTIFICIAL INTELLIGENCE ON MANAGERIAL DECISION MAKING

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The use of artificial intelligence (AI) is fundamentally reshaping decision-making processes in management. This paper examines the adoption of modern AI technologies in managerial practices and explores how AI tools can augment human intelligence to improve both the quality and efficiency of decisions. Through a review of the literature and a focused analysis, we identified key areas and challenges in applying AI to managerial decision-making. The findings indicate that AI tools support managers by facilitating the collection of relevant and timely decision-making information. However, AI implementation also introduces challenges, including ethical and legal considerations—particularly related to data privacy—and highlights the need for managers to develop new skills to use AI tools effectively. The study further suggests introducing comprehensive training programs so that management can leverage AI's potential while minimizing associated risks. This paper contributes to the ongoing debate on AI's role in management by offering valuable insights for both researchers and practitioners aiming to integrate AI into their decision-making processes.



## 1 Uvod

Sodobne organizacije na različne načine uporabljajo umetno inteligenco (UI), zlasti velike jezikovne modele (LLM), za večanje učinkovitosti, avtomatizacije in kakovosti odločanja (Bhattacharya, 2020; Vaswani, 2023; Djurdjič, 2023). Ker tovrstne tehnologije postajajo vse pogostejše, se postavlja vprašanje, kako lahko dopolnjujejo kognitivno-vedenjske sposobnosti managerjev. Pomembno pa je opozoriti tudi na izzive in morebitno pristranskost, ki spremljata uvedbo teh tehnologij v podjetjih (Datatron, 2024; Elcock, 2024; Florkin, b.d.).

Vsak dan na stotine milijonov ljudi zajema fotografije, snema videe in pošilja besedilna sporočila. Podjetja po vsem svetu zbirajo obsežne podatke o preferencah in nakupih potrošnikov, vlade pa zbirajo vse od popisne statistike do policijskih poročil. Pretvorba fizičnih informacij v digitalne formate (digitizacija) in nato uporaba vpogledov, ki temeljijo na podatkih, za optimizacijo organizacijskih procesov (digitalizacija), sta informatiki in strojnemu učenju omogočili dostop do ogromnih količin podatkov. Sodobni sistemi UI, zlasti tisti, ki temeljijo na velikih nevronskih mrežah, lahko samodejno obravnavajo podatkovno intenzivne naloge in tako nižajo stroške ter pospešujejo odločanje, kadar so podatki dovolj kakovostni (Brennen & Kreiss, 2016; AlMahamid & Grolinger, 2021; Ashritha & Reddy, 2023; Northeastern University, 2024). Raziskave kažejo, da se vsak dan ustvari več kot 2,5 kvintilijona bajtov podatkov, pri čemer so ocene za leto 2020 napovedovale do 1,7 MB podatkov vsako sekundo na posameznika (Northeastern University, 2024).

Strojno učenje v obliki nadzorovanega, nenadzorovanega in okrepljenega učenja že dolgo prispeva k številnim poslovnim aplikacijam – denimo z odločitvenimi drevesi, razvrščanjem (ang. clustering) ter naključnimi gozdovi (ang. random forests) (LeCun, Bengio & Hinton, 2015; Alpaydin, 2020; AlMahamid & Grolinger, 2021; Vaswani, 2023). Veliki jezikovni modeli, kot so GPT-4, Claude in Gemini, pa so se šele pred kratkim uveljavili kot prelomna orodja UI, zgrajena predvsem na arhitekturi Transformer. Odlikuje jih učinkovito nadgrajevanje z dodatnimi podatki in parametri, s čimer pridobijo multimodalne sposobnosti (Bengesi idr., 2023; Naveed idr., 2024).

## 2 Učinkovitost, iskanje iztočnic in ovire pri implementaciji UI

UI, zlasti veliki jezikovni modeli, ima velik potencial za hitrejše sprejemanje odločitev z obsežno in hitro analizo podatkov (Brockmann & Anthony, 2002; Patton, 2003; Kolbjørnsrud idr., 2016; Brynjolfsson & McAfee, 2017; Sharda idr., 2020; Microsoft, b.d.). Kljub temu je uspeh odvisen od specializiranih znanj, kot je denimo tehnika iskanja iztočnic ali strateški nadzor. Številne organizacije še vedno omahujejo z uvajanjem UI zaradi vodstvenih in infrastrukturnih ovir (Hradecky idr., 2022; Schönberger, 2023), pa tudi zaradi vprašanj zaupanja, preglednosti, stroškov in predpisov (Bley idr., 2022; Neumann idr., 2022). Poleg tega razprava o popolnoma prilagojenih ali komercialnih rešitvah UI (Wu idr., 2023) razkriva kompromise med prilagojenostjo posamezni domeni, razpoložljivimi viri in varstvom podatkov. Dodatno zapleta položaj t. i. digitalni dolg (ang. digital debt), pri katerem zastarele rešitve dodatno obremenjujejo zaposlene, ki sicer želijo avtomatizirati določene naloge, če s tem izboljšajo svoje počutje (Microsoft, 2023a; 2023b; 2023c). V središču raziskovalnega zanimanja tako ostaja vprašanje, kako lahko organizacije uspešno uvedejo LLM-je in ob tem obdržijo ravnovesje med učinkovitostjo ter etičnimi, varnostnimi in zaupnimi vidiki.

## 3 Metodologija

Bazo podatkov Web-of-Science (WoS) smo preiskali z iskanjem literature, ki v povzetku vsebuje tako »management decision making« kot »large language models«. Iskanje smo omejili na povzetke, da bi povečali natančnost in relevantnost rezultatov, saj povzetki jedrnato predstavljajo osrednjo temo članka in vključitev iskalnega niza nakazuje na njegovo pomembnost. Nato smo uporabili funkcijo »Analyse Results« na WoS-spletišču in prejeli preglednico, ki prikazuje pogostost pojavitev posameznih WoS-kategorij in odstotek člankov v teh kategorijah (od skupno 194 rezultatov). Te ugotovitve so služile za analizo tematik, ki so jih članki obravnavali.

## 4 Rezultati in razprava

Rezultati kažejo, da je najpogostejša WoS-kategorija Engineering Electric Electronic, ki se je v zbranih rezultatih pojavila 26-krat; to poudarja pomen električne energije in električnih sistemov v raziskavah o managerskem odločanju in strojnih učnih

metodah. Sledijo Computer Science Information Systems (25), Computer Science Interdisciplinary Applications (16) ter Computer Science Artificial Intelligence (15).

Medicinska področja se pojavljajo pogosto, skupaj 37-krat, okoljska in geoznanstvena področja pa 19-krat, medtem ko se je Telecommunications pojavila 11-krat (glej Tabela 1).

Ti zapisi predstavljajo raznovrstna znanstvena in tehnična področja, z izrazitim poudarkom na upravljanju virov (npr. vodni viri), računalniških raziskavah (npr. metode računalništva) in aplikativnem inženirstvu (npr. gradbeništvo, arhitektura strojne opreme, konstrukcije). Poleg tega so pomembne tudi medicinske discipline (npr. kirurgija, ortopedija, gastroenterologija) in okoljske vede (npr. meteorologija, atmosferske znanosti, trajnostne zelene tehnologije).

**Tabela 1: Pogostost WoS kategorij**

Web of Science (WoS) kategorije	Pogostost kategorij	% of 194
Engineering Electrical Electronic	26	13.402
Computer Science Information Systems	25	12.887
Computer Science Interdisciplinary Applications	16	8.247
Computer Science Artificial Intelligence	15	7.732
Health Care Sciences Services	13	6.701
Medicine General Internal	13	6.701
Telecommunications	13	6.701
Medical Informatics	11	5.67
Environmental Sciences	10	5.155
Geosciences Multidisciplinary	9	4.639

Na splošno gre za interdisciplinarno usmerjenost k optimizaciji ključne infrastrukture—od vodnih in energetskih virov do računalniških orodij in zdravstvenih sistemov—kar kaže na težnjo po nadaljnem razvoju tako teoretičnih kot aplikativnih raziskav.

Naslednji zapisi odražajo še širši obseg akademskih in strokovnih področij, vključno z agronomijo, biologijo, ekologijo, medicino (npr. anesteziologija, nevrologija, dermatologija), družbenimi vedami (npr. sociologija, psihologija) in inženirskimi specializacijami (npr. okoljsko, morsko, industrijsko inženirstvo). Poleg tega pa

raziskave v nastajajočih tehnologijah, kot so nanoinformacijske vede, računalniška biologija in vesoljske znanosti, kažejo vse večjo integracijo interdisciplinarnih metod pri obravnavi globalnih izzivov—od trajnosti do inovacij v zdravstvu.

Enkratne omembe posameznih področij še dodatno poudarjajo širino specializiranih raziskav, ki obsegajo naravoslovje (npr. biologija, ekologija), medicino (npr. anesteziologija, intenzivna nega), inženirstvo (npr. okoljsko, morsko) ter širša humanistična in družboslovna področja (npr. javna uprava, pravo, zgodovina). Ta raznolikost kaže na zavezanost k razvoju znanja v raznolikem naboru znanstvenih, tehnoloških, družbenih in humanističnih ved.

Pomembno je, da se vzpostavijo celoviti programi usposabljanja, ki vključujejo priročnike in delavnice. Le-te bodo managerjem ponudile znanje in orodja za uspešno, odgovorno in učinkovito vključevanje umetne inteligence v poslovne procese, s poudarkom na številnih koristnih aplikacijah, od odločanja do tržnih analiz.

## 5 Zaključek

Umetna inteligenca, zlasti v obliki velikih jezikovnih modelov, močno vpliva na managersko odločanje, saj pospešuje analizo podatkov in izboljšuje kakovost odločitev v različnih sektorjih—od inženirstva do zdravstva in varovanja okolja. Kljub temu pa etična in pravna vprašanja, vključno z varovanjem podatkov in tveganjem t. i. halucinacij pri UI, poudarjajo pomen strogih kontrolnih mehanizmov, preglednosti ter gradnje zaupanja. Managerji morajo osvojiti nova znanja, zlasti na področju tehnike iskanja iztočnic, da zagotovijo zanesljive izide UI, pri čemer se soočajo z infrastrukturnimi in vodstvenimi izzivi. Interdisciplinarnost, ki jo potrjujejo različne tematike v bazi Web of Science, priča o široki uporabnosti umetne inteligence. V prihodnje bo uspešno uvajanje UI temeljilo na neprestanem izobraževanju, etičnem upravljanju ter odgovornem vključevanju tako prilagojenih kot komercialnih modelov UI.

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## O avtorjih

Maja Meško je redna profesorica na Fakulteti za organizacijske vede Univerze v Mariboru. Poleg habilitacije za področji management ter kadrovskega management ima habilitacijo za redno profesorico iz kineziologije (znanost v športu) na Fakulteti za šport Univerze v Ljubljani. Njeni raziskovalni interesi vključujejo management, psihologijo managementa, zdravje na delovnem mestu in vodenje. Sodelovala je in še vedno sodeluje v različnih projektih. Je avtorica in soavtorica številnih znanstvenih člankov.

Tine Bertoncel je docent na Fakulteti za management Univerze na Primorskem. Raziskovalno se osredotoča predvsem na vpliv tehnološkega napredka, zlasti umetne inteligence, na gospodarstvo ter kako digitalne inovacije vplivajo na managerske prakse in odločanje. Sodeluje v različnih raziskovalnih projektih in je avtor in soavtor številnih znanstvenih člankov.





# UMETNA INTELIGENCA IN ETIČNA VPRAŠANJA V MANAGEMENTU: ISKANJE RAVNOTEŽJA

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Hitri razvoj umetne inteligence prinaša številne priložnosti za izboljšanje učinkovitosti in inovativnosti v managementu, hkrati pa odpira tudi kompleksna etična vprašanja. Ta prispevek raziskuje etične dileme, povezane z uvedbo umetne inteligence v poslovne procese, ter išče ravnotežje med izkoriščanjem tehnologije in zagotavljanjem etičnih standardov. Z analizo literature in primerov dobre prakse identificiramo ključna vprašanja, kot so pristranskost v algoritmih, transparentnost odločitev ter vpliv uporabe umetne inteligence na zaposlene in delovno okolje. Rezultati študije kažejo, da kljub potencialnim koristim uporabe umetne inteligence managerji pogosto naletijo na izzive pri zagotavljanju etične uporabe teh orodij. Pomembna je ozaveščenost o problematiki zaščite podatkov, pravic delavcev in diskriminacije, ki lahko izhajajo iz neomejenega zaupanja v tehnične rešitve. Prispevek predlaga razvoj etičnih okvirov in smernic za uporabo umetne inteligence v managementu ter priporočila za usposabljanje vodstvenih kadrov, da se zavedajo teh vprašanj in lahko sprejemajo odgovorne odločitve.

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# ARTIFICIAL INTELLIGENCE AND ETHICAL ISSUES IN MANAGEMENT: SEEKING BALANCE

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The evolution brought on by artificial intelligence (AI) along with its applications generates increased opportunities to increase efficiency and also promote innovation in management alongside creating a plethora of ethical challenges to deal with. This paper examines how AI can present ethical issues for businesses and, at the same time, sheds light on how technology could be employed more ethically. From the literature and examples of best practices, we highlight issues regarding algorithmic injustice, the use of AI in decision-making without discrimination, and the influence of AI usage on the employees and the organization itself. According to the study results, even though artificial intelligence tools may be beneficial to an organization, managers, on the other hand, are faced with the dilemma of making sure that these tools are applied ethically. Understanding these important workers' rights issues and discrimination problems that may occur from overdependence on technology is essential. In this paper, we recommend setting proper ethical principles and policies regarding AI use in management and also recommend training management on such issues and the need to make ethical decisions.



## 1 Uvod

Hiter razvoj umetne inteligence in njene vse večje uporabe v poslovnem svetu sta za organizacije predstavila tako priložnosti kot etične izzive. Po eni strani lahko umetna inteligenca izboljša učinkovitost, spodbuja inovacije in poenostavi procese odločanja (Wang et al., 2020). Vendar pa uvedba umetne inteligence vzbuja tudi pomisleke glede algoritemske pristranskosti, ustrezne uporabe umetne inteligence pri odločanju ter vpliva na zaposlene in organizacijske strukture (Wang et al., 2020; Bhattacharya, 2020; Barton & Pöppelbuß, 2022). Eden od glavnih izzivov je možnost algoritemske nepravilnosti, kjer lahko sistemi umetne inteligence ohranijo pristranskost in diskriminacijo, ki je bodisi lastna podatkom, ki se uporabljajo za usposabljanje algoritmov, bodisi uvedena skozi proces načrtovanja. (Bhattacharya, 2020; Floridi & Cows, 2019). Druga etična dilema je ustrezna uporaba umetne inteligence pri odločanju, zlasti ko gre za občutljive ali visoko tvegane odločitve, ki lahko pomembno vplivajo na posameznike ali družbo. Takšne odločitve lahko vključujejo področja, kot so zdravstvena oskrba, zaposlovanje in pravosodje, kjer napačne odločitve lahko povzročijo resne posledice za posameznike in družbo. Pomembno je zagotoviti, da so algoritmi pregledni in pravični, ter da se redno preverjajo in posodablajo, da se preprečijo morebitne pristranskosti in nepravilnosti. Organizacije se morajo zato osredotočiti na razvoj in implementacijo etičnih smernic ter okvirov za uporabo umetne inteligence. Pomembno je, da se zagotovi preglednost in odgovornost pri uporabi teh tehnologij, da se preprečijo morebitne zlorabe in nepravilnosti. (Floridi & Cows, 2019). Poleg tega je ključnega pomena vključevanje različnih deležnikov v proces razvoja umetne inteligence, da se zagotovi, da so upoštevani različni vidiki in perspektive (Barton & Pöppelbuß, 2022). S tem pristopom lahko organizacije izkoristijo prednosti umetne inteligence, hkrati pa zmanjšajo tveganja in etične izzive, ki jih prinaša njena uporaba. (Wang et al., 2020).

Ta prispevek preučuje etična vprašanja, s katerimi se morajo spoprijeti podjetja pri vključevanju umetne inteligence v svoje poslovanje. Prispevek poudarja potrebo, da organizacije vzpostavijo etična načela in politike, ki bodo usmerjale etično uporabo umetne inteligence, ter pomen usposabljanja menedžerjev za sprejemanje informiranih in etičnih odločitev glede izvajanja umetne inteligence.

## 2 Prednosti umetne inteligence

Umetna inteligenca prinaša številne prednosti, ki lahko bistveno prispevajo k izboljšanju poslovnih procesov in spodbujanju inovacij. Sposobnost avtomatizacije rutinskih nalog povzroča učinkovitost in produktivnost, medtem ko napovedno vzdrževanje zmanjšuje operativna tveganja in povečuje varnost. Generativna umetna inteligenca omogoča hitro ustvarjanje novih produktov in storitev, kar pa prinaša veliko novih možnosti v različnih vejah industrije. Poleg tega pa analitika podatkov omogoča hitrejšo in bolj informirano odločitev, kar se pravi čas odločitve šteje kot pomembno v dinamičnem poslovnem okolju.

Zanimivo je, da je umetna inteligenca sposobna izvajati določene rutinske naloge, zato zmanjša potrebo po fizični intervenciji in povečuje produktivnost. Recimo, da podjetja, kot sta Google ali Amazon, umetno inteligenco izkoriščata za optimizacijo svojih procesov in izboljšanje izkušenj strank. Tudi umetna inteligenca omogoča napovedno vzdrževanje, kar znižuje operativna tveganja in povečuje varnost (Djurđič, 2023). Umetna inteligenca je osnova inovacij, saj omogoča nove uporabe podatkov in tehnologij. ChatGPT, kot primer generativne umetne inteligence, je spremenil proces ustvarjanja novih produktov in storitev, zaradi česar je prišlo do konca številnih novosti v mnogih panogah. Organizacije na globalni ravni začnejo vlagati milijarde dolarjev v umetno inteligenco, kar očitno razkriva njen potencial pri preoblikovanju poslovanja (Product, 2024). Analitika podatkov v realnem času zmanjšuje čas, potreben za sprejemanje boljših odločitev. To je imperativ v hitrih poslovnih okoljih, kjer hitrost in natančnost odločitev določata preživetje podjetja. Napredna umetna inteligenca omogoča podjetjem boljše razumevanje tržnega področja ter razumevanje potreb in zahtev strank, kar vodi do bolj informiranih in realističnih odločitev (Kako se umetna inteligenca uporablja v poslovanju?, 2023).

Kljub tem prednostim je ključnega pomena, da organizacije upoštevajo etične izzive in zagotovijo pravično ter odgovorno uporabo umetne inteligence. S sprejetjem etičnih smernic in okvirov lahko podjetja ne le izkoristijo vse prednosti umetne inteligence, temveč tudi zmanjšajo tveganja in rešujejo etične dileme, ki jih prinaša njena uporaba. Tako lahko umetna inteligenca postane orodje za trajnostni razvoj in družbeno odgovorno poslovanje, kar bo koristilo tako podjetjem kot širši družbi.

### 3 Etični izzivi umetne inteligence

Umetna inteligenca prinaša tudi pomembne etične izzive, ki jih morajo organizacije upoštevati pri njeni uporabi. Med ključne etične izzive spadajo vprašanja transparentnosti, zasebnosti, pristranskosti, odgovornosti in vpliva na delovna mesta. Transparentnost je bistvenega pomena za zagotavljanje zaupanja v sisteme umetne inteligence. Pomanjkanje preglednosti lahko vodi do nezaupanja uporabnikov in težav pri razumevanju, kako sistemi sprejemajo odločitve (Florkin, 2024). Uporaba umetne inteligence pogosto vključuje obdelavo velikih količin osebnih podatkov, kar odpira vprašanja glede varstva zasebnosti. Pomembno je zagotoviti, da so podatki ustrezno zaščiteni in da se spoštujejo pravice posameznikov (Molek, 2023). Sistemi umetne inteligence lahko odražajo pristranskosti, ki so prisotne v podatkih, na katerih so bili usposobljeni. To lahko vodi do diskriminacije in nepravičnih odločitev. Organizacije morajo biti pozorne na te pristranskosti in si prizadevati za razvoj pravičnih in nepristranskih sistemov (Molek, 2023a). Jasno določanje odgovornosti za odločitve, ki jih sprejemajo sistemi umetne inteligence, je ključno. Pomembno je, da so odgovorni posamezniki ali organizacije, ki razvijajo in uporabljajo te sisteme, ter da obstajajo mehanizmi za reševanje morebitnih težav (Molek, 2023). Avtomatizacija in uporaba umetne inteligence lahko vplivata na delovna mesta, kar lahko povzroči izgubo delovnih mest in spremembe v naravi dela. Organizacije morajo razmisliti o teh vplivih in sprejeti ukrepe za podporo delavcem pri prehodu na nove vloge (Molek, 2023a).

Z upoštevanjem teh etičnih izzivov lahko organizacije zagotovijo, da umetna inteligenca prispeva k trajnostnemu razvoju in družbeno odgovornemu poslovanju.

### 4 Algoritemska pristranost umetne inteligence

Algoritemska pristranost se nanaša na sistematične napake ali predsodke, prisotne v algoritmih, ki poganjajo sisteme umetne inteligence, kar vodi do nepravičnih in diskriminatornih rezultatov. Algoritemska pristranost lahko izvira iz različnih virov, kot so podatki, uporabljeni za usposabljanje algoritmov, zasnova samih algoritmov ali predpostavke in pristranskosti, ki so del razvijalcev in raziskovalcev, ki stojijo za sistemi umetne inteligence. Na primer, če so podatki o usposabljanju, uporabljeni za razvoj sistema zaposlovanja, ki temelji na umetni inteligenci, nagnjeni k določeni demografski skupini, lahko posledični algoritem pokaže pristranost v

svojih priporočilih za zaposlovanje, kar lahko prikrajša premalo zastopane skupine. (Parthasarathy & Padmapriya, 2023). Poleg tega lahko zaradi zapletenosti in nepreglednosti številnih sistemov umetne inteligence prepoznavanje in obravnavanje teh pristranskosti postane izziv. Ker umetna inteligenca postaja vse bolj prodorna v procesih odločanja, je ključnega pomena razumeti in ublažiti možnost algoritemske pristranskosti, da se zagotovi pravičnost in pravičnost.

Algoritemska pristranskost se torej pojavi, ko umetna inteligenca proizvaja rezultate, ki so sistematično in nepravično netočni ali pristranski zaradi napačnih predpostavk v procesu strojnega učenja. Eden glavnih vzrokov za pristranskost je uporaba podatkov, ki že vsebujejo obstoječe družbene in kulturne predsodke. Na primer, če podatki za usposabljanje algoritmov vsebujejo večinoma informacije o določeni demografski skupini, lahko to vodi do pristranskih rezultatov, ki ne odražajo raznolikosti celotne populacije. Posledice pristranskosti v podatkih so lahko resne. Pristranski algoritmi lahko erodirajo zaupanje strank, izkrivljajo rezultate in povzročajo napačne odločitve. Na primer, pristranskost v algoritmih za zaposlovanje lahko vodi do diskriminacije določenih skupin kandidatov, kar zmanjšuje raznolikost in pravičnost v delovnem okolju (Elcock, 2024). Prav tako lahko pristranski algoritmi v zdravstvenem varstvu povzročijo neenakosti v dostopu do zdravstvenih storitev in oskrbe.

### Primeri diskriminacije zaradi umetne inteligence

Eden najbolj znanih primerov algoritemske pristranskosti je sistem COMPAS (Correctional Offender Management Profiling for Alternative Sanctions), ki se uporablja v ameriškem pravosodnem sistemu za napovedovanje verjetnosti ponovitve kaznivih dejanj. Raziskave so pokazale, da je ta sistem dvakrat pogosteje napačno označil temnopolte obtožence kot visoko tveganje za ponovitev kaznivega dejanja v primerjavi z belimi obtoženci (Datatron, 2024). Drug primer je algoritem za zaposlovanje, ki ga je uporabljal Amazon. Leta 2015 so ugotovili, da je njihov algoritem diskriminiral ženske kandidate za tehnične vloge, ker je bil usposobljen na podatkih, ki so vključevali večinoma moške kandidate (Omowole, 2021). Ta pristranskost je bila posledica zgodovinskih podatkov o zaposlovanju, ki so odražali obstoječe neenakosti v tehnološki industriji. Prav tako je bil v ZDA odkrit algoritem, ki je bil uporabljen v zdravstvenih sistemih za napovedovanje potreb po dodatni zdravstveni oskrbi. Ta algoritem je favoriziral bele paciente pred temnopoltimi, ker

je temeljil na zgodovinskih podatkih o stroških zdravstvene oskrbe, ki so bili nižji za temnopolte paciente z enakimi zdravstvenimi stanji (Datatron, 2024).

## 5 Odgovorna uporaba umetne inteligence

Organizacije morajo sprejeti celovit pristop, ki vključuje več vidikov odgovorne uporabe umetne inteligence:

1. **Etične smernice in politike:** Organizacije morajo razviti in implementirati jasne etične smernice in politike za uporabo umetne inteligence. Te smernice naj vključujejo načela pravičnosti, transparentnosti, odgovornosti in spoštovanja zasebnosti. Pomembno je, da so te politike redno posodobljene glede na tehnološki napredek in družbene spremembe (Florkin, 2024).
2. **Usposabljanje in ozaveščanje:** Ključno je, da so vsi zaposleni, zlasti tisti, ki delajo neposredno z umetno inteligenco, ustrezno usposobljeni in ozaveščeni o etičnih vprašanjih, povezanih z uporabo umetne inteligence. To vključuje razumevanje potencialnih pristranskosti, tveganj za zasebnost in drugih etičnih izzivov (Molek, 2023).
3. **Transparentnost in razlaga:** Sistemi umetne inteligence morajo biti zasnovani tako, da so njihove odločitve razumljive in razložljive. Transparentnost pri delovanju umetne inteligence povečuje zaupanje uporabnikov in omogoča boljše razumevanje, kako in zakaj so bile sprejete določene odločitve (Molek, 2023a).
4. **Pravičnost in nepristranskost:** Organizacije morajo zagotoviti, da njihovi sistemi umetne inteligence delujejo pravično in nepristransko. To vključuje redno preverjanje in odpravljanje pristranskosti v podatkih in algoritmih, ki se uporabljajo za usposabljanje umetne inteligence.
5. **Varstvo zasebnosti:** Uporaba umetna inteligenca mora biti skladna z zakonodajo o varstvu podatkov in zasebnosti. Organizacije morajo sprejeti ukrepe za zaščito osebnih podatkov in zagotoviti, da se podatki uporabljajo na način, ki spoštuje pravice posameznikov (Molek, 2023a).
6. **Odgovornost in odgovornost:** Pomembno je, da so jasno določene odgovornosti za odločitve, ki jih sprejemajo sistemi umetne inteligence. Organizacije morajo vzpostaviti mehanizme za reševanje morebitnih težav

in zagotoviti, da so odgovorni posamezniki ali skupine, ki razvijajo in uporabljajo umetne inteligence. (Florin, 2024).

7. Vpliv na družbo in delovna mesta: Organizacije morajo upoštevati širši družbeni vpliv uporabe UI, vključno z vplivom na delovna mesta. To vključuje sprejemanje ukrepov za podporo delavcem pri prehodu na nove vloge in zagotavljanje, da umetna inteligenca prispeva k pozitivnim družbenim spremembam (Molek, 2023).

Z upoštevanjem teh načel lahko organizacije zagotovijo, da uporaba umetne inteligence prispeva k trajnostnemu razvoju in družbeno odgovornemu poslovanju, kar bo koristilo tako podjetjem kot širši družbi.

## 6 Zaključek

Umetna inteligenca prinaša številne prednosti, ki lahko bistveno izboljšajo poslovne procese in spodbudijo inovacije. Vendar pa njena uporaba prinaša tudi pomembne etične izzive, ki jih morajo organizacije skrbno obravnavati. Ključnega pomena je, da podjetja vzpostavijo jasne etične smernice in politike, ki bodo usmerjale odgovorno uporabo umetne inteligence.

Zagotavljanje transparentnosti, varstva zasebnosti, pravičnosti in nepristranskosti ter jasnega določanja odgovornosti so bistveni koraki za etično uporabo umetne inteligence. Poleg tega je pomembno, da organizacije vlagajo v usposabljanje in ozaveščanje zaposlenih o etičnih vprašanjih, povezanih z umetno inteligenco.

S sprejetjem teh ukrepov lahko podjetja ne le izkoristijo vse prednosti umetne inteligence, temveč tudi zmanjšajo tveganja in rešujejo etične dileme, ki jih prinaša njena uporaba. Tako lahko umetna inteligenca postane orodje za trajnostni razvoj in družbeno odgovorno poslovanje, kar bo koristilo tako podjetjem kot širši družbi.

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## O avtoricah

Maja Meško je redna profesorica na Fakulteti za organizacijske vede Univerze v Mariboru. Poleg habilitacije za področji management ter kadrovskega managementa ima habilitacijo za redno profesorico iz kineziologije (znanost v športu) na Fakulteti za šport Univerze v Ljubljani. Njeni raziskovalni interesi vključujejo management, psihologijo managementa, zdravje na delovnem mestu in vodenje. Sodelovala je in še vedno sodeluje v različnih projektih. Je avtorica in soavtorica številnih znanstvenih člankov.

Mirjana Pejić Bach je redna profesorica na Katedri za informatiko na Ekonomski fakulteti Univerze v Zagrebu. Doktorirala je iz modeliranja sistemske dinamike na Ekonomski fakulteti Univerze v Zagrebu. Izobraževala se je na MIT Sloan School of Management na področju sistemske dinamike in pri OliviaGroup na področju rударjenja podatkov. Njena raziskovalna področja vključujejo strateško uporabo informacijske tehnologije v poslovanju, podatkovne vede, simulacijsko modeliranje, raziskovalno metodologijo ter kvalitativno in kvantitativno analizo, še posebej multivariatno statistiko

in modeliranje strukturnih enačb. Pejić Bach je urednica več znanstvenih revij, indeksiranih v Scopus in WoS, ter je organizirala več konferenc.

Tine Bertonec je docent za področje poslovne informatike in znanstveni sodelavec na Fakulteti za management Univerze na Primorskem. Njegova raziskovalna področja so umetna inteligenca pri procesih odločanja in managerski sistemi zgodnjega obveščanja. Je avtor ali soavtor številnih člankov v mednarodnih znanstvenih revijah kot so International journal of information management, Data, International journal of e-services and mobile application, Systems research and behavioral science kot tudi avtor dveh znanstvenih monografij. Je član raziskovalnih projektov TeachXR in Greentech.

# VPLIV UMETNE INTELIGENCE NA UPRAVLJANJE OSKRBOVALNIH VERIG

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Umetna inteligenca vedno bolj spreminja različne vidike poslovanja podjetij. Na področju upravljanja z oskrbovalnimi verigami se uporablja za analizo podatkov in napovedovanje povpraševanja, optimizacijo logistike in transportnih poti ter prepoznavanje neučinkovitosti. Rezultat tega je boljša odzivnost na spreminjanje povpraševanja, skrajševanje dobavnih rokov in nižanje stroškov. Osnovi namen tega članka je pregled in analizira uporabe umetne inteligence pri upravljanju oskrbovalnih verig z uporabo baze podatkov WoS. Osnovi cilj je narediti analizo o vplivu umetne inteligence na uspešnost upravljanja oskrbovalnih verig, določiti katere vrste umetne inteligence izboljšajo učinkovitost upravljanja oskrbovalnih verig ter področja, ki predstavljajo potencial za izboljšave kakor tudi vpliv uporabe umetne inteligence na uspešnost na upravljanje oskrbovalnih verig.

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# THE IMPACT OF ARTIFICIAL INTELLIGENCE ON SUPPLY CHAIN MANAGEMENT TITLE

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Artificial intelligence is increasingly changing various aspects of business operations. In the field of supply chain management, it is being used to analyse data and forecast demand, optimise logistics and transport routes, and identify inefficiencies. The result is better responsiveness to fluctuations in demand, shorter delivery times, and lower costs. The basic aim of this article is to investigate and analyse the use of artificial intelligence in supply chain management using the WoS database. The basic objective is to conduct an analysis of the impact of artificial intelligence on supply chain management performance, to determine which types of artificial intelligence improve supply chain management efficiency and which areas have the potential for improvement, and to examine the impact of the application of artificial intelligence on supply chain management performance.



## 1 Uvod

Uporaba orodij umetne inteligence zelo pomembno vpliva na upravljanje oskrbovalnih verig. Podjetja, ki se ukvarjajo z logistiko, s pomočjo orodij umetne inteligence bistveno bolj učinkovito spremljajo pošiljke in predvidevajo potrebe po prevozu (Rahimi in Alemtabriz, 2022). Sodobna orodja umetne inteligence omogočajo bistveno boljše odločanje ter izboljšajo kakovost storitev. Razvoj uporabe umetne inteligence se je začel z uvedbo ekspertnih sistemov in fuzzy logike ter je zaradi razvoja obdelave velikih baz podatkov, napredne analitike in globokega učenja dosegel zrelost po letu 2010 (Li, 2020).

Uporaba umetne inteligence se je po letu 2010 zelo razširila, kar je na eni strani zelo pozitivno, hkrati pa se pojavi tudi negotovost glede delovnih mest in načina upravljanja podjetij (Li, 2020). Prav tako pa je zaznati pomanjkanje ustrezne literature o uporabi umetne inteligence na področju oskrbovalnih verig (Hartmann in Moeller, 2014).

Rezultat te raziskave kažejo, da so raziskave na tem področju razpršene, zato je potrebna jasna in celovita razvrstitev (taksonomija), ki bi raziskovalcem omogočila boljše razumevanje, kako se je umetna inteligenca v oskrbovalnih verigah uporabljala v preteklosti, kako se uporablja danes in kakšne so možnosti za njeno uporabo v prihodnosti.

Raziskava se osredotoča na tri ključna vprašanja:

- Kakšen je trenutni napredek na področju uporabe umetne inteligence v oskrbovalnih verigah?
- Kateri tipi umetne inteligence in okolja so bili preučeni?
- Kam so usmerjene nadaljnje raziskave?

Da bi pridobili vpogled v obstoječe povezave in raziskovalne vzorce smo izvedli obsežno analizo literature z uporabo taksonomije, bibliometrične analize in poglobljenih omrežnih ocen (Nayak in Choudhary, 2022) in sicer tako da smo analizirali: citatna omrežja (kako se članki povezujejo prek citatov in razkrivajo vplivna dela ali avtorje), sodelovanje (kateri avtorji ali institucije največ sodelujejo pri raziskavah umetne inteligence v oskrbovalnih verigah), vsebinske vzorce (povezave

med ključnimi temami (npr. globoko učenje, stojno učenje, ekspertni sistemi) razkrivanje trendov in vrzeli v raziskavah). Ta pristop omogoča vpogled v obstoječe povezave in raziskovalne vzorce. Po podatkih McKinseyja so podjetja, ki uporabljajo umetno inteligenco v oskrbovalnih verigah zmanjšala logistične stroške za 15 %, raven zaloga za 35 % ter izboljšala storitve za 65 %. Čeprav so ti rezultati preliminarni, se resničen potencial umetne inteligence morda skriva v še natančnejših napovednih analizah (Camargo et al., 2020).

## 2 Metodologija

Cilj članka je raziskati vpliv umetne inteligence na učinkovitost upravljanja oskrbovalnih verig z uporabo baze podatkov WoS. Članek analizira vrste umetne inteligence, ki največ pripomorejo k izboljšanju upravljanja z oskrbovalnimi verigami ter identificira področja, ki imajo največji potencial za uporabo in vpliv na agilnost in vitkost oskrbovalnih verig.

Web of Science (WoS) ponuja zmogljiv iskalnik z različnimi iskalnimi parametri, kot so "iskanje po dokumentih", "iskanje po avtorjih", "iskanje po pripadnosti" in "napredno iskanje" za številna polja, kot so "naslov članka, povzetek, ključne besede", "naslov vira", "leto objave" itd. Ključni iskalni izrazi v tej študiji so bili "Artificial Intelligence" in "Artificial Intelligence in Supply Chain Management Performance". Raziskava je zajela objave na teh področjih v obdobju 2014–2024. Iz pridobljenih podatkov so bili pridobljeni naslednji podatki: vrsta dokumenta, predmetno področje, vrsta vira, število objav po državah ali regijah in število objav na leto.

## 3 Umetna inteligenca

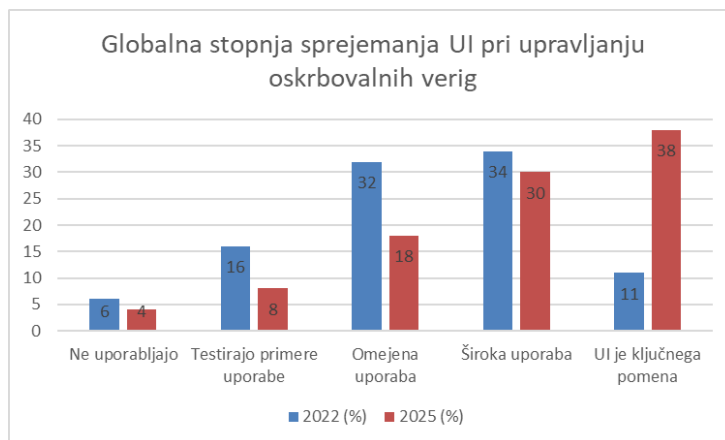
Od svojega nastanka leta 2012 je umetna inteligenca, zaradi različnih dejavnikov, doživela obdobja razvoja kakor tudi nazadovanja. V zadnjih dveh desetletjih pa se je zaradi rasti količine podatkov in večje kompleksnosti, zanimanje zanjo ponovno povečalo (Scholten et al., 2014). Večina raziskav poudarja potenciale umetne inteligence v različnih poslovnih funkcijah.

Umetna inteligenca (UI) je opredeljena kot omrežje računalnikov, ki lahko posnema človeški intelekt pri sprejemanju odločitev za reševanje poslovnih problemov (Huang & Rust, 2018). Bistvena vloga umetne inteligence je, da pomaga pri oblikovanju poslovnih odločitev ter se uči iz podatkov. Umetna inteligenca omogoča prepoznavanje šibkih točk v oskrbovalnih verigah optimizira razpoložljive vire (Fosso-Wamba & Akter, 2019). Omogoča prepoznavanje tržnih trendov, optimizacijo notranjih in zunanjih oskrbovalnih verig ter avtomatizacijo rutinskih nalog s tem pa tudi izboljšanje kakovost izdelkov (Jabbour et al., \*2020). Ključen element konkurenčnosti so prilagojene rešitve kot tudi zanesljivost oskrbovalnih verig. S pomočjo umetne inteligence so razviti sistemi za prepoznavanje profilov strank in ponujanje individualiziranih izdelkov.

„Ekspertni sistemi“, znani tudi kot sistemi, ki temeljijo na znanju, so podpodročje umetne inteligence, ki se osredotoča na razvoj programske opreme, ki daje računalnikom sposobnost opravljanja nalog, ki so jih v preteklosti opravljali ljudje s pomočjo specializiranih navodil in znanja na področju upravljanja oskrbovalnih verig (Pournader et al., 2021). Glede na raziskave, ki so jih opravili Jakupović in drugi (2014), se ekspertni sistemi zelo dobro obnesejo na področjih, na katerih je mogoče človeško inteligenco strukturirati. Če ni strukturirana se učinkovitost ekspertnih sistemov drastično zmanjša (Haenlein & Kaplan, 2019). Ta težava postane še očitnejša, ko poskušamo s pomočjo ekspertnih sistemov reševati kognitivne motnje.

V zadnjih letih se je povečalo zanimanje za prakso uporabe tehnik umetne inteligence pri modeliranju in simulaciji zapletenih sistemov na področju upravljanja oskrbne verige (Chen et al., 2022). Z uporabo umetne inteligence v kontekstu modeliranja in simulacije je mogoče pridobiti bolj poglobljen vpogled v delovanje sistemov, to pa poveča sposobnost sprejemanja boljših odločitev (Bennett in Hauser, 2013). Vse pogostejše se uporablja umetno inteligenco pri upravljanju oskrbovalnih verige za izboljšanje učinkovitosti z vidika agilnosti in vitkosti.

Za analizo pregleda literature sta bili uporabljeni kvantitativna analiza in kvalitativna analiza. Kvantitativni element poročila obsega panoge, povezane z upravljanjem oskrbovalne verige kjer se izvajajo tehnike in tehnologije umetne inteligence. Del tega so tudi procesi zaznavanja, interakcije in odločanja. Del kvantitativnega vrednotenja literature bo tudi nabavno poslovanje, logistika, upravljanje virov in informacijski delovni proces.



**Slika 1. Globalna stopnja sprejemanja umetne inteligence v oskrbovalnih verigah in proizvodnih podjetjih (2022 in 2025)**

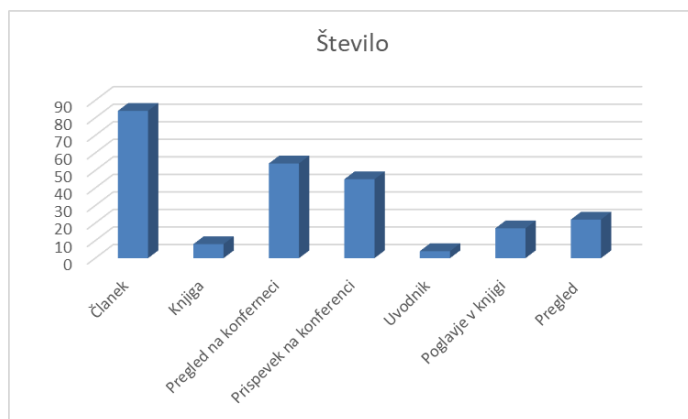
Vir: Statista (2022)

Po drugi strani se pri kvalitativnem vrednotenju literature upošteva pomanjkanje znanstvene literature o učinkih umetne inteligence na uspešnost upravljanja oskrbovalne verige. Bolj neposredno na obravnavano temo je raziskava pokazala, da je vpliv UI na upravljanje oskrbovalne verige dosegel drugo in tretje mesto po deležu respondentov, ki so navedli potencial za zmanjšanje stroškov in povečanje prihodkov v vseh osmih preučevanih poslovnih funkcijah (Tirkolae et al., 2022). O povečanju prihodkov je poročalo 63 % anketirancev, o zmanjšanju stroškov pa 61 %. Najverjetnejše aplikacije, ki so spodbudile te spremembe, so bile ugotovljene pri napovedovanju prodaje in povpraševanja, analitiki izdatkov in optimizaciji omrežja, ki so vse del upravljanja oskrbne verige. Družba McKinsey & Company (2019) je povzela perspektivne učinke umetne inteligence na upravljanje oskrbovalne verige. Internet stvari (IoT), robotika in preskriptivna analitika so pred umetno inteligenco (UI), ki je trenutno na sedmem mestu. Skoraj četrtina tistih, ki so sodelovali v raziskavi, predvideva, da bo umetno inteligenco sprejela v naslednjih dveh letih.

Za pridobivanje in ocenjevanje stanja aplikacij umetne inteligence na področju upravljanja oskrbovalnih verig in njenega vpliva na njihovo delovanje je bila uporabljena podatkovna zbirka WoS. Podatkovna baza vključuje veliko število recenzirane literature: znanstvene revije, poglavja v knjigah in zbornike konferenc.

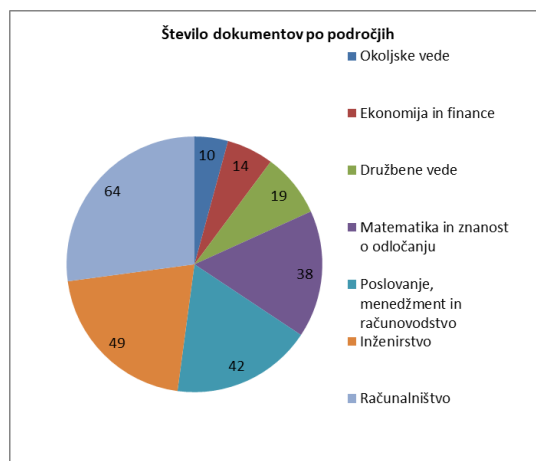


Rezultati so bili izpopolnjeni tako, da vključujejo objave na raziskovalnih področjih v obdobju 2014-2024. Pridobljeni podatki so bili uporabljeni za pridobitev naslednjih dejstev: a) vrsta dokumenta, b) predmetno področje, c) vrsta vira, d) in število publikacij po državah ali regijah. Iskanje je bilo omejeno le na recenzirane znanstvene članke. Rezultati analize so prikazani na slikah 2-6.



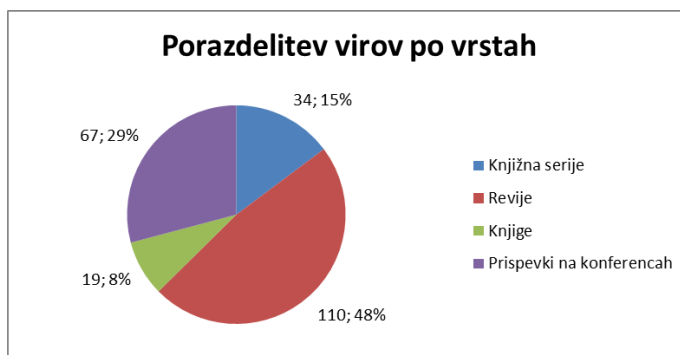
Slika 2: Vrsta dokumenta

Slika 2 prikazuje, da so članki najbolj priljubljena vrsta dokumentov, sledijo jim pregledi in prispevki na konferencah.



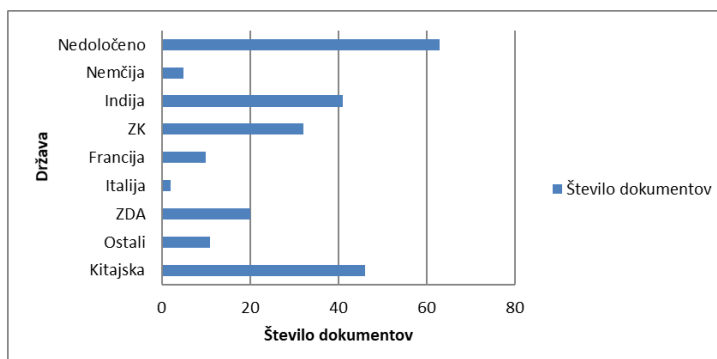
Slika 3: Število dokumentov po področjih

Slika 3 prikazuje število dokumentov po različnih področjih raziskav. Raziskave so torej močno osredotočene na tehnične in poslovne discipline, medtem ko manjši delež raziskav nakazuje priložnosti za razvoj na družbenih, okoljskih in ekonomskih področjih.



Slika 4: Porazdelitev po vrstah vira

Iz slike 4 je razvidno, da je porazdelitev med vrstami virov: revije, knjižne serije, konferenčne zbornike in knjige, naslednja: 48 %, 15 %, 29 % oziroma 8 %.



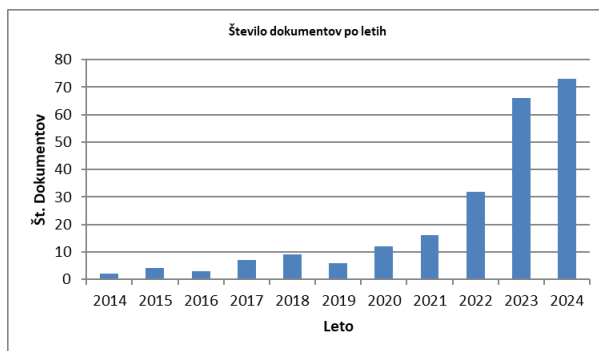
Slika 5: Število dokumentov na temo umetne inteligence v upravljanju oskrbovalnih verig

Slika 5 prikazuje število WoS dokumentov na temo umetne inteligence v upravljanju oskrbovalnih verig z razdelitvijo prispevkov glede na državo izvora. Več kot polovica dokumentov izhaja iz Indije, Kitajske in kategorije "Nedoločeno," kar poudarja osredotočenost na te države oziroma pomanjkljivosti v klasifikaciji podatkov.

Manjše države, kot sta Italija in Nizozemska, imajo minimalen vpliv na podatkovno strukturo, kar lahko kaže na manjšo vključenost ali relevantnost.

#### 4 Vpliv umetne inteligence na uspešnost upravljanja oskrbovalnih verig

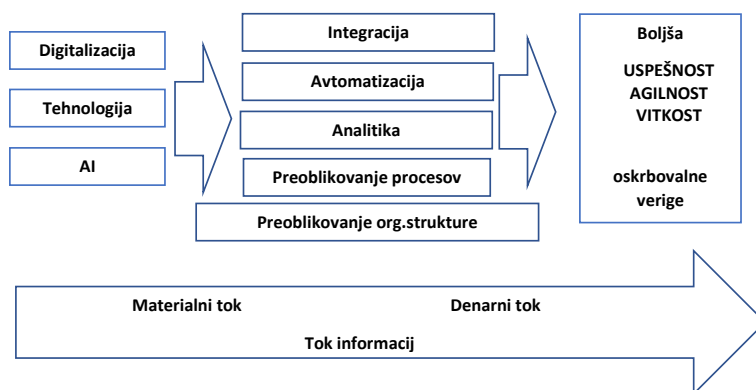
Merjenje uspešnosti nam omogoča boljše razumevanje, kako izpolniti pričakovanja trga in dosegati dolgoročne cilje. Namesto da bi se osredotočali zgolj na uspešnost posameznega podjetja v oskrbovalni verigi, pregled celotne oskrbovalne verige poudarja soodvisnosti med vsemi vključenimi podjetji. Takšen pristop omogoča boljše razumevanje delovanja celotnega sistema, usmerja aktivnosti sodelujočih in razkriva učinkovitost deležnikov ter drugih udeležencev v oskrbovalni verigi. Upravljanje oskrbovalne verige se v veliki meri opira na oblikovanje in uporabo meril uspešnosti. Učinkovitost delovanja oskrbovalne verige znotraj podjetja lahko merimo s spremljanjem ključnih kazalnikov, kot so čas priprave, stopnja izpolnitve naročil in pravočasnost dostave (Yu et al., 2017). Vendar pa so ta merila pogosto oblikovana znotraj posameznega podjetja, kar pomeni, da ne zajemajo celotnega obsega delovanja oskrbovalne verige.



Slika 6: Število dokumentov po letih

Slika 6 prikazuje število dokumentov, objavljenih na leto v obdobju 2014-2024. Od leta 2012, ko je bila v tem letu uvedena umetna inteligenca, je opazen trend naraščanja števila objav. Ekspozitna rast števila objav po letu 2020 kaže na hitro razvijajočo se uporabo umetne inteligence v tej panogi. To sovпада z razvojem tehnologij AI, povečanjem dostopnosti podatkov in potrebami po optimizaciji oskrbovalnih verig. Pričakovati je, da bo raziskovanje na tem področju v prihodnjih

letih še naprej raslo, saj organizacije vedno bolj iščejo inovativne rešitve za izzive v oskrbovalnih verigah.



Slika 7: Digitalizacija upravljanja z oskrbovalnimi verigami

Na sliki 7 je prikazan okvir za digitalizacijo upravljanja oskrbovalne verige. Umetna inteligenca je ena izmed tehnologij, ki jih je mogoče uporabiti pri upravljanju oskrbovalne verige, kot navaja pregledana literatura. Rešitve, ki jih poganja umetna inteligenca, lahko zaradi svoje sposobnosti obdelave velikih količin podatkov temeljito spremenijo upravljanje zalog. Sestavni deli digitalizacije upravljanja oskrbovalne verige vključujejo integracijo informacij, virov in omrežij, avtomatizacijo procesov in inteligentnih sistemov, analitiko v realnem času ter optimizacijo procesov in napovedovanje (Xie et al., 2020). Cilj digitalizacije in industrije 4.0 je preoblikovati oskrbovalne verige v inteligentne sisteme, ki odpravljajo asimetrične in redundantne informacije ter povečujejo učinkovitost. Uspešnost teh sistemov se meri z vidikov, kot so vidljivost, personalizacija, trajnost, inovativnost, agilnost in vitkost (leagility), kar omogoča večjo prilagodljivost in nižje stroške (Xie et al., 2020).

Mohsen (2023) poudarja uporabo umetne inteligence, oblaka, interneta stvari in veriženja blokov v oskrbovalnih verigah. Tehnologija oblaka omogoča hitro izvajanje aktivnosti in preglednost, veriženje blokov izboljšuje sledenje procesom, internet stvari pa natančnejše strateško odločanje. Velike baze podatkov igrajo

ključno vlogo pri načrtovanju, logistiki, inovacijah in oblikovanju strategij (Mohsen, 2022).

Umetna inteligenca omogoča avtonomno upravljanje oskrbovalnih verig z visoko stopnjo neodvisnosti in učinkovitosti (Stoyanov, 2021). Izboljšuje distribucijo, logistična vozlišča, prodajo, načrtovanje in napovedovanje povpraševanja (Toorajipour et al., 2021). Študija McKinsey & Company (2021) je pokazala, da umetna inteligenca povečuje preglednost logističnih procesov, omogoča hitro prilagajanje spremembam in zmanjšuje izgube.

## 5 Zaključek

Cilj prispevka je bil raziskati in predstaviti uporabo umetne inteligence (UI) pri upravljanju oskrbovalne verige in njen vpliv na uspešnost teh procesov. Na podlagi predstavljenega lahko zaključimo, da je umetna inteligenca ključna za izboljšanje napovedovanja povpraševanja, distribucije, transporta, upravljanja zalog in načrtovanja, saj povečuje odzivnost, zmanjšuje odpadke in izboljšuje sodelovanje med deležniki. Kljub tem prednostim uvedba umetne inteligence zahteva znatne vire in odpira vprašanja glede varnosti in zasebnosti podatkov. Pregled literature razkriva pomanjkanje standardizacije in konkretnih metod za merjenje donosnosti naložb, težave z integracijo sistemov UI z obstoječimi sistemi ter omejeno število raziskav o etičnih in zasebnostnih vidikih. V prihodnje se pričakuje širša uporaba umetne inteligence, boljša integracija z obstoječimi sistemi, večji poudarek na etičnosti ter razvoj analitičnih orodij za obvladovanje tveganj. Napredek bo zaznamovan tudi s povezovanjem umetne inteligence z veriženjem blokov, kar bo omogočilo varnejše in preglednejše rešitve za upravljanje oskrbovalnih verig.

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# DIGITAL EDUCATION FOR SELF-CARE BEHAVIOR TO PREVENT RESPIRATORY INFECTIONS IN VULNERABLE POPULATIONS: A REVIEW

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Digital education is increasingly recognised as powerful tool for addressing inequities in healthcare and education among vulnerable populations. Such populations, characterised by specific disadvantages, frequently encounter significant obstacles in accessing conventional educational and healthcare resources. The advent of the global pandemic, namely the Coronavirus disease 2019 (Covid-19), has further compounded the challenges confronting these populations, thereby necessitating the development of novel approaches to address their educational needs. Furthermore, health prevention strategies have been shown to improve general outcomes and protect communities. Digital technologies, including telehealth platforms, mobile health applications, and online learning systems, have emerged as useful solutions to overcome these challenges, offering scalable, flexible, and cost-effective ways to deliver tailored educational content while empowering users to take the responsibility to develop and maintain their health and wellbeing.

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## 1 Introduction

The adoption of digital technologies within healthcare education has allowed a higher access and interaction for individuals with health information (Dunn & Hazzard, 2019). Digital educational interventions not only improve access to healthcare information, but also empower citizens to actively engage themselves in their care through personalized and interactive learning experiences (Harris et al., 2023).

Digital educational interventions are increasingly recognized as powerful tools for addressing inequities in healthcare and education among vulnerable populations. One critical area where digital education has demonstrated significant strength is in the prevention of respiratory infections, particularly among vulnerable populations (Goni et al., 2023). Respiratory infections, such as influenza-like illnesses and respiratory syncytial virus, pose a significant health burden on vulnerable populations, including the elderly, immunocompromised individuals, and those with underlying chronic conditions (Colosia et al., 2023).

### 1.1 Respiratory infections

Respiratory infections are among the most prevalent and impactful disease conditions worldwide, representing a substantial burden on global health systems and populations. Lower respiratory tract infections (LRTIs), including pneumonia, bronchitis, and influenza, are a leading cause of death, especially in low- and middle-income countries (LMICs) (Goni et al., 2023; Li et al., 2014).

Preventive strategies have proven to be highly effective in mitigating the impact of these diseases, particularly in reducing transmission, hospitalizations, and mortality (Debbag et al., 2024). Vaccination programs are among the most impactful measures, with vaccines for influenza, pneumococcus, and *Haemophilus influenzae* type B (Hib) significantly reducing the incidence of severe respiratory conditions (Hanage & Schaffner, 2024). Other preventive measures, such as hand hygiene, the use of face masks, and avoiding crowded spaces, also play critical roles.

During the COVID-19 pandemic, the global adoption of mask-wearing and physical distancing significantly reduced the spread not only of SARS-CoV-2, but also of other respiratory infections like influenza (Damette & Huynh, 2023). However, despite this success, disparities in access to preventive care remain a significant challenge. Populations in LMICs and underserved areas are often excluded from vaccination campaigns due to logistical, financial, or infrastructural barriers (Kaddar et al., 2013). Additionally, the adoption of such measures is often hindered by various and interrelated factors that span individual, systemic, and societal levels. Expanding these efforts is essential for maximizing the impact of respiratory infection prevention on global health outcomes, along with increasing public awareness and education about preventive practices (Fokam et al., 2023). Cultural misconceptions further complicate the adoption of preventive measures. Similarly, social norms and stigma associated with certain preventive behaviours can discourage adherence.

## **1.2 The growth of digital education**

The rapid evolution of digital technology has profoundly reshaped the way in which patients access and are engaged with health information.

Education has been recognized as a cornerstone of public health, playing a vital role in promoting awareness, fostering behavioral change, and equipping individuals with the knowledge needed to make informed decisions about their health (Kolbe, 2019). Traditional educational interventions in healthcare have relied on in-person methods, such as community workshops, printed materials, and public health campaigns delivered through mass media platforms like television and radio (Robinson et al., 2014). These approaches have been instrumental in disseminating critical health information and addressing public health emergencies, including vaccination programs and the management of infectious diseases (Hunt & Linos, 2022). Despite their success, these traditional methods often face challenges in scalability, accessibility, and personalization. Printed materials may not be adapted to diverse literacy levels, while in-person campaigns can be resource-intensive and difficult to implement in geographically dispersed or underserved areas (Wolf et al., 2018). Furthermore, traditional educational methods may lack the immediacy and interactivity needed to effectively engage contemporary audiences (Liman Kaban & Karadeniz, 2021).

These limitations have facilitated the integration of digital technologies, which can enhance and revolutionize the delivery of healthcare education; in fact, digital platforms have emerged as essential tools in delivering educational content and health services. However, this rapid shift also revealed persistent inequities in digital access, known as the digital divide. Vulnerable populations often lacked the infrastructure, skills, or devices needed to engage fully with these technologies, exacerbating existing disparities (Eruchalu et al., 2021; Gordon, 2020).

### **1.3 Vulnerability among population**

Vulnerability in healthcare refers to a population's increased susceptibility to adverse health outcomes due to a combination of individual, social, and systemic factors. According to Gordon (2020), vulnerability arises from intersecting determinants such as socio-economic status, age, underlying health conditions, geographic location, and access to healthcare services. These factors not only amplify the risk of diseases like respiratory infections but also limit the capacity of affected populations to engage in preventive and treatment measures.

Socio-economic status plays a central role in health vulnerability. Individuals in low-income households often experience barriers to healthcare access, including the inability to afford vaccines, limited transportation to healthcare facilities, and inadequate access to digital tools necessary for health education (Gordon, 2020).

Age is another critical determinant of vulnerability. Older adults, for instance, are disproportionately affected by respiratory infections such as influenza, pneumonia, and respiratory syncytial virus (RSV) due to weakened immune systems and coexisting chronic conditions (Colosia et al., 2023). Children under five years old are similarly vulnerable, particularly to conditions like pneumonia, which is responsible for significant morbidity and mortality in this age group.

Individuals with chronic health conditions, such as diabetes, cardiovascular disease, or chronic obstructive pulmonary disease (COPD), are at elevated risk for severe outcomes from respiratory infections.

Geographic location further exacerbates vulnerability. Rural and remote communities often lack healthcare infrastructure, making it challenging to access preventive measures such as vaccines and timely treatment.

Many individuals experience overlapping vulnerabilities. For example, an elderly person with diabetes living in a low-income, rural area faces compounded risks due to their age, chronic condition, and geographic isolation. Gordon (2020) emphasizes that addressing such intersecting vulnerabilities requires holistic and tailored interventions that consider the diverse needs of at-risk populations.

To mitigate these vulnerabilities, it is critical to implement strategies that enhance healthcare access, provide targeted education, and address systemic inequities.

#### **1.4 Aim of the study**

This review explores the current digital education tools for respiratory infection prevention, with a focus on its application in vulnerable populations.

## **2 Research methodology**

This narrative review (Chiappinotto et al., 2023) has synthesized findings from diverse sources, including PubMed, Scopus, and grey literature (e.g., policy reports, government documents).

The search strategy employed a combination of Medical Subject Headings (MeSH) terms and keywords, such as “Health Education,” “Self-Care,” “Respiratory Tract Infections,” “Digital Health,” and “Vulnerable Populations.”

Studies were selected based on their relevance to digital interventions, self-care promotion, and their applicability to at-risk groups, with a particular focus on interventions aimed at addressing health disparities. Inclusion criteria emphasized articles published within the last decade, practical applications in public health, and evidence-based findings. Gray literature sources, such as global health reports and non-governmental organization documents, were included to capture real-world insights and policy implications.

The methodology ensures a comprehensive narrative synthesis, integrating evidence from a wide range of academic and practical perspectives.

### 3 Results and Discussion

#### 3.1 Digital Health Education for vulnerable populations

Defined as the ability to access, understand, and apply health information, health literacy influences an individual's capacity to make informed decisions, adhere to treatment regimens, and engage in preventive care. Digital educational tools are central to advancing health literacy, including mobile health applications, telehealth platforms, e-learning systems, and hospital-based technologies, in particular for vulnerable populations. These groups often encounter significant barriers to accessing traditional health education and care (Blount et al., 2023). Digital education interventions offer scalable, flexible, and cost-effective ways to deliver tailored educational content, while empowering users to take charge of their health and wellbeing (Kaihlanen et al., 2022). Digital tools operate by disseminating accurate health information, fostering active user engagement, and offering decision-making support. Real-time feedback, gamification, and tailored content increase user motivation and adherence to recommended behaviours (Eysenbach, 2011).

Mobile health applications, for instance, are increasingly used to support chronic disease management. These tools offer features such as personalized reminders, educational modules, and progress tracking, all of which foster greater engagement and adherence to treatment plans. Studies have demonstrated their effectiveness in improving outcomes for chronic conditions like diabetes, hypertension, and asthma. For example, patients using a diabetes management app reported better glycaemic control and a deeper understanding of their condition (Harris et al., 2023).

Digital platforms have demonstrated efficacy in delivering structured, interactive, and personalized educational content that enhances comprehension and facilitates behavior change (Kaihlanen et al., 2022).

Telehealth platforms represent another critical innovation, particularly for populations with limited mobility or geographic barriers. By enabling remote consultations and virtual health education sessions, telehealth reduces the need for

physical travel, making healthcare more accessible for older adults and those in rural areas. Meanwhile, e-learning platforms played a critical role in disseminating evidence-based information about infection prevention, vaccination, and public health measures (Monaghesh & Hajizadeh, 2020; Torres et al., 2021). Older adults with chronic conditions have especially benefited from telehealth interventions, which provide convenient access to healthcare professionals and educational resources, improving self-efficacy and reducing hospitalizations among aging populations reducing (Blount et al., 2023).

E-learning modules also play a significant role: online platforms that deliver tailored educational content have proven effective in addressing knowledge gaps and promoting self-care behaviours. These modules are often designed to cater to specific populations, incorporating multimedia elements like videos, infographics, and interactive quizzes to enhance engagement and comprehension (Kaihlanen et al., 2022).

### **3.2 Limitation of Digital Educational Interventions**

Despite their potential, digital education interventions face numerous barriers that limit their effectiveness and accessibility. The first one is the digital divide, which encompasses disparities in access to technology, internet connectivity, and digital literacy. Socioeconomically disadvantaged populations are disproportionately affected, often lacking the financial means to purchase devices or pay for internet services. Rural areas also face infrastructural challenges, with unreliable connectivity further restricting access (Eruchalu et al., 2021).

Digital literacy is another significant barrier, particularly among older adults who may not be familiar with modern technologies. Complex user interfaces and insufficient training exacerbate these difficulties, leading to frustration and disengagement. Older users often require additional support to navigate digital platforms effectively, highlighting the need for user-friendly designs and targeted training programs (Bertolazzi et al., 2024).

Medical vulnerability further complicates the use of digital tools, particularly among older adults and individuals with disabilities. Age-related declines in cognitive and physical function, coupled with limited experience with technology, often hinder

older adults' ability to navigate digital platforms. Inclusive design is important to address these challenges, recommending features such as large fonts, voice-guided navigation, and compatibility with assistive devices (Bertolazzi et al., 2024). Similarly, individuals with disabilities require specialized accessibility features, such as screen readers, tactile interfaces, or captioned videos, to ensure equitable engagement.

Cultural and linguistic barriers also play a critical role in shaping the effectiveness of digital education. Programs that fail to account for cultural norms, language preferences, or social contexts may alienate their target audiences, reducing engagement and impact. Involving community stakeholders is pivotal in the design process to ensure that digital tools are culturally relevant and resonate with users (Tutt et al., 2022). For instance, multilingual support and culturally adaptive content have been shown to improve vaccination uptake among immigrant communities, demonstrating the value of inclusive approaches (Torres et al., 2021). Programs that fail to account for cultural norms, language differences, or specific community needs often struggle to engage users. Therefore, educational programs aimed at preparing the next generation should provide strategies to overcome these challenges (Szara & Klukow, 2023).

#### **4 Conclusion**

This review has explored the role of digital education interventions in addressing these challenges.

Digital educational interventions represent a transformative opportunity to enhance health equity and empower vulnerable populations. By leveraging technology to deliver tailored, accessible, and scalable educational content, these tools have the potential to bridge critical gaps in healthcare delivery. However, realizing this potential requires addressing persistent barriers such as the digital divide, low digital literacy, and cultural insensitivity.

The integration of hybrid models, investments in digital infrastructure, and the adoption of user-centric designs are essential steps toward creating inclusive and effective interventions. Hybrid educational models, which combine digital tools with in-person support, offer a promising solution to many of these challenges, as scalability and flexibility of digital platforms with the personalized engagement of



face-to-face interactions. They also help build trust and rapport, which are essential for engaging vulnerable populations.

Furthermore, innovations in Artificial Intelligence and adaptive learning systems can enhance the customization and impact of these tools. Policymakers, healthcare providers, and technology developers must collaborate to ensure that digital education interventions are sustainable, culturally competent, and accessible to all. Digital literacy training should be prioritized, with programs tailored to the needs of specific populations. As the digital world continues to evolve, the potential for these interventions to promote health literacy, empower self-care, and improve health outcomes rests immense. With a concerted effort to address existing challenges, digital educational tools can play a pivotal role in shaping a more equitable and informed society. Future efforts should focus on creating inclusive, user-centric digital tools that align with the diverse needs of vulnerable populations. Investments in infrastructure, training, and emerging technologies will further enhance the capacity of digital education to meet the challenges of modern healthcare. As digital tools continue to evolve, their potential to promote health equity and improve patient outcomes will only grow, fostering a healthier and more informed society.

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# POUČEVANJE HIGIENE ROK Z UPORABO NAVIDEZNE RESNIČNOSTI

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Higiena rok je eden ključnih ukrepov za preprečevanje bolnišničnih okužb in s tem zagotavljanja kakovosti v zdravstvenih organizacijah. Poučevanje zdravstvenih delavcev in stalno izobraževanje sta zato nujno potrebna, za kar so na voljo tudi novejša metode kot je navidezna resničnost, ki omogoča realistično izkušnjo z uporabo naglavnega zaslona. V okviru projekta INOTEH-ZDRAV smo s 360-stopinjsko kamero posneli postopek umivanja in razkuževanja rok v okolju bolniške sobe na podlagi pripravljenega scenarija, po principu petih trenutkov za higieno rok Svetovne zdravstvene organizacije. Posnetek smo obdelali s programoma Insta360 Studio in Adobe Premiere Pro, s pomočjo programske platforme Unity pa vključili interakcije s katerimi so uporabniki svoje znanje sproti preverjali. Na ta način omogočamo vključitev modernih tehnologij v izobraževanje in hkrati zagotavljamo ustrezne učne vsebine tudi z uporabo navidezne resničnosti.

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# TEACHING HAND HYGIENE USING VIRTUAL REALITY

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Hand hygiene is one of the key measures to prevent hospital-acquired infections and thus ensure quality in healthcare organisations. Healthcare worker education and continuous training are therefore essential, and newer methods such as virtual reality, which allows a realistic experience using a heads-up display, are available. The InTECHiE project used a 360-degree camera to record the process of handwashing and hand disinfection in a hospital room environment, based on a prepared scenario, following the World Health Organisation's Five Moments for Hand Hygiene. The footage was processed using Insta360 Studio and Adobe Premiere Pro, and the Unity software platform was used to include interactions that allowed users to check their knowledge on the fly. This way, we are able to integrate modern technologies into education, while also providing relevant learning content through the use of virtual reality.



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## 1 Uvod

Higiena rok je ena najučinkovitejših strategij za preprečevanje okužb v zdravstvenih ustanovah in eden od pokazateljev kakovosti oskrbe (Mouajou, et al., 2022). Pri tem je potrebno upoštevanje veljavnih smernic, med katerimi je posebej pomembnih pet trenutkov za higieno rok Svetovne zdravstvene organizacije. Ti narekujejo higieno rok pred stikom s pacientom, pred čistim oz. aseptičnim opraviлом, po možnem stiku s telesnimi tekočinami oz. izločki, po stiku s pacientom ter po stiku s pacientovo okolico (WHO, 2021). Poleg omenjenega je ključno upoštevanje pravilnega postopka oz. tehnike umivanja in razkuževanja rok, ki bi ga morali dosledno upoštevati vsi zdravstveni delavci (Hillier, 2020). Izobraževanja ter redni programi usposabljanj so nujni in že široko vpeljani v učne načrte zdravstvenih delavcev, vendar je pri njihovem načrtovanju pozornost potrebno namenjati raznolikosti in doseganju strokovne usposobljenosti (Seidel-Fischer, et al., 2024). Iz obstoječih raziskav lahko ugotovimo, da praktične simulacije, videoposnetki in drugi avdiovizualni mediji izboljšajo skladnost higiene rok pri negovalnem osebju (Martos-Cabrera, et al., 2019). Eden od modernejših načinov izobraževanja je usposabljanje z uporabo navidezne resničnosti. Navidezna resničnost z uporabo naglavnega zaslona in sodobne grafike omogoča, da udeleženci takšnih izobraževanj preizkusijo zelo realističen simulacijski svet (Al-Ansi, et al., 2023). Izobraževanje higiene rok z navidezno resničnostjo je torej zanimiv in sodoben pristop, ki lahko dopolni običajna predavanja. Raziskave kažejo, da je takšen način učenja med udeleženci običajno dobro sprejet, povečuje njihovo zadovoljstvo in da bi takšen način izobraževanja izbrali tudi v prihodnje (Eichel, et al., 2022; Gasteiger, et al., 2023). V okviru pilotnega projekta »Inovativne učne tehnologije za zdravje ljudi in okolja« (INOTEH-ZDRAV), ki se izvaja za namen prenove visokega šolstva za zelen in odporen prehod, tudi na Fakulteti za zdravstvene vede uporabljamo navidezno resničnost v sklopu poučevanja higiene rok. V ta namen smo posneli 360 stopinjska videoposnetka umivanja in razkuževanja rok, za uporabo v očalih za navidezno resničnost, ki temeljita na strokovnih smernicah prej opisanih petih trenutkov za higieno rok Svetovne zdravstvene organizacije. Posnetka higiene rok smo ustrezno tehnično uredili in vanju vključili številne interakcije, s katerimi udeleženci izobraževanj sproti preverjajo in na inovativen način utrjujejo že obstoječe znanje. Na ta način v izobraževalni proces vključujemo moderne, digitalne in sodobne tehnologije, ki popestrijo in obogatijo tradicionalne metode poučevanja. V nadaljevanju bomo tako podrobneje predstavili proces ustvarjanja 360 stopinjskega

videoposnetka higijene rok za uporabo v očalih za navidezno resničnost, obdelavo videoposnetka in vključitev interakcij.

## 2 Materiali in metode - načrtovanje in snemanje 360 stopinjskega videoposnetka

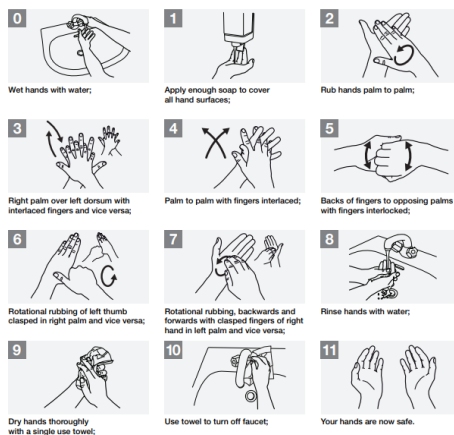
### 2.1 Priprava scenarija

Za videoposnetka umivanja in razkuževanja rok smo si najprej pripravili scenarij. Ta je vseboval pravilen postopek umivanja in razkuževanja rok po posameznih korakih in ravnanje igralca v videoposnetku. Načrtovali smo postavitev kamere v prostoru, pri čemer smo pozornost usmerili na ustrezno osvetlitev prostora. Pravilen postopek umivanja in razkuževanja rok je temeljil na smernicah Svetovne zdravstvene organizacije, kot je prikazano na Sliki 1 in Sliki 2.

## How to Handwash?

WASH HANDS WHEN VISIBLY SOILED! OTHERWISE, USE HANDRUB

**Duration of the entire procedure: 40-60 seconds**



Slika 1: Pravilen postopek umivanja rok

Vir: WHO, 2009a



# How to Handrub?

RUB HANDS FOR HAND HYGIENE! WASH HANDS WHEN VISIBLY SOILED

⌚ Duration of the entire procedure: 20-30 seconds



Slika 2: Pravilen postopek razkuževanja rok

Vir: WHO, 2009b

## 2.2 Snemanje 360 stopinjskih posnetkov



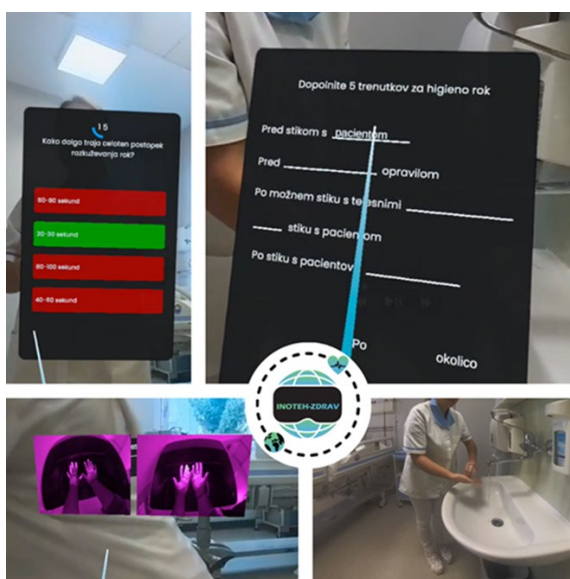
Slika 3: Utrinki iz snemanja

Vir: Lasten

Snemanje je poteklo v Univerzitetnem kliničnem centru Maribor, v eni od bolniških sob, pod nadzorom strokovnjakov iz Enote za obvladovanje bolnišničnih okužb. Utrinki iz snemanja so vidni na Sliki 3. Uporabili smo kamero (Insta360 X3) ter aplikacijo Insta360 Studio.

### 2.3 Obdelava videoposnetka in vključitev interakcij

Po uspešno zaključenem snemanju smo 360 stopinjske videoposnetke s programom Insta360 Studio pogledali na osebem računalniku. Na sekundo natančno smo načrtovali izrez posameznega dela videoposnetka, ki smo jih nato združili v celoto s pomočjo programa Adobe Premiere Pro. Celoten videoposnetek smo ponovno pogledali in prav tako na sekundo natančno pripravili predlog vključitve različnih interakcij. Interakcije smo v videoposnetek vključili z uporabo programske platforme Unity. Vključene interakcije so vidne na Sliki 4. Ko sta bila videoposnetka pripravljena, smo ju predali v strokovni pregled sodelujočim strokovnjakom iz Enote za obvladovanje bolnišničnih okužb, tako da sta videoposnetka brezhlebna tudi iz strokovne plati. Udeleženci izobraževanj si tako pripravljena videoposnetka lahko ogledajo s pomočjo naglavnega zaslona v navidezni resničnosti.




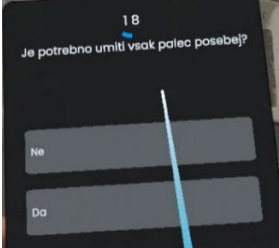
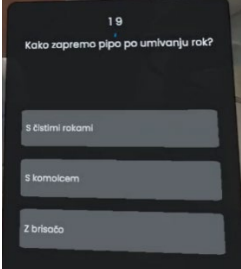
Slika 4: Interakcije v videoposnetku

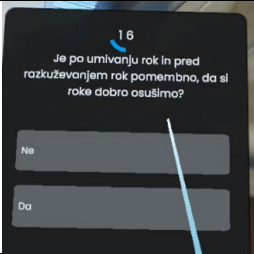

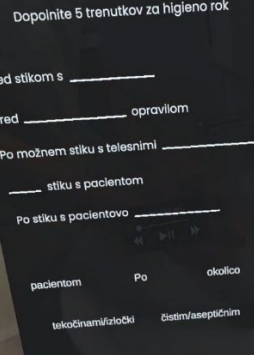
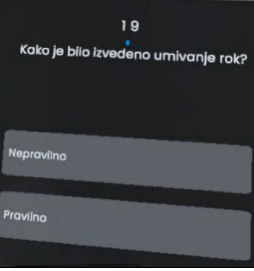
Vir: Lasten

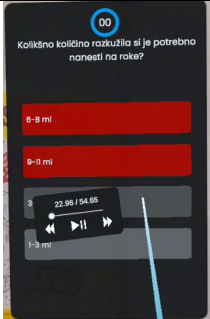
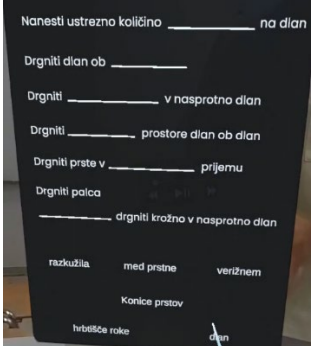
### 3 Rezultati in diskusija

Kot omenjeno smo v 360 stopinjske videoposnetke vključili številne interakcije, ki so prikazane v Tabeli 1. Skupno je bilo v oba 360 stopinjska videoposnetka vključenih 9 interakcij. Videoposnetka smo zasnovali tako, da mora uporabnik za nadaljevanje ogleda označiti vse pravilne odgovore oz. naloge pravilno rešiti. Na ta način spodbujamo sprotno učenje in preverjanje znanja.

Tabela 1: Vključene interakcije

Interakcija	Vsebina interakcije	Interakcija v 360 stopinjskem videoposnetku (posnetek zaslona)
Izbira pravilnega odgovora	<p>Kako dolgo traja celoten postopek umivanja rok?</p> <ul style="list-style-type: none"> <li>– 70-90 sekund</li> <li>– 15-30 sekund</li> <li>– 100-120 sekund</li> <li>– <b>40-60 sekund</b></li> </ul>	
Izbira pravilnega odgovora	<p>Je potrebno umiti vsak palec posebej?</p> <ul style="list-style-type: none"> <li>– Ne</li> <li>– <b>Da</b></li> </ul>	
Izbira pravilnega odgovora	<p>Kako zapremo pipo po umivanju rok?</p> <ul style="list-style-type: none"> <li>– S čistimi rokami</li> <li>– <b>S komolcem</b></li> <li>– Z brisačo</li> </ul>	

Interakcija	Vsebina interakcije	Interakcija v 360 stopinjskem videoposnetku (posnetek zaslona)
Izbira pravilnega odgovora	<p>Je po umivanju rok in pred razkuževanjem rok pomembno, da si roke dobro osušimo?</p> <ul style="list-style-type: none"> <li>- Ne</li> <li>- <b>Da</b></li> </ul>	
Izbira pravilnega odgovora	<p>Kako dolgo traja celoten postopek razkuževanja rok?</p> <ul style="list-style-type: none"> <li>- 60-80 sekund</li> <li>- <b>20-30 sekund</b></li> <li>- 80-100 sekund</li> <li>- 40-60 sekund</li> </ul>	
Dopolnjevanje besednih zvez (drag and drop)	<p>Dopolnite 5 trenutkov za higieno rok:</p> <p>Pred stikom s <b>pacientom</b></p> <p>Pred <b>čistim/aseptičnim</b> opravilom</p> <p>Po možnem stiku s telesnimi <b>tekočinami/izločki</b></p> <p>Po stiku s pacientom <b>okolico</b></p> <p>Po stiku s pacientovo <b>okolico</b></p>	
Izbira pravilnega odgovora	<p>Kako je bilo izvedeno umivanje rok?</p> <ul style="list-style-type: none"> <li>- <b>Neppravilno</b></li> <li>- Pravilno</li> </ul>	

Interakcija	Vsebina interakcije	Interakcija v 360 stopinjskem videoposnetku (posnetek zasлона)
Izbira pravičnega odgovora	Kolikšno količino razkužila si je potrebno nanesti na roke? <ul style="list-style-type: none"> <li>– 6-8 ml</li> <li>– 9-11 ml</li> <li>– 3-5 ml</li> <li>– 1-3 ml</li> </ul>	
Dopolnjevanje besednih zvez (drag and drop)	Nanesti ustrezno količino razkužila na dlan Drgniti dlan ob dlan Drgniti hrbtišče roke v nasprotno dlan Drgniti med prstne prostore dlan ob dlan Drgniti prste v verižnem prijemu Drgniti palca Konice prstov drgniti krožno v nasprotno dlan	

Vir: Lasten

Poleg virtualne resničnosti se pri poučevanju higiene rok uporabljajo tudi številne druge metode poučevanja. Med njimi so uporaba virtualnih učilnic (Ng & Or, 2020), uporaba avdio vizualnih elektronskih naprav (Boscart et al., 2008), uporaba video izobraževanja (Chen & Chiang, 2007), uporaba principa igrifikacije (Marques et al., 2017), uporaba mobilne tehnologije (Lary et al., 2020), mobilnih aplikacij (Gasteiger, et al., 2021; Muršec, et al., 2024) in virtualne tehnologije (Choi & Noh, 2020). Raziskovalci so se poučevanja higiene rok majhnih otrok med drugim lotili z digitalno intervencijo, ki je vključevala animirana navodila (Graichen, et al., 2024), aplikacijo, ki je temeljila na igri (Arbianingsih, et al., 2018), sicer pa tudi z obogateno resničnostjo (Mather, et al., 2017). Uporaba različnih digitalnih tehnologij je lahko ustrezna dopolnitev že vpeljanih izobraževalnih metod (Fernandes et al., 2024). Pregled mobilnih aplikacij za higieno rok nakazuje, da je njihova kakovost različna, vendar je predvsem pomembno, da se že v času njihove zasnove vpeljuje veljavne smernice in da pri tem sodelujejo strokovnjaki s tega področja (Muršec, et al., 2024), kar velja tudi za pripravo digitalnih učnih gradiv.

### 3 Zaključek

Z uporabo navidezne resničnosti in tudi drugih digitalnih tehnologij lahko izboljšamo higieno rok med zdravstvenimi delavci pa tudi med pacienti in obiskovalci zdravstvenih ustanov. Digitalne tehnologije z interaktivnimi vsebinami lahko izboljšajo znanje glede pravilne higiene rok ter z možnostjo ponavljajočega se učenja prispevajo k zmanjšanemu prenosu bolnišničnih okužb in s tem h kakovosti v zdravstvenih organizacijah. Pri načrtovanju in vpeljavi novih načinov izobraževanja je posebej pomembno, da so ti premišljeno zasnovani na strokovni literaturi in smernicah ter da pri njihovem nastanku sodelujejo strokovnjaki iz specifičnih področij.

#### Zahvala

Ta referat je del projekta Inovativne učne tehnologije za zdravje ljudi in okolja. Projekt sofinancirata Republika Slovenija, Ministrstvo za visoko šolstvo, znanost in inovacije, in Evropska unija – NextGenerationEU. Projekt se izvaja skladno z načrtom v okviru razvojnega področja Pametna, trajnostna in vključujoča rast, komponente Krepitev kompetenc, zlasti digitalnih in tistih, ki jih zahtevajo novi poklici in zeleni prehod (C3 K5), za ukrep investicija F. Izvajanje pilotnih projektov, katerih rezultati bodo podlaga za pripravo izhodišč za reformo visokega šolstva za zelen in odporen prehod v Družbo 5.0: projekt Pilotni projekti za prenovo visokega šolstva za zelen in odporen prehod.

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# THE GENDER PAY GAP IN THE CZECH REPUBLIC

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The paper deals primarily with the issue of the Gender Pay Gap in the Czech economy. The issue of equal pay for workers in both the business and non-business sectors is one of the important priorities of the EU's 2030 strategy. Europe-wide, it can be said that it has been declining in the long term. Our paper, which analyses data on this for the period from 2013 to 2024, reports on the situation and developments over the past twelve years in the Czech Republic. In this article we examine the Gender pay gap and its relation to the education of workers in the following educational categories: elementary, secondary vocational, general secondary, bachelor, master and doctorate (Ph.D.). The second research question is then formulated as follows. Here we have done the analysis for three age categories: under 30, 30-50 and over 50. The data sources for the analysis were the annual database Average Earnings Information System (ISPV), which is prepared for the Ministry of Labour and Social Affairs of the Czech Republic and is updated regularly once a year in the second quarter of the year. Some basic time series analyses were performed in MS Excel using its standard functions. More complex analyses were then performed in Python, in particular in the NumPy and stats models modules. For graphical displays we used MS Excel functions. Our results suggest that the gender pay gap in percentage terms has been decreasing very slowly over the long term.

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gender pay gap by  
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## 1 Introduction

The gender pay gap (GPG) is a long-standing and complex problem that persists across different sectors and countries and exacerbates social injustice.

Despite significant progress in gender equality, GPG continues to manifest itself in many forms, influenced by a complex interplay of factors including discrimination, occupational segregation and different expectations of work and family roles. This pay gap is defined as the difference between the average earnings of men and women, often expressed as a percentage of men's earnings. Despite legislative efforts and increasing awareness of this issue, the gender pay gap still persists, as will be seen in our analyses conducted in the Czech Republic. The GPG is not simply a reflection of differences in education or experience; rather, it is compounded by systemic biases and workplace cultures that undervalue women's contributions (Khoreva, 2011; Bishu and Alkadry, 2016).

Perceptions of the gender pay gap play a significant role in shaping women's work experiences and career trajectories. Khoreva points out that perceived differences can lead to negative psychological outcomes such as lowered self-esteem and increased stress, which can further exacerbate the gap by discouraging women from negotiating salaries or promotions (Khoreva, 2011). Similarly, Dawson discusses how pessimistic expectations among women may contribute to their complacency about unequal pay, making them less likely to seek better opportunities or advocate for fair compensation (Dawson, 2017).

According to a study (Litman et al., 2020), women in the anonymous online labour market earn on average 10.5% less than men, even when factors such as experience, education and other human capital are taken into account.

This study shows that gender pay gaps can arise even in the absence of overt discrimination, job segregation or inflexible working conditions.

Cha and Weeden (2014) argue that the increasing wage returns associated with overwork have prevented the gender pay gap from converging, suggesting that women often face barriers to accessing the same overtime and advancement opportunities as their male counterparts. Further, research by Sasso et al. (2021) shows that while GPG has narrowed in certain sectors, it remains persistent,

particularly in challenging environments such as healthcare, where newly trained male physicians earn significantly more than their female counterparts (Chen et al., 2021).

Other research conducted by the Pew Research Center shows that U.S. women in 2022 will earn an average of 82 cents for every dollar earned by men, a slight improvement over 2002 when it was 80 cents (Kochhar, 2023). This slow progress suggests that despite women's increasing educational attainment and entry into the labour market, structural and individual factors persist that perpetuate this gap.

GPG is the result of a combination of factors, including human capital, work assignment, time flexibility and discrimination. Reducing GPG requires not only legislative measures, but also changes in social and organisational attitudes towards women's pay and employment. The gender pay gap is a multidimensional problem that requires a comprehensive understanding of both its economic and psychological dimensions. (Chen et al., 2021; Lyons and Zhang, 2023; Blevins et al., 2019).

The aim of the paper is to analyse the evolution of the Gender Pay Gap in the Czech economy over the past nine years, i.e., from 2016 to 2024. In our analysis, we focus specifically on the relationship between the evolution of the gender pay gap and the age categories of Czech employees, as well as the relationship between the gender pay gap and the level of education. We summarized these analysed dimensions of the problem in the following two research questions:

- **RQ1: The Gender Pay Gap Decreases with Increasing Education.**
- **RQ2: The Gender Pay Gap Increases or Decreases with the Older Age of the Working Person.**

## **2 Methodology**

For the preparation of this paper, we needed to address two questions from a methodological point of view:

- What data do we process and how did we get it?
- What methods do we use for data analysis and interpretation?

## 2.1 What data do we process and how did we get it?

We have been obtaining data for our research since 2000 from Třexima, a. s., which conducts a regular statistical survey among Czech economic entities called the "Average Earnings Information System" for the needs of the Ministry of Labour and Social Affairs of the Czech Republic. It is based on the annual responses of more than 2,000,000 workers operating in approximately 25,000 economic entities in the Czech Republic and the data are always collected for the second quarter of the respective year (ISPV, 2024).

## 2.2 What methods do we use for data analysis and interpretation?

Basic data analysis and presentation is performed using tools and basic statistical functions for time series analysis in MS Excel. The subsequent data analysis was then performed in Python, especially in the NumPy and statsmodels modules. For the purpose of RQ1, we performed the analysis for the three age categories under 30, 30-50 and over 50. For the analysis to obtain answers for RQ2, we analyse the data according to the following education categories: elementary, secondary vocational, general secondary, bachelor, master and doctorate (Ph.D.).

To calculate the eigenvalue of the gender pay gap, we used the methodology of the "Gender pay gap in unadjusted form" database (Eurostat, 2024). The calculation is based on this methodology:

$$\text{Gender Pay Gap (percentage)} = (\text{Male wages} - \text{Female wages}) / \text{Male wages} \times 100$$

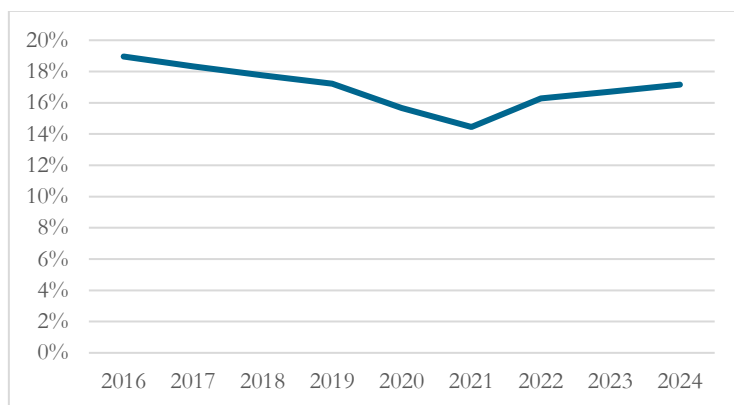
For each year and for calculating the gender pay gap, we used the median wage for each category.

## 3 Results and Discussion

For the evaluation of individual research questions, we processed a set of data from the database "Average Earnings Information System". This is approximately a batch of 2,000,000 data records per year (there are just under 5,000,000 employees in the Czech Republic) from approximately 25,000 economic entities in the Czech

Republic. Thus, for the time period from 2016 to 2024, we have analysed more than 18,000,000 records on wages and salaries of workers in the Czech Republic. As mentioned in the methodology, we used median income to characterize the year, which provides a better view of wages and salaries than the average, which takes into account the higher number of high-income groups in the statistical sample.

The evolution of the gender pay gap in the Czech economy in the period under review is shown in Figure 1.



**Figure 1: Gender Pay Gap in the Czech Economy**

Source: Own, data: (ISPV, 2024)

The graph shows a steady decline in the indicator between 2016-2021. Here we are dealing with a period of relative stability, which was ended by the epidemic of covid 19. On the other hand, the post-epidemic period reversed this positive trend. In particular, the jump between 2021 and 2022 was quite large. The current trend between 2023 and 2024 suggests a slight unravelling of the income gap between the sexes. Overall, however, the gender pay gap in percentage terms has fallen from 19% at the beginning of the period to 17% in 2024.

The Covid tooth in the decline of the gender pay gap made us wonder if there is a link between this variable and inflation, which has increased significantly in 2022 (15.1%) and 2023 (10.7%) compared to previous years when it never exceeded 4%. Therefore, we examined the correlation between these two variables and arrived at a very weak negative correlation with a value of 0.35. Thus, we do not consider this

dependence to be significant. We therefore looked at another possibility, namely the dependence on the unemployment rate, where we obtained a very similar result in the correlation calculation, but with the opposite sign - a correlation coefficient of 0.39 - i.e., a very weak correlation.

### 3.1 The Gender Pay Gap Decreases with Increasing Education

We also analyse the gender pay gap for individual groups of workers according to their level of education. The evolution of the gender pay gap in this area is shown in Figure 2.

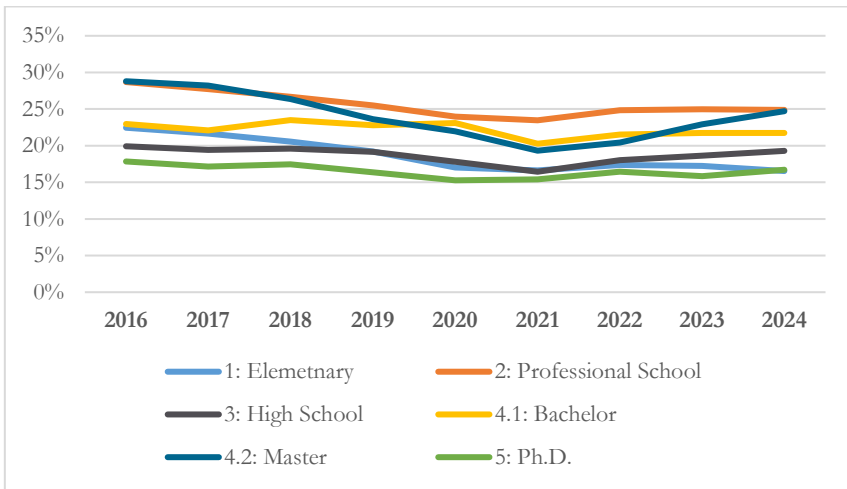


Figure 2: Gender Pay Gap According to Education Category

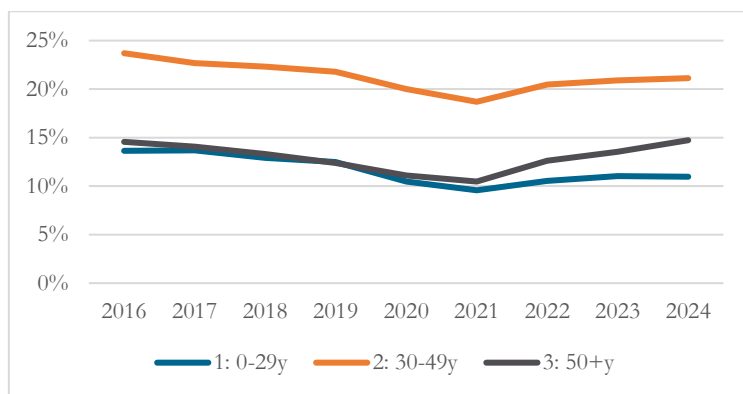
Source: Own, data: (ISPV, 2024)

If we assess the development of the gender pay gap from a long-term perspective, in all categories this indicator has either declined or stagnated. For the elementary education category, the decline is 5 percentage points, reaching a low of 17%. The professional school's education category has the highest gender pay gap, but still fell by three percentage points from 28% to 25%. The High School category has seen a stagnation of the indicator at 20% in the period under review, with a decline until 2021 and a subsequent increase in the period of economic recovery after the covid epidemic.<sup>19</sup> The Bachelor's education category has then seen a decline of one percentage point over the period under review from 23% to 22%. The Master

education category, however, experienced the most dynamic development during the period under review, with the gender pay gap falling by 4 percentage points from 29% percent to 25% in 2024. However, it reached a minimum value of 19% in 2021. The most interesting situation is for doctoral education, where the value of the gender pay gap remained the same over the period under review and where it is de facto the lowest in the whole economy (17%).

### 3.2 The Gender Pay Gap Increases or Decreases with the Older Age of the Working Person

Another dimension that we address in our research is the analysis of the gender pay gap in relation to the age categories of employees. The development of the situation in the Czech Republic in the period under review is shown in Figure 3 below.



**Figure 3: Gender Pay Gap According to Age**

Source: Own, data: (ISPV, 2024)

All observed categories successfully follow the tooth covid model. However, there are large differences in the different age categories studied. A consistently high gender pay gap is shown by the results for the generation 30-49, i.e., de facto for generation Y. This is the best performing generation in the economy. The evolution of the gender pay gap for the other two age categories studied was very similar until the economic recovery after the covid epidemic (10% in 2021). After that, however, the trend for the 50+ category diverges markedly and rises sharply. In contrast, the gender pay gap for the youngest category increases by only one percentage point to

11% in 2024. This development is very positive. Our further analyses, e.g., by occupation, show that the gender pay gap is significantly lower for the youngest generation of employees (Generation Z) than for the other age categories studied. For ICT specialists in 2022, the gender pay gap for this age category was negative (Nedomova, Maryska and Doucek, 2024).

#### 4 Conclusions and Discussion

The analysis provides a comprehensive view of the evolution of the gender pay gap in the Czech economy between 2016 and 2024, across various dimensions. The methodology used, in particular the use of median income as a central indicator, has proved crucial to more accurately capture pay inequalities compared to the average, which tends to be influenced by high income groups.

The long-term trend in GPG suggests a general decline from 19% at the start of the period to 17% in 2024, albeit with significant fluctuations. The stability observed between 2016 and 2020 corresponds to a period of macroeconomic equilibrium, while the COVID-19 pandemic has significantly accelerated this decline in GPG, probably due to structural changes in the labour market, such as shifts between sectors and the expansion of flexible forms of work. After 2021, however, the trend reversed, with the most significant increase in GPG occurring between 2021 and 2022, corresponding to the period of economic recovery after the pandemic. The dependence of GPG on macroeconomic factors such as inflation or unemployment was found to be weak (correlations of -0.35 and 0.39), suggesting the need to look at other possible factors influencing this trend.

A key factor influencing GPG is education. Higher levels of education are generally associated with lower GPG, with the largest decline observed for workers with a master's degree, where GPG fell from 29% to 25%. Interestingly, workers with a doctorate consistently have the lowest GPG (17%) across the economy, suggesting that higher qualifications may contribute to greater pay equity. On the other hand, the stagnation of GPG in some categories, such as secondary education, highlights the need for a deeper examination of the barriers that prevent a more significant reduction in inequalities in these groups.



Analysis of GPG by age reveals generational differences. The highest GPG persists among workers aged 30-49, i.e., Generation Y, which is a key executive component of the labour market. In contrast, younger workers (Generation Z) have a significantly lower GPG, which is a positive trend. This trend is supported by data from specific occupations such as ICT specialists, where even a negative GPG value was recorded for the younger generation in 2022. This suggests the potential for greater pay equity among the youngest working generation.

Although only weak correlations have been found between GPG and macroeconomic indicators, broader labour market dynamics such as sectoral shifts or occupational segregation are likely to play a more significant role. Positive trends among young workers and in promising sectors such as ICT may reflect changing attitudes towards pay equity.

Overall, the results underline the importance of targeted policies to address persistent inequalities. Prioritising interventions for specific groups, such as middle generation workers or high GPG sectors, together with promoting higher education and promoting equal working conditions, is key. Further research should focus on the impact of legislative measures, sectoral trends and other factors such as caring responsibilities or cultural norms to better understand and address the complex issue of GPG in the Czech labour market.

## **5 Limits and Open Issues**

The topic of the Gender Pay Gap is one of the "evergreen" topics in economics, especially in Western countries. Although our research analyses a time series with a relatively large number of records, there are some limits to be aware of when looking deeper into the data.

### **5.1 Research Limits**

The basic limitations of this paper are that we evaluate the gender pay gap data in time series for the second quarter of each year. This means that minimum wage and salary compensation (vacation, etc.) is included in workers' wages and salaries in this period, and also that workers' minimum compensation is included in this period

compared to other parts of the year. Thus, the data we have analysed are closest to the basic wage and salary rates.

Other limitations are the potential for cross-analyses across multiple dimensions of research simultaneously. In such cases, we very often end up with a situation where we do not have a sufficiently representative sample of data to analyse the relationship between some variables. Therefore, we cannot perform this analysis at an acceptable level of significance.

Some distortion of the research is also caused by the fact that economic entities are registered according to the place of registration of the company, not according to the actual place of operation. Here, it is mainly the branches of large companies that are included in the data collection at headquarters. For the purposes of this article, this limit does not apply.

## **5.2 Open Issues**

To extend our research on the gender pay gap, there is a wide range of research directions that could contribute to a deeper understanding of this issue. One key area is a sectoral gap analysis that would focus on specific sectors with high or low GPG, such as health, education or ICT. It would also be important to distinguish between the private and public sectors, where there may be significant differences in wage policies.

It is also open to explore the impact of working time and flexible forms of work. Factors such as part-time, teleworking or flexible working hours can significantly influence the gender pay gap, and studying them in detail could reveal new links. A regional analysis would in turn allow a comparison of GPG between different regions of the Czech Republic, taking into account different levels of economic development, regional policies or unemployment rates.

Further extension of the research could include long-term trends and exploring the impact of legislative measures such as mandatory reporting of gender pay gaps or the introduction of quotas for senior positions. At the same time, it would be useful to compare the development of GPG in the Czech Republic with international

trends, especially within the European Union, where different cultural, economic and legislative factors may play a significant role.

In the context of technological change, it would be useful to examine how digitisation and automation are affecting the gender pay gap, for example through the emergence of new occupations or changes in labour requirements.

Finally, it would be interesting to focus on the experiences and attitudes of employers. Qualitative research could reveal how organisations perceive the issue of GPG, what strategies they apply to reduce it and what barriers they see in these measures. All these lines of research could contribute to a deeper understanding of the causes of persistent inequalities and to the formulation of effective policies and measures to address them.

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# IZZIVI IN PRILOŽNOSTI NASLEDSTVA V DRUŽINSKIH PODJETJIH: SLOVENSKI KONTEKST IN PRAKTIČNE REŠITVE

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Družinska podjetja so ključni del gospodarstva, vendar se soočajo s posebnimi izzivi, zlasti pri prenosu nasledstva. Raziskave kažejo, da le 30 % podjetij preživi prehod na drugo generacijo, zgolj 3 % pa na tretjo. Nasledstvo vključuje prenos lastništva in upravljanja, proces pa je zapleten zaradi vpliva družinskih odnosov, čustvenih vprašanj ter pomanjkanja pripravljenosti. V Sloveniji, kjer je večina družinskih podjetij nastala v začetku devetdesetih let, se ustanovitelji podjetij približujejo upokojitvi. Ta trenutek predstavlja kritično obdobje, saj je njihov odhod pogosto povezan z nepredvidljivimi težavami. Uspešen prenos zahteva skrbno načrtovanje, vključevanje družinskih članov in razumevanje ključnih dejavnikov, kot so družinska struktura, ambicije naslednikov ter pravna in finančna vprašanja. V prispevku predstavljamo pregled družinskega podjetništva v Sloveniji in učinkovitost prenosa nasledstva, tudi na primeru družinskega podjetja Dines, d. o. o. V diskusiji podamo rešitve za izboljšanje tega procesa v družinskih podjetjih.

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# CHALLENGES AND OPPORTUNITIES OF SUCCESSION IN FAMILY BUSINESSES: SLOVENIAN CONTEXT AND PRACTICAL SOLUTIONS

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entrepreneurship

Family businesses are a key part of the economy, but they face specific challenges, especially when it comes to succession. Research shows that only 30% of businesses survive the transition to the second generation, and only 3% to the third. Succession involves the transfer of ownership and management, and the process is complicated by the influence of family relationships, emotional issues, and lack of preparedness. In Slovenia, where most family businesses were established in the early 1990s, company founders are approaching retirement. This moment represents a critical period, as their departure is often associated with unpredictable problems. A successful transfer requires careful planning, the involvement of family members, and an understanding of key factors such as the family structure, the ambitions of the successors, and legal and financial issues. In this paper, we present an overview of family entrepreneurship in Slovenia and the effectiveness of succession transfer, also using the example of the family business Dines d.o.o. In the discussion, we provide solutions for improving this process in family businesses.



## 1 Uvod

Družinska podjetja so ključni del svetovnega gospodarstva, saj ustvarjajo delovna mesta, spodbujajo inovacije in prispevajo h gospodarski stabilnosti. Več kot 80 % podjetij na svetu je v družinski lasti (EY Slovenia, 2022). Kljub njihovem pomenu za gospodarstvo kot celoto pa se družinska podjetja soočajo z edinstvenimi izzivi, zlasti pri prenosu nasledstva, ki vključuje prehod lastništva in upravljanja na naslednjo generacijo. Omenjeni izzivi so pogosto povezani ravno z zapletenimi družinskimi odnosi, pomanjkanjem pripravljenosti in odsotnostjo skrbno načrtovanih strategij prenosa podjetja na naslednjo generacijo oz. generacije (Howorth in Robinson, 2021). Raziskave kažejo, da le 30 % družinskih podjetij preživi prehod na drugo generacijo, zgolj 3 % pa uspešno nadaljujejo poslovanje s tretjo generacijo (Rane et al., 2023; Djurić, 2021).

V Sloveniji, kjer je večina družinskih podjetij nastala v začetku 90. let, se ustanovitelji zdaj približujejo upokojitvi, kar predstavlja kritično obdobje za slovenska družinska podjetja. Glede na poročilo GEM (Širec, Tominc, Bradač Hojnik, Rus in Crnogaj, 2023) kar 29,8 % zgodnjih podjetnikov v Sloveniji opredeljuje njihov motiv za podjetništvo z željo po nadaljevanju družinskega podjetja oz. tradicije. Nepripravljenost na prenos lastništva in upravljanja pogosto vodi do težav, ki lahko ogrozijo dolgoročno uspešnost teh podjetij. Na to lahko vpliva tudi neusklajenost med pričakovanji staršev in otrok glede karijerne izbire (Civić in Marič, 2023). Proces prenosa nasledstva v družinskih podjetjih še dodatno otežujejo kompleksni pravni in finančni vidiki ter pomanjkanje ustreznih veščin ter različna pričakovanja družinskih članov (Gavrić in Braje, 2024; Klaczak, 2023).

V prispevku se osredotočamo na družinsko podjetništvo v Sloveniji in na proučevanje učinkovitosti prenosa nasledstva. Skozi kritični pregled sekundarnih virov literature bomo izpostavili različne možnosti in podali predloge, vse z namenom osvestiti deležnike v družinskih podjetjih o pomenu skrbno načrtovanega prenosa nasledstva za dolgoročno stabilnost in uspešnost družinskega podjetja. Predstavili bomo tudi primer družinskega podjetja Dines, d. o. o.

## 2 Pregled literature

Družinsko podjetje je podjetje, ki ga ustanovijo in vodijo člani ene družine (Stoyanovich in Marič, 2024). V takem podjetju družina pomembno vpliva na upravljanje, odločanje in odnose. Družinska podjetja predstavljajo osrednji del gospodarstva, saj ustvarjajo delovna mesta, spodbujajo inovacije in prispevajo h gospodarskemu razvoju (Rane et al., 2023; Klaczak, 2023). Družinska podjetja imajo posebnosti v organizacijski strukturi, kulturi in odločanju v primerjavi z drugimi podjetji (Stoyanovich in Marič, 2024). Temeljijo namreč na prepletu družinskih in poslovnih odnosov, kar jim zagotavlja edinstvene prednosti, kot so dolgoročna vizija, večja zvestoba zaposlenih in trdna družbena odgovornost (Djurić, 2021). Hkrati pa lahko ravno ta prepletenost povzroča težave, zlasti pri prenosu nasledstva, saj prihaja do razkoraka med osebnimi in poslovnimi interesi (Carmeli in Dothan, 2023). V sliki 1 predstavljamo prepletenost treh neodvisnih, a prepletenih podsistemov v družinskih podjetjih.



**Slika 1: Model treh krogov**

Vir: Walsh, 2015; v Božič, 2019

Prenos nasledstva v družinskih podjetjih vključuje prehod lastništva in upravljanja na naslednjo generacijo. Ključnega pomena je za dolgoročno preživetje družinskega podjetja, vendar raziskave kažejo, da uspešen prenos nikakor ni sam po sebi zagotovljen. Po podatkih namreč le 30 % družinskih podjetij preživi prehod na drugo generacijo, medtem ko zgolj 3 % nadaljujejo poslovanje s tretjo generacijo (Wu et al., 2024). Po podatkih EY Slovenija (2022) pa jih celo 13 % preživi tretjo generacijo, vendar pa je tu treba upoštevati, da je vse več družinskih podjetij tudi uporabnikov storitev svetovalnih podjetij. Tudi države so prepoznale pomembnost te tematike in skozi agencije nudijo ustrezno podporo (EY Slovenia, 2022).



Ravno pomanjkanje načrtovanja je eden glavnih razlogov za neuspeh prenosa nasledstva (Howorth in Robinson, 2021). Dosedanje raziskave in izkušnje iz okolja opozarjajo na vpliv družinskih konfliktov, različnih ambicij naslednikov ter pomanjkanje znanj in izkušenj, kar zbrano vodi v težave pri prenosu poslovanja (Gavrić in Braje, 2024). Poleg tega je sam proces prenosa zapleten zaradi pravnih in finančnih vprašanj, ki zahtevajo celovito razumevanje in pripravo (Allen in French, 2023) in pogosto tudi vključitev zunanjih strokovnjakov, čemur pa se v družinskih podjetjih pogosto izogibajo zaradi nezaupanja v osebe, ki niso hkrati tudi člani družine.

Uspešen prenos nasledstva temelji na več ključnih dejavnikih, kot so: jasna komunikacija, vključenost naslednikov v proces odločanja in načrtovanje s poudarkom na dolgoročni stabilnosti podjetja (LeCounte, 2022). Vključevanje naslednikov v upravljanje podjetja pred prenosom lastništva omogoča postopno pridobivanje znanj in izkušenj, potrebnih za uspešno vodenje podjetja (Bargoni et al., 2023), pri čemer se kot glavna težava pojavi že to, da je večinoma več kot en naslednik – od druge generacije naprej pa jih je še več. Pomembno je tudi vzpostavljane formalnih struktur, kot so upravni odbori ali svetovalna telesa, ki pomagajo zmanjšati vpliv družinskih čustev na poslovne odločitve (Howorth in Robinson, 2021).

Večina družinskih podjetij v Sloveniji je nastala po letu 1991, kar pomeni, da so njihovi ustanovitelji zdaj v fazi, ko se soočajo z vprašanjem prenosa nasledstva (Djurić, 2021). Ta podjetja imajo specifične značilnosti, ki izhajajo iz tranzicijskega gospodarstva, v katerem so bila ustanovljena, in družbenega okolja, ki poudarja družinske vrednote (Klaczak, 2023). Raziskave opozarjajo, da slovenska družinska podjetja pogosto ne vključujejo naslednikov dovolj zgodaj v poslovne procese, kar zmanjšuje njihovo pripravljenost za prevzem vodenja (Abdukarimovich et al., 2023). To je lahko posledica več dejavnikov, med katerimi so lahko tudi zaščita otrok od prezgodnje odgovornosti in mišljenje »naj uživa v mladosti in brezskrbnosti« ali pa izrazita samovolja staršev, zaradi česar imajo otroci odpor do dela v družinskem podjetju.

Ugotavljamo, da so inovacije in digitalna preobrazba ključnega pomena za trajnostni razvoj družinskih podjetij (EY Slovenia, 2022), te pa se v primeru družinskih podjetij pojavijo kot izzivi, saj so bolj tradicionalno naravnana in se držijo t. i. preverjenih

poti do uspeha. Vpeljava novih tehnologij in prilagajanje digitalnim trendom sicer omogočata povečanje konkurenčnosti ter olajšujeta prehod na nove generacije vodij (Sultana in Turkina, 2023), vendar pa je to odvisno od tega, ali so predstavniki starejših generacij sploh seznanjeni oz. usposobljeni za delo s temi tehnologijami. Že sama digitalizacija namreč hkrati omogoča tako boljše upravljanje kot tudi spremljanje poslovnih procesov, kar zmanjšuje tveganja, povezana s prenosom nasledstva (Rane et al., 2023).

Na podlagi opravljenega pregleda literature torej sklepamo, da je uspešen prenos nasledstva ključnega pomena za dolgoročno preživetje družinskih podjetij. To dosežemo skozi jasno strategijo, zgodnje vključevanje naslednikov ter spodbujanje inovacij in digitalne transformacije. Vse naštetu so bistveni elementi za obvladovanje izzivov, povezanih s procesom nasledstva v družinskih podjetjih. V slovenskem kontekstu je potreben še poseben poudarek na prilagoditvah, ki upoštevajo specifične značilnosti lokalnega okolja in zgodovinskih dejavnikov.

### 3 Primer podjetja Dines, d. o. o.

Podjetje Dines, d. o. o., je družinsko podjetje z bogato zgodovino, ki se ukvarja s hišnim prezračevanjem ter prodajo in montažo toplotnih črpalk. Ustanovljeno je bilo leta 1989 in je skozi leta doživelo več sprememb, vključno s prestrukturiranjem, ki mu je omogočilo rast in konkurenčno prednost. Ponujajo širok nabor storitev in izdelkov ter delujejo v skladu z evropskimi standardi. Njihov poslovni model temelji na prodaji izdelkov, servisiranju, sodelovanju s partnerji in inovativnem pristopu k trgu. Ključni partnerji vključujejo dobavitelje, gradbena podjetja, industrijske naročnike in javne institucije. Finančno je podjetje stabilno, nizko kreditno izpostavljeno in močno likvidno, kar mu omogoča konkurenčno poslovanje. V prihodnosti načrtujejo širitev na zahodne evropske trge. Glavne konkurenčne prednosti podjetja so: širok cenovni spekter izdelkov, usmerjenost h kakovosti in odlična poprodajna servisna podpora.

V podjetju Dines, d. o. o., se ravno soočajo z izzivi nasledstva v družinskem podjetju. Oče in mama še vedno držita vajeti nad poslovanjem podjetja, vendar pa je sin g. Domen Deu praktično že prevzel vodenje podjetja Dines, d. o. o. Na to se je že dlje časa pripravljaval skozi svoje aktivno delo v družinskem podjetju, ki je postalo po zaključku študija polna zaposlitev in njegova popolna odgovornost. Poleg sina

imata še hči, ki pa trenutno ni zaposlena v družinskem podjetju in kariero gradi izven družinskega podjetja.

V podjetju Dines, d. o. o., torej že lahko prepoznamo prenos vodenja na naslednjo generacijo, medtem ko se o prenosu lastništva še ne pogovarjajo oz. ta tema še ni aktualna. Tudi tudi v drugih družinskih podjetjih v prehodu iz prve na drugo generacijo družine ni posebnih težav, saj starši večinoma nasledstvo v lastništvu v enakem deležu delijo med otroke in so tudi še naprej, čeprav iz ozadja, prisotni ter vplivni pri delovanju oz. vodenju družinskega podjetja. Pri družinskem podjetju Dines, d. o. o., bi posebej izpostavili močno povezanost družine in dobro komunikacijo med družinskimi člani.

## **4 Diskusija**

Prenos lastništva in upravljanja družinskega podjetja na naslednjo generacijo je eden najkompleksnejših procesov, s katerimi se družinska podjetja soočajo (Howorth in Robinson, 2021). Glavni izzivi izhajajo iz prepletanja poslovnih in družinskih odnosov, pomanjkanja komunikacije ter nepreglednih vlog družinskih članov v podjetju (Gavrić in Braje, 2024). Kot pogosto oviro zasledimo tudi odsotnost formalnega načrta prenosa, kar povečuje tveganje za konflikte med družinskimi člani (Bargoni et al., 2023).

Težave pogosto nastanejo pri prenosu na naslednje generacije, kjer pa poleg lastniškega deleža v družinskem podjetju pride tudi do vprašanj o vodenju in izbiri naslednika v vodenju podjetja, saj se število naslednikov lahko z vsako naslednjo generacijo poveča. Odlaganje formalnega načrta prenosa je posledica neprimerne odlašanja starejših generacij, kar se kasneje pokaže kot velika napaka. Nasledstva v družinskih podjetjih ravno zaradi tega ne obravnavamo kot dogodek, ampak kot proces (Božič, 2019). Pomanjkanje pripravljenosti naslednikov pogosto izhaja iz njihovega omejenega sodelovanja v poslovnih procesih ali nezadostne želje po prevzemu vodstvenih vlog (Allen in French, 2023).

Čustvena vprašanja prav tako dodatno otežujejo prenos nasledstva. Napačno je pričakovanje, da vsi zasledujejo samo interes podjetja in postavljajo svoje interese na stran. Konflikti, povezani z različnimi pričakovanji glede prihodnosti podjetja, ambicije naslednikov in občutek izgube nadzora s strani ustanoviteljev, lahko povzročijo napetosti znotraj družine (Carmeli in Dothan, 2023). Prav tako pravna in

finančna vprašanja, kot so davčne obveznosti in dedovanje, zahtevajo ustrezno pravno in finančno svetovanje (Abdukarimovich et al., 2023).

Kljub izzivom pa prenos nasledstva odpira številne priložnosti za družinska podjetja. Zgodnje vključevanje naslednikov v poslovne procese in postopno predajanje odgovornosti omogoča nemoten prenos znanj in izkušenj (Howorth in Robinson, 2021). Prav tako postavitve jasne strategije prenosa, ki vključuje vse ključne deležnike, prispeva k zmanjšanju konfliktov in povečanju stabilnosti podjetja (LeCounte, 2022).

Inovacije, ki se jim v družinskih podjetjih zaradi tradicionalnega in netvegane pristopa k poslovanju pogosto izogibajo, so prav tako pomembna priložnost za rast in razvoj družinskih podjetij. Raziskave kažejo, da podjetja, ki uspešno vključijo naslednjo generacijo v razvoj novih produktov in storitev, dosegajo višjo stopnjo konkurenčnosti na trgu (Bargoni et al., 2023). Spodbujanje inovacij v povezavi z ohranjanjem družinskih vrednot lahko družinskim podjetjem zagotovi dolgoročno stabilnost (Abdukarimovich et al., 2023). Pogosto pride do konflikta med predstavniki starejše in novejšje generacije glede vpeljave novih trendov v družinska podjetja, saj so predstavniki starejših generacij pogosto bolj zadržani, medtem ko so predstavniki mlajših generacij pogosto preveč zagreti – prava pot je neka uravnotežena sredina s tehtnim premislekom in mogoče poskusno vpeljavo.

Vzpostavitev formalnih struktur, kot so upravni odbori in svetovalna telesa, omogoča objektivno odločanje in zmanjšuje vpliv družinskih čustev na poslovanje (Howorth in Robinson, 2021), kar je še posebej pomembno pri večjih in starejših družinskih podjetjih z večjim številom deležnikov. Pogosto se ustanovljajo družinski skladi, ki bdijo nad družinskim premoženjem, ki zajema tudi družinsko podjetje oz. podjetja, ko se močno razvije in diverzificirajo dejavnosti. Poleg tega je ključnega pomena razvoj trajnostnih strategij, ki upoštevajo družinske vrednote in omogočajo dolgoročno rast (Carmeli in Dothan, 2023) na ravni celotnega poslovanja – tu se še posebej pokaže močna prepletenost podjetja in družine, družinskih vrednot in poslovnih vrednot.

V Sloveniji je spodbujanje sodelovanja med generacijami ter krepitev inovacij in digitalizacije ključnega pomena za uspešno premagovanje izzivov prenosa nasledstva. S tem se družinskim podjetjem omogoča, da ohranijo svojo pomembno

vlogo v gospodarskem ekosistemu in prispevajo k trajnostnemu razvoju (Klaczak, 2023).

## **5 Zaključek**

Ugotovili smo, da imajo družinska podjetja pomembno vlogo pri gospodarskem razvoju, a se soočajo s številnimi izzivi, zlasti pri prenosu nasledstva. Kljub njihovemu prispevku pa ostaja prenos nasledstva eden ključnih izzivov za dolgoročno stabilnost in uspešnost teh podjetij. Raziskave kažejo, da le majhen delež družinskih podjetij preživi prehod na drugo generacijo, še manj pa na tretjo, kar poudarja potrebo po skrbnem načrtovanju in izvedbi prenosa (Howorth in Robinson, 2021; Wu et al., 2024). Kot glavne dejavnike, ki vplivajo na uspešnost prenosa, smo identificirali kompleksne družinske odnose, pomanjkanje pripravljenosti naslednikov ter pravne in finančne izzive (Howorth in Robinson, 2021). Predstavili smo tudi primer podjetja Dines, d. o. o.

Ugotovili smo, da številna podjetja nimajo ustreznega načrtovanega procesa prenosa, kar lahko vodi do nestabilnosti in celo propada podjetja (Klaczak, 2023) zaradi pomanjkanja pripravljenosti naslednikov in zapletenosti družinskih odnosov. Predstavniki starejše generacije v družinskih podjetjih se morajo z mlajšimi poglobljeno pogovarjati in jih poskušati razumeti. Ravno pomanjkanje podpore lahko negativno vpliva na razvoj mlajše generacije (Civić in Marič, 2023). Kljub tem izzivom proces prenosa nasledstva odpira tudi pomembne priložnosti. Zgodnje vključevanje naslednikov, uporaba digitalnih orodij in spodbujanje inovacij so ključni elementi, ki omogočajo dolgoročno stabilnost in konkurenčnost podjetij (Sultana in Turkina, 2023).

Izpostavili smo pomen jasne strategije za prenos nasledstva, ki vključuje formalne strukture za podporo odločanju in postopno predajanje odgovornosti naslednikom (LeCounte, 2022) ter pravočasno vključevanje naslednikov v družinska podjetja. Poleg tega smo poudarili pomen izboljšanja komunikacije med družinskimi člani, razvoj digitalnih kompetenc ter usmerjenost v trajnostno rast in inovacije (Bargoni et al., 2023). Še posebej mlajše generacije lahko z večjim poznavanjem digitalnih tehnologij igrajo ključno vlogo pri modernizaciji poslovanja.

Za ohranjanje družinskih podjetij kot temelja slovenskega gospodarstva je ključno oblikovanje okolja, ki spodbuja sodelovanje med generacijami, ohranja družinske vrednote, omogoča digitalno preobrazbo in krepi inovacijsko kulturo. V Sloveniji je to vlogo prevzela agencija SPIRIT (EY Slovenia, 2022), ki spodbuja pravočasno pripravo na prenos lastništva in razvoj kompetenc naslednikov v družinskih podjetjih. Zavedanje o pomenu skrbno načrtovanega prenosa nasledstva lahko prispeva k trajnostnemu razvoju družinskih podjetij in zagotovi njihovo pomembno vlogo tudi v prihodnosti (Gavrić in Braje, 2024) za gospodarski razvoj in stabilnost države.

### Zahvala

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## **O avtorjih**

Anastasiya Nikolaeva Stoyanovich je magistrica kadrovskih in izobraževalnih sistemov, ki je svojo magistrsko nalogo posvetila raziskovanju izzivov internacionalizacije družinskih podjetij. Pri celotnem raziskovalnem procesu so ji pomagale izkušnje, pridobljene v družinskem podjetju, v katerem je tudi sama zaposlena. Do zdaj je sodelovala na več znanstvenih konferencah, ki predstavljajo odlično priložnost za izmenjavo znanja in prispevek k akademski razpravi.

Domen Deu je slovenski podjetnik, povezan z družinskim podjetjem Dines, d. o. o., ustanovljenim leta 1989, ki se specializira za ogrevanje, prežračevanje in klimatizacijo. Leta 2017 je na GEA College – Fakulteti za podjetništvo zaključil diplomsko delo z naslovom "Inovativni poslovni model za rast podjetja Dines, d.o.o.", v katerem je analiziral obstoječi poslovni model podjetja in predlagal inovativne strategije za njegovo rast. V svojem delu se osredotoča na uvajanje sodobnih rešitev na področju energetske učinkovitosti in trajnostnega razvoja, s čimer prispeva k nadaljnjemu uspehu podjetja Dines, d. o. o.

Dr. Miha Marič je raziskovalec s področja vodenja, managementa in organizacijskih ved. Doktoriral je na Ekonomski fakulteti Univerze v Ljubljani. Trenutno je zaposlen kot izredni profesor na Fakulteti za organizacijske vede Univerze v Mariboru. Njegovi raziskovalni interesi so moč, vodenje, organizacijsko vodenje, kadrovski management, organizacija in management. Je avtor številnih izvirnih znanstvenih člankov, znanstvenih monografij ter poglavij v znanstvenih monografijah in strokovnih člankov ter prispevkov na znanstvenih konferencah. Je član uredniških odborov revij, bil je urednik in recenzent ter član programskih odborov več mednarodnih konferenc. Sodeluje tudi pri raziskovalnih projektih in svetovalnem delu.

Ivan Todorović dela na Fakulteti za organizacijske vede Univerze v Beogradu. Njegovo strokovno področje vključuje organizacijsko načrtovanje, prestrukturiranje, svetovanje pri upravljanju, razvoj poslovnih modelov in podjetništvo. Kot poslovnega svetovalca ga je najelo več kot 50 podjetij, ki svoje poslovne dejavnosti izvajajo v balkanski regiji. Sodeloval je pri številnih projektih, ki jih je financirala Republika Srbija ali mednarodne institucije, kot so EBRD, UNIDO in USAID. Je soavtor več kot 80 objav v mednarodnih in domačih monografijah, revijah in zbornikih konferenc ter recenzent več mednarodnih znanstvenih revij in konferenc. Bil je gostujoči predavatelj v Sloveniji na Fakulteti za organizacijske vede Univerze v Mariboru. Kot svetovalec za poslovni razvoj je podprl več startup podjetij, jim pomagal pri ustanavljanju poslov in zbiranju investicijskega kapitala. Njegove študentske ekipe so osvojile nagrade na mednarodnih tekmovanjih startupov in študij primerov, sam pa je bil član zmagovalnih ekip na HULT Global Case Challenge 2012 v Londonu in na Balkan Case Challenge 2010

na Dunaju. Usposablja tudi akademske mentorje za delo s študentskimi startupi in pomaga inkubatorjem pri razvoju njihovih zmogljivosti za podporo startup podjetjem.



# THE JOURNEY TO SCHOOL AS AN INFLUENCING FACTOR ON SCHOOL GRADES AT VOCATIONAL COLLEGES

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This study aims to investigate the relationship between travelling to school and the academic performance of vocational school students. In doing so, the study draws on teaching-learning theories as well as previous studies on travel to school factors. The results of the study show that an active journey to school can improve well-being, which in turn has a positive effect on grades. However, the data did not confirm that an active journey to school leads directly to better grades or that longer journeys to school have a negative impact on grades. These results emphasise the role of the journey to school for the well-being of pupils. It can therefore be assumed that travelling to school as part of students' daily lives plays an important role in their emotional well-being and should therefore be considered in a broader context when it comes to creating a conducive educational environment.

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## 1 **Research question, state of research and research gap**

Teaching-learning theories form the basis for students' learning success. According to behaviourist learning theories, learning consists of the formation of associations between sensory impressions and impulses for action and manifests itself in changes in behaviour. Constructivist theories of learning recognise learning as the active construction of knowledge. Every cognitive activity must be seen in a spatial and social context (Fürstenau, 2019, p. 7). Several influencing factors have an effect on cognitive performance. In the studies by Martínez-Gómez et al. (2011, p. 303) and Rummer and Herzmann (2014, p. 90), correlations were established between individual factors relating to the journey to school, such as time or the organisation of the journey (active or passive). A bundling of these influencing factors with a final consideration based on the pupils' performance has not yet been conceptualised.

The way of travelling to school has various effects on the students. Klocke et al. (2017, p. 7) show that a journey to school that takes longer than 45 minutes can lead to concentration problems. There is a correlation between the length of the journey to school and irritability as well as concentration problems. Rummer and Herzmann (2014, p. 90) found evidence that a long, passive journey to school has a negative impact on pupils' performance. This research result was attempted to be explained by the correlation between the lack of homework time and the long journey to school. However, this assumption could not be confirmed. Instead, Rummer and Herzmann (2014, p. 90f) assumed an inverse causal relationship. The students tried to compensate for the negative effects of the longer journey to school by spending more time on homework. Stöhr et al. (2019, p. 5) also show that travelling long distances every day has a negative impact on health, performance, satisfaction and stress levels.

Stöhr et al. (2019, p. 6) point to the positive influence of active travel to school. García-Hermoso et al. (2017, p. 1) come to the conclusion that actively walking 30 to 60 minutes to school can have a positive influence on grades in maths and language. Rummer and Herzmann (2014, p. 91) show a contrasting result. They found no correlation between an actively organised journey to school and school grades.

There are diverging results in gender-specific studies of the journey to school. According to Martínez-Gómez et al. (2011, p. 303), a correlation between an actively organised journey to school and higher performance at school could be demonstrated in pupils. García-Hermoso et al. (2017, p. 1), on the other hand, found no significant correlation between gender, the way to school and the grade. Furthermore, it can be noted that most studies look at female pupils between the ages of 6 and 13. There is also sufficient data on the commuting of adults to work. Grobe (2012, p. 8) found that commuting to work can have a significant impact on health. For pupils from middle school to working life, there are no target-oriented research results to date. For this reason, this study will look at the journey to school for students at vocational schools and how the journey to school is organised. Specifically, it is investigated whether a significant correlation can be established between the organisation of the journey to school and the school grade. In this context, further stress dimensions in the organisation of the journey to school must be examined. The time aspect is only one dimension here; the question of the mode of transport and the associated perception of stress will also be the subject of this research project with regard to their effects on the school grade (Sixt et al., 2018, p. 134). This study thus examines the tension between actively and passively organised journeys to school in connection with the grades achieved at vocational colleges.

## 2 Generation of hypotheses

Martínez-Gómez et al. (2011, p. 302) show that active travel to school has a positive effect on school grades. Breithecker and Dordel (2003, p. 13f) also confirm this correlation. The study shows that exercise has a positive influence on performance and concentrated learning. Pupils with a more pronounced movement behaviour during breaks and lessons make fewer mistakes in performance assessments than pupils who do not move. Boos (2010, p. 101) explains the link between movement and memory in her study as follows: "Movement can therefore be a physiological stimulus for the hippocampus, which then switches "on receive". It strengthens thinking and helps the brain to grow in volume when it threatens to shrink measurably from the 3rd decade of life." (Boos, 2010, p. 101).

*Hypothesis 1:* Pupils who actively organise their journey to school have better grades.

Klocke (2017) comes to the conclusion that there is a demonstrable link between the length of the journey to school and concentration problems as well as irritability. He cites the lack of sleep caused by the longer journey to school as the reason for this. Pupils with a long journey to school get up on average around 30 minutes earlier than pupils with a short journey to school. Klocke (2017, p. 6) was able to prove that a longer journey to school causes more stress for pupils. It can be assumed that the results obtained with seventh-grade students also apply to older students. Pfaff (2014, p. 116) investigated the psychological effects of commuting in professional life and came to the conclusion that the lack of free time can even lead to psychosomatic illnesses. This finding can also be applied to students, as they lack the time for leisure activities and thus the balance to school due to the longer journey to school. The lack of free time increases the occurrence of psychosomatic illnesses and demonstrably reduces well-being (Drummer, 2021, p. 225). Due to the poorer well-being, the students' performance is lower. This dissatisfaction and the resulting lower performance has a negative impact on school grades, as these students make more mistakes in performance assessments. The higher frequency of errors ultimately leads to a lower grade in the performance assessment and, accordingly, to a lower final grade (Breithecker & Dordel, 2003, p. 10). Hypotheses 2 and 3 can be generated from these findings. They take into account both the duration of the journey to school and well-being in connection with school performance.

*Hypothesis 2:* A journey to school longer than 30 minutes has a negative effect on the school grade.

*Hypothesis 3:* An active journey to school mediates well-being, which has a positive effect on the grade.

### **3 Research design**

A quantitative survey method was chosen to answer the formulated research questions. In order to conduct a quantitative examination of the relationship between the students' perception of stress and their school grades, an anonymous online survey was conducted in the vocational schools at the beginning of the practical semester from 12 March 2023 to 14 June 2023. The vocational schools visited by the students during the practical semester serve as the basis for the survey.

The survey refers to students from seven vocational schools with different educational backgrounds.

The questionnaire used contains both biographical questions and questions about the students' well-being on the way to school, which are examined by observing the dependent, independent and mediator variables. In this empirical study, the effects of the mode of transport and the duration of the journey to school on the school grade are analysed.

The first research question of this study focuses on identifying the most frequently used mode of transport for travelling to school among students. For this purpose, the results are standardised using a single selection. To record the means of transport, the results of the questionnaire are divided into the three subgroups *active*, *active (motorised)* and *passive* using a categorisation method. The active category includes walking and cycling. The active (motorised) category includes active driving a car, motorbike/scooter or e-scooter. The passive category includes travelling to school by car as a passenger or using the bus or train.

The use of an active or passive mode of transport and the *duration of the journey to school* are defined as independent variables, while the *school grade* is considered a dependent variable. In order to analyse the relationship between these variables, *well-being* is selected as a mediator variable. This makes it possible to investigate the mechanisms that influence the relationship between the mode of transport and the school grade and thus to gain a deeper understanding of the relationship.

The second research question in this study aims to record the time spent travelling to school. For this purpose, a question with eight possible answers is used, which relate to different times of the journey to school and range from zero to over 60 minutes. Subsequently, the stress level of the test subjects in connection with their journey to school is recorded. A six-point Likert scale is used (Kumar, 2011, p. 170). The data was collected using a slider. Due to the fact that the use of a seven-point Likert scale offers the possibility of frequent selection of the mean value, such a scale is not used in this study.

The next question refers to the determination of the modal value of the report card grades of each individual student. For this purpose, a six-point scale is used as an evaluation scale and the data is recorded using a slider. This allows the frequency of occurrence of certain grade values to be recorded. The mean of grades is 2.49 (on a scale from 1 – very good to 6 – unsatisfactory) and is normal distributed.

At the end of the survey, the respondents' biographical data is collected, focussing on gender and age. The gender information is collected by using a single selection (54% female and 46% male students). It is then necessary for the students to enter their age in a text field. The mean age of the participants is 21,65 years.

To check whether the students have answered the questions in the questionnaire truthfully, a control question is implemented which asks the students to indicate whether they are students at a vocational school. The possible answers are either yes or no. In cases where significant deviations are found with regard to the individual processing time in relation to the average total processing time, these data points are removed from the raw data set.

## **4 Results**

### **4.1 Evaluation procedure**

To analyse the questionnaire, the data from the Sociosurvey online survey tool is first imported into the IBM SPSS Statistics program. The next step is the necessary data cleansing and preparation so that the variables can be used for further analyses. This involves, for example, deleting variables that are not relevant for further analyses and missing entries, as well as adjusting the scale levels. Based on the control question, seven items are considered unusable. This includes an adjustment rate of approximately 1.8%. Furthermore, the students in the survey indicated their main mode of transport using a single choice. The first step here is to cluster the information into active, active (motorised) and passive and recode it accordingly. This allows the sample to be divided into three groups, which are then compared with each other. The analysis is first divided into a descriptive and then an inferential statistical procedure. The descriptive analysis includes demographic data such as gender and age, as well as information on the duration and type of travel on the way

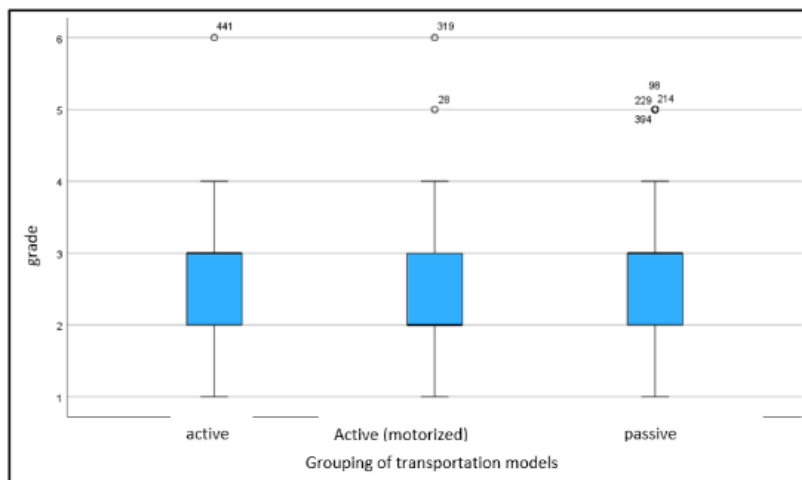
to school. In the demographic data, both gender and age are unremarkable. However, the mode of transport is very unevenly distributed.

**Table 1: Frequency of the individual means of transport**

Mode of Transport				
Valid	Frequency	Percent	Valid Percent	Cumulative Percent
On foot	65	12.2%	12.2%	12.2%
Bicycle	11	2.1%	2.1%	14.3%
Motorcycle / Scooter (E-Scooter, etc.)	12	2.3%	2.3%	16.5%
Car (self-driving)	189	35.5%	35.5%	52.1%
Car (driven by parents, etc.)	33	6.2%	6.2%	58.3%
Bus / Train	222	41.7%	41.7%	100.0%
Total	532	100.0%	100.0%	100.0%

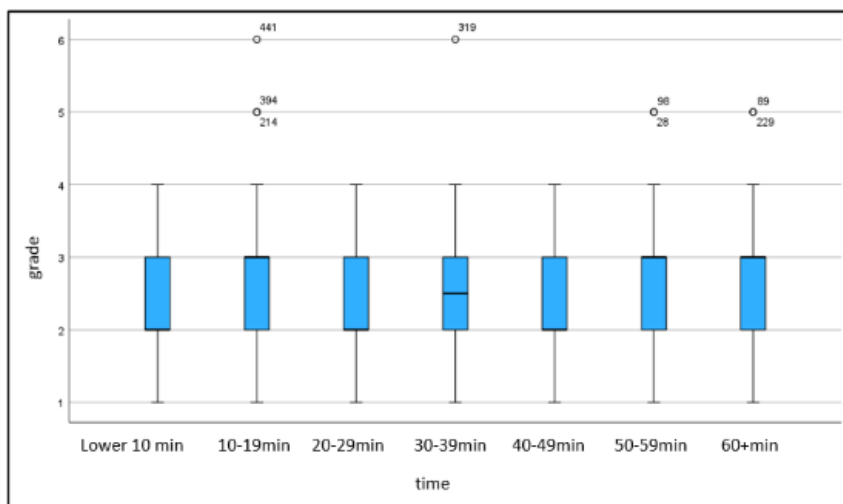
Source: Own

Among other things, boxplots are created. However, these boxplots do not show any significant anomalies.



**Figure 1: Boxplots of the school grade depending on the duration of the journey to school**

Source: Own



**Figure 2: Boxplots of the school grade depending on the means of transport**

Source: Own

Furthermore, the assumption of normal distribution is tested. Only the school grades are normally distributed. Therefore, the T-test could not be used and an ANOVA (Analysis Of Variance) was used instead. The mediation analysis is then carried out using Hayes' process. For the third hypothesis, the *mode of transport* is assumed to be the predictor (independent variable) and the *school grades* as the criterion (dependent variable). The mediator variable is *well-being*. Since the survey asks about the students' perception of stress, the values must be recoded so that the highest value of stress perception is now the lowest value of well-being. This is also carried out analogously for all other values. The indirect as well as the direct effects of the independent variable *mode of transport* on the dependent variable *school grades* are thus analysed, taking into account the recoded mediator variable *well-being*.

## 4.2 Results for hypothesis 1

For hypothesis 1, the means of transport serves as a nominally scaled, independent variable with three characteristics or groups. The dependent variable, school grade, is ordinally scaled. The first hypothesis belongs to the family of difference hypotheses, as we are interested in the differences between the three groups of the predictor variable. Variance analysis is used as the method of statistical evaluation,

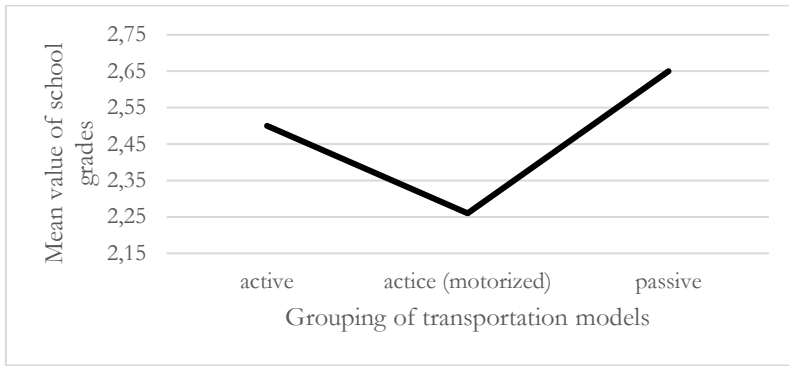


as the differences between more than two groups are analysed. A prerequisite for the analysis of variance is variance homogeneity, which is tested using a Levene test. The null hypothesis of the Levene test is equality of variance, and since the p-value  $p=0.141$  is above the significance level of 5%, the null hypothesis is retained and homogeneity of variance is assumed. After performing ANOVA, the paired comparisons between the groups are performed under the Bonferroni correction.

**Table 2: Significance tests (ANOVA) of the school grade depending on the means of transport**

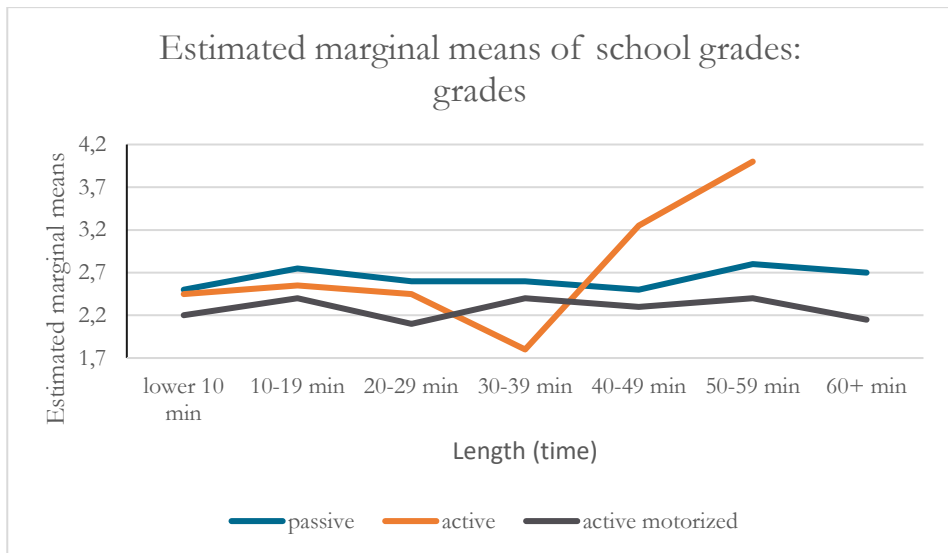
Dependent variable: School grade							
	(I) Transport grouping	(J) Transport grouping	Mean value difference	Std- error	Sig.	Confidence Interval	
						Lower limit	Upper limit
Bonferroni	active	active (motorized)	,241	,118	,125	-,04	,53
		passive	-,171	,115	,413	-,45	,11
	active (motorized)	active	-,241	,118	,125	-,53	,04
		passive	-,412*	,083	<,001	-,61	-,21
	passive	active	,171	,115	,413	-,11	,45
		active (motorized)	,412*	,083	<,001	,21	,61
Tamhane	active	active (motorized)	,241	,125	,156	-,06	,54
		passive	-,171	,123	,427	-,47	,13
	active (motorized)	active	-,241	,125	,156	-,54	,06
		passive	-,412*	,081	<,001	-,61	-,22
	passive	active	,171	,123	,427	-,1	,47
		active (motorized)	,412*	,081	<,001	,22	,61

No significant differences were found here, except between the "active (motorised)" and "passive" groups. Hypothesis 1 is therefore not confirmed.



**Figure 3: Mean values of the school grades depending on the type of means of transport**  
Source: Own

### 4.3 Results for hypothesis 2



**Figure 4: School grades depending on time and means of transport**  
Source: Own

Here, the independent variable duration of the journey to school is ordinal-scaled, while the dependent variable school grades is interval-scaled. As with the first hypothesis, this is a difference hypothesis, which is analysed using ANOVA. The Levene test is not significant in this case ( $p=0.767$ ), so that equality of variance is

assumed. After performing the analysis of variance using the T-test, the paired comparisons are made using the Bonferroni correction. The corresponding p-values are equal to 1 everywhere, i.e. perfectly non-significant. This means that the null hypothesis cannot be rejected and no significant differences can be detected.

Hypothesis 2 is therefore not accepted and the results cannot be transferred to the population.

#### 4.4 Results for hypothesis 3

In this hypothesis, the dependent metric variable is school grade. As in the first hypothesis, the primary independent variable means of transport is no-minimum scaled. The variable well-being acts as a mediator here. This variable is Likert-scaled with six levels and thus ordinal-scaled, which can also be regarded as quasi-metric for the purposes of the analysis (Kronthaler, 2022, p. 19). Mediated regression is selected as the method of analysis here in order to be able to measure and evaluate direct and indirect effects. Such a mediation analysis makes it possible to check whether the type of mode of transport predicts the trend in school grades and whether the direct path is mediated by well-being. A direct effect is a direct causality between the dependent and independent variable. An indirect effect is the effect that an independent variable has on a mediator, which in turn has an effect on the dependent variable. The following values were determined as part of the inferential statistical analysis:

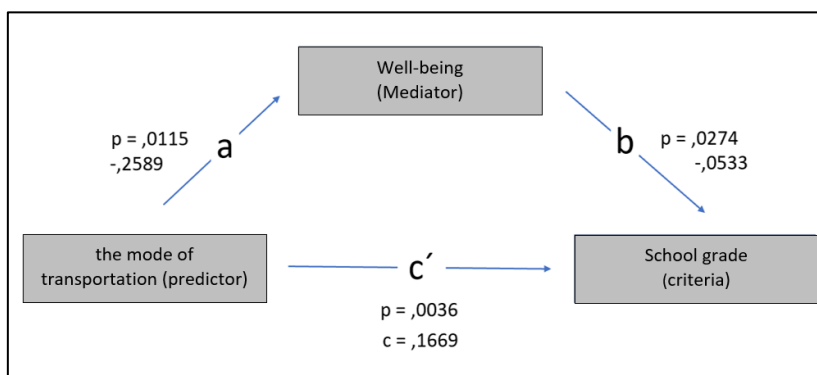


Figure 5: Significance levels and coefficients of mediation

Source: Own

All three paths are significant with a probability of error of less than 5%. There is a significant negative correlation between the independent variable of means of transport and well-being. The same applies to the effect of well-being on the school grade. There is a significant positive correlation between the independent variable means of transport and the school grade. The indirect effect via the path a-b is estimated as follows:  $b = 0.0138$ . The associated 95% confidence interval has the following limits: [0,006; 0,0328]. Since 0 is not included in the confidence interval, the results are significant. It can be stated that the relationship between the type of mode of transport and the tendency of school grades is partially mediated by well-being. Hypothesis 3 is therefore confirmed.

## 5 Conclusion, limitations and perspective

### 5.1 Conclusion

The empirical study "The journey to school as an influencing factor on school grades at vocational colleges" provides a nuanced picture of the connection between the journey to school and the school grades of students at vocational schools. The first hypothesis, which thematised the influence of the means of transport on school grades, is not confirmed by the research results. An actively organised journey to school therefore has no significant impact on students' academic performance. However, the second hypothesis, which assumed a negative correlation between journey time to school of over 30 minutes and school grades, was also not confirmed by the data collected. The third and final hypothesis, which investigated the indirect influence of an active journey to school on school grades through the promotion of well-being, showed positive results, so that the hypothesis could be confirmed.

To summarise, the study reflects the complexity of the topic. It shows that the journey to school, although it does not appear to have a direct influence on school grades in the survey, is nevertheless an important factor for mental health. The journey to the educational institution is an elementary part of the students' daily lives and indirectly influences their eudaemonia. These findings encourage us to look at the journey to school in a broader context and to recognise the role of the journey to school in creating a conducive educational environment.

## **5.2 Limitations**

School grades are influenced by many different factors, such as motivation, self-efficacy, prior knowledge, parents' level of education and cognitive abilities. However, the interactions and dependencies of these factors with the organisation of the journey to school would exceed the scope of this study. There is also a regional limitation, as the survey is strongly related to the city of Aachen and the surrounding catchment area. The possibilities for reaching schools are specific to the city region, meaning that the findings can only be transferred to a nationwide level to a limited extent. The studies used to generate the hypotheses analysed various target groups and influencing factors. Different study designs, items and scales were used for this purpose. The present study faced the challenge of analysing the target group of students at vocational colleges. Learners at vocational schools are characterised by a wide range of demographic features and differ greatly in terms of their age, life situation or school-leaving qualifications. Conclusions that could be derived from other studies may not be causally transferable to the target group analysed.

Another problem is the sample size of 550 participants, which must be considered a non-representative number of students. Furthermore, it must be noted that the survey had to be carried out as a very rough estimate on the part of the school grades, as the survey took place at a time when the report card grades were already in the distant past. This means that the survey may be prone to errors. In addition, the school grades were given by the pupils themselves and were therefore not subject to any checks. The specific question of the means of transport should also be considered in this context, as in retrospect categories in the area of transport such as the bicycle receive very little attention in relation to vocational schools. Whether this is related to the time of year in which the survey was conducted could not be analysed at this point. The control question was already problematic during the survey, as some students at the full-time school were of the opinion that they were not part of a vocational school, which further reduced the size of the sample.

## **5.3 Perspective**

The organisation of the journey to school and the associated factors influencing pupils' performance were investigated by Rummer and Herzmann (2014), Martínez-Gómez et al. (2011), Stöhr et al. (2019) and in the present study. A common,

dominant factor could not be consistently identified in all studies. Further investigations are needed to exclude demographic and socio-cultural confounding variables. Many studies are limited to an age-specific test group. Differences in school travel behaviour and the effects on performance must be determined across all age groups in order to obtain meaningful results.

In view of the available research results, there are several practical conclusions for teachers in the context of teaching-learning theories. In particular, the realisation that the type and route to school can have a demonstrable influence on academic performance is an important implication. Constructivist teaching approaches emphasise the importance of the spatial and social environment for cognitive activities (Fürstenau, 2019). In this context, teachers should consider the journey to school as an integral part of the learning environment and consider appropriate pedagogical measures. As a teacher, it would be advisable to consider students' individual needs and plan interventions where necessary. For students with longer journeys to school, teachers could develop strategies to minimise stress and negative effects on performance. This could include, for example, promoting relaxation techniques, organising learning groups on the way to school or integrating movement elements into the school day.

The available results suggest that an active journey to school can have a positive impact on academic performance (García-Hermoso et al., 2017; Martínez-Gómez et al., 2011). This could motivate teachers to communicate the importance of an active journey to school to pupils and parents and to promote appropriate measures. A further impulse could include the organisation of journeys to school on foot or by bicycle, the promotion of sporting activities on the way to school or raising awareness of the choice of suitable means of transport. At this point, however, it should also be noted that an active journey to school is not practicable for all pupils. Accordingly, not all learners can benefit from it. In order to take these learners into account, it would also be conceivable to increase activity within the school day. For example, so-called movement breaks could be offered during school hours (Müller & Dinter, 2020, p. 155f). However, it should be noted that the available results are not conclusive and further research is needed to better understand the complex relationships between school travel behaviour, individual factors and academic performance. Overall, teachers should be aware that the journey to school is not just a physical transition from home to school, but an integral part of the learning

environment that can influence academic performance. By integrating this knowledge into pedagogical practice, teachers can help ensure that students can learn and develop under optimal conditions.

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# ADOPTION OF SHARED ECONOMY: CASE OF AIRBNB IN THE CZECH REPUBLIC

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The aim of the paper is to analyze use of AirBnB and similar services in the Czech Republic. Data were collected using an online questionnaire. In total, 529 respondents took part in the research. Impact of risk-aversion, gender, and age on use of platforms like AirBnB was tested using ordinal regression. Risk-aversions and age were found to have a significant impact. Risk-aversion is negatively linked to use of shared services, while age is positively associated with use of shared services. To encourage more widespread adoption, shared economy platforms should work to decrease the perceived risk associated with their services. By making users feel safer and more secure, even those who are naturally more risk-averse will be more likely to use the platform.

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## 1 Introduction

The rapid growth of the sharing economy has transformed traditional industries, particularly in the tourism sector (Zervas et al., 2017). One of the most prominent examples of the sharing economy is AirBnB, a platform that enables individuals to rent out their homes or apartments to travelers (Sthapit & Jiménez-Barreto, 2018; Zervas et al., 2017).

The aim of this paper is to analyze the use of AirBnB and similar services in the Czech Republic. This study aims to investigate the factors that influence the adoption of AirBnB and similar shared economy platforms in the Czech Republic. The research employed an online questionnaire to collect data from 529 respondents. The study examined the impact of risk-aversion, gender, and age on the use of shared economy platforms.

The findings of other scholars reveal that risk-aversion and age have a significant impact on the use of shared economy platforms (Richthofen, 2022; Sthapit & Jiménez-Barreto, 2018; Zervas et al., 2017). Risk-averse individuals are less likely to use these platforms, while older individuals are more likely to utilize them (Richthofen, 2022; Sthapit & Jiménez-Barreto, 2018; Zervas et al., 2017).

Our research has several limitations, as the study was conducted on a sample of university students. Nevertheless, the findings suggest that to encourage more widespread adoption of shared economy platforms, operators should focus on reducing the perceived risk associated with their services (Richthofen, 2022; Sthapit & Jiménez-Barreto, 2018; Zervas et al., 2017). By making users feel safer and more secure, even those who are naturally more risk-averse will be more likely to use the platform (Richthofen, 2022; Sthapit & Jiménez-Barreto, 2018).

The study helps to understand the factors that influence the adoption of shared economy platforms. According to this theory, an individual's intention to perform a behavior is determined by their attitude, subjective norm, and perceived behavioral control (Sthapit & Jiménez-Barreto, 2018).

## **2 Theoretical Background and Literature Review**

Within the scope of this study, risk-aversion, gender, and age are considered key determinants influencing an individual's willingness to engage with shared economy platforms.

Risk-aversion denotes a person's inclination to steer clear of uncertain or potentially risky situations. Individuals exhibiting a higher degree of risk-aversion are less likely to participate in shared economy platforms, as they may view these platforms as carrying greater risks compared to conventional alternatives.

The sharing economy has significantly impacted the tourism industry, with platforms like AirBnB gaining widespread popularity (Mallinson et al., 2020). To ensure the continued growth and adoption of these platforms, operators must address the concerns of risk-averse individuals and cater to the needs of older users.

The literature on the sharing economy provides some insights into the factors that influence the adoption of shared economy platforms. Research has shown that the adoption of shared economy platforms is influenced by demographic factors, cognitive factors, and beliefs.

Moreover, cross-cultural studies have found that the uncertainty avoidance dimension of culture can influence the adoption of shared economy platforms (Muñoz-Leiva et al., 2018). Gender and age influence the adoption of technological innovations, including shared economy platforms (Benson et al., 2019). Specifically, younger individuals and men are more likely to adopt new technologies, while older individuals and women may be more risk-averse and less likely to use shared economy platforms.

Gender and age are also expected to play a role in the adoption of shared economy platforms. Previous research has found that younger individuals and women are more likely to use shared economy platforms. Drawing on these theoretical insights, this study aims to examine the impact of risk-aversion, gender, and age on the use of AirBnB and similar shared economy platforms in the Czech Republic.

The sharing economy has been a topic of significant interest in the academic literature, particularly in the context of the tourism industry. One of the most successful models in the sharing economy is AirBnB, which enables peer-to-peer transactions and has enjoyed high growth in recent years (Sthapit & Jiménez-Barreto, 2018).

Researchers have explored various aspects of AirBnB and the sharing economy in the tourism industry (Sthapit & Jiménez-Barreto, 2018). A key theme in the literature is the provision of authentic experiences, environmental concerns, and socialization as important factors in the adoption of peer-to-peer accommodation platforms (Kuhzady et al., 2020). Trust and negative attitudes of established businesses and government are also identified as barriers to the development of the sharing economy in tourism (Kuhzady et al., 2020).

A recent review of the literature on the sharing economy in hospitality and tourism reveals three predominant themes: drivers to participate in the sharing economy, the sharing economy as a disruptive business model, and the impacts of the sharing economy and corresponding regulatory issues (Kuhzady et al., 2021). The review also highlights that the majority of the existing research has focused on the hospitality and accommodation sectors, with most studies drawing insights from the AirBnB context (Kuhzady et al., 2021).

Another study explores how the sharing economy has influenced consumption and competition in the tourism sector, particularly in the hotel industry. It finds that AirBnB has disrupted traditional tourism models, leading to shifts in consumer behavior and heightened competition (Varsanis et al., 2019).

Overall, the literature provides valuable insights into the factors driving the adoption of shared economy platforms in tourism and the challenges and impacts associated with their expansion. Understanding these dynamics is essential for developing strategies that enhance the accessibility and appeal of such platforms, particularly for risk-averse individuals and older demographics.

### 3 Methodology

The survey instrument was designed to gather information on the respondents' use of AirBnB and similar shared economy platforms, as well as their demographic characteristics and risk-aversion levels. Data were collected using a web-based questionnaire on 1ka.si. The sample size was 529 (289 men and 240 women). It was a convenience sample consisting of university students. Respondents did not receive any monetary nor any other type of incentives. A known limitation is that 95% of the respondents were 24 years old or younger.

The dependent variable was use of shared services, such as AirBnB. It was measured on a scale from 1 to 4 where 1 stood for yes, often; 2 stood for yes, sometimes, 3 stood for no, but I think about it; and 4 stood for no. The independent variable was risk-aversion. It was measured on a 1-10 Likert scale where 1 stood for risk-loving, and 10 stood for risk-averse. Control variables were gender, and age.

Ordinal regression function of IBM SPSS 27 will be used to test how risk-aversion, gender, and age influence use of shared services such as AirBnB. A variance inflation factor (VIF) will be used to evaluate the extent of multicollinearity.

### 4 Results

The ordinal regression model of shared services like AirBnB is provided in Table 1. All VIFs were lower than 1.06, therefore, collinearity is not a problem.

**Table 1: Ordinal regression model**

	Estimate	Std. Error	Wald	df	Sig.
<b>Threshold [use = 1]</b>	-3.560	0.702	25.727	1	0.000
[use = 2]	-1.632	0.685	5.676	1	0.017
[use = 3]	-1.019	0.684	2.223	1	0.136
<b>Location Risk aversion</b>	0.137	0.039	12.270	1	0.000
<b>Age</b>	-0.125	0.032	15.489	1	0.000
<b>[Gender=man]</b>	0.140	0.165	0.724	1	0.395
<b>[Gender=woman]</b>	0 <sup>a</sup>			0	

Legend: a. This parameter is set to zero because it is redundant.

Source: Own

Cox and Snell pseudo-R<sup>2</sup> is 0.051, Nagelkerke pseudo-R<sup>2</sup> is 0.055, McFadden pseudo-R<sup>2</sup> is 0.020, and the significant of the full model is below 0.001.

The analysis of the sample at hand indicates that use of shared services like AirBnB has a positive and significant relationship with risk-loving (as reversed risk-aversion) and age. No significant effect of gender was found, despite the sample being fairly balanced with approximately 55% men and 45% women.

## 5 Discussion

Risk-aversion and age explain the best the threshold between frequent and occasional users, and the worst the threshold between people who never used any shared service like AirBnB but consider doing so and people who do not consider doing so. The latter is not a huge problem as both categories represent non-users anyway. The threshold between occasional users and people who never used shared services like AirBnB but consider doing so is significant at 0.05 level.

## 6 Actionable Recommendation

According to Lee & Deale (2021), "guests may be worried about having a host become upset if they complain about the cleanliness of the accommodations or use the cancellation policy; [t]his finding might also connect to the respondents' perceptions that if something goes wrong during check-out, there may be no one on site to help". Services, such as AirBnB could possibly decrease a perceived risk by better communicating that these issues are addressed, i.e. that they are not a real problem.

## 7 Conclusions

The aim of the research was to investigate selected factors impacting use of shared services, such as AirBnB. The primary question was whether risk-aversion could explain this phenomenon. Gender and age were selected as control variables.

Our findings indicate that risk-loving (as reversed risk-aversion) and age have a positive impact on use of shared services like AirBnB in young adults. No significant effect of gender was identified in the sample at hand.

A known limitation is reliance on a convenience sample - university students in particular – where 95% of respondents were up to 24 years old.

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# METODOLOGIJA ZA KVALITATIVNO VREDNOTENJE ODPRTIH PODATKOV

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Glede na hitro naraščajočo količino odprtih podatkov in dejstvo, da so ti široko dostopni, je pomembno, da so podatki ne le dostopni, temveč tudi dosegajo primerno kakovost za nadaljnjo uporabo. Ta je namreč ključna za zagotavljanje pravih, uporabnih in zanesljivih rezultatov, zato je pred ponovno uporabo smiselno oceniti, v kakšnem stanju so podatki. V ta namen smo razvili metodologijo za kvalitativno vrednotenje odprtih podatkov, pri čemer smo elemente metodologije izbrali na podlagi pregleda obstoječih raziskav in pristopov k vrednotenju kakovosti podatkov. Pristop, ki ga predlagamo, ni specifično prilagojen posameznim strokovnim področjem, temveč vključuje splošne kazalnike kakovosti, ki omogočajo široko uporabnost metodologije. V okviru ciljnega raziskovalnega projekta smo metodologijo prilagodili uporabi na portalu Odprtih podatkov Slovenije (OPSI), s čimer želimo spodbuditi uporabo slovenskih odprtih podatkov v različnih raziskovalnih in poslovnih področjih.

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# METHODOLOGY FOR QUALITATIVE EVALUATION OF OPEN DATA

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The increasing availability of open data and open data platforms emphasizes the need for reliable evaluation methods to ensure data quality. Effective assessment is critical as the promotion of open data reuse gains momentum, while the quality of this data, often published as a by-product of government processes, can be inconsistent. This paper explores how existing research addresses the challenge of open data assessment and highlights the lack of methodologies applicable to Slovenian open data portals. Existing frameworks are usually limited to assessing either metadata or specific datasets. To fill this gap, we propose a novel methodology based on a comprehensive review of current approaches. This framework is designed to assess multiple dimensions of open data quality and serves as a basis for the development of automated tools for assessing datasets and data portals.



## 1 Uvod

Pojem odprti podatki predstavlja vse podatke, do katerih lahko vsakdo dostopa, jih uporablja, spreminja ali deli za katerikoli namen. Zaradi razpršenosti podatkov se pojavljajo težave pri njihovem kvalitativnem vrednotenju in ponovni uporabljivosti (Vetrò idr., 2016). Večina raziskav se osredotoča na metapodatke, saj je to področje standardizirano z uporabo RDF slovarjev in različnih lestvic kriterijev, po drugi strani pa so raziskave na polju podatkov samih bistveno manj raziskane zaradi raznolikosti v njihovi vsebini in vsebini podatkovnih zbirk. Problematike nastajajo zaradi pomanjkljivih, nenatančnih, nepopolnih, zastarelih in neveljavnih podatkov, nejasnih vrednosti, prevelike količine informacij za procesiranje in manjka bistvenih podatkov, nekatere izmed njih pa so bolj tehnične narave, kot so neustrezno opredeljeni ali težko dostopni formati, odsotnost standardov in standardne programske opreme za obdelavo odprtih podatkov ter razdrobljenost programske opreme in aplikacij. Ker je večina metodologij iz pregleda literature usmerjena zgolj v formate, je vsebina prepuščena uporabniku, hkrati pa je med seboj težko primerljiva zaradi raznolikosti v modalnosti in uporabljenih tipih.

Ročni pregled podatkovnih zbirk na portalu OPSI je razkril podobne težave, zlasti sintaktične napake (manjkajoče črke, šumniki, posebni znaki), raznolikost formatov ter vprašljivo povezljivost podatkov in ocenjevanje njihovih podatkovnih zbirk. Najpogostejši format PCAXIS ima denimo omejena, zastarela orodja in deluje zgolj na operacijskem sistemu Windows. Glavni cilj je ustvariti koherentno in celovito metodo za učinkovito vrednotenje kakovosti podatkovnih zbirk in njihovih odprtih podatkov za uporabo tako na ravni državnega portala odprtih podatkov OPSI kot potencialno tudi na ravni drugih (evropskih) podatkovnih portalov.

## 2 Pregled področja

V pregledu literature smo se osredotočili na pregled temeljnih standardov za zagotavljanje kvalitete podatkov, metapodatkovne in podatkovne študije, evropske uredbe na področju odprtih podatkov ter ostale evropske dokumente, slovensko zakonodajo ter analitična poročila na področju odprtih podatkov s portala *data.europa.eu* (Evropski podatkovni portal).

Metapodatkovne študije so področje kvalitativnega ocenjevanja podatkov obravnavale z orodji, kot je *LMZZM* (Debattista idr., 2016), ki je bilo vzpostavljeno za potrebe vrednotenja povezanih odprtih podatkov in temelji na štirih ciljih – razširljivost, interoperabilnost, nadgradljivost in prilagodljivost – ter na metodologiji Dataset Quality Ontology (daQ) (Debattista idr., 2014), ki je namenjena abstraktnemu prikazu podatkov. Med novejša raziskava spada tudi Data Quality Vocabulary (DQV) (Albertoni idr., 2020), ki ga je razvil Konzorcij svetovnega spleta (W3C) in v glavnem temelji na slovarju DCAT.

Podatkovne študije se osredotočajo na problematiko kvalitete podatkov, pri čemer se je zaradi svoje široke zasnove in aplikativnosti kot najrelevantnejša izkazala študija *Open data quality measurement framework: Definition and application to Open Government Data* (Vetrò idr., 2016), od katere smo prevzeli metodološki okvir in 8 metrik. Izpostaviti velja tudi metodologijo *LANG* (Zhang idr., 2019), ki predstavlja dvostopenjsko zasnovan model za vrednotenje sintaktičnih in semantičnih vidikov kvalitete in je bila avtomatizirana. Študija *A Method to Screen, Assess, and Prepare Open Data for Use* (Krasikov idr., 2023) se osredotoča na podjetniški vidik uporabe odprtih podatkov in vključuje sistematični pregled, oceno ter pripravo odprtih podatkov ne zgolj s tehničnega stališča, temveč tudi s stališča koristnosti odprtih podatkov v specifičnih kontekstih.

Najaktualnejša evropska uredba na področju odprtih podatkov, *Direktiva o odprtih podatkih in ponovni uporabi informacij javnega sektorja* (Direktiva (EU) 2019/1024, 2019), podaja predloge za prenovno in dopolnitev področja, pri čemer obravnava razpoložljive formate, zagotavljanje dostopa do dinamičnih podatkov v realnem času z ustreznimi tehničnimi sredstvi, medsebojno povezovanje vzpostavljenih zbirk na več nivojih EU ter povečanje ponudbe dragocenih javnih podatkov za ponovno uporabo, hkrati pa tudi podatke javnih podjetij, raziskovalnih organizacij in organizacij, ki financirajo raziskave.

V slovenski zakonodaji se na naslovno tematiko odprtih podatkov navezuje *Zakon o dostopu do informacij javnega značaja* (ZDIJZ-E, 2015; ZDIJZ-G, 2022) ter *Uredba o posredovanju in ponovni uporabi informacij javnega značaja* (Uredba o posredovanju, 2016; Uredba o spremembah uredbe o posredovanju, 2022), ki v pravni red Republike Slovenije med drugim prenašata zgoraj opisano evropsko *Direktivo (EU) 2019/1024*.

Uradni portal za evropske podatke (*data.europa.eu*) je bil vzpostavljen novembra 2015 in predstavlja enotno točko dostopa do odprtih podatkov držav Evropske unije, institucij, agencij in organov EU ter drugih evropskih držav. V okviru portala so pogosto izvedene študije in analize, ki predstavljajo podlago za izboljšavo, popravilo in razvoj portala, njihovi rezultati pa služijo tudi razvoju ostalih podobnih portalov in zbirk z odprtimi podatki. Poročila o zrelosti odprtih podatkov so osredotočena na štiri glavna področja – državna zakonodaja, vpliv ponovne uporabe podatkov, ocena nacionalnih portalov ter mehanizmi za kvaliteto (meta)podatkov –, njihov namen pa je vključenim državam osvetliti razumevanje stopnje zrelosti njihovih odprtih podatkov in ponuditi pomoč pri opazovanju ter primerjanju lastnega napredka z drugimi. Istočasno poročila izpostavljajo najboljše prakse, ki jih je mogoče prenesti v druge nacionalne in lokalne okvire.

### 3 Metodologija

Predlagana metodologija je osnovana na podlagi pregleda literature in ročnega pregleda portala OPSI, ki je potekal od oktobra 2023 do februarja 2024 in katerega primer lahko najdemo na Slika 1.

IME ZBIRKE	SPLETNA POVEZAVA	DATUM	FORMAT	POPOLNOST	PRAVILNOST KATEGORIZACIJE	ZANESLIVOST	UPORABLIVOST (PREMEŠLJIVOST) (SIRPANT/BESEDOLO)	POTREBA PO NAMENI (NEMEN) (UREJANJE/PORAVILNOST) ANUJ?	PODATKI O OPOZBE	
Register nepremične kulturne dediščine	<a href="https://podatki.gov.si/dataset/register-nepremicne-kulturne-dediscline">https://podatki.gov.si/dataset/register-nepremicne-kulturne-dediscline</a>	1.12.23	XLS	POMANJLJIVO	DA	NE	BESEDILO (Obširna)	MOGOČE	/	Niso navedeni vsi avtorji
Register nepremične kulturne dediščine	<a href="https://podatki.gov.si/dataset/register-nepremicne-kulturne-dediscline">https://podatki.gov.si/dataset/register-nepremicne-kulturne-dediscline</a>	1.12.23	GPKG	POMANJLJIVO	DA	NE	BESEDILO (Obširna)	MOGOČE	/	Niso navedeni vsi avtorji
Register nepremične kulturne dediščine	<a href="https://podatki.gov.si/dataset/register-nepremicne-kulturne-dediscline">https://podatki.gov.si/dataset/register-nepremicne-kulturne-dediscline</a>	1.12.23	GML	POMANJLJIVO	DA	NE	BESEDILO (Obširna)	MOGOČE	/	Niso navedeni vsi avtorji
Register nepremične kulturne dediščine	<a href="https://podatki.gov.si/dataset/register-nepremicne-kulturne-dediscline">https://podatki.gov.si/dataset/register-nepremicne-kulturne-dediscline</a>	1.12.23	ZIP	POMANJLJIVO	DA	NE	BESEDILO (Obširna)	MOGOČE	/	Niso navedeni vsi avtorji
Razvid izpostavljenosti	<a href="https://podatki.gov.si/dataset/razvid-izpostavljenosti">https://podatki.gov.si/dataset/razvid-izpostavljenosti</a>	1.12.23	CSV	POMANJLJIVO	DA	NE	BESEDILO (Obširna)	MOGOČE	/	Obsevana z CSV datoteki.
Libri iz registre nepremične kulturne dediščine	<a href="https://podatki.gov.si/dataset/libri-iz-registra-nepremicne-kulturne-dediscline">https://podatki.gov.si/dataset/libri-iz-registra-nepremicne-kulturne-dediscline</a>	1.12.23	ZIP	POMANJLJIVO	DA	NE	BESEDILO (Obširna)	MOGOČE	/	Niso navedeni vsi avtorji
Libri iz registre nepremične kulturne dediščine	<a href="https://podatki.gov.si/dataset/libri-iz-registra-nepremicne-kulturne-dediscline">https://podatki.gov.si/dataset/libri-iz-registra-nepremicne-kulturne-dediscline</a>	1.12.23	CSV	POMANJLJIVO	DA	NE	BESEDILO (Obširna)	MOGOČE	/	Niso navedeni vsi avtorji
Število novih dostopov in dostav iznanosti, opredeljena starost ob dostopanju in povprečen čas za dokončanje študija za področju znanosti doktorata ter splošni, Slovenski, vedstva	<a href="https://podatki.gov.si/dataset/steviloznanosti">https://podatki.gov.si/dataset/steviloznanosti</a>	1.12.23	PCAXIS	POMANJLJIVO	DA	NE	NE	DA	Podatki obstajajo (Podatki manjkajo za 2006-2012 in področje "in nutimeljnični drži M ter N 2020	
Evidenca javnih zavodov na področju kulture	<a href="https://podatki.gov.si/dataset/evidenca-javnih-zavodov-na-podrocju-kulture">https://podatki.gov.si/dataset/evidenca-javnih-zavodov-na-podrocju-kulture</a>	1.12.23	DOCK	POMANJLJIVO	DA	DA	BESEDILO + SIRPANT (Obširna)	MOGOČE	Podatki obstajajo (in podatek manjka; podatek " "	
Evidenca javnih zavodov na področju kulture	<a href="https://podatki.gov.si/dataset/evidenca-javnih-zavodov-na-podrocju-kulture">https://podatki.gov.si/dataset/evidenca-javnih-zavodov-na-podrocju-kulture</a>	1.12.23	CSV	POMANJLJIVO	DA	DA	BESEDILO + SIRPANT (Obširna)	MOGOČE	Podatki obstajajo (in podatek manjka; podatek " "	
POHOJNE POTE PO OBČINI GORISKA PLANINA	<a href="https://podatki.gov.si/dataset/pohodne-pote-obcine-goriska-planina">https://podatki.gov.si/dataset/pohodne-pote-obcine-goriska-planina</a>	1.12.23	CSV	DA	DA	DA	NE	NE	/	
POHOJNE POTE PO OBČINI GORISKA PLANINA	<a href="https://podatki.gov.si/dataset/pohodne-pote-obcine-goriska-planina">https://podatki.gov.si/dataset/pohodne-pote-obcine-goriska-planina</a>	1.12.23	XLSX	DA	DA	DA	NE	NE	Zaznani format: XLS	
Vrti in senosne šole v Meati občini Koper	<a href="https://podatki.gov.si/dataset/vrti-senosne-sole-v-meati-obcini-koper">https://podatki.gov.si/dataset/vrti-senosne-sole-v-meati-obcini-koper</a>	1.12.23	GEOJSON	/	/	/	/	/	Zaznani format: JSON	
Vrti in senosne šole v Meati občini Koper	<a href="https://podatki.gov.si/dataset/vrti-senosne-sole-v-meati-obcini-koper">https://podatki.gov.si/dataset/vrti-senosne-sole-v-meati-obcini-koper</a>	1.12.23	CSV	/	/	/	/	/	/	
Seznam osnovnih šol v Meati občini Novo mesto	<a href="https://podatki.gov.si/dataset/seznam-osnovnih-sol-v-meati-obcini-novo-mesto">https://podatki.gov.si/dataset/seznam-osnovnih-sol-v-meati-obcini-novo-mesto</a>	1.12.23	CSV	DA	DA	DA	NE	NE	/	
Seznam osnovnih šol v Meati občini Novo mesto	<a href="https://podatki.gov.si/dataset/seznam-osnovnih-sol-v-meati-obcini-novo-mesto">https://podatki.gov.si/dataset/seznam-osnovnih-sol-v-meati-obcini-novo-mesto</a>	1.12.23	XLSX	DA	DA	DA	NE	NE	/	
POHOJNE POTE PO OBČINI IZOLANA	<a href="https://podatki.gov.si/dataset/pohodne-pote-obcine-izolana">https://podatki.gov.si/dataset/pohodne-pote-obcine-izolana</a>	1.12.23	CSV	DA	DA	DA	NE	NE	/	
POHOJNE POTE PO OBČINI IZOLANA	<a href="https://podatki.gov.si/dataset/pohodne-pote-obcine-izolana">https://podatki.gov.si/dataset/pohodne-pote-obcine-izolana</a>	1.12.23	XLSX	DA	DA	DA	NE	NE	Zaznani format: XLS	

Slika 1: Ročni pregled portala OPSI

Vir: Lasten

Proces izdelave nove metodologije za kvalitativno ocenjevanje odprtih podatkov je potekal v več fazah:

1. Ročni pregled podatkovnih zbirk na portalu OPSI in identifikacija problematik.

2. Iskanje literature na področju kvalitativnega vrednotenja odprtih podatkov. Uporabili smo ključne besede: »odprti podatki«, »metodologija«, »kvaliteta odprtih podatkov« in »ocenjevanje odprtih podatkov«.
3. Nabor in pregled člankov, ki ustrezajo raziskovalni nameri, pri čemer smo jih natančno predelali ter izpisali metodološke principe, problematike ter predloge za rešitve na danem področju.
4. Sinteza vseh izsledkov v obliki novega metodološkega orodja, ki naslavlja obstoječe problematike in izpostavlja potencialne pomanjkljivosti.
5. Jasna opredelitev dimenzij in metrik, preko izračuna katerih dobimo vrednosti, ki predstavljajo rešitve za aktualne problematike.

Tabela 1: Definicije metrik, ustrezne za portal OPSI

Dimenzija	Metrika ( $m$ )	Spremenljivke	Formula	Merilo
Popolnost	Odstotek popolnih celic (Vetrò idr., 2016)	v: število vrstic, s: število stolpcev, cn: število nepopolnih celic, c: število celic	$c = v \cdot s; m_1 = \left(1 - \frac{cn}{c}\right) \cdot 100$	[0 %, 100 %]
	Odstotek popolnih vrstic (Vetrò idr., 2016)	v: število vrstic, vn: število nepopolnih vrstic	$m_2 = \left(1 - \frac{vn}{v}\right) \cdot 100$	[0 %, 100 %]
	Odstotek popolnih stolpcev	s: število stolpcev, sn: število nepopolnih stolpcev	$m_3 = \left(1 - \frac{sn}{s}\right) \cdot 100$	[0 %, 100 %]
Unikatnost	Odstotek popolnosti metapodatkov v podatkovnih zbirkah	m: število metapodatkov, mn: število nepopolnih metapodatkov	$m_4 = \left(1 - \frac{mn}{m}\right) \cdot 100$	[0 %, 100 %]
	Odstotek predvidenih vrednosti v celicah	vr: število vrednosti, vrp: število naključnih vrednosti (črke, številke, simboli itn.)	$m_5 = \left(1 - \frac{vrp}{vr}\right) \cdot 100$	[0 %, 100 %]
	Odstotek nepodvojenih vrstic (Vetrò idr., 2016; Neumaier idr., 2016)	vp: število podvojenih vrstic, v: število vrstic	$m_6 = \left(1 - \frac{vp}{v}\right) \cdot 100$	[0 %, 100 %]
	Odstotek nepodvojenih vrednosti v celicah	pvr: število podvojenih vrednosti, vr: število vrednosti	$m_7 = \left(1 - \frac{pvr}{vr}\right) \cdot 100$	[0 %, 100 %]
	Pearsonov korelacijski koeficient	x: izbrani stolpec, y: stolpec za primerjavo	$\rho_{X,Y} = \frac{cov(X,Y)}{\sigma_X \sigma_Y}$	[-1, 1]
Doslednost	Odstotek pravilno poimenovanih stolpcev	s: število stolpcev, spn: število nepričakovano poimenovanih stolpcev	$m_8 = \left(1 - \frac{spn}{s}\right) \cdot 100$	[0 %, 100 %]
	Odstotek doslednosti podatkovnih tipov	pt: število podatkovnih tipov, ptn: število nepričakovanih podatkovnih tipov	$m_9 = \left(1 - \frac{ptn}{pt}\right) \cdot 100$	[0 %, 100 %]

Dimenzija	Metrika ( <i>m</i> )	Spremenljivke	Formula	Merilo
Uparljivost	Odstotek navedenih podatkovnih tipov	pt: število podatkovnih tipov, ptnm: število navedenih podatkovnih tipov	$m_{10} = \left(1 - \frac{ptnm}{pt}\right) \cdot 100$	[0 %, 100 %]
	Odstotek veljavnih podatkovnih tipov	pt: število podatkovnih tipov, ptnv: število neveljavnih podatkovnih tipov	$m_{11} = \left(1 - \frac{ptnv}{pt}\right) \cdot 100$	[0 %, 100 %]
	Odstotek strojno berljivih podatkovnih zbirk	pz: število podatkovnih zbirk, pzsn: število strojno neberljivih podatkovnih zbirk	$m_{12} = \left(1 - \frac{pzsn}{pz}\right) \cdot 100$	[0 %, 100 %]
Ponovna uporabljivost (MQA)	Odstotek podatkovnih zbirk z licenco	pz: število podatkovnih zbirk, pzbl: število podatkovnih zbirk brez licence	$m_{13} = \left(1 - \frac{pzbl}{pz}\right) \cdot 100$	[0 %, 100 %]
	Odstotek podatkovnih zbirk s kontaktno točko	pz: število podatkovnih zbirk, pzbkt: število podatkovnih zbirk brez kontaktne točke	$m_{14} = \left(1 - \frac{pzbkt}{pz}\right) \cdot 100$	[0 %, 100 %]
	Odstotek podatkovnih zbirk z informacijo o izdajatelju	pz: število podatkovnih zbirk, pzbi: število podatkovnih zbirk brez informacije o izdajatelju	$m_{15} = \left(1 - \frac{pzbi}{pz}\right) \cdot 100$	[0 %, 100 %]
Natančnost	Odstotek sintaktično natančnih celic (Vetrò idr., 2016)	cn: število celic z napakami (šumniki, posebni znaki, številke itn.), c: število celic	$m_{16} = \left(1 - \frac{cn}{c}\right) \cdot 100$	[0 %, 100 %]
Razumljivost	Jasnost poimenovanja	p: podatki, pt: podatkovni tipi, spsp: sintaktično natančna in semantično ustrezna pravila za poimenovanje	Uporaba NLP (Natural Language Processing) (Chowdhary idr., 2020) ali ročno preverjanje podatkov za dodelitev točk jasnosti.	Subjektivno [0, 5]
	Odstotek stolpcev v razumljivem podatkovnem tipu	snpt: število stolpcev v nerazumljivem podatkovnem tipu, s: število stolpcev	$m_{17} = \left(1 - \frac{snpt}{s}\right) \cdot 100$	[0 %, 100 %]
Aktualnost	Zamuda v objavi (Vetrò idr., 2016)	ddi: datum dostopnosti informacij, do: datum objave, zd: začetni datum obdobja obstoja podatkovne zbirke, kd: končni datum obdobja obstoja podatkovne zbirke	$ddi = kd + 1; m_{18} = 1 - \frac{do - kd}{kd - zd}$	$(-\infty, 1]$
Skladnost	Skladnost z eGMS (Vetrò idr., 2016)	v: vir, di: datum izdelave, k: kategorija, n: naslov, o: opis, id: identifikator, iz: izdajatelj, j: jezik	$m_{19} = v + di + k + n + o + id + iz + j$	[0, 8]
	Petvezdični odprti podatki (Berners-Lee, 2006)	dpol: dostopnost podatkov v formatu z odprto licenco, psb: podatki v strojno berljivi obliki, dpnf: dostopnost podatkov v nelastniškem formatu, uosi: uporaba odprtih standardov organizacije W3C ter URI za identifikacijo, kp: kontekstualizacija podatkov ter ostalih dostopnih podatkov	$m_{20} = dpol + psb + dpnf + uosi + kp$	[0, 5]
Sledljivost	Sled izdelave (Vetrò idr., 2016)	v: vir, di: datum izdelave	$m_{21} = v + di$	[0, 2]
	Sled posodobitev (Vetrò idr., 2016)	sp: seznam posodobitev, dp: datum posodobitev	$m_{22} = sp + dp$	[0, 2]

Vir: Lasten

### 3.1 Definicije dimenzij in metrik

Zaradi široke in splošno uporabne zasnove metodologije SPDQM (Vetrò idr., 2016; Moraga idr., 2009) smo iz nje prevzeli nekatere dimenzije, metrike, spremenljivke in formule, pri čemer smo nekatere določili na podlagi ročnega pogleda, druge pa smo pridobili iz ostalih okvirjev, označenih v Tabela 1. Ker predlagana metodologija temelji tako na metodologijah, ki so usmerjene v splošno obravnavo, kot tudi tistih, ki so prilagojene specifičnim kontekstom, lahko pričakujemo ugodne rezultate znotraj konteksta portala OPSI.

#### 3.1.1 Popolnost

Dimenzija, ki določa, do katere stopnje podatki vsebujejo vrednosti za vse pričakovane značilnosti:

- Odstotek popolnih celic.
- Odstotek popolnih vrstic.
- Odstotek popolnih stolpcev.
- Odstotek popolnosti metapodatkov v podatkovnih zbirkah: metrika je izračunana na podlagi števila metapodatkov in števila manjkajočih metapodatkov.
- Odstotek predvidenih vrednosti v celicah: označuje odsotnost naključnih vrednosti v celicah znotraj podatkovnih zbirk. Spremenljivki za izračun metrike sta število vrednosti in število naključnih vrednosti, kot so naključne črke, številke, posebni znaki itd., pri čemer vsakršno odstopanje znotraj celice velja kot naključna vrednost.

#### 3.1.2 Unikatnost

Dimenzija, ki določa, do katere stopnje so podatki edinstveni:

- Odstotek nepodvojenih vrstic.
- Odstotek nepodvojenih vrednosti v celicah: izračunan na podlagi podvojenih vrednosti v celicah znotraj podatkovne zbirke.



- Pearsonov korelacijski koeficient: opisuje, do katere stopnje sta v podatkovnih zbirkah povezana dva različna stolpca. Spremenljivki za izračun metrike sta izbrani stolpec in stolpec za primerjavo. Da bi izračunali Pearsonov korelacijski koeficient, kovarianco stolpcev delimo s standardnima odklonoma stolpcev.

### 3.1.3 Doslednost

Dimenzija, ki določa, do katere stopnje se podatki pojavljajo v enaki obliki:

- **Odstotek pravilno poimenovanih stolpcev:** predstavlja stolpce, ki so poimenovani brez slovničnih napak in s šifrantom oz. besedilom in je izračunan na podlagi števila nepričakovano poimenovanih stolpcev.
- **Odstotek doslednosti podatkovnih tipov:** v procentih označuje doslednost uporabe podatkovnih tipov v podatkovnih zbirkah. Število nepričakovanih podatkovnih tipov, ki je poleg števila vseh uporabljenih podatkovnih tipov spremenljivka za izračun metrike, predstavlja podatkovne tipe, ki niso predvideni za področje določene podatkovne zbirke.

### 3.1.4 Uparljivost

Dimenzija, ki določa, do katere stopnje se podatki med seboj povezujejo:

- **Odstotek navedenih podatkovnih tipov:** v procentih označuje prisotnost navedenih podatkovnih tipov v podatkovnih zbirkah. Število navedenih podatkovnih tipov, na podlagi katerega izračunamo metriko, označuje podatkovne tipe (zaporedna številka, datum, ime občine itd.), ki ne obstajajo znotraj podatkovne zbirke.
- **Odstotek veljavnih podatkovnih tipov:** v procentih označuje prisotnost veljavnih podatkovnih tipov v podatkovnih zbirkah. Število neveljavnih podatkovnih tipov, na podlagi katerega izračunamo metriko, označuje podatkovne tipe (zaporedna številka, datum, ime občine itd.), ki vsebujejo napake v zapisu znotraj podatkovne zbirke.
- **Odstotek strojno berljivih podatkovnih zbirk.**

### 3.1.5 Ponovna uporabljivost

Dimenzija, ki določa, do katere stopnje so podatki bodočim uporabnikom na voljo za ponovno uporabo. Navedene metrike so zasnovane za uporabo na nivoju portala in ne za posamezne podatkovne zbirke:

- Odstotek podatkovnih zbirk z licenco.
- Odstotek podatkovnih zbirk s kontaktno točko: v procentih označuje, do katere stopnje so v podatkovnih zbirkah prisotni kontaktni podatki v primeru, da ima uporabnik vprašanja glede podatkov in se želi obrniti na lastnika.
- Odstotek podatkovnih zbirk z informacijo o izdajatelju.

### 3.1.6 Natančnost

Dimenzija, ki določa, do katere stopnje se podatki zanesljivo pojavljajo v pravilni obliki in ne dopuščajo napak:

- **Odstotek sintaktično natančnih celic:** spremenljivki za izračun metrike sta število celic z napakami pri kodiranju (pretvorba šumnikov in posebnih znakov) in skupno število celic.

### 3.1.7 Razumljivost

Dimenzija, ki določa, do katere stopnje so podatki razumljivi in enostavni za uporabo:

- **Jasnost poimenovanja:** ocenjuje, do katere subjektivne stopnje je v podatkovnih zbirkah prisotna jasnost poimenovanja. Spremenljivke, ki predstavljajo predpogoj oz. so upoštevane za sistem točkovanja, so podatki (p), podatkovni tipi (pt) ter sintaktično natančna in semantično ustrezna pravila za poimenovanje (sspp). Da bi izračunali jasnost poimenovanja, moramo pri podatkih in podatkovnih tipih upoštevati sintaktično natančna in semantično ustrezna pravila za poimenovanje.

- **Odstotek stolpcev v razumljivem podatkovnem tipu:** v procentih označuje prisotnost stolpcev v razumljivem podatkovnem tipu v podatkovnih zbirkah. Število nerazumljivih podatkovnih tipov, ki je poleg števila stolpcev spremenljivka v formuli za izračun metrike, predstavlja podatkovne tipe, pri katerih na podlagi danega imena ni razumljivo označeno, katere podatke vključujejo.

### 3.1.8 Aktualnost

Dimenzija, ki določa, do katere stopnje so podatki objavljeni pravočasno:

- **Zamuda v objavi:** opisuje, od kdaj do kdaj so bili določeni podatki dostopni.

### 3.1.9 Skladnost

Dimenzija, ki določa, do katere stopnje so podatki skladni z določenimi standardi:

- **Składnost z eGMS:** opisuje, do katere mere so podatkovne zbirke skladne z e-Government Metadata Standard.
- **Petzvezdični odprti podatki:** ocenjuje skladnost podatkovnih zbirk s pogoji petzvezdičnega sistema za ocenjevanje, pri čemer je vsaka podatkovna zbirka vrednotena s toliko zvezdicami, kot izpolnjuje pogojev.

### 3.1.10 Sledljivost

Dimenzija, ki določa, do katere stopnje je mogoče spremljati sledi podatkovnih zbirk:

- **Sled izdelave:** spremlja število sledi o izdelavi podatkovne zbirke.
- **Sled posodobitev:** spremlja število sledi o posodobitvah podatkovne zbirke.

## 4 Zaključek

Jasno je, da je kvalitativno ocenjevanje odprtih podatkov problematično. Idealu se najbolj približajo Vetrò idr. (2016), ki poskušajo zajeti rešitve, ki bi delovale v splošnem, na ključnih portalih, hkrati pa tudi na posamičnih portalih. Ker smo pri gradnji metodologije upoštevali mnoge predloge iz pregleda literature, lahko trdimo, da metodologija upošteva širok in raznolik spekter problematičnih aspektov. Poleg izdelave nove metodologije je smiselno tudi preveriti njeno učinkovitost z avtomatiziranim orodjem, ki bi tako kot pri metodologiji LANG (Zhang idr., 2019) dalo skoraj identične rezultate ročnemu pregledu, pri čemer bi z manjšim časovnim naporom hkrati zagotovili višjo kvaliteto in zanesljivost rezultatov. Pod to uvrščamo tudi predlog MQA, ki poziva k nujnosti rednega preverjanja podatkov in po zadnjem pregledu še ponovnega preverjanja dostopnosti, s čimer zagotovimo aktualnost in ažurnost podatkovnega portala.

Z ubranim pristopom smo izčrpno in široko zajeli predloge in rešitve tujih metodologij na osnovi različnih podatkovnih portalov. Predlagali smo rešitve za problematike, ki so prisotne na specifičnem portalu OPSI, ter odprli pot za nadaljnje raziskovanje na področju kvalitativnega vrednotenja odprtih podatkov, hkrati pa z metodologijo vzpostavljamo podlago za izdelavo avtomatiziranega orodja za preverjanje podatkovnih zbirk.

### Priznanje

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# TRAILBLAZING SUSTAINABILITY: LESSONS FROM UNIVERSITY EFFORTS SO FAR

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Universities are pivots not only of knowledge but also of their practices, which must be sustainable in an age of environmental crisis and thus set an example for others because the academy has always been a beacon and guide, even in the most difficult times. Universities should also educate and "shape" the students who will be our future and the decision-makers who will impact us all. Bearing this in mind, the authors of the paper have decided to outline the examples of beneficial sustainable practices of the universities with special reference to the sustainable mobility practices of university students and employees because of their impact in the fight against climate change. In this way, the existing practices, as case studies that can be applied outside the institutions where they started, pave the way for other universities to include the improvement of sustainability as a necessary goal in their strategies.

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## 1 Introduction

*"Happiness can be found even in the darkest of times, if one only remembers to turn on the light."* – J.K. Rowling

Sustainability, sustainable development (SD), and attaining the Sustainable Development Goals (SDGs) have become vital, necessary, and sufficient states for civilisation to move on from the "environmental mess" it created and exist in the long run. On this path of survival, universities are pivots not only of knowledge but also of their own practices, which must be sustainable and thus "lead by example" (Amaral et al., 2015), because the academy has always been a beacon and guide even in the most difficult times.

The planet's future growth must be based on the preservation of "natural capital" (air, water, and other environmental resources) while preserving a balance between human activity and nature's ability to replenish itself. "Environmental concerns" should be addressed in all major plans, programs, and processes for social progress. Existing environmental crises require holistic environmental education, and that is why at the 1972 United Nations Conference on the Human Environment, it was recommended in the 19<sup>th</sup> Principle of the The Stockholm Declaration that all nations promote environmental education, which must be adequate as well as quality, "developed in accordance with the principles of sustainability with the aim of including environmental issues in order to expand the basis for responsible behavior of individuals, organizations, and communities in the protection and improvement of the environment" (United Nations [UN], n.d.).

For these reasons, today's societies demand high-quality education programs that promote sustainability and environmental protection (Petrović, 2024). This demonstrates the crucial and essential role that universities play as higher education institutions that educate and "shape" the students who will be our future and the decision-makers and leaders who will impact us all. According to Gaitán-Angulo and others (2022) "universities, being the training center for future professionals and agents of change, have the responsibility to provide society with professionals who, in the exercise of their profession, meet our current needs without compromising the possibilities of future generations to respond to theirs". In addition "by demonstrating best practice in their operations, research and teaching, universities



have both multiple and multiplier effects on society" (Ralph & Stubbs, 2013). We need to keep in mind the so-called "third mission of the university" - trying to enhance people's lives and solve global concerns (Sady et al., 2019).

To this it should be added that universities have "played an instrumental role in encouraging SD, whether that be through education, research, operations, community partnerships, and more" (vanessalevesque, n.d.). Other universities might include sustainability improvement as a crucial aim in their goals and strategies by implementing current sustainable university practices. These strategies describe universities' approaches to sustainability, as well as key commitments such as achieving net zero carbon, improving low-carbon travel, increasing environmental performance, promoting sustainability in teaching and learning, research, and innovation, and reducing negative operational environmental impact. In this way, universities, as higher education institutions, outline their sustainability initiatives and show a way to balance economic and social progress with a concern for the environment and preserving natural resources.

## 2 Sustainable University

Every university is distinct and, as a result, addresses sustainability issues in a varied manner. Also, each university faces different challenges in its efforts to be sustainable and introduce sustainability in higher education (HE). Table 1 lists these challenges.

There is no generally applicable concept of a sustainable university, just as there is no single answer to sustainability challenges, but rather a diversity of approaches (vanessalevesque, n.d.). Some of definitions of sustainable university are:

- Sustainable university is "a higher educational institution, as a whole or as a part, that addresses, involves and promotes, on a regional or a global level, the minimization of negative environmental, economic, societal, and health effects generated in the use of their resources in order to fulfill its functions of teaching, research, outreach and partnership, and stewardship in ways to help society make the transition to sustainable lifestyles" (Velazquez et al., 2006).

- A sustainable university is an institution that incorporates sustainable practices into many sections of its curricula while also encouraging students, staff, and visitors to evaluate and minimise the impact that they have on the planet (Celikdemir et al., 2017).
- Sustainable universities educate future generations, promote research initiatives, and engage with external organisations to maintain the community's long-term viability in terms of the environment, economy, and society (Sonetti et al., 2016).
- Sustainable universities contribute to SD both locally and globally (Bhowmik et al., 2018).
- Sustainable universities educate global citizens on how they may contribute to SD via their lives, careers, and overall life choices (The UNEP Sustainable University Framework, n.d.).

**Table 1: Challenges of sustainability in HE**

Introducing sustainability in higher education			
Challenges to introducing sustainability into HE	Terminological challenges	Teaching and learning challenges	Curriculum orientation
Planning and implementing organizational changes in university	Ensuring a shared understanding of sustainability and related concepts	Creating sustainability-related dynamic learning processes	Choosing among the inter-disciplinary, horizontal (across different courses), vs. vertical curricular approach (by introducing separate, specialized courses)
Introducing changes into university management	Developing new sustainability-related HE concepts	Introducing problem-solving teaching and learning methods	Choosing among the cross-disciplinary (isolated, task-specific integration across courses), vs. inter-disciplinary (topic-specific integration across courses, including sharing of methods), vs. multi-disciplinary (field-specific integration across courses, retaining specific fields and methods within disciplines), vs. trans-disciplinary approaches (focusing on inclusiveness and real-world problems, transgressing the HE disciplines)
Ensuring stakeholder involvement	Addressing the lack of university staff and administrators' sustainability knowledge	Shifting content-centered HE teaching and learning toward the student-centered approach	
Ensuring sustainability leadership and shared values	Addressing the lack of university staff and administrators' competencies to generate and implement innovative concepts	Ensuring the active role of students in academic teaching and learning	

Source: Alfirić et al. (2024), Figueiró and Raufflet (2015)

## 2.1 Sustainable University Model

According to the author, Velazquez, and others (2006), the development of the model of a sustainable university has four phases:

- "Phase one: Developing a sustainability vision for the university.
- Phase two: The mission statement.
- Phase three: Sustainability committee: creating policies, targets, and objectives.
- Phase four: Sustainability strategies (education, research, outreach and partnership, sustainability on campus)."

This model (Figure 1) highlights that sustainability activities should be based on continual improvement: Plan – Do – Check – Act and "should be made through incremental steps" (Velazquez et al., 2006), as well as stated by Lozano (2004).

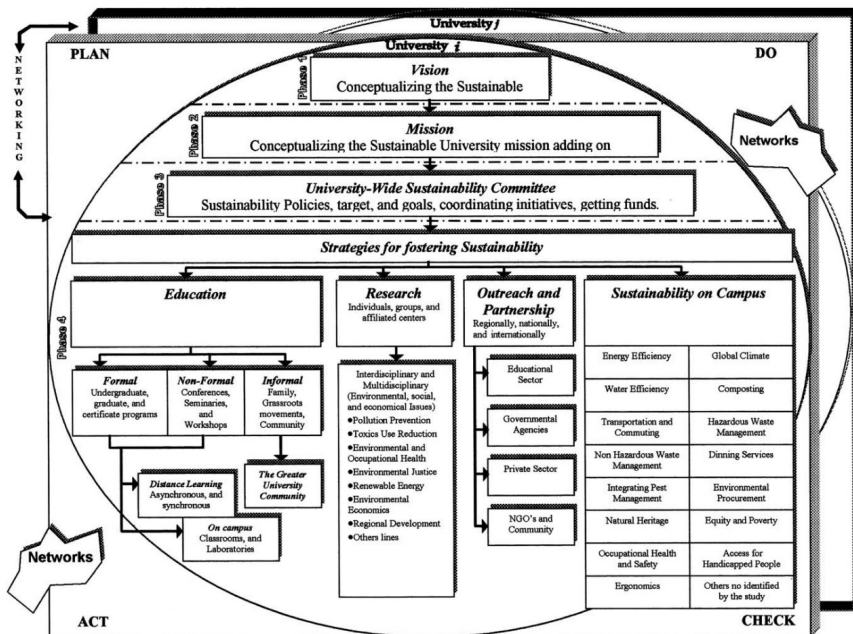


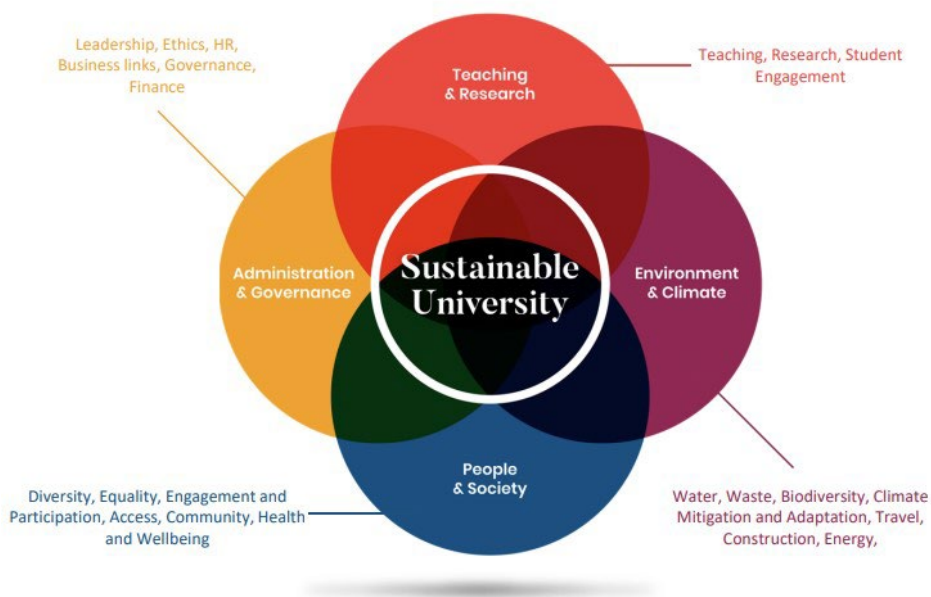
Figure 1: Sustainable university model

Source: Velazquez et al. (2006)

UNEP's Sustainable University Framework (2021) recognises four core areas of a sustainable university model (Figure 2):

- "1. Teaching and Research.
- 2. People and Society.
- 3. Environment and Climate.
- 4. Administration and Governance."

These four core areas are utilised to calculate a university's quadruple bottom line. Figure 2 also lists common aspects included in these universities' core areas (leadership, ethics, HR, business links etc.).



**Figure 2: Sustainable university four core areas**

Source: United Nations Environment Programme - UNEP (2021)

## **2.2 Sustainability Reporting at Universities**

Sustainable reporting (SR) displays universities' commitment to SD, SDGs, and sustainability and can motivate other higher education institutions to take similar activities and responsibilities for their own actions towards a more sustainable future. Universities can also use SR as a tool for promoting cooperation and partnerships with other organisations or stakeholders in gained efforts for achieving SDGs (Strategist & Strategist, 2024).

In general, SR can be defined as "the process of communicating an organization's sustainability performance to stakeholders" (Kazemi et al., 2023; Kolk & Pinkse, 2006). SR gives information on the environmental, social, and financial implications, as well as efforts to achieve sustainability.

There are different frameworks and guidelines for SR such as the GRI, Sustainability Accounting Standard Boards (SASBs) and Integrated Reports (IR). They refer to non-financial reporting and therefore can be applied at universities (De Villiers et al., 2022; Purcell et al., 2019; Yang et al., 2019). The GRI principles are the most often used and implemented as a framework for SR in universities, particularly in Europe (Del Mar Alonso-Almeida et al., 2014; González et al., 2017). According to QS World University Rankings 2025: Sustainability 2025 (QS International, 2025), there are 1,744 ranked higher education institutions in the field of sustainability, especially in the areas of their environmental and social impact, as well as governance.

When it comes to universities' SR, their sustainability frameworks commonly include the following areas: Teaching and Learning, Research, Operations and Infrastructure, Engagement & Partnerships, and SDGs. In most cases, priority initiatives and commitments to improvement include climate change, energy efficiency, green building, transportation and travel, food, procurement, waste, plastic-free, water, general sustainability performance assessment, health and well-being, biodiversity, land use plan, justice, equity, diversity, inclusion...

### 3 Sustainable Mobility in Higher Education: Case Studies of Improvements in Transport and Travel Practices

"By adopting eco-friendly practices, such as reducing carbon emissions, conserving water, and protecting biodiversity, sustainable travel contributes to the preservation of delicate ecosystems and helps combat climate change" (Partners, 2024). Climate changes represent the worst environmental crisis because they are causing a climate crisis of the global ecosystem of the planet Earth.

When it comes to transport at universities, it must be noted that all SRs emphasise the need for sustainable university transportation, including business, staff, and student travel, having in mind their responsibilities for tonnes of CO<sub>2</sub> equivalent (CO<sub>2</sub>e) emissions per year (e.g., ca. 97,000tCO<sub>2</sub>e at Imperial College London (2024), which made up 10% of the university's carbon footprint, as much as its electricity consumption). University transport involves business travel and travelling by car and includes all local, national, and international travel taken on behalf of the university.

As a result, universities proposed the following opportunities for implementing sustainable mobility:

- Implementation of Sustainable Travel Policy (principles: "avoidance of air travel for national travel, with a limited number of exceptions where air travel is required; flight class is restricted to economy class, unless for health reasons or disability; first-class air travel is not allowed for any reason; support the uptake of first-class and direct flights, and sleeper rail or coach services where practical" (The University of Edinburgh, 2025)).
- Active travel can be achieved by developing sustainable travel facilities such as bike racks, repair stations, and water refill points, ensuring safety and security, providing cycle hire and maintenance services, hosting e-bike docking stations, offering adult bike training, offering discounts, and purchasing second-hand bikes (University of Leeds, 2025).
- Using public transport.
- Opportunities for more sustainable travelling by car (driving to the university is not encouraged): limited car parking, using electric vehicles along with electric car charging points at the university, carpooling/lift sharing, car hire.

- Virtual meetings for reducing emissions with the support of Microsoft Teams, Zoom..., hosting a virtual or hybrid conference.
- Promotion of using mobile applications for sustainable mobility of students and university staff.

## 4 Conclusion

Universities can and should play an important role in making society more sustainable by teaching and developing world leaders, as well as researching to allow a sustainable future. In general, a sustainable university should demonstrate its commitment to sustainability by not only teaching students about the notion and philosophy of SD, but also integrating this concept into daily organisational management. Moving forward, universities must build on the findings of previous studies and continue to engage in sustainable practices (Radaković et al., 2024).

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# INTERNI AKTI IN PRAVNI PROCESI V ORGANIZACIJAH TER UMETNA INTELIGENCA

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Interni akti avtonomnega prava zajemajo pravotvorno dejavnost sprejemanja pravnih norm in nadzora nad njihovim izvrševanjem v samoupravnih organizacijah in skupnostih. V njihovem delovanju se manifestirajo potrebe organizacij civilne družbe ter njihovih članov glede pravne varnosti in enakosti. Na splošno velja, da vsebino avtonomnih pravnih norm oblikujejo samoupravni subjekti v okviru ustave in zakonov. Umetna inteligenca s svojimi algoritmi nudi velike možnosti pri pripravi splošnih aktov, ugotavljanju njihove skladnosti z zakonodajo, njihovem posodabljanju in avtomatiziranju nadzora nad njihovim izvrševanjem. Ob vsej nesporni koristi orodij umetne inteligence za pripravo odločitev, mora ostati končna pravna odločitev v rokah človeka, njegovega razuma in njegove odgovornosti.

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# INTERNAL ACTS AND LEGAL PROCESSES IN ORGANIZATIONS AND ARTIFICIAL INTELLIGENCE

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Internal acts of autonomous law cover the law-making activity of adopting legal norms and controlling their enforcement in self-governing organizations and communities. In their operation, the needs of civil society organizations and their members regarding legal security and equality are manifested. In general, it is considered that the content of autonomous legal norms is formed by self-governing entities within the framework of the constitution and laws. Artificial intelligence with its algorithms offers wide possibilities in the preparation of general acts, determining their compliance with legislation, updating them and automating the control over their execution. Despite all the undeniable benefits of artificial intelligence tools for legal work, the final decision must remain in the hands of man, his intellect and his responsibility.



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## 1 Uvod

Interni akti avtonomnega prava zajemajo bolj ali manj samostojno v razmerju do države pravotvorno dejavnost sprejemanja pravnih norm in nadzora nad njihovim izvrševanjem v samoupravnih organizacijah in skupnostih, od lokalnih skupnosti, preko gospodarskih družb do najrazličnejših društev in drugih nevladnih organizacij. V njihovem delovanju se manifestirajo potrebe organizacij civilne družbe ter njihovih članov pri zasledovanju ciljev in namena delovanja, obenem pa tudi zagotavljanja pravne varnosti in enakosti v notranjih razmerjih. Tako notranji pravni akti določajo pristojnosti in postopke, ki jih izvajajo notranje enote in posamezni deli organizacije. S tem zagotavljajo predvidljivost in relativno stabilnost ter varnost notranjih razmerij ter procesov vodenja in upravljanja v organizaciji.

Na splošno velja, da vsebino avtonomnih pravnih norm oblikujejo samoupravni subjekti v okviru ustave in zakonov, znotraj tega pravnega okvira pa so ti subjekti pri postavljanju prava in procesih njihovega izvrševanja svobodni. Pri tem je potrebno dodati in izpostaviti še posamezne statute, ki jih lahko ima samoupravna organizacija v posameznem pravnem redu. To so na primer status nevladne organizacije v javnem interesu<sup>1</sup>, drugi z zakonom podeljeni statusi organizacije, kot npr. status krovne športne organizacije<sup>2</sup>. Status v obliki neposrednega ali posrednega članstva, in s tem dodaten okvir normiranja, pa lahko pridobi organizacija tudi v združenju organizacij na posameznem področju civilnega in svobodnega združevanja ljudi, kot je na primer članstvo športne organizacije v nacionalni panožni športni zvezi, le te pa v mednarodni športni zvezi kot je na primer Mednarodni olimpijski komite, Evropska nogometna zveza, Svetovna nogometna zveza, itd. (Prezelj v Rakočević Bergant et. 2020, str. 25-41). Ali pa npr. članstvo gospodarske družbe v cehovskem združenju, kot je na primer Gospodarska zbornica Slovenije<sup>3</sup>, itd.. Vsi ti statusi imajo tako neposreden ali posreden vpliv na pravotvornost posamezne organizacije (Chappelet 2010, str. 41-47). Z drugimi besedami to pomeni, da imajo tako organizacijsko kot tudi zunanje pravno okolje kot sta npr. državna zakonodaja ali pravo Evropske unije vpliv na interne pravne akte samoupravnih organizacij. Ob pozitivno pravni zakonodaji, ki lahko pogojuje ali omejuje pravotvornost samoupravne organizacije, ne smemo zanemariti tudi

<sup>1</sup> 6. čl. Zakon o nevladnih organizacijah (Ur. l. RS 21/18).

<sup>2</sup> 41. in 42. čl. Zakon o športu (Ur. l. RS 29/17).

<sup>3</sup> Za več glej Zakon o gospodarskih zbornicah (Ur. l. RS 60/06, 110/09 in 77/11).

vpliva odločitev različnih sodišč na pravno prakso in razvoj pravnega sistema in s tem posledično tudi na normativno dejavnost posamezne samoupravne organizacije ter človekovih pravic kot osnovnih načel sodobne družbe.

Kadar govorimo o umetni inteligenci je potrebno opredeliti pojem, kaj z njim razumemo in s katerega zornega kota proučujemo predmet ali pojav. Iz našega razumevanja in za potrebe tega članka umetna inteligenca predstavlja neko intelektualno delo, ki ga izvede računalnik oz. tehnološko orodje. Nenazadnje na to nakazuje jezikovna razlaga samega izraza, ki je opredeljen kot neko bolj ali manj »intelektualno delo«<sup>4</sup>. Prav slednje predstavlja pomemben razločevalni element od drugih tehnoloških orodij, ki nam jih nudi moderna tehnologija, kot so npr. t.i. pametne pogodbe »smart contracts« na »blockchain« verigah. Pri slednjih gre za pogodbe - pogodbene kode, ki so samo izvršljive ob nastopu določenega dejstva, ki je pre-determinirano in zajeto v vsebini pogodbe.<sup>5</sup> Drugače pa umetna inteligenca s svojimi algoritmi oziroma modeli učenja nudi velike možnosti v postopku pravotvornosti posamezne organizacije na način, da pomaga pri pripravi splošnih aktov, ugotavljanju njihove skladnosti z zakonodajo, njihovem posodabljanju in avtomatiziranju nadzora nad njihovim izvrševanjem.

Prav intelektualni doprinos orodij umetne inteligence predstavlja veliko pomoč pri analizi vhodnih podatkov in pripravi osnutkov pravnih aktov. Pri samodejnem odločanju pa mora biti navzoč človekov nadzor zaradi zagotavljanja pravne varnosti oziroma zaščite pravic posameznikov in organizacij (fizičnih in pravnih oseb). Ob vsej nesporni koristi orodij umetne inteligence za pripravo odločitev (Kerrigan, 2022, str. 23), mora torej ostati končna pravna odločitev, ki predstavlja spremembo pravnega stanja za posameznika ali organizacijo, v rokah človeka, njegovega razuma in njegove odgovornosti.<sup>6</sup> Prav zagotovitev temeljnih načel, etičnosti, varnosti, demokratičnosti in interesov družbe, kot osnove za področje delovanje umetne

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<sup>4</sup> Dostopno na <https://fran.si>, dne 9.1.2025.

<sup>5</sup> De Filippi, P., Wray, C., & Sileno, G. (2021). Smart contracts.

Internet Policy Review, 10(2), <https://doi.org/10.14763/2021.2.1549>, dostopno dne 9.1.2025.

<sup>6</sup> Podobno npr. Kranjc, 2024, str. 567: »Čeprav lahko tehnologija prevzame marsikatero rutinsko nalogo, bodo le ljudje lahko odločali o subtilnih vprašanjih, kaj je pravični in kaj ne. Potrebno bo veliko modrosti in previdnosti, da bomo lahko ustvarjalno vključili v pravno delo te dragocene tehnološke dosežke in hkrati preprečili njihove zlorabe in negativne učinke.«

inteligence sta zasledovala tudi Evropski parlament in svet, ki sta sprejela Uredbo (EU) 2024/1689 o določitvi harmoniziranih pravil o umetni inteligenci.<sup>7</sup>

## 2 Vrste internih aktov

Pri avtonomnem pravnem urejanju odnosov v organizaciji so nekateri akti obvezni že po zakonu. To so:

- Temeljni akt oziroma družbena pogodba organizacije<sup>8</sup>,
- Pravilnik o promociji zdravja na delovnem mestu<sup>9</sup>,
- Pravilnik o prepovedi alkoholiziranosti in dela pod vplivom prepovedanih substanc – s postopki preverjanja<sup>10</sup>,
- Pravilnik o prepovedi mobinga<sup>11</sup>,
- Akt o sistemizaciji delovnih mest (če je več kot 10 zaposlenih)<sup>12</sup>,
- Pravilnik o računovodstvu<sup>13</sup>,
- Pravilnik o varstvu osebnih podatkov<sup>14</sup>.

Polega tega pa sprejemajo ljudje v organizacijah še številne interne akte, ki niso neposredno zahtevani po zakonu, ki pa omogočajo urejenost notranjih organizacijskih razmerij, odnosov in procesov kot na primer :

- Pravilnik o delovnih razmerjih,
- Pravilnik o plačah in drugih prejemkih iz delovnega razmerja,
- Pravilnik o letnem dopustu,

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<sup>7</sup> Uredba (EU) 2024/1689 Evropskega parlamenta in Sveta o določitvi harmoniziranih pravil o umetni inteligenci in spremembi uredb (ES) št. 300/2008, (EU) št. 167/2013, (EU) št. 168/2013, (EU) 2018/858, (EU) 2018/1139 in (EU) 2019/2144 ter direktiv 2014/90/EU, (EU) 2016/797 in (EU) 2020/1828 (Akt o umetni inteligenci) z dne 13. junija 2024, dostopno na [https://eur-lex.europa.eu/legal-content/SL/TXT/HTML/?uri=OJ:L\\_202401689](https://eur-lex.europa.eu/legal-content/SL/TXT/HTML/?uri=OJ:L_202401689), dostopno dne 11.1.2025.

<sup>8</sup> 4. člen Zakona o društvih (Ur. l. RS 64/11) in npr. 137. čl. Zakona o gospodarskih družbah (Ur. l. RS 65/09).

<sup>9</sup> 6. čl. Zakona o varnosti in zdravju pri delu (Ur. l. RS 43/11).

<sup>10</sup> 51/3 čl. Zakona o varnosti in zdravju pri delu :« Delodajalec ugotavlja stanje iz prvega odstavka tega člena po postopku in na način določenima z internim aktom delodajalca.»

<sup>11</sup> 47. čl. Zakona o delovnih razmerjih (Ur. l. RS 21/13).

<sup>12</sup> 22/2 čl. Zakona o delovnih razmerjih: »Delodajalec je dolžan s splošnim aktom določiti pogoje za opravljanje dela na posameznem delovnem mestu oziroma za vrsto dela. Ta obveznost ne velja za manjše delodajalce.«

<sup>13</sup> 52. čl. Zakona o računovodstvu (Ur. l. RS 23/99): »Pravne osebe uredijo naloge in organizacijo računovodstva ter pravice in odgovornosti pooblaščenih oseb za razpolaganje z materialnimi in finančnimi sredstvi v pravilniku o računovodstvu.

<sup>14</sup> 24. in 25. čl. Splošne uredbe Evropskega parlamenta in Sveta z dne 27. 4. 2016 (EU 216/679), 48. čl. Zakona o delovnih razmerjih.

- Pravilnik o varovanju poslovne skrivnosti,
- Pravilnik o službenih potovanjih,
- Pravilnik o delu od doma ipd.

Navedeni akti tvorijo notranji sistem pravil organizacije. Zato morajo biti pripravljene po načelih dobrega pravnega urejanja in nomotehnično dorečeni ter usklajeni z ustavo in zakoni<sup>15</sup>. Poleg tega je zahtevana tudi njihova medsebojna usklajenost, koherentnost oziroma neprotislovnost. Ob tem je pomembno še dejansko izvajanje notranjih splošnih pravnih aktov v vsakodnevni odnosih med ljudmi in pri izvajanju (pravnih) procesov, ki so potrebni za doseganje ciljev organizacije. Prav kompleksnejša struktura pravnega urejanja organizacije in reševanje sporov v organizaciji omogoča jasnejše zasledovanje ciljev organizacije in doseganje dolgoročnejših ter kompleksnejših ciljev te organizacije (Barber 2010 str. 27 - 30).

Kadar vključimo v oblikovanje internih aktov orodja umetne inteligence, morajo biti algoritmi, ki so namenjeni učenju umetne inteligence pravilno zasnovani in vključevati - v smislu bazičnih navodil za izvedbo neke operacije - najprej načela dobrega pravnega urejanja (3.1) in potem metodične prijeme nomotehnike (3.2) ter mehanizme za ugotavljanje dejanske skladnosti ravnanja z normativnimi okviri (3.3).

### 3.1 Načela pravnega urejanja

Za pravno urejanje notranjih odnosov v organizaciji in njenih razmerij z drugimi organizacijami je treba upoštevati vsa načela dobrega pravnega sistema. Izhodišče lahko predstavlja načelo restriktivnosti, ki je v slovenski Resoluciji o normativni dejavnosti ubesedeno kot napotek, naj s pravnimi normami urejamo razmerja »...le v primerih, ko zastavljenih ciljev ni mogoče uresničiti na drug način...«<sup>16</sup>. Pri tem so pomembna tudi resolucijska vodila o sorazmernosti in samoomejevanju ter načelo o potrebnosti in jasnosti pravnega normiranja.

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<sup>15</sup> Za pripravo državnih predpisov je bil že v prejšnjem desetletju vzpostavljena aplikacija oziroma modularno ogrodje za pripravo elektronskih dokumentov – MOPEd – v katerem se lahko pripravljajo besedila predpisov in pripadajoči dokumenti, ki spremljajo postopek priprave splošnega pravnega akta.

<sup>16</sup> Resolucija o normativni dejavnosti (ReNDcj, Ur. l. RS 95/09).



Za odločitve, katere družbene odnose je treba vnaprej urediti z zakonom ali pa s kakšno drugo vrsto splošnih pravnih aktov, je nujno slediti resolucijskemu načelu potrebnosti normiranja<sup>17</sup> ter upoštevati izoblikovane strokovne podlage pravne teorije in prakse ter dejanske družbene razmere v konkretni globalni družbi. V iskanju sredine med subnormiranostjo (podnormiranjem) in hipernormiranostjo (prenormiranjem) se je bolje nagibati na stran manjšega obsega pravnega normiranja. Več prostora kaže prepustiti drugim vrstam družbenih norm kot so morala, običaji, strokovna pravila določenih področij človekove dejavnosti in spontanemu ravnanju ljudi, njihovim izkušnjam in racionalnosti. Pravo sicer res posega v eksistenčno pomembne in potencialno konfliktno družbene odnose, vendar je le »ultima ratio«, t. j. skrajno sredstvo za njihovo oblikovanje in urejanje.

Načelo sorazmernosti opozarja na proporcionalnost pri predpisovanju obveznosti, kar zahteva tudi izbiro med različnimi vrstami splošnih pravnih aktov, s katerimi urejamo družbene odnose. Pri tem gre za politično in strokovno zahtevna vprašanja razmejevanja med ustavo, zakonom, uredbo in pravilnikom na eni strani ter za razmejevanje med državnimi in avtonomnimi (samoupravnimi) pravnimi viri znotraj organizacije na drugi strani. Ob ohranjanju splošnosti in načelnosti zakonskega urejanja je mogoče s podzakonskimi in notranjimi pravnimi akti organizacij zagotavljati ustrezno sorazmernost med pravnimi okviri družbenih razmerij in poljem pravno nevezanega ravnanja posameznikov in njihovih organizacij. Zoperstaviti se je treba težnjam po obsežnem in podrobnem pravnem normiranju odnosov v organizacijah in nadomeščanju moralnih, običajnih in strokovnih pravil s pravnimi normami.

Ne nazadnje kaže opozoriti na potrebno jasnost, preciznost, nedvoumnost in določnost jezikovnih izrazov v pravnih aktih. S tem se zagotavljata vrednoti pravne varnosti in zaupanja v pravo. Z opredelitvijo pojmov na začetku akta, njihovo dosledno uporabo v celotnem besedilu, razumljivimi legalnimi definicijami in logično strukturo pravnega akta uspešno sledimo določnosti pravnih zapovedi. Ureditev organizacije naj vsebuje dorečene pravne norme, ki jih nato razlagajo naslovljenci pri svojem dejanskem vedenju in ravnanju ter na koncu sodišča in upravni organi v procesu udejanjanja pravnih predpisov oziroma njihovem prenašanju iz »law in books« v »law in action«.

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<sup>17</sup> Več o načelih normiranja v Igličar, 2021, str. 46 – 62.

Pomembno načelo pri sprejemanju splošnih in abstraktnih pravnih aktov je tudi načelo demokratičnosti, ki predstavlja možnost sodelovanja vseh zainteresiranih oseb, skupin oseb in organizacij pri pripravi vsebini pravnega akta. To načelo je potrebno upoštevati ne samo zaradi možnosti sodelovanja in enakih možnosti v procesu nastajanja akta ampak se preko načela demokratičnosti v procesu zagotavlja pluralnost interesov, vrednot in pogledov, itd. Prav usklajevanje le teh vodi v pripravo dobrega akta, ki bo kljuboval času in spremembam v družbi oz. organizaciji v kateri se sprejemajo.

### 3.2 Algoritemsko zajete metode nomotehnik

Računalniški algoritem mora upoštevati zaporedje nalog, ki jih je treba izvesti pri oblikovanju splošnega pravnega akta ali pa pri usklajevanju splošnih pravnih aktov v okviru pravnega sistema, tako v vertikalni kakor tudi v horizontalni smeri.<sup>18</sup>

Pripravljanje delovnih besedil splošnih pravnih aktov (zakonov, uredb, pravilnikov, statotov, odlokov itd.) je zahtevno in odgovorno strokovno delo. Splošni pravni akti in v njih vsebovane pravne norme morajo čim bolj verno odraziti družbeno stvarnost, vnesti vanjo potrebno družbeno stabilnost ter istočasno omogočiti objektivno utemeljene družbene spremembe. Za uveljavitev nakazane funkcije prava je treba spoznati osnovne družbene vrednote in postavljene cilje ter nato s splošnimi pravnimi normami, ki jih sprejemamo v določenih postopkih, urediti tiste družbene odnose, ki so pomembni za delovanje posameznikov in njihovih združenj. Oblikovanje splošnih pravnih aktov zahteva poleg poznavanja osnovnih metod normiranja še sposobnost ustreznega jezikovnega izražanja, sposobnost oblikovanja ustrezne strukture aktov in strokovno utemeljene postopke njihovega pripravljavanja in sprejemanja.

(a) V procesu priprave in sprejemanja splošnih pravnih aktov:

prehajajo družbene vrednote v splošne in abstraktne pravne norme,

(b) opredeljujejo se cilji, ki jih želi doseči normodajalec ter določajo pravna sredstva za doseg te ciljev,

(c) iz množice družbenih odnosov odbira normodajalec tiste odnose, ki jih institucionalizirajo pravne norme,

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<sup>18</sup> Za več glej Chappelet 2010, str. 41-47.

(d) v pravni sistem se vključujejo nove norme ali v sistemu spreminjajo dotlej veljavne norme,

(e) vnaprej in za nedoločeno število pravnih subjektov določa normodajalec pričakovano družbeno vedenje,

(f) za določene posebne življenjske primere opredeljuje normodajalec specifične načine ravnanja, ki je drugačno od tipskega ravnanja ali navaja vzorčne primere splošnega ravnanja.

Poti, načini in pristopi (metode) navedenega organiziranega delovanja v katerem oblikujemo in postavljamo splošne pravne norme se zato raztezajo od (a) aksiološko-deontoloških, (b) pravno-političnih, (c) socioloških in (d) logičnih metod, do (e) abstraktnih ter (f) kazuističnih vidikov človeškega mišljenja.

### 3.3 Dejanska uporaba umetne inteligence (algoritemsko)

Uporaba umetne inteligence je v veliko pomoč pri t.i. administraciji pravnega sistema in statistični obdelavi podatkov, kjer gre za ugotavljanje oziroma preverjanje in zagotavljanje skladnosti pravnih pravil v okviru določenega sistema pravil. Tega lahko definiramo kot državni, naddržavni sistem ali celo sistemu pravil določenih združenj organizacij, kot je na primer združevanje športnih organizacij v t.i. evropskem modelu športa.<sup>19</sup> V tem delu je uporabnost umetne inteligence veliko lažje izvedljiv in sprejemljiv, kakor uporaba umetne inteligence pri uporabi pravnih norm v dejanskih situacijah, kjer gre za subsumpcijo dejanskega stanja pod pravno normo in posledično vrednotenje subsumiranega dejanskega stanja in določitev sankcije.

Tudi za ugotavljanje skladnosti dejanskega ravnanja z zahtevami pravil morajo algoritmi upoštevati pravne posebnosti nadzorovalnih procesov. Ko pravo institucionalizira določene družbene vrednote ter usmerja vedenje naslovljencev (Novak, 2024, str. 228) posega tudi v interese posameznikov in skupin. Kadar posamezni ali skupinski interesi odstopajo od javnih interesov zavarovanih s pravnimi normami, prihaja pogosto do neskladnosti ravnanja naslovljencev z normami splošnih pravnih aktov. Za ugotavljanje tega razkoraka med dejanskim in normativnim ter za sprožanje procesov, ki naj sankcionirajo protipravno delovanje

<sup>19</sup> Resolucija Sveta in predstavnikov vlad držav članic, ki so se sestali v okviru Sveta, o ključnih značilnostih evropskega modela športa 2021/C 501/01, dostopno na <https://eur-lex.europa.eu/legal-content/SL/TXT/?uri=celex%3A42021Y1213%2801%29>, dostopno dne 10.1.2025.

so zopet lahko v veliko pomoč orodja umetne inteligence. Vendar pa je ta proces veliko bolj občutljiv in tvegan, kajti posledice imajo neposreden konkreten vpliv v realnem času in prostoru, ki se jih včasih ne da rehabilitirati oz. odpraviti škodnih posledic zaradi napake v procesu sprejemanja odločitve.

#### 4 Zaključek

Razvoj in uporaba umetne inteligence, je in bo vse bolj prisotna v vsakodnevnem delovnem okolju posameznika, organizacij in družbe, tudi v pravnem. Tako se že sedaj umetna inteligenca, kot pomoč uporabniku uporablja v procesih analize zbirke podatkov in dokumentov, pri pripravi aktov, napovedi izida sodnega postopka, zbiranja dokazov v postopkih, ko se s pomočjo umetne inteligence analizira velika količina podatkov in na tej podlagi predlaga uporabniku določeno rešitev, verjetnost izida, itd..

Za organizacije in združenja organizacij, ki jih povezuje hierarhična povezanost preko pravnih norm je uporabna vrednost umetne inteligence lahko velika pri izdelavi in zagotavljanju skladnosti dokumentov, zlasti splošnih in abstraktnih pravnih aktov v okviru določenega sistema pravil. Dodatno, kakor dokazuje praksa<sup>20</sup>, pa lahko koristi tudi kot pomoč pri oblikovanju individualnih in konkretnih pravnih aktov npr. pri zagotavljanju skladnosti z ustaljeno prakso oz. z odločitvami v podobnih primerih, določanju verjetnosti, itd. Pri tem je potrebno ločiti dispozitivno pogodbeno raven od sprejemanja odločitev v sklopu postopkov, ki so lahko t.i. ugotovitveni ali deklaratorni administracijski postopki, ali pa disciplinski in sodni postopki. Predvsem v sodnih postopkih gre za veliko kompleksnejše pravno dejanje kot zgolj uporaba abstraktne pravne norme v konkretni zadevi, kjer odločitev poleg subsumpcije dejanskega stanja pod pravno normo zahteva in predstavlja celovitejšo vrednotno oceno, vrednotenje okoliščin, dejstev, čutnih zaznav ljudi, itd.

Ne glede na dejstvo, da so orodja umetne inteligence lahko uporabniku v veliko korist, pa je potrebno opozoriti tudi na dileme in odprta vprašanja, ki se pojavljajo ob uporabi algoritmov umetne inteligence in njenem učenju v pravu. Še posebej pa v postopkih sprejemanja odločitev v različnih postopkih, kot so npr. sodni postopki, ki za posameznika lahko predstavljajo poseg v eksistenčne dobrine. Prav etičnost in zagotavljanje nadzora na delom umetne inteligence, na kar opozarja tudi zgoraj

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<sup>20</sup> Npr. Nekatera sodišča v Združenih državah uporabljajo t.i. Correctional Offender Management Profiling for Alternative Sanctions za določanje verjetnosti ponovljivosti dejanja, [https://en.wikipedia.org/wiki/COMPAS\\_\(software\)](https://en.wikipedia.org/wiki/COMPAS_(software)), dostopno dne 10.1.2025.

omenjena Uredba EU, je pri tem ključna skrb in omejitve. Ne glede na koristnost in uporabnost orodij umetne inteligence mora, t.i. rdeči gumb za sprejem končne odločitve, ostati v rokah človeka, njegovega razuma in odgovornosti. Kajti človek preko svojega znanja, izkušenj, ki jih je pridobil v okviru izobraževanja, socializacije in odnosov v realnem - materialnem svetu še vedno predstavlja varnost in zaupanje, da bo odločitev sprejeta razumno in v skladu s korpusom družbenih vrednot, ki naj bi se odsevale v času in prostoru. Kot piše npr. Sklaroff 2017<sup>21</sup>, je načelo bona fides nemogoče izraziti v računalniški kodi. Zaenkrat!

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<sup>21</sup> Sklaroff, J. M. (2017). Smart contracts and the cost of inflexibility. *University of Pennsylvania Law Review*, 166, 263–303. [https://scholarship.law.upenn.edu/prize\\_papers/9/](https://scholarship.law.upenn.edu/prize_papers/9/), dostopno dne 11.1.2024.



# ORGANIZATION OF THE “COURT/JUDICIAL LAW” IN CROATIA AND EU AS A SYNTHESIS OF CIVIL-COMMERCIAL AND CRIMINAL LAW

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The paper treats the problem of the existence of "court/judicial law" as a unity of civil-commercial and criminal law in Croatia and European Union. The "division" in the legal space of the Republic of Croatia and in the EU member states arose from the past and is basically the result of the specific character and "political preference" of the criminal justice system. However, the division into civil-commercial and criminal law is maintained in Croatian law and in European Union even now, either by inertia as a habit that is difficult to change, or (most likely) by individual interests within the judiciary and judicature. In a democratic civil society, not political but economic crime prevails, which cannot be followed and understood without knowledge of both civil-commercial and criminal law. Ongoing, mostly too slow and ineffective criminal proceedings in Croatia and EU (many of them in "specialized" courts of justice), fully confirm this thesis.

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## 1 Introduction

"Court/judicial law" is at this moment in EU and especially in Croatia a completely unnamed legal concept.<sup>1</sup> It will take time for it to "become domesticated", to become a named institute and, of course, the question is when this will happen and whether it will happen at all. The general development of law, however, is moving towards the formation of the clear institute of "court/judicial law" as a set of knowledge and skills that every judge of regular courts must have (or will need to acquire).

In Croatian law as well as in the laws of main EU member states (Germany, France, Italy, Austria), the division into civil and criminal judges (although, very dubious) has recently shown even a tendency to strengthen; moreover, an atmosphere is being created that there is (almost) a subjective right to be only a civil ("civilist") or only a criminal judge ("criminalist"). Open or tacit justifications of such a concept start from the "advocacy" for the necessary "specialization" of judges because this in itself and by the nature of things raises the quality of trials and the level of legality in state.

The reality, however, is quite the opposite and the insistence on separating civil and commercial law from criminal law causes an impoverishment of legal knowledge which, although "specialized" on the one hand (e.g. in the special courts), on the other hand (in practice) is increasingly "connected" and without this connection it is not possible to follow the increasingly complex movements in society, especially in areas that involve multiple branches of law.

If one wishes to deepen the theoretical aspect of this opinion, it is only necessary to emphasize that (Croatian and EU) law - both theoretically and practically and professionally and scientifically - is sufficiently divided (into public-private, civil and commercial, labor, family, criminal, etc.) and that any further "atomization" of law becomes suspect and objectively unacceptable.

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<sup>1</sup>The terms "court law" or "judicial law" come from the Anglo-American legal circle and denote mainly solutions of court practice in legal cases. The laws of the Euro-continental legal circle (Germany, Italy, France, Austria, Croatia), except in rare cases, some of which will be presented in this work, use the same expressions only in the context of presenting "court or judicial praxis".



The title of this paper does not raise the question of the need for a synthesis of civil and commercial and criminal law (especially through the institute of "court/judicial law"); on the contrary, the paper starts from the *a priori* necessity of this synthesis and tries to provide relevant answers as to why this synthesis is necessary. The author of this paper is, however, aware that such a "position on synthesis" will encounter (considerable) resistance. Something that has existed for a long time and on a massive scale always exists because certain interests (proprietary or non-proprietary) are behind it and it is always the most difficult to fight against them.

It should also be taken into account that the existing division into civil and criminal judges (and lawyers in general) is the result of a certain historical inertia, that it has become a firmly and deeply rooted habit (and habits are difficult to abandon) and that in the understanding of many lawyers it is "such in itself".

In so-called "transitional" countries (as Croatia), problem is becoming increasingly greater because the necessary change in the state legal system must be carried out with the habits of the old system. Law (and judiciary as one of the pillars of society) must follow the movements (changes) in the state, but it must also be an important element of security and stability in society. The synthesis of civil-commercial and criminal law should not undermine or call into question this social dimension.

If such a synthesis were to be accepted (neither easy nor short process), the question of a peaceful, gradual and reasonable organization of legal and judicial system at all levels remains, first and foremost. This does not mean constantly postponing this problem's resolution, because modern life does not allow for "tapping" on the spot and actually punishes any inability and unwillingness of the state to remove from the legal system conditions that hinder and stop the development of society.

It should also be said at the outset that the proposed synthesis<sup>2</sup> of civil-commercial and criminal law in Croatia and EU does not in the least call into question the constitutional principle of the independence of the judiciary; indeed, it even

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<sup>2</sup> The proposed synthesis briefly means that the organization of "court/judicial" law in Croatia and the EU member states should: 1) have a unique organization of general "natural" courts which will then organize within their system the best "specialized" assistance to subjects of law (without the existence of specialized or *ad hoc* courts) and 2) develop judges who will not only be specialized in one matter ("civilians" or "criminalists") but know both matters (civil-commercial and criminal) of law.

strengthens this principle because, in essence, it seeks to find solutions to improve the quality of trials (and a better-quality judge is always a more independent judge). The content of the paper is organized into four parts. The first part of the paper (introduction) identifies the theoretical and practical importance and problems of the topic, defines the purpose and objectives of the research and describes paper's general content. The second part (reasons for the "separation" of civil-commercial law and criminal law) analyses the reasons for the division of the Croatian and EU (some member states) legal system into civil-commercial law and criminal law, which came from practice and politics (and not from theory or legislation). The third part (theoretical and practical reasons for the "synthesis" of civil-commercial law and criminal law) presents the reasons for the synthesis of civil-commercial law and criminal law in Croatian and EU legal system and provides answers to all questions regarding it. The fourth part (conclusion) presents a synthesis of all solutions and insights of the paper and states its expected scientific contribution.

## **2 Reasons for the "separation" of civil-commercial law and criminal law**

In the science of former Yugoslav and now Croatian law, there are not find any specific works that either traced the path of such a "division" of civil-commercial and criminal law or justified it later. It is the same with the legal theory of the most important EU member states (Germany, Italy, France, Austria).

One thing, meanwhile, is not in dispute. The division was created by practice. However, it is not possible to determine exactly when, how, and with what legal argumentation it came about. For example, the assumption that in Croatia (former Yugoslavia) it was politically directed is not without foundation.<sup>3</sup> Therefore, using the example of Croatia, an attempt will be made to explain all the relevant reasons for this separation. In any case, the division has existed since the very beginnings of the former state (1945) and it still exists today, with no signs of its reconsideration. Since 1990 there have been newer, even more drastic forms of this division.

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<sup>3</sup> It is a well-known fact that in the former state or system, almost all (certainly around 90%) court presidents were criminal (penal) judges. This was certainly a clear expression of a certain political stance.

In the (recent) Croatian law, for example, special regulations against serious forms of crime stand out in particular - the USKOK Act 2009 - above all.<sup>4</sup> This law, among other things, stipulated that: 1) "USKOK courts" are only some county courts (Zagreb, Split, Rijeka and Osijek), 2) "USKOK judges" are only criminal judges, but not all of them, but only some, specially selected ones, 3) these judges have an increased salary and some other benefits, 4) these judges, which is emphasized as particularly important, have passed a "security check"<sup>5</sup>.

The proclaimed goal of the USKOK Act (increased fight against serious crime) is not doubtful, but the solutions in the law are very doubtful. Admittedly, the effects of USKOK to date (from 2009 onwards) should be analysed rationally, but even a general analysis based on the work and results to date does not give positive answers. Crime has not been reduced and neither have investigative and trial procedures been faster or more efficient. The expected special expertise of the "USKOK courts" (and "USKOK judges") is not visible, and in some (very important) cases even rookie mistakes have been recorded (e.g. failure to seize the object of a criminal offense).

Based on such legal solutions, the first aspect of the division problem in the Croatian legal (judicial) system opens up. Courts and judges are possibly divided into "equal" and "more equal", and this certainly does not contribute to the harmonious operation of the entire judicial system. Therefore, based on what has been presented regarding the topic, it could be concluded that the former federal concept (from the SFRY era) of the criminal court (and criminal judges) as a "particularly" important court (and "particularly" important judges) has not been abandoned in Croatia.<sup>6</sup>

The second argument of the concept that justifies the division into civil-commercial and criminal law is the reference to the increased expertise of these special (in the described case of "USKOK") judges and state attorneys. It is forgotten, however,

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<sup>4</sup> *Zakon o Uredu za suzbijanje korupcije i organiziranog kriminaliteta* (Act on the Office for the Suppression of Corruption and Organized Crime), Narodne Novine, 76/09, 116/10, 145/10, 57/11, 136/12, 148/13, 70/17. The popularly called "USKOK Act" was first passed in 2009.

<sup>5</sup> The subject of "security checks" is regulated in the law of the Republic of Croatia by a special act - *Zakon o sigurnosnim provjerama* (Security Checks Act), Narodne Novine, br. 85/08, 86/12. It is good that the Croatian legislator regulated such an important and sensitive matter by regulation, but it is an open question whether such regulation enables the achievement of the proclaimed goals expressed in the title of the law. According to the author of this paper, the best "security check" is - the results of the work (of judges) and the analysis of those results.

<sup>6</sup> Sociologically and logically, it is incomprehensible why a criminal case (e.g. giving and receiving a bribe of a few thousand euros) would be more difficult, professionally more complex and socially more valuable than, for example, a commercial dispute with a value of several tens of millions of euros.

that "USKOK" state attorneys and judges operate primarily in the field of economic crimes where the civil-commercial dimension is an integral, sometimes even decisive part of the criminal law norm.

Both main reasons for the division (1. greater importance of some courts compared to others and 2. increased professional "specialization" of judges) into civil-commercial and criminal law are actually *argumentum a contrario* and at the same time two main reasons for the synthesis that the paper deals with: shouldn't every court that protects the rights of citizens and business entities be equally important and doesn't the professional "specialization" of individual judges (and lawyers in general) require the unification of knowledge of several branches of law in a certain domain?

In the Republic of Croatia, the State attorney's office (*Državno odvjetništvo*)<sup>7</sup> unites the former "Public Prosecutor's Office" (*Javno tužilaštvo*) and the "Public Attorney's Office" (*Javno pravobraniteljstvo*) in one integral institution (body). On the one hand, this is not a good solution because the state attorney as a "public prosecutor" acts on the principle of independence from the executive branch, and as an "ombudsman" must necessarily cooperate with the executive branch in a coordinated manner. On the other hand, the current situation is good in that the Chief State Attorney is a person who is equally proficient in both criminal and civil law - all that remains is to extend this solution to all state attorneys and all judges.<sup>8</sup>

### 3 Theoretical and practical reasons for the "synthesis" of civil-commercial and criminal law

The previously described reasons for separation, since they are insufficient to justify such a process, speak in favour of merging these two branches of law into a single whole. At the general level of law and legal science, the question of the relationship between the "specialty (specialization) of law" and "law as a unity" should be opened

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<sup>7</sup> Zakon o državnom odvjetništvu (State attorney's office Act), Narodne novine, br. 67/18, 21/22, article 3. par. 1.: "(1) Državno odvjetništvo samostalno je i neovisno pravosudno tijelo ovlašteno i dužno postupati protiv počinitelja kaznenih djela i drugih kažnjivih djela, poduzimati pravne radnje radi zaštite imovine Republike Hrvatske te podnositi pravna sredstva za zaštitu Ustava Republike Hrvatske i zakona."

<sup>8</sup> Another logical question arises (which is only superficially touched upon in the thesis of the paper): why is the system of organization of the state attorney's office in Croatia "unified" (following the solution of this paper on the synthesis of civil-commercial and criminal law) and the system of courts "divided" and fragmented into general (regular) and various special courts (following the division into civil-commercial and criminal law, but also more than that)?

(or reopened). It is certain that the specialization of law and lawyers has its place in legal life, but it is equally important to take into an account the "entirety of law".

In natural sciences, for example, there is a special concept - "atom" - it is the last and smallest particle of an element, which, however, contains all the characteristics of that element. Following that example, "court/judicial law" would be the atomic (i.e. the smallest) unit of law that contains all the elements of the relevant law and that cannot be "broken" into even smaller, different or finer parts.

This thesis, as the main general argument for the synthesis of civil-commercial and criminal law, has a special basis on the following (theoretical-practical) reasons:

- original Austrian law, as a historical model for many laws<sup>9</sup> (particularly Croatian law), did not recognize the division into civil-commercial and criminal law,<sup>10</sup>
- in many courts there were and are "dualist" judges (who deal equally with civil-commercial and criminal law) and most lawyers also deal with both parts of law,<sup>11</sup>
- the state attorney's office cumulates both civil and criminal law in its jurisdiction,
- civil judges (civil and commercial) in resolving the so-called previous questions must apply the "other" branch of law,<sup>12</sup>
- in criminal proceedings, an issue from the field of civil and commercial law is not a question of fact but a question of law<sup>13</sup> and

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<sup>9</sup> Kühn, Z. (2011). *The Judiciary in Central and Eastern Europe: Mechanical Jurisprudence in Transformation?*, Martinus Nijhoff Publishers, Leiden, USA, Czechia, Netherlands, 1-4.

<sup>10</sup> The chief editor of the Austrian General Civil Code (*ABGB*) of 1812 was the great jurist Franz Zeiller (1751-1828) who was also, very interestingly, one of the editors of the Austrian Criminal Code of 1803 (*Codex poenalis criminibus*). Zeiller was also a professor and rector of the University of Vienna, but also an advisor to the Supreme Court (the so-called *Hofrat* - expert advisor).

<sup>11</sup> Krenn, C. (2022). *The Procedural and Organizational Law of the European Court of Justice - an incomplete transformation*, Cambridge University Press, United Kingdom, 5-25.

<sup>12</sup> Both civil and criminal judges may find themselves in the situation of resolving so-called preliminary issues in civil or criminal proceedings. They can "avoid" this (wait for the issue to be resolved by "that other" judge), but they can also resolve such an issue themselves (the resolution of that issue then applies only to that case). By the nature of the matter, in such a case, the civil or criminal judge must also be familiar with the "other" law.

<sup>13</sup> A criminal issue in civil proceedings (and *vice versa*) is not a question of fact (for which, e.g. one could seek someone's expert opinion) but a question of law that the judge must know (*iura novit curia*).

- final key argument: the criminal acts of economic crime cannot be understood, investigated and tried without increased knowledge of both branches of law.

The last reason (argument) deserves a more detailed analysis. A particularly valuable qualification and systematization of economic crimes (fraud in business operations, economic crimes, fraud) in Croatian legal literature was given back in 2010.<sup>14</sup> Even a first glance at the terms contained in these crimes (abuse, trust in business operations, fraud<sup>15</sup>, evasion<sup>16</sup>, bankruptcy crimes<sup>17</sup>, crimes against market competition<sup>18</sup>, money laundering, capital markets, etc.) indicates that these crimes cannot be understood without knowledge of their civil and commercial component which is actually an integral part of the overall criminal law norm.<sup>19</sup>

This thesis can be test in the most famous criminal proceeding in the Republic of Croatia (against one of the former Prime Ministers of the Republic of Croatia.). The subject of the proceeding is the charge of accepting bribes and abuse of position. According to the public prosecution, this second offense consists in the fact that (in return for the bribe received) a minority shareholder was given the right to manage the company, as a permanent right of this shareholder. The matter, as is known, is still *sub iudice*<sup>20</sup> and any entry into the merits of the criminal offense must be very carefully avoided. However, the civil and commercial dimensions of this criminal proceeding can be pointed out, especially through three questions: 1. Is the contract on the transfer of management rights void as a product of the criminal offense of accepting bribes? 2. Is the same contract possibly invalid because the minority

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<sup>14</sup> Novoselec, P., Roksandić Vidlička, S. (2010). Gospodarska kaznena djela u novom Kaznenom zakonu, *Hrvatski ljetopis za kazneno pravo i praksu*, Vol. 17, No. 2., 699-728. Economic crimes (fraud in business operations, economic crimes, fraud) are numerous and socially very dangerous (abuse, fraud, evasion, bankruptcy crimes, crimes against market competition, crimes against the capital market, violation of creditors' rights, favoritism, accepting and giving bribes, etc.). It does not take much to prove that in almost all of these crimes, a civil law (civil-commercial) feature is clearly expressed and that without knowledge of civil law a criminal law norm cannot be properly understood and judged.

<sup>15</sup> Rider, B. (2015). (Research Handbook on) International Financial Crime. Elgar Publishing, Northampton, USA, 315-380.

<sup>16</sup> Bourton, S. (2024). Tax Evasion and the Law: A Comparative Analysis of the UK and USA, Routledge, London, United Kingdom, 2-18.

<sup>17</sup> Wickowski, S. (2007). Bankruptcy Crimes, 3rd edition, Beard Books, Washington, USA, 1-16.

<sup>18</sup> Johnson, D. (2025). Competition Law and Financial Crime, Routledge, New York, USA, 4-22.

<sup>19</sup> Cools, M. and others (2011). EU Criminal Justice, Financial & Economic Crime: New Perspectives, Maklu Publishers, Antwerpen, Belgium, 24-31.

<sup>20</sup> The case (has), in fact, been *sub iudice* for a very long time (some other proceedings against the same defendant are ongoing in parallel), but the length is certainly conditioned by some civil law "complications" of the case.

shareholder receives the exclusive right to manage the company? and 3. (especially important) Is the same contract a valid condition that the minority shareholder will manage the company as long as he has the shareholder (co-ownership) share that he currently has? There is no doubt that these are primarily civil (civil-commercial) issues and that, very likely, the rather inefficient course of the criminal proceedings in question is largely due to the neglect (perhaps, in fact, most likely insufficient knowledge) of the aforementioned civil-commercial component of the case.

Author's overall commitment to the synthesis of civil-commercial and criminal law has also foothold in one particular concept, almost non-existent in the Croatian law for the contrary of the laws of main EU member states (Germany, Italy, Austria). It is the institute of the "natural judge" (*der Gesetzliche Richter, il giudice naturale*)<sup>21</sup>. It is a concept related to strict respect for absolute, real, territorial and "collegial" jurisdiction.<sup>22</sup> The German Constitution (article 101. par. 1.) under the name *Verbot von Ausnahmegerichten* (prohibition of exceptional, extraordinary courts) determines that such (irregular, unnatural, exceptional, extraordinary) courts are inadmissible (*...sind unzulässig*) and that citizens cannot be deprived of their right to their lawful judge (*niemand darf seinem gesetzlichen Richter entzogen werden*)<sup>23</sup>. The Constitution of the Republic of Austria also stipulates similarly (in article 83. paragraph 2.)<sup>24</sup>.

The right to a natural judge (*das Recht auf den gesetzlichen (bestimmten) Richter*) is, according to German law, the so-called *Justizgrund Recht* (foundation of court/judicial law) which determines (in advance and precisely) which court and which judge will have jurisdiction in specific trials (both from a substantive and procedural point of view).

<sup>21</sup> Backhaus, V. (2010). *Der Gesetzliche Richter im Staatsschutzstrafrecht*, Peter Lang, Frankfurt (Main), Germany, 15-24; Ragone, S., D'Amico G. (2011). The Evolution and *Gestalt* of the Italian Constitution in Von Bogdandy, A., Huber, P.M., Ragone S., *Constitutional Foundations, Volume II*, Oxford University Press, United Kingdom, 309-315; Scorselli, G. (2010). *Ordinamento giudiziario e forense*, 3a edizione, Giuffrè Editore, Milano, Italy, 203-206.

<sup>22</sup> The right to a "natural judge" (*das Recht auf gesetzlichen Richter*) includes the right and obligation to have a judge with absolute subject-matter, territorial and collegial jurisdiction decide on a specific legal matter. Walter, R., Mayer, H. Kucsko-Stadlmayer, G. (2007). *Bundesverfassungsrecht*, Beck, Vienna, Austria, 771-775. Simply put, natural and legal persons as subjects seeking a specific legal protection must know in advance exactly which court will hear the case and which judge in that court (as a rule, exactly in order). Such consequences of the rule on the "right to a natural judge" also call into question some other Croatian domestic solutions (e.g. "moving" files from one court to another, computer "selecting" the competent appellate court, etc.), but here it is important to say that the *gesetzlicher Richter* described above must be equally familiar with civil and commercial law and criminal law.

<sup>23</sup> *Grundgesetz für die Bundesrepublik Deutschland (Grundgesetz, 1949)*, Artikel 101.1. (*Verbot von Ausnahmegerichten*): "(1) *Ausnahmegerichte sind unzulässig. Niemand darf seinem gesetzlichen Richter entzogen werden.*"; freely translated: (Prohibition of extraordinary, extraordinary courts): "(1) Extraordinary (exceptional) courts are not permitted. No one may be deprived of his natural judge."

<sup>24</sup> *Österreichische Bundesverfassung (OB, 1920)*, Artikel 83.2.: "(2) *Niemand darf seinem ordentlichen Richter entzogen werden.*"; freely translated: "(2) No one may be denied their regular judge."

Such a principle eliminates the appearance of "special" or *ad hoc* courts and judges, and in other words, citizens and legal entities must have the certainty that their case will be heard by a judge who is designated and provided for by law. What would the introduction, application and observance of such a principle mean in the Croatian judiciary? In concrete, the elimination of "annual work schedules" in courts (because all judges would have to do everything), and the schedules actually start from the division into civil and criminal judges. Cases in courts (at all levels) would be received in such a way that they come to the judge who is first in line at a moment. Same can apply to state attorneys who conduct investigation procedures.

Both civil and criminal matters require, at their very beginning, a clear legal diagnosis<sup>25</sup> that will either be confirmed or overturned by the end of the procedure. Such a diagnosis, however, is not possible if the jurisdiction provided for by law is not in the hands of a lawyer who is competent in the overall "court/judicial law". Indeed, the contrary (and now undoubtedly prevailing) situation is unconvincing when, in the context of the same factual event (e.g. a traffic accident), the criminal part is tried by one judge and the civil part by another.

Contrary to the point presented here of governing the entire "court/judicial law" as a "whole" and "synthesis" it is regulated in the Croatian Rules of Procedure of the Constitutional Court (art. 31. par. 1. item 4.)<sup>26</sup>, where the judges of the Constitutional Court have secured for themselves (because the Rules of Procedure are not an act of the state) the right to request the opinion of a legal expert ("... scientific advisors of the Constitutional Court"). It is not legally coherent that the judges of the Constitutional Court, who are, according to Croatian Constitution<sup>27</sup> (art. 126. par. 1.), "prominent jurists", have the privilege popularly known as "joker calls" (and contrary to the millennial rule of *iura novit curia*) while the judges of first instance

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<sup>25</sup> The first "legal diagnosis", especially in criminal proceedings, is very often of decisive importance for the final outcome of the proceedings. Just as in medicine it is extremely important whether the doctor in the emergency room has correctly identified what is going on (and this then enables treatment with a positive outcome), so in criminal law it is very often decisive whether the "essence of the matter" has been affected. In economic crime, this "essence" is usually very complex and can only be "discovered" by a legal expert who is familiar with "judicial law" as a synthesis of civil-commercial and criminal law.

<sup>26</sup> *Poslovnik Ustavnog suda Republike Hrvatske* (Rules of Procedure of the Constitutional Court of the Republic of Croatia), Narodne Novine, 181/03, 16/06, 30/08, 123/09, 63/10, 121/10, 19/13, 37/14, 2/15, art. 31.: "(1) U ustavnosudskom postupku u kojem obnaša dužnost suca-izvjestitelja, sudac je ovlašten: ... 4. tražiti stručna mišljenja o pojedinim predmetima od znanstvenih savjetnika Ustavnog suda..."

<sup>27</sup> *Ustav Republike Hrvatske* (The Constitution of the Republic of Croatia), Narodne Novine, 56/90, 135/97, 08/98, 113/00, 124/00, 28/01, 41/01, 55/01, 76/10, 85/10, 05/14.



(usually municipal) courts, who are usually younger and less professionally experienced, do not have this opportunity. However, the "joker call" system is not actually possible in actual litigation (investigative or trial). Decisions must be made quickly, decisively and confidently. There is no time to turn to anyone who could possibly "help". The assumption of such (good) conduct is certainly a quality knowledge of "court/judicial law" as a whole of civil-commercial and criminal law.

Perhaps such an assumption is best reflected in the resolution of the "preliminary questions". Preliminary (prejudicial) questions are not factual but legal questions. Their knowledge is also affected by the maxim of *iura novit curia*. Where the issue is indeed a preliminary one, the civil or criminal judge has the option of "transferring" the matter to the competent (the "other") court and awaiting its decision; he may, however, resolve the matter himself, but this then applies only to the specific case: article 12. of the Croatian Civil Procedure Act (ZPP Act 1991) and article 18. of the Croatian Criminal Procedure Act (ZKP Act 2008).

ZPP<sup>28</sup> has a provision (art. 12. par. 1.)<sup>29</sup> that the civil court may resolve such an issue itself, unless "...unless otherwise provided for by special regulations." ZKP<sup>30</sup> does not have a similar provision (art. 18.)<sup>31</sup> but this rule is "implied" because it belongs to the general procedural rules. However, the real situation in practice, especially in cases of so-called economic crimes or, for example, litigation for compensation for damage, is quite different. In a trial in the area of economic crime (especially in criminal offences of abuse of office), one cannot wait for the decision of the "other" court to, for example, say whether the legal transaction by which a specific abuse of office was committed is valid. The criminal judge must decide this himself, because he is obliged to do so by a criminal law norm. We can follow a similar pattern in the

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<sup>28</sup> *Zakon o parničnom postupku* (Civil Procedure Act), Narodne Novine, 53/91, 91/92, 58/93, 112/99, 88/01, 117/03, 88/05, 02/07, 84/08, 96/08, 123/08, 57/11, 148/11, 25/13, 89/14, 70/19, 80/22, 114/22, 155/23.

<sup>29</sup> *ibidem*, article 12. par. 1: "*Kad odluka suda ovisi o prethodnom rješenju pitanja postoji li neko pravo ili pravni odnos, a o tom pitanju još nije donio odluku sud ili drugi nadležni organ (prethodno pitanje), sud može sam riješiti to pitanje ako posebnim propisima nije drugačije određeno. Odluka suda o prethodnom pitanju ima pravni učinak samo u parnici u kojoj je to pitanje riješeno. U parničnom postupku sud je u pogledu postojanja kaznenog djela i kaznene odgovornosti počinitelja vezan za pravomoćnu presudu kaznenog suda kojom se optuženik oglašava krivim.*"

<sup>30</sup> *Zakon o kaznenom postupku* (Criminal Procedure Act), Narodne novine 152/08, 76/09, 80/11, 121/11, 91/12, 143/12, 56/13, 145/13, 152/14, 70/17, 126/19, 126/19, 130/20, 80/22, 36/24.

<sup>31</sup> *ibidem*, article 18.: "(1) *Ako primjena kaznenog zakona zavisi od prethodnog rješenja pravnog pitanja za čije je rješenje nadležan sud u kojem drugom postupku ili koje drugo državno tijelo, kazneni sud može sam riješiti to pitanje prema odredbama koje važe za dokazivanje u kaznenom postupku. Rješenje tog pravnog pitanja od strane kaznenog suda ima učinak samo za kazneni predmet o kojem taj sud raspravlja.* (2) *Ako je o takvu prethodnom pitanju već donio odluku sud u kojem drugom postupku ili drugo državno tijelo, takva odluka ne veže kazneni sud što se tiče ocjene je li počinjeno određeno kazneno djelo.*"

civil area; for example, in damages proceedings for compensation for damage based on affective value (the value that "the thing had for the injured party") under article 1089. of the Croatian Civil Obligations Act (ZOO)<sup>32</sup>, where the right to compensation exists only when the criminal offence was committed intentionally. Therefore, if criminal proceedings are already underway for such a criminal offence (which destroyed an object of affective value for the injured party) the civil judge will act wisely if he waits for the outcome of the criminal proceedings; it is not, however, a legal error if, despite criminal proceedings, he resolves the criminal issue himself as a preliminary issue (but this then only applies to civil proceedings and in principle it is not appropriate to do so because criminal proceedings may end differently). In cases where criminal proceedings have not been initiated or have not yet been initiated (and the civil judge cannot initiate it) or cannot be initiated (because, for example, the first defendant has died), the civil judge must resolve the preliminary issue himself and answer the important problem - whether the criminal offence was committed intentionally.

In such a situation and *vice versa* (and in all similar situations that often come or may come before) there is no need to prove how much a civil judge is obliged to know criminal law or how much a criminal judge is obliged to know civil-commercial law. It is evident that in this case criminal law is an integral part of the civil law norm. Quite similarly or almost identically to parts of criminal law (primarily in economic crimes), civil and commercial law is an integral part of the criminal law norm.

The problem certainly includes the resolution of "proprietary claims" (*imovinskopravni zahtjevi*) within the framework of criminal proceedings.<sup>33</sup> Criminal judges show a tendency to avoid adhesion civil within criminal proceedings. In this sense, the ZKP somehow works in their favour (article 153. par. 1.)<sup>34</sup> because criminal judges can remove the hearing and decision on adhesion issues if this would "significantly delay the criminal proceedings", that is, if the information from the criminal proceedings

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<sup>32</sup> *Zakon o obveznim odnosima* (Civil Obligations Act), Narodne Novine, 35/05, 41/08, 125/11, 78/15, 29/18, 126/21, 114/22, 156/22, 155/23, article 1089. par. 4.: "(4) Kad je stvar uništena ili oštećena kaznenim djelom učinjenim namjerno, sud može odrediti visinu naknade prema vrijednosti koju je stvar imala za oštećenika."

<sup>33</sup> Croatian ZKP incorrectly uses the term "proprietary claim" (*imovinskopravni zahtjev*). This is old terminology that should be replaced with the term "civil claim", which, as a more modern term, allows for the adhesion of litigation on non-proprietary issues (especially the protection of personality rights and the repair of non-proprietary damage).

<sup>34</sup> *Zakon o kaznenom postupku, op.cit.*, article 153. paragraph 1.: "(1) Imovinskopravni zahtjev koji je nastao zbog počinjenja kaznenog djela raspravit će se na prijedlog oštećenika u kaznenom postupku, ako se time ne bi znatno odugovlačio taj postupak."

does not provide a reliable basis for the full or partial adoption of the civil claim, in which case they will refer the injured party to litigation (article 158. par. 3.)<sup>35</sup>.

The situation from article 153.1. should be resolved by emphasizing more strongly the obligation to resolve civil issues in the context of criminal proceedings in an adhesion manner - so that adhesion proceedings are the rule and not the exception. In this sense, the injured party should be granted the right to appeal against the rejection of adhesion civil proceedings and the appellate court should have broader authority and more decisive practice in imposing adhesion proceedings. The legal situation envisaged by the provision of article 158.3. is similar: if there is no "reliable basis" for adoption (in whole or in part), the injured party's request should be rejected, as the civil court would also act in the same way in civil proceedings. The existing tendency to "escape" from the adhesion civil procedure within the framework of criminal proceedings is certainly also the result of the deficient knowledge of civil, commercial, labour, family and other parts of the total private law on the part of criminal judges. The consequences of this are clear: two procedures are conducted regarding the same factual event instead of resolving everything in one (criminal) procedure. The adhesion civil procedure and all its exposed repercussions in Croatian law actually strengthen the idea of a symbiosis of civil-commercial and criminal law in both the substantive and procedural segments.

The "tailwind" to the concept of "court-judicial law" expressed here is also given by the latest amendments to the ZPP (from 2022)<sup>36</sup> in the matter of so-called "illegal evidence"; the ZKP regulated this somewhat earlier<sup>37</sup> in article 10. of the Act. The Constitution of the Republic of Croatia<sup>38</sup> (in article 29. paragraph 4.)<sup>39</sup> stipulates, quite generally, that "evidence obtained illegally cannot be used in court proceedings". The Croatian ZPP (article 32.), just like the ZKP (article 10.), stipulates that court decisions cannot be based on evidence obtained illegally ("illegal evidence"). The text of the Constitution, or rather the content of that text, is therefore repeated. However, in article 10. paragraph 2. of the ZKP there has been lists 4 situations in which evidence is "illegal", while the ZPP does not contain such

<sup>35</sup> *ibidem*, article 158. paragraph 3.: "(3) Kad sud donese presudu kojom se okrivljenik oslobada optužbe ili kojom se optužba odbija ili kad rješenjem obustavi kazneni postupak, uputit će oštećenika da imovinskopравни zahtjev može ostvarivati u parnični..."

<sup>36</sup> *Zakon o izmjenama i dopunama Zakona o parničnom postupku*, Narodne Novine, 80/2022.

<sup>37</sup> *Zakon o izmjenama i dopunama Zakona o kaznenom postupku*, Narodne Novine, 143/12, 145/13.

<sup>38</sup> *Ustav Republike Hrvatske, op.cit.*

<sup>39</sup> *ibidem*, article 29. paragraph 4: "Dokazi pribavljeni na nezakonit način ne mogu se uporabiti u sudskom postupku."

a provision. Does this mean that a civil judge can also "reach out" to these provisions of the Criminal Procedure Code, or that he or she should be familiar with them?

However, the Croatian Criminal Procedure Code (ZKP) does not contain a provision on the "depth" of the permissible interference with the relevant human (constitutional) rights, or to what extent it is possible to violate these rights and for the judge to use the evidence in a decision in a specific civil or court proceeding. Such a provision is, for example, has the German Constitution<sup>40</sup>, which stipulates: 1. that the envisaged limitation of constitutional rights may apply generally to all situations and not only to individual cases (article 19. paragraph 1.) and 2. that in such a case the fundamental constitutional right may not be violated (*angetastet*) in its essential content (article 19. paragraph 2). It seems that this rule, as an important interpretative rule, could also apply to the Croatian constitutional legal system.

Finally, the described symbiosis or unity of civil-commercial and criminal law in Croatia and some EU member states is somewhat greater in criminal than in civil-commercial law, but it undoubtedly exists in both of these branches of law. Some modern developments in civil law (primarily the strong expansion of non-proprietary and personality rights) bring not only civil-commercial and criminal law into ever greater connection, but also bring both into a further connection with another branch of law - constitutional law.

Therefore, at the end of this chapter, it should be concluded that not only "theoretical-scientific" but also "everyday-practical" reasons speak in favour of the construction of the institute of "court-judicial law" as a synthesis, unity and whole of civil-commercial and criminal law.

#### 4 Conclusion

The immediate reason for writing this paper was the content of the advertisement of the Croatian State Judicial Council on the election of judges of regular courts, especially higher courts (county courts, first and foremost, but also the Supreme Court of the Republic of Croatia). Namely, these advertisements explicitly state that a judge is being elected for the "civil department" or the "criminal department". This

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<sup>40</sup> *Grundgesetz für die Bundesrepublik Deutschland, op.cit.*

is a more recent practice. Previously, this "specialization" was not mentioned in advertisements for the appointment of judges, so the division into civil and criminal judges was implemented tacitly and through the annual schedules of judges.

The tendency of division, therefore, not only persists but also strengthens in its practical manifestations. It goes without saying that the relevant Croatian laws (the Act on Courts<sup>41</sup>, the Act on the State Judicial Council<sup>42</sup>) do not foresee such a thing. Admittedly, they do not defend it, but this does not mean that this practice is *praeter legem* good and should be continued. The science of law (which is not a tendency characteristic only of our circumstances) has long neglected the sociological-legal aspects of the judiciary and justice. Normative-legal analyses prevail, certainly the necessary ones, but the overall legal system will not go in the right direction if we neglect the due analyses of real developments in the world of law.

The proposed and presented analysis of the current state of the Croatian and some main EU member states legal system organization and the proposal for a change of understanding probably do not have much chance of success, at least not immediately or at least not so soon. Namely, the "opposite state" that has become a habit, and a firmly rooted habit, is too deep and too long-lasting. Anglo-American lawyers (and judges) do not recognize and do not know the existing division of "court or judicial law" into civil-commercial and criminal law and they also consider criminal proceedings to be a civil case (state vs. defendant). In Croatia and EU states (Euro-Continental legal circle), the existing division is also "encouraged" by the division within civilian law. "Mandatory law" is regulated, studied and judged sometimes as civil and sometimes as commercial law. From the example of the Croatian law - the law to be applied is one (ZOO), the courts are different, and the procedure is the same (ZPP). Therefore, the perspective of "court/judicial law" (*sudsko pravo*) is possible on a very "long stick"; there is a little chance that the construction of such a unique (understanding) law will even be initiated, let alone realized. But that is not a reason not to think about it (the synthesis of civil-commercial and criminal law), on the contrary.

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<sup>41</sup> *Zakon o sudovima* (Act on Courts), Narodne Novine, 28/13, 33/15, 82/15, 82/16, 67/18, 126/19, 130/20, 21/22, 60/22, 16/23, 155/23, 36/24.

<sup>42</sup> *Zakon o Državnom sudbenom vijeću* (State Judicial Council Act), Narodne Novine, 116/10, 57/11, 130/11, 13/13, 28/13, 82/15, 67/18, 126/19, 80/22, 16/23, 83/23, 155/23.

In this paper, author have also put forward a thesis that certainly requires deeper analysis and verification - that, for example, in Croatia, the "USKOK" state attorney's office or the judiciary has the characteristics or at least some characteristics of "exceptional courts" ("specialized courts", "*ad hoc* courts", "extraordinary courts", *Ausnahmsgerichte*). For the purposes of this paper, however, it is sufficient to state that the existence of such judicial bodies enhances (and certainly does not weaken) the division between "civilians" and "criminals" and even deepens the division between "criminals" themselves. If even a possible constitutional procedure for examining the constitutionality of the relevant "USKOK laws" in Croatia were to (still) withstand the constitutionality test before the Constitutional Court, the fact remains that, especially in civil and criminal proceedings of the highest level of social importance, "court/judicial law" should be applied as a whole - as a unique legal synthesis of civil-commercial and criminal law.

It should also be emphasized as very indicative that the idea of "court/judicial law" as an indivisible whole is already maturing in practice where numerous judges state that they do not have the necessary knowledge for that "mixed" disputes and need additional education. The construction of "court/judicial law" is therefore not just some distant *de lege ferenda* thought, but is already a clear practical problem. Another question is how to organize the "additional education" that the judges are talking about. Surely, it cannot be some kind of month-long course or something similar.

The basic message of this paper (the creation of "court-judicial law" but also the organization of courts so that judges are not divided into "civilians" and criminalists") certainly does not have a special chance of being immediately accepted. However, in the long term, Republic of Croatia and EU member states will certainly find itself in need of a stronger, perhaps even very radical, change to the entire legal system and then it would be worth seriously considering the issues raised by this paper. The current impotence of criminal courts in the area of economic crime will probably continue, perhaps to the point where the state, its citizens and economic life entities will no longer be able to tolerate it.

The concept of "synthesis" that the paper addresses is present at this moment in judicial and legal life at: 1) the level of undergraduate law studies, 2) the level of trainee and advisory internships of future judges and state attorneys and 3) the level of taking the bar exam (to some extent also at the level of smaller municipal courts

where, by the nature of the job, "everything" has to be done). The "separation" occurs at the level of larger municipal courts, at the level of county courts it is already in full "development" and then it follows judges and state attorneys until the end of their careers. In other words, when a judge or state attorney enters a higher level of legal decision-making, he or she must be either one or the other - either a civil or criminal judge. This should (attempt to) change.

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# NOVOSTI V NACIONALNI REŠITVI eNAROČANJE

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eNaročanje je informacijski sistem za elektronske napolitve in naročanje pacientov na specialistične zdravstvene storitve. Vključuje centralne čakalne sezname in ažurne podatke o čakalnih dobah. Vključeno je več kot 2.100 vrst zdravstvenih storitev, možen je pregled pacientovih e-napotnic in e-naročil. Leta 2024 so bile v eNaročanju uvedene številne spremembe in izboljšave. Nadgradnje so bile izvedene v sodelovanju z Ministrstvom za zdravje, Zavodom za zdravstveno zavarovanje Slovenije, vzdrževalcem rešitev eNaročanje in zVEM ter programskimi hišami, ki vzdržujejo lokalne informacijske sisteme. Novosti zmanjšujejo administrativne obremenitve zdravnikov. Opomniki na prihajajoče termine bodo vplivali na zmanjšanje neopravičenih odsotnosti pacientov, prenaročanje najdlje čakajočih pa bo zmanjšalo število čakajočih pacientov in čakalne dobe.

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# NEW FEATURES IN THE NATIONAL EAPPOINTMENT SOLUTION

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eAppointment (eNaročanje) is an information system for electronic referrals and scheduling of patients for specialist healthcare services. It includes centralized waiting lists and up-to-date information on waiting times. The system covers more than 2,100 types of healthcare services and allows the review of patients' e-referrals and e-appointments. In 2024, numerous changes and improvements were introduced to eAppointment. The upgrades were implemented in collaboration with the Ministry of Health, the Health Insurance Institute of Slovenia, the eAppointment solution maintainer, the zVEM platform, and software companies maintaining local information systems. These innovations reduce the administrative burden on doctors. Appointment reminders will help decrease patient no-shows, while rescheduling for the longest-waiting patients will reduce the number of patients on waiting lists and shorten waiting times.



## **1 Uvod**

eNaročanje predstavlja eno izmed ključnih rešitev v okviru slovenskega sistema eZdravja, ki se osredotoča na izboljšanje dostopa do zdravstvenih storitev, optimizacijo delovanja zdravstvenih zavodov ter boljše upravljanje celotnega zdravstvenega sistema. Kot del širše digitalizacije slovenskega zdravstva eNaročanje omogoča enostavno, hitro in pregledno rezervacijo terminov za zdravstvene storitve, tako na primarni, sekundarni kot tudi terciarni ravni. Gre za nacionalni informacijski sistem, ki omogoča elektronsko napotitev in naročanje pacientov na različne ravni zdravstvene oskrbe (Stanimirović & Indihar, 2016). Ta rešitev je bistvenega pomena tako za paciente kot za zdravstvene izvajalce, saj omogoča večjo fleksibilnost, preglednost in učinkovitost izvajanja delovnih procesov v celotnem zdravstvenem sistemu.

Za paciente je eNaročanje velik korak naprej, saj jim omogoča, da v realnem času izbirajo termine in izvajalce, kar zmanjša čakalne dobe, povečuje dostopnost in zagotavlja boljše prilagajanje potrebam posameznika. Preko sistema lahko pregledujejo proste termine pri različnih izvajalcih, kar jim omogoča, da se odločijo za najbolj primeren čas in strokovnjaka, s čimer se povečuje zadovoljstvo in zmanjšuje stres zaradi nejasnosti in dolgotrajnega čakanja. Poleg tega pa eNaročanje omogoča, da pacienti na enostaven način spremljajo status svojih napotitev in čakalnih seznamov, kar povečuje transparentnost in zmanjšuje občutek negotovosti glede dostopa do potrebne zdravstvene oskrbe.

Zdravstvenim zavodom eNaročanje prinaša številne prednosti pri obvladovanju in optimizaciji delovnih procesov. S sistemom eNaročanja lahko bolj učinkovito spremljajo delovanje posameznih enot in izvajalcev, kar omogoča bolj učinkovito usklajevanje virov, boljšo porazdelitev nalog ter zmanjšanje napak in nepredvidenih izpadov. Zdravstveni delavci in administrativni oddelki so tako bolj produktivni, saj se zmanjša potreba po usklajevanju z pacienti ter zmanjšajo zamude in napake pri napotitvah in naročanju. Prav tako je mogoče bolje spremljati zasedenost posameznih oddelkov in zagotavljati, da so zdravstvene storitve enakomerno porazdeljene, kar pripomore k večji pravičnosti in dostopnosti za vse paciente.

Za odločevalce na najvišji ravni je eNaročanje izjemno pomembno orodje pri spremljanju stanja javnega zdravja v državi. Z analizo podatkov, pridobljenih iz sistema eNaročanja, lahko spremljajo čakalne dobe, število čakajočih pacientov in obremenjenost posameznih zdravstvenih zavodov. To omogoča sprejemanje informiranih odločitev glede potrebnih vlaganj v zdravstveno infrastrukturo, reorganizacijo virov in izboljšanje dostopa do zdravstvene oskrbe. Poleg tega se tako zagotovi večja transparentnost sistema, saj odločevalci dobijo boljši vpogled v trenutne izzive in potrebo po prilagoditvah zdravstvenih politik in strategij.

eNaročanje kot del digitalizacije slovenskega zdravstva ne prinaša le tehnološke izboljšave, temveč predstavlja tudi kulturni premik v načinu, kako se zdravstvene storitve organizirajo, dostopajo in spremljajo. Gre za sistem, ki omogoča boljšo interoperabilnost z drugimi sistemi in zagotavlja boljše povezovanje različnih ravni zdravstvene oskrbe. Z večjo uporabo eNaročanja se povečuje tudi kakovost zdravstvene oskrbe, saj omogoča boljše usklajevanje, večjo transparentnost in večjo dostopnost za paciente, pri čemer se izboljšuje tudi učinkovitost dela zdravstvenih izvajalcev.

V prispevku bomo podrobneje opisali in analizirali delovanje sistema eNaročanja v Sloveniji, predstavili podatke o njegovem razvoju in uporabi skozi leta ter osvetlili njegove prednosti in izzive. Obravnavali bomo, kako ta rešitev prispeva k izboljšanju kakovosti zdravstvenih storitev in kako lahko pripomore k nadaljnji optimizaciji slovenskega zdravstvenega sistema v prihodnosti.

## 2 Metodologija

V prispevku predstavljamo analizo funkcionalnosti in uporabe rešitve eNaročanje v okviru eZdravja. Glavni cilj raziskave je bil preučiti delovanje, razvoj in uporabo rešitve eNaročanje skozi leta. Da bi odgovorili na zastavljena vprašanja, smo uporabili metodologijo študije primera (Kljajić Borštnar, 2021; Yin, 2018). Ta metodološki pristop omogoča poglobljeno analizo specifičnih primerov in kombinacijo več virov podatkov za celovito razumevanje obravnavanega pojava. Glede na to, da je razvoj celotnega področja digitalizacije zdravstva še vedno v relativno zgodnji fazi, je bil slednji metodološki pristop ocenjen kot najbolj ustrezen za izvedbo raziskave. Na področju namreč še ni dovolj raziskav, ki bi lahko celovito

osvetlile ozadje, delovanje in uporabo informacijske rešitve eNaročanje in slednje izsledke podkrepile s kvantitativnimi metodami in kazalniki.

V prvem koraku smo izvedli pregled obstoječe literature, ki obravnava rešitev eNaročanje in širši kontekst eZdravja. Pri tem smo uporabili virov, kot so znanstveni članki, knjige ter raziskovalna poročila (Kosednar, 2023; Kosednar, 2023a; Kosednar, 2024; Plevnjak & Stanimirović, 2024; Rant et al., 2017; Rant & Stanimirović, 2019; Stanimirović et al., 2022; Yang et al., 2022; Zidarn et al., 2018). Poleg literature smo analizirali tudi projektno dokumentacijo, navodila za uporabnike in tehnične specifikacije rešitve eNaročanje. Tak pristop nam je omogočal razumevanje zgodovinskega razvoja in tehničnih aspektov rešitve.

V drugem koraku smo izvedli analizo dejanskih podatkov o uporabi rešitve. Pridobili smo statistične podatke iz administratorskega modula rešitve eNaročanje, ki omogoča vpogled v poslovne in administrativne vidike uporabe sistema. Ti podatki so bili pridobljeni v januarju 2025 in zajemajo aktualne kazalnike uporabe rešitve. Poleg tega smo opravili tudi opazovanje uporabe sistema v realnem okolju, da bi bolje razumeli vsakodnevne izzive in priložnosti, ki jih ponuja rešitev.

Analiza funkcionalnosti in uporabe rešitve eNaročanje je bila izvedena v obdobju decembra 2024 in januarja 2025. Združevanje podatkov iz različnih virov nam je omogočilo celovit pregled nad obravnavanim področjem ter identifikacijo ključnih izzivov in prednosti sistema. Takšen pristop je ključen za razumevanje vpliva rešitve eNaročanje na vse deležnike znotraj slovenskega zdravstvenega sistema ter širši kontekst digitalizacije zdravstva in predloge nadaljnjih izboljšav.

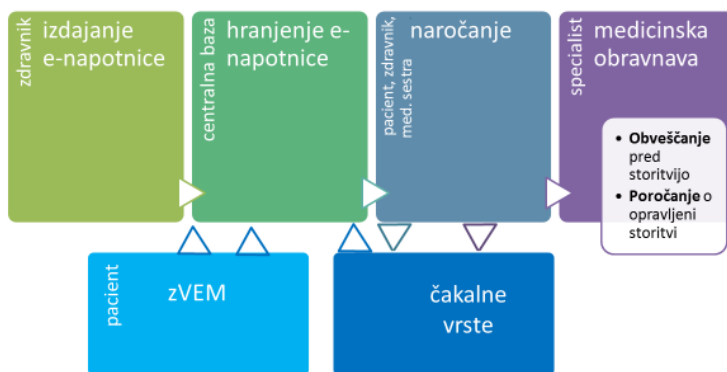
### **3 Rezultati**

eNaročanje je nacionalni informacijski sistem za namene elektronske napotitve in elektronskega naročanja na zdravstvene storitve s primarne na sekundarno in terciarno raven in znotraj sekundarne in terciarne ravni (Stanimirović & Indihar, 2016). Namenjena je tudi spremljanju čakalnih dob. Rešitev eNaročanje je bila uvedena na nacionalni ravni leta 2016. 10. aprila 2017 je Ministrstvo za zdravje (MZ) izenačilo elektronske in papirne napotnice.

Informacijsko rešitev eNaročanje sestavljajo tri komponente: napotovanje, naročanje in čakalne vrste. Pri napotovanju zdravnik v svojem lokalnem informacijskem sistemu izdela elektronski dokument e-napotnica. Elektronsko ga podpiše in s tem prenese v centralni sistem eNaročanja.

Na osnovi e-napotnice se izvede naročanje na napoteno zdravstveno storitev (slika 1). Elektronsko naročanje lahko izvede pacient sam prek spletnega portala zVem, to pa lahko naredijo tudi medicinska sestra oz. zdravnik, ki je izdal e-napotnico, administrator na infotočki ali svetovalec v klicnem centru eZdravja. Poleg elektronskega naročanja obstaja tudi možnost naročanja neposredno pri izvajalcih zdravstvene dejavnosti, in to osebno, po telefonu ali po pošti, tako kot je to veljalo še pred uvedbo rešitve eNaročanje.

Na osnovi podatkov, pridobljenih iz lokalnih sistemov izvajalcev zdravstvene dejavnosti, se v centralnem sistemu eNaročanja vzdržuje centralni čakalni seznam s prvimi prostimi termini za vse zdravstvene storitve, ki jih izvajalci izvajajo. Zbrani podatki se objavljajo v portalu Čakalne dobe.



Slika 1: Proces eNaročanja

Vir: Lasten

V okviru eNaročanja deluje tudi ePosvet, ki omogoča osebnim zdravnikom varno elektronsko posvetovanje o zdravstvenih problemih pacientov pri specialistih. Pacient mora obiskati specialista le v primeru, če ta s pomočjo ePosveta ugotovi, da je obisk potreben in o tem tudi obvesti osebnega zdravnika. To je eden od ukrepov

skrajševanja čakalnih vrst, saj se v tem primeru pacient ne postavi v čakalno vrsto pri specialistu, če to ni potrebno. (Rant et al., 2018).

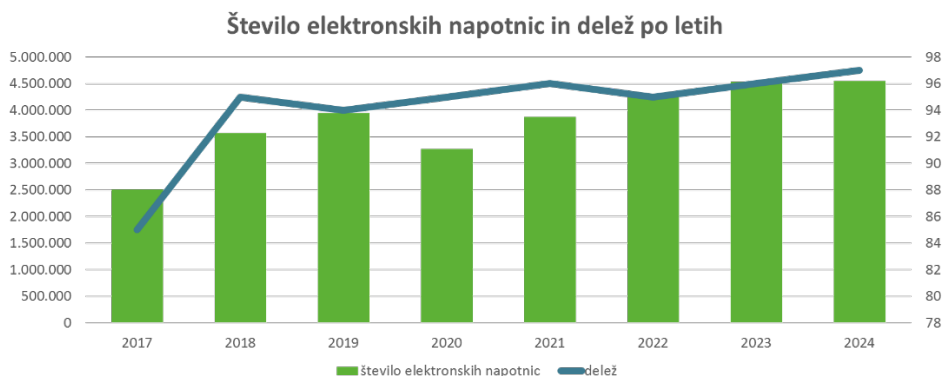
Rešitev eNaročanje nudi pacientom hitro, varno in učinkovito naročanje na zdravstvene storitve. Poenostavlja izbiro izvajalca zdravstvene storitve glede na čakalno dobo in kraj izvedbe ter omogoča učinkovito obveščanje naročenega pacienta o morebitnih spremembah terminov in potrebnih predpripravah na izvedbo zdravstvene storitve. Izvajalci zdravstvene dejavnosti zagotavljajo posredovanje napotnic v elektronski obliki, omogočanje e-naročanja, poročajo o prvih prostih terminih in o čakalnih dobah v nacionalni čakalni seznam.

Ključne prednosti eNaročanja so centralni (nacionalni) čakalni seznam, v katerega morajo izvajalci zdravstvene dejavnosti sproti poročati podatke, prikaz ažurnih podatkov o čakalnih dobah, pregled pacientovih napotnic in naročil, ter naročanje za paciente prek spleta. Zelo uporabna je tudi povezava s portalom za paciente zVEM, kjer pacient zase in za svoje otroke ali druge osebe, za katere je pooblaščen, lahko spremlja napotnice in naročila. Lahko spremlja čakalne dobe za vrste zdravstvenih storitev in se nanje tudi naroča.

### **3.1 Podatki o uporabi**

V prikaz podatkov o čakalnih dobah je vključeno več kot 2.100 različnih vrst zdravstvenih storitev. Neposredno elektronsko naročanje je možno na več kot 700 storitev. V letu 2024 je bilo 97 % napotnic elektronskih. Mesečno se izda več kot 450.000 e-napotnic in ustvari več kot 660.000 e-naročil. Od uvedbe sistema eNaročanje je bilo skupaj izdano več kot 30 milijonov e-napotnic, vsaj eno storitev za eNaročanje pa izvaja več kot 1100 izvajalcev.

V letih 2020 in 2021 je opazen padec izdaj e-napotnic, od leta 2020 do 2024 pa število e-napotnic spet narašča in presega 4 milijone letno. Delež e-napotnic med vsemi napotnicami je od leta 2020 vsaj 95 %. V letu 2024 je bilo 97 % napotnic izdanih elektronsko (slika 2).



Slika 2: Število in delež e-napotnic po letih

### 3.2 Spremembe in izboljšave v letu 2024 (Kosednar, 2024a)

Nacionalna rešitev eNaročanje je v letu 2024 doživela številne spremembe in izboljšave.

#### 3.2.1 Napotnice do zaključka zdravljenja

Novela Pravil obveznega zdravstvenega zavarovanja<sup>2</sup> (POZZ) predvideva vpeljavo napotnic do zaključka zdravljenja. To pomeni, da je omogočena izdaja samo napotnic do zaključka zdravljenja (trajnih). Ukinja se izdaja enkratnih in obdobjnih (večkratnih) napotnic, ukinja se podaljševanje napotnic in prenos naročil na novo napotnico. Prav tako se ukinja pooblastila 1, 2, 3, saj se šteje, da ima napotni zdravnik samodejno vsa pooblastila (pregled, zdravljenje, nadaljnje napotovanje). Ukinja se omejitev izdaje povezanih napotnic na samo en nivo, možno je veriženje povezanih napotnic v več nivojih.

#### 3.2.2 Potisna obvestila v aplikaciji zVEM

Pacient v mobilni aplikaciji že sedaj prejema potisna obvestila o prejetih izvidih in posodobljenem povzetku podatkov o pacientu. Iz eNaročanja bo prejemal obvestila o izdanih napotnicah in terminih, na katere je naročen. Na ta način bo pacient pravočasno obveščen o svojih zdravstvenih obravnavah, kar bo zagotovo zmanjšalo



neopravičene izostanke in pomembno vplivalo na ozaveščanje o dolžnostih pacienta.

### 3.2.3 Pravilnik o naročanju in upravljanju čakalnih seznamov

Predlog pravilnika o naročanju in upravljanju čakalnih seznamov ter najdaljših dopustnih čakalnih dobah (Pravilnik o naročanju in upravljanju čakalnih seznamov ter najdaljših dopustnih čakalnih dobah, 2024) prinaša novo definicijo nedopustno čakajočega pacienta. Nedopustno čakajoč pacient je pacient, katerega čakalna doba presega najdaljšo dopustno čakalno dobo, določeno glede na stopnjo nujnosti za posamezno vrsto zdravstvene storitve. Pacient postane nedopustno čakajoč z dnem, ko število dni od prve uvrstitve na čakalni seznam preseže najdaljšo dopustno čakalno dobo. Relativna čakalna doba predstavlja razmerje med dejanskim številom dni čakanja in najdaljšo dopustno čakalno dobo glede na stopnjo nujnosti za posamezno vrsto zdravstvene storitve. Za potrebe prenaročanja in naročanja pacientov, ki čakajo najdlje po novi definiciji, je bil v eNaročanju implementiran tako imenovani “novi” oz. relativni koeficient, s pomočjo katerega lahko izvajalci prenaročijo pacienta, ki čaka najdlje. (Kosednar, 2024a).

## 4 Diskusija

Neodvisno poročilo Evalvacija ukrepov iz enotne zbirke ukrepov, Vrednotenje učinkov implementacije projekta eZdravje: eRecept, eNaročanje (Ministrstvo za javno upravo, 2019) navaja ključne pozitivne spremembe. Za zdravnike so to izboljššan dostop do podatkov posameznega pacienta, omogočeno elektronsko poslovanje in izmenjava e-dokumentov, učinkovitejše izvajanje zdravstvenih storitev, dostopnejše in hitrejše analize podatkov, boljši nadzor nad napotitvami in pridobivanje statistike.

Pacientom je omogočen vpogled v čakalne vrste, izboljšana in poenostavljena je možnost naročanja pri zdravniku, lažja je izbira lokacije termina in izvajalca zdravstvene dejavnosti, možnost odpovedi termina in ponovnega naročila. Podatki o napotitvi so varno shranjeni.

Za leta 2016, 2017 in 2018 poročilo navaja samo za eNapotnico 31,7 milijonov prihrankov.

Najnovejše dopolnitve zmanjšujejo obremenitve zdravnikov napotovalcev in napotnih zdravnikov (specialistov), ker bodo napotnice do zaključka zdravljenja zagotovile neprekinjeno zdravstveno obravnavo pacienta brez potrebe po izdaji nove napotnice zaradi poteka prejšnje. Specialistom omogočajo nadaljnje napotovanje pacientov na dodatne zdravstvene storitve brez omejitev. Pacientom je prav tako olajšan dostop do zdravstvenih storitev na specialistični ravni brez skrbi zaradi veljavnosti napotnice. Pričakujemo, da bodo potisna obvestila, ki bodo pacienta opomnila na prihajajoče termine, vplivala na zmanjšanje neopravičenih odsotnosti pacientov. Možnost prenaročanja najdlje čakajočih pa bo vplivala na zapolnitev možnih praznin v urnikih zdravstvenih ustanov in posledično zmanjšala število čakajočih pacientov ter čakalne dobe.

## 5 Zaključek

Rešitev eNaročanje je ena od rešitev eZdravja v Sloveniji. Čeprav je v uporabi že od leta 2017, se še vedno razvija. Izdaja e-napotnic se vsakodnevno uporablja pri izvajalcih zdravstvene dejavnosti, precejšnja je tudi uporaba elektronskega naročanja. Nekaj izzivov je še pri upravljanju čakalnih seznamov, predvsem so tu težave zaradi slabih in nepopolnih podatkov, ki jih posredujejo izvajalci zdravstvene dejavnosti.

Navedene rešitve predstavljajo pomembne nadgradnje in nove funkcionalnosti nacionalnih rešitev eZdravja. Zmanjšujejo obremenitve zdravnikov napotovalcev in napotnih zdravnikov (specialistov). Pričakujemo, da bodo potisna obvestila pacientom vplivala na zmanjšanje neopravičenih odsotnosti pacientov. Možnost prenaročanja najdlje čakajočih pa bo vplivala na zapolnitev možnih praznin v urnikih zdravstvenih ustanov in posledično zmanjšala število čakajočih pacientov ter čakalne dobe.

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# TOWARDS GOAL-ORIENTED RECOMMENDER- AND DATASPACE- DRIVEN VOLUNTEERING

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Voluntary engagement is an indispensable cornerstone of Critical Infrastructures (CI) such as civil protection, disaster, crisis and rescue management as well as health and social services. Sustainability of the voluntary sector, however, is massively endangered by profound changes in demography, social structure, and volunteer motives in the sense of individualization and pluralization of society. This paper tackles these key challenges by giving an overview on our digital platform for goal-oriented volunteering across and independently of different non-profit organizations. This platform is intended to be a first step towards synergistically aligning the goals and competencies of volunteers with the activity requirements of CI by proposing first ideas on using recommender and dataspace technologies.

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systems,  
goal theory,  
personal informatics,  
persuasive systems,  
recommender systems,  
dataspaces



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## 1 Introduction

Voluntary engagement is a vital pillar of Critical Infrastructures (CI), including civil protection, disaster management, and health services, making it essential for society. Globally, over 10% of people volunteer, rising to 23% in the EU and 46% in Austria. Austrian volunteers contribute 14.7 million hours weekly, with 5.8 million hours dedicated to CI (BMSGPK, 2022; UN, 2022). However, sustainability of the voluntary sector for CI is under threat from (i) *demographic changes* resulting in growing volunteering demands, and (ii) significant *motivational and social change* (UN, 2022). Personal benefits and skill acquisition now play a larger role, leading to greater *diversification* and necessitating alignment with CI activity requirements (Simsa, et al., 2019). Volunteers demand for flexibility leads to fragmentation, emphasizing the need for goal-oriented, competence-based bundling of formal and informal (i.e., independent of Non-Profit Organization (NPO)) volunteering (UN, 2022).

IT support for volunteering has focused on managing engagement through NPOs, neglecting volunteers' personal goals beyond these organizations. Aligning IT tools with personal goal-setting can enhance performance, engagement, and well-being (Locke et al., 2019). This gap is critical, as effective IT support is essential as effective IT support benefits both NPOs and volunteers (UN, 2022). Thus, our research project »*CIvolunteer*« (*CI Powered by Volunteers*, cf. Figure 1) envisions »cross-NPO engagement by personal goals«. This paper, first, contributes an in-depth discussion of the deficiencies and challenges of the state-of-the-art of (i) *goalification*, particularly from the perspective of *operationalization* of goals, as well as (ii) *bundling of volunteering*, from an *IT support perspective*, in Section 2. Based thereupon, second, the conceptual framework of our *goalification platform for volunteering* — “goalification” being a play on the term “gamification” (Docherty, 2018) — is presented in Section 3 together with first ideas towards *Large Language Model (LLM)-based recommender functionality*. Thirdly, in Section 4 *dataspace functionality* for volunteer bundling is discussed. Finally, our contributions are summarized in Section 5.

## 2 State-of-the Art – Goalification and Volunteer Bundling

The selection of related work aligns with our goal of providing a *goalification platform for volunteering*, leveraging *recommender* and *dataspace* technologies. Accordingly, the discussion is divided into (1) *goalification* and its *operationalization*, and (2) *IT support for volunteering, including engagement bundling* (see Figure 1).

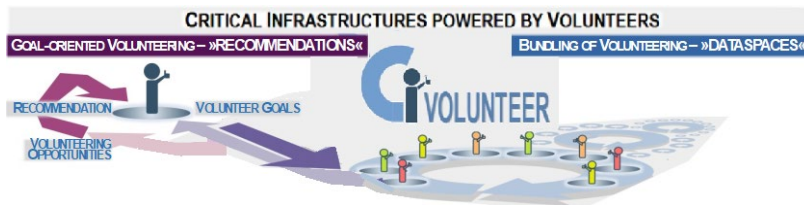


Figure 1: Overview of »CIvolunteer«

Source: Own

### 2.1 Goalification & Operationalization

Goal setting helps individuals achieve objectives, improving performance, engagement, and well-being (Locke et al., 2019). Research either targets specific aspects of goal setting, (e.g., Ekhtiar et al., 2023; Cham et al., 2019) or explores related fields like personal informatics (Li et al., 2010), persuasive systems (Oinas et al., 2009), behavior change techniques (BCT) (Corker et al., 2023), habit formation (Stawarz et al., 2015) or Self-Determination Theory (SDT) (Villalobos et al., 2020).

**Deficiencies and Challenges.** From an *application-oriented point of view*, the benefits of goal setting have been adopted by a plethora of *goalification apps*, which have emerged for many facets of life, not only in the work context but especially for personal use increasing well-being (Locke et al., 2019). However, as highlighted in our survey (Pröll et al., 2024), these apps neither address the voluntary sector nor support the complete *goalification lifecycle*, from planning goals to acting thereupon and finally analyzing their outcome (Holding et al., 2023). Besides, the *operationalization* of goals into executable activities is rarely, and at best quite rudimentary supported by goalification apps and remains underexplored in goal-setting research (Epstein et al., 2020, Niess et al., 2018). This lack originates not least in the fact that goal setting empowers users to bring in their individual point of view by setting goals on basis

of *personal motives* and *psychological needs*, often leading to quite *abstract (aka. qualitative) goals* (e.g., setting the goal to increase one's well-being by the end of the year), thus ultimately challenging its *operationalization* (Niess et al., 2018) (cf. Section 3).

## 2.1 Volunteering IT Support & Volunteer Bundling

Volunteering IT support (Pröll et al., 2016, 2017, 2020a, 2020b) is dominated by *commercial, NPO-centric Volunteer Management Systems (VMS)* as shown in our evaluation of 18 VMS using over 100 evaluation criteria (Pröll et al., 2016). These VMS *manage volunteers, organizational structures various phases the volunteering process* including scheduling, execution, rewards, and assessments, features for communication, coordination, and customization (Pröll et al., 2016). In the informal sector Volunteer Web Portals primarily facilitate simple activity placements to connect volunteers with regional opportunities (Pröll et al., 2016).

**Deficiencies and Challenges.** Most of these systems are, however, (i) *walled volunteering "data silos"*, i.e., preventing a human-centric and NPO-overarching exploitation of volunteering data (e.g., activities accomplished by a particular volunteer or competencies acquired) (Pröll et al., 2016) and (ii) they *lack* any mechanisms for *personal goal setting, activity recommendation, progress monitoring and reflection* beyond simple activity and competence documentation, e.g., *digital volunteer passports* (Pröll et al., 2020a, 2020b). In order to strengthen the volunteer sector, however, bundling of volunteer engagement is of fundamental importance. This requires in turn to base upon the numerous existing VMS being already employed since decades by NPO's in various domains, ranging from civil protection, disaster, crisis and rescue management to health and social services, food supply and harvesting. Not least because of this broad variety of domains, the underlying data of these VMS is characterized by (i) various kinds of *heterogeneity*, from syntactic to structural and semantic, (ii) and different forms of *persistency mechanisms*, from simple file-based mechanisms to different CMS and DBMS, thus challenging data sharing and exchange being crucial for bundling of volunteer engagement (cf. Section 4).

## 3 LLM Powered Goalification App at a Glance

Based on our conceptual goalification framework proposed in (Pröll et al., 2024a, 2024b) and the state-of-the art discussed in Section 2, we realized a first prototype of our »CIvolunteer« goalification app, providing basic goalification functionalities



and an initial version for LLM-based recommendations for operationalizing goals (cf. Figure 2, including exemplary frontend mockups of our prototype).

### 3.1 Goalification Framework as Conceptual Basis

**Methodology.** Our conceptual goalification framework systematizes and integrates the required functionality for a goalification platform. We base our approach on goal theory (Locke et al., 2019) and draw from design space conceptualizations in fields like personal informatics (Li et al., 2010), persuasive systems (Oinas et al., 2009),

BCT (Corker et al., 2023), habit formation (Stawarz et al., 2015) and SDT (Villalobos et al., 2020) to form a kind of overarching framework. At its core is a *process-oriented perspective* covering the entire goalification lifecycle (Holding et al., 2023). Feasibility is justified by a mapping of this perspective and its functionality to eight existing design space conceptualizations (Proell et al., 2024a).



Figure 2: Conceptual Goalification Framework and Frontend Mockups

Source: Own

**Goalification Process.** Following the design space conceptualizations of Li et al. (2010) and Ohlin et al. (2015) and the goalification lifecycle (Holding et al., 2023), our process perspective includes three key phases for comprehensive goalification

support: (i) *planning*, in terms of eliciting, defining, setting, and operationalizing quantitative and qualitative goals (ii) *acting*, consisting of pursuing and tracking goals, and (iii) *analysing*, covering reflecting goals and consequencing thereof, aligning with action research principles (Heckhausen, 2007). Each phase offers distinct, complementary functionality and mind-sets. This approach not only mirrors real-world app usage but also provides flexibility for diverse volunteering domains and motives through its spiral cycles, arbitrary start points, and nested structure.

### 3.2 Goal Operationalization by LLM-based Recommendations

Operationalizing goals is vital in the planning phase but is rarely supported by goalification apps, partly due to the challenge of abstract qualitative goals (Niess et al., 2018). This section presents first ideas for supporting goal operationalization through *LLM-based recommendations* (Pröll et al., 2024c).

**Traditional Recommender Technologies Inadequate.** Current *recommender systems* use *collaborative filtering* (similar users have similar preferences), *content-based filtering* (users prefer items with features like those they've liked before) or a *combination* of both (Ricci et al., 2022). These methods often assume *stable preferences*, which may not align with the *evolving nature of personal goals* (Niess, et al., 2018). Instead, volunteering recommendations should prioritize helping users achieve their goals effectively, e.g., prioritizing opportunities that supports multiple goals over those that address only one (Papadimitriou, 2018).

**LLMs as Silver Bullet?** LLM-based recommenders offer a promising solution by operationalizing both *quantitative goals* (e.g., for the goal to intensify volunteering neighborhood assistance, all related opportunities seem reasonable) and more complex qualitative goals (e.g., enhancing social competence through volunteering) (Niess, et al., 2018, Pröll et al., 2024c). Leveraging natural language understanding, LLMs can better capture user preferences, item descriptions, and context, improving recommendation accuracy (Hua et al., 2023; Liu et al., 2023; Lin et al., 2024; Wang et al., 2024). This makes then the most promising approach for goal-oriented volunteering.

**LLM-based Goal Operationalization Approach.** As a first step we explored how *LLMs* can serve as *annotators* to provide labeled ground truth data of *personal goals* (both *quantitative and qualitative*) and *volunteering opportunities* (both *regional and supra-regional*). We compared existing approaches and proposed their adoption to the peculiarities of our domain (Pröll et al., 2024c), see Figure 3.

Second, to assess the impact of different label-based models, we proposed using *transfer learning* (Wang et al., 2016) with customized cross-encoder models (Reimers et al., 2019) to *fine-tune models*. We then evaluated the *feasibility* of various labeling approaches and the resulting models using appropriate metrics and statistical tests.

Our findings indicate that fine-tuned models based on LLM-generated labels achieve high precision. By using a self-trained model, we eliminate the need for costly external queries, improving efficiency and scalability. Currently, the recommendation mechanism relies on simple goal-to-activity matching, but future work will integrate user profiles for more dynamic recommendations that consider goals, activities, and individual preferences. We are also developing an extension that uses reinforcement learning to adapt recommendations to evolving user preferences, enhancing personalization and long-term utility.

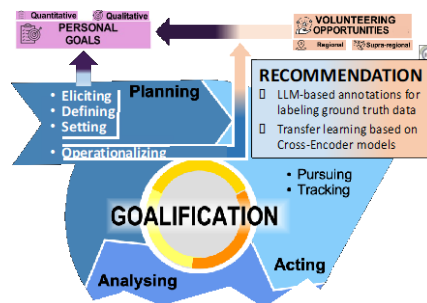


Figure 3: LLM-based Goal Operationalization by Recommendation

Source: Own

## 4 Volunteer Bundling using Dataspaces

Besides aligning personal goals of volunteers with activity requirements of NPOs through recommendations, bundling of volunteering across different NPOs is crucial, especially in crisis situations. In the following, we discuss (i) applying the

dataspace paradigm to the volunteering sector (cf. Fig. 4), highlighting its *key characteristics* and a *potential usage scenario* for *volunteer engagement bundling*, through three basic principles as well as (ii) considerations for their implementation.

#### 4.1 Goal Operationalization by LLM-based Recommendations

Introduced by Franklin et al. (2005), dataspace provide an abstraction layer for data and service management, addressing the data-centric nature of modern society (Abadi et al., 2022). Dataspace follow the “*FAIR philosophy*”, ensuring findability, accessibility, interoperability, and reuse of data and services, leveraging *semantic technologies* (Hauf et al., 2024). The dataspace paradigm is well-suited to tackling the challenges outlined in Section 2.2, by enabling (i) inter-NPO data and service sharing, (ii) in diverse formats, (iii) controlled by data producers, (iv) accessible through various VMS, and (v) support for different applications like our goalification platform. While existing dataspace proposals focus on domains like agriculture, energy, and healthcare (Bacco et al., 2024), none yet target the volunteering sector, and only few base their work on real-world data/services (Giess et al., 2025).

**Three basic Principles of a Volunteering Dataspace.** Based on this rationale, the essence of dataspace and their application to our volunteering use case in terms of a novel “*volunteering dataspace*” is summarized by three core principles (cf. Figure 4).

##### (1) Volunteering Data Co-Existence & Pay-As-You-Go Integration Levels.

Our volunteering dataspace will use a *federated, co-existence approach* for heterogeneous data, preserving data at its source (Franklin et al., 2005), including volunteering data from various VMS across different NPOs. *Basic functionality*, like on-demand queries, should be provided regardless of data heterogeneity or integration. Data integration should follow an agile “pay-as-you-go” strategy (Franklin et al., 2005), leading to a progressively evolving volunteering dataspace. Unlike traditional *schema first* approaches in relational DBMS, our dataspace will adopt a *data first, (integrated) schema later or never* policy similar to NoSQL systems (Abadi et al., 2022). This is essential as the dataspace is *domain-agnostic* and does not rely on a fixed unifying schema for volunteering data. Volunteering data will be integrated only *gradually, whether and when necessary*, with *low upfront and maintenance costs* as the big assets, requiring, however, to be balanced with potentially *restricted base functionality* (Wang et al., 2016).

Relationships between resources will be inferred automatically, e.g., through user feedback or as new VMS data sources are added (Bacco et al., 2024).

**(2) Data Querying Service Levels.** Due to limited data integration and loosely coupled VMS data sources, *querying* our volunteering dataspace will *vary in service levels*, with best-effort or approximate answers based on the integration level (Bacco et al., 2024). The dataspace will rely on a *brokering hub* (cf. Figure 4) to share its VMS resources, including details like source, name, location, size, creation date, and owning NPO. The resulting catalogue of products (*data* and *services*) (Giess et al., 2025) will be a key functionality of our volunteering dataspace.

**(3) Data and Service Sovereignty.** From a policy perspective, our volunteering dataspace should be a *distributed system* governed by a framework that enables *secure, trustworthy* data and service sharing while maintaining *sovereignty* (Bacco et al., 2024) without central authority control. Participants – whether NPOs or volunteers – should have control over who, how, when, and at what price their data and services are used, ensuring the data producer retains control (Wang et al., 2016). Finally, volunteering data of NPOs should be managed completely independent of the according VMS that produce or consume this data, thus being in line with the W3C Verifiable Credentials Data Model (W3C, 2024).

#### 4.1 Goal Operationalization by LLM-based Recommendations

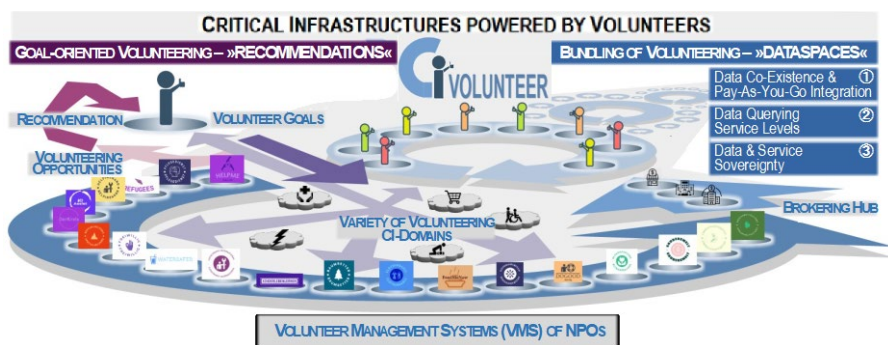


Figure 4: Dataspace-based Bundling of Volunteering

Source: Own

»**BrokeringHub**« as **Initial Step**. As an initial step towards establishing a novel dataspace for volunteering, we propose a so-called »*BrokeringHub*«, where *lightweight adapter plug-ins* allow NPOs and volunteers themselves to contribute proven competencies, open activities and achieved goals, while allowing sponsors to offer, e.g., incentives. The challenge is to create an *open and scalable platform* via connection services such as *Zapier* and *IFTTT* (Cosar, 2021) instead of "yet another data silo/island solution". Building on this, purely syntactic data exchange should be "lifted" to a semantic level by *semantic integration as needed*, building an adequate basis for coordination and cooperation by applying standards such as *Linked Open Data* and *ontologies* (Hauf et al., 2024).

**Engagement Asset Ontology for Structural Pay-as-you-go Integration.** A common core ontology formalizing volunteering concepts and relationships in-between has been proposed in our previous work (Pröll et al., 2020a), providing the fundament for *structural pay-as-you-go* integration. Based on the metaphor »*I am what I do*«, a basis for deriving the common core concepts of volunteer engagement has been found in the area of *linguistic research*, notably in the prominent work of Vendler about the aspectual classification of verbs (Vendler, 1957), as well as by considering well-known upper ontologies like SUMO (Niles and Pease, 2001) or DOLCE (Gangemi et al., 2002). The core of generic concepts of our ontology expresses the fact, that `Engagement in Activities` running through certain `States` may lead to `Accomplishments` and various `Achievements`, justified by some `Evidence`. Although this so-called *engagement asset ontology* (Pröll et al., 2020a), focuses on volunteering, special attention has been paid to provide a core of generic concepts being applicable to a much broader range of application areas. This is achieved on the one hand by enabling *white-box reuse*, i.e., subtyping to extend the pre-defined type taxonomies, thereby coping with peculiarities of assets issued by, e.g., different NPOs. On the other hand, *black-box reuse* is supported through explicit extension points, allowing to enhance and configure the ontology by specifying, e.g., further properties (Pröll et al., 2020b).

**LLMs for Behavioral Pay-as-you-go Integration.** In order to populate this ontology, a central challenge is the semantic integration of competencies acquired in different NPOs, using appropriate semantic matching technologies as basis for *behavioral pay-as-you-go integration*. Competencies are usually described in textual form by different rules that have to be fulfilled in the respective NPO, e.g., completion of

certain courses. Modern LLMs provide possibilities for the analysis of semantic equality, which can serve as a basis for semantic matching, thus being one important challenge for our future research.

## 5 Conclusion

This paper provided a first step towards »cross-NPO engagement by personal goals«. Based on an in-depth discussion of the state-of-the-art in goalification and volunteering IT support, a goalification platform for volunteering has been presented, followed by first ideas in using LLM-based recommender for goal operationalization and dataspace for engagement bundling. Future work is mainly focused on improving LLM-based recommender and in using LLMs also as a core mechanism for behavioral pay-as-you-go integration in our volunteering dataspace, allowing the semantic matching between volunteering data (e.g., activities, achievements or competencies) of different NPOs.

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# JAVNOZDRAVSTVENI PROBLEMI IN VPLIV UI NA EKONOMSKO BREME BOLEZNI

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Umetna inteligenca (UI) vedno bolj igra pomembno vlogo tudi v zdravstvu. V večini držav po svetu različne bolezni, kot so demenca, mišično-skeletne bolezni ter druge kronične bolezni predstavljajo veliko finančno breme za zdravstvene blagajne. Namen pričujočega dela je prikazati rezultate dveh analiz ekonomskega bremena bolezni v Sloveniji ter ugotoviti ali lahko UI vpliva na zmanjševanje ekonomskega bremena. Raziskave so pokazale, da je bilo v Sloveniji ocenjeno ekonomsko breme proučevanih javnozdravstvenih problemov zelo visoko. Uporaba UI ima velik potencial, saj lahko pomembno prispeva k preprečevanju ali zamiku bolezni. Z zgodnjim odkrivanjem in natančnejšo diagnozo teh bolezni omogoča pravočasno ukrepanje, kar prepreči dolgoročne zaplete in zmanjšuje potrebo po daljši rehabilitaciji ali zapletenih kirurških posegih, kar pa ugodno vpliva na stroške zdravstvenega sistema, predvsem pa pomeni večjo kakovost življenja za bolnike. To pa pomeni zmanjšanje tako socialnega kot ekonomskega bremena družbe. UI je izjemno zmogljivo orodje, vendar ne more nadomestiti strokovnjakov, ki zagotavljajo celostno obravnavo in človeški vidik zdravljenja in s tem najboljše rezultate za bolnika. S tem pa se odpira prostor za razpravo o sodelovanju med tehnologijo, človekom in organizacijami.

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# PUBLIC HEALTH ISSUES AND THE IMPACT OF AI ON THE ECONOMIC BURDEN OF DISEASES

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Artificial intelligence (AI) is playing an increasingly important role in healthcare. In most countries, various diseases such as dementia, musculoskeletal disorders and other chronic diseases are a major financial burden on health budgets. The aim of this paper is to present the results of two analyses of the economic burden of diseases in Slovenia and to determine whether AI can have an impact on reducing the economic burden. The studies showed that the estimated economic burden of the studied public health problems in Slovenia was very high. The use of AI has great potential as it can make an important contribution to preventing or delaying disease. By detecting and diagnosing these diseases earlier and more accurately, it allows timely action to prevent long-term complications and reduce the need for prolonged rehabilitation or complex surgery, which has a positive impact on the cost to the healthcare system and, most importantly, means a better quality of life for patients. This means a reduction in both the social and economic burden on society. AI is an extremely powerful tool, but it cannot replace the professionals who provide holistic treatment and the human aspect of healing, and thus the best results for the patient. This opens up the debate on the collaboration between technology, people and organisations.



## 1 Uvod

Mišično-skeletne bolezni, demenca ter druge kronične bolezni predstavljajo velik javnozdravstveni problem ter veliko finančno breme za zdravstvene blagajne. Mišično-skeletne bolezni se lahko razvijejo v katerikoli starosti, najpogosteje pa se pojavljajo od obdobja adolescence naprej (WHO, 2019). Z naraščanjem števila starejših se bo vpliv bolezni na posameznika in družbo zagotovo povečeval (Lewis in sod., 2019; Kofol Bric, 2010; Kofol Bric, 2012). Razvoj mišično-skeletnih bolezni je precej odvisen od dejavnikov tveganja, poleg bioloških, kot sta spol in starost ter genetskih, na razvoj bolezni vplivajo številni drugi dejavniki, ki so povezani z načinom življenja, to so pomanjkanje gibanja, povečana telesna teža, slabše prehranske navade, kajenje, poškodbe (WHO, 2021; EUMUSC, 2011; GovUK, 2022; Lewis in sod., 2019). Med mišično-skeletne bolezni sodi več kot 150 vrst bolezni mišic, kosti, sklepov, pripadajočih tkiv, npr. sklepnih ovojnic, vezi in kit. Najpogostejša mišično-skeletna obolenja so poškodbe, zlomi, povezani s krhkostjo kosti, bolečine v vratu, hrbtu, osteoartritis ter sistemska vnetna stanja, kot je npr. revmatoidni artritis. Navadno jih spremlja bolečina, pogosto kronična, omejena mobilnost, zmanjšanje funkcionalnosti in sposobnosti za delo, socialno življenje (WHO, 2019). Zdravstvene težave, ki nastanejo zaradi teh bolezni, vodijo v slabšo kakovost življenja ter lahko pripeljejo do prezgodnje upokojitve. Vsaka predčasna upokojitev, ki bi jo lahko preprečili oz. zamaknili za določeno obdobje, predstavlja izgubo človeškega kapitala, kar pomeni za družbo veliko socialno in ekonomsko škodo. Prav tako pa zdravstvene težave, ki nastanejo zaradi sindroma demence, vodijo v slabšo kakovost življenja prizadete osebe in njihovih svojcev, predčasno upokojitev in prizadenejo vsakodnevno življenje oseb, ki zbolijo in njihovih bližnjih. Bolezen pa je tudi veliko finančno breme tako za svojce oz. skrbnike kot za zdravstveni sistem. Zato je pomembno zgodnje prepoznavanje in diagnosticiranje bolezni. Demenca tako ni le zdravstveni problem, ampak močno obremenjuje svojce in družbo kot celoto. Demenca je sindrom, ki ga povzroča možganska bolezen, navadno kronična ali progresivna, kjer gre za motnjo več višjih kortikalnih funkcij, vključno spomina, mišljenja, orientacije, razumevanja, računskih zmožnosti, učnih sposobnosti ter govornega izražanja in presoje (MKB 10, 2005). Sindrom demence se lahko začne že pred 65. letom, z relativno hitro potekajočim propadanjem možganov in številnimi izrazitimi motnjami višjih kortikalnih funkcij in jo imenujemo zgodnja demenca, ali pa po 65. letu, kot jo poimenujemo demenca s kasnim začetkom, ki se prepozna po navadi v poznih 70. letih ali pozneje, počasi

napreduje, njen glavni znak je motnja spomina (MKB 10, 2005). Demenca je tako posledica nevrodegenerativnih, žilnih, vnetnih ali drugih bolezni možganov, ki se pri posamezniku razvijajo postopoma. Sodobni nevrološki diagnostični pristopi z uporabo analize bioloških označevalcev, nevrofizioloških ter naprednih slikovnih metod, omogočajo opredelitev narave bolezenskega procesa že v zgodnjih fazah bolezni, ko pri posamezniku še ne gre za razvito klinično sliko demence. Natančna in zgodnja diagnoza zagotavlja izbiro ustreznega terapijskega pristopa, napoved prognoze bolezni in zasnovo postdiagnostične obravnave, hkrati pa osebi z demenco in njegovim svojcem olajša soočanje z boleznijo in omogoči načrtovanje prihodnosti (MZ, 2022). Osebe z napredovano demenco imajo v zadnjem obdobju življenja običajno ne le kognitivno, temveč tudi telesno oslabeledost in tako so lahko popolnoma odvisne od oskrbe in pomoči drugih oseb pri najosnovnejših življenjskih aktivnostih. Pri tem imajo lahko težave npr. s prehranjevanjem, hujšajo, so inkontinentne, nepokretne in negibne, lahko imajo rane zaradi preležanin in se ne morejo več sporazumevati. Lahko imajo bolečine, vedenjske odklone ali nevropsihiatrične simptome. Pogosto imajo tudi druge pridružene bolezni (MZ, 2022). Predvideva se, da bodo ekonomski stroški demence skokovito naraščali v Evropi, do leta 2030 bodo po ocenah narasli na več kot 250 milijard evrov. Njena razširjenost po vsem svetu pa se bo do leta 2050 skoraj potrojila, kar spodbuja razvoj preventivnih in kurativnih posegov ter iskanje inovativnih rešitev tudi s pomočjo UI (Wolters, Ikram, 2018).

Umetna inteligenca (UI) zadnja leta hitro pridobiva pomen na številnih področjih, še posebej pa v zdravstvu, kjer lahko pomembno prispeva k odkrivanju, preprečevanju in obvladovanju bolezni. Kronične bolezni, med katere sodijo demenca, mišično-skeletne bolezni in številna druga obolenja, že vrsto let predstavljajo veliko breme tako za posameznike kot za zdravstvene sisteme po vsem svetu, vključno s Slovenijo. Stroški zdravljenja in dolgotrajnih terapij pogosto presegajo zmogljivosti zdravstvenih blagajn, kar neposredno vpliva na razpoložljivost virov ter družbeno blaginjo. Prav zato se raziskovalci in strokovnjaki usmerjajo v preučevanje možnih rešitev, ki jih ponujata razvoj in uporaba UI.

Namen pričujočega dela je prikazati rezultate dveh analiz ekonomskega bremena bolezni v Sloveniji v obdobju 2020-2023 ter ugotoviti ali lahko UI vpliva na zmanjševanje ekonomskega bremena ter ali lahko UI pomembno prispeva k preprečevanju ali zamiku bolezni.

## 2 Metodologija izračuna bremena bolezni

### 2.1 Izračun bremena mišično-skeletnih bolezni in demence

Ocenjeni ekonomski stroški mišično-skeletnih bolezni in demence, oz. breme temelji na izračunu direktnih, oz. neposrednih stroškov, ki so povezani z zdravljenjem in izračunu indirektnih oz. posrednih stroškov, ki so povezani z izgubljeno produktivnostjo, ko je oseba zaradi bolezni odsotna z dela ter z izgubljenim prihodnjim zaslužkom, oz. izgubljenim dohodkom zaradi prezgodnje upokojitve. kako bolezen vpliva na zdravstveni sistem ali celotno družbo in, kaj to pomeni v ekonomskem smislu (Toth, 2004).

Neposredni stroški vključujejo zdravila, prve kurativne obiske na primarni ravni, obiske v ambulanti na sekundarni ravni in hospitalizacije.

Posredni stroški vključujejo začasno odsotnost z dela, izgubljeni dohodek iz dela zaradi nezmožnosti za delo in izgubljeno neplačano gospodinjsko delo zaradi nezmožnosti za delo.

Storitve zdravstvene službe, kot so obiski na primarni in sekundarni ravni, hospitalizacije, zdravila, začasna odsotnost z dela ter prezgodnja upokojitvev, so za mišično-skeletne bolezni in demenco izračunane po diagnozah po MKB 10-klasifikaciji (MKB, 2005), ki so prikazane v Preglednici 1 in 2

**Tabela 1: Nabor diagnoz upoštevanih pri izračunu mišično-skeletnih bolezni**

GLAVNE DIAGNOZE (osnovni vzroki)	MKB-10
M16	Artroza kolka (koksartroza)
M17	Artroza kolena (gonartroza)
M25	Druge motnje sklepa, ki niso uvrščene drugje
M54	Bolečina v hrbtu (dorzalgija)
M75	Okvare (lezije) rame
M79	Druge motnje mehkega tkiva, ki niso uvrščene drugje

Vir: MKB 10, 2005

**Tabela 2: Nabor diagnoz upoštevanih pri izračunu demence**

<b>GLAVNE DIAGNOZE (osnovni vzroki)</b>	<b>MKB-10</b>
<b>F00*</b>	<b>Demenca pri Alzheimerjevi bolezni izzani</b>
F00.0*	Demenca pri Alzheimerjevi bolezni z zgodnjim začetkom (G30.0)
F00.1*	Demenca pri Alzheimerjevi bolezni s kasnim začetkom (G30.1)
F00.2*	Demenca pri Alzheimerjevi bolezni, atipična ali mešana oblika (G30.8)
F00.9*	Demenca pri Alzheimerjevi bolezni, neopredeljena
<b>F01</b>	<b>Vaskularna demenca</b>
F01.0	Hitro nastala vaskularna demenca
F01.1	Multiinfarktna demenca
F01.2	Subkortikalna vaskularna demenca
F01.3	Mešana kortikalna in subkortikalna vaskularna demenca
F01.8	Druge vrste vaskularne demence
F01.9	Vaskularna demenca, neopredeljena
<b>F02*</b>	<b>Demenca pri drugih boleznih, uvrščenih drugje</b>
F02.0*	Demenca pri Pickovi bolezni (G31.0)
F02.1*	Demenca pri C-J. bolezni (A81.0)
F02.2*	Demenca pri Huntingtonovi bolezni (G10)
F02.3*	Demenca pri Parkinsonovi bolezni (G20)
F02.4*	Demenca pri bolezni zaradi HIV
F02.8*	Demenca pri drugih opredeljenih boleznih, ki so uvrščene drugje
<b>F03</b>	<b>Neopredeljena demenca</b>
	Druge degenerativne bolezni živčevja
<b>G30</b>	<b>Alzheimerjeva bolezen</b>
G30.0	Alzheimerjeva bolezen z zgodnjim začetkom
G30.1	Alzheimerjeva bolezen s kasnim začetkom
G30.8	Druge vrste Alzheimerjeva bolezen
G30.9	Alzheimerjeva bolezen, neopredeljena

Vir: MKB 10, 2005



Metodologijo računov nacionalnih transferjev (angl. National Transfer Accounts) smo uporabili pri izračunu stroškov izgubljenega dohodka iz dela zaradi nezmožnosti za delo in izgubljenega neplačanega gospodinjskega dela zaradi nezmožnosti za delo (Sedlak idr., 2020).

Izračun ocene stroškov na osnovi zbirk NIJZ je možen le za prve kurativne obiske pri osebnem zdravniku, ne pa tudi za ponovne obiske. Prve kurativne obiske v splošni ambulanti smo ovrednotili s ceno Zavoda za zdravstveno zavarovanje (ZZZS). Stroške ambulantnih storitev na primarni ravni smo ocenili s pomočjo podatkov o številu obiskov iz zbirke o zunajbolnišnični zdravstveni statistiki (ZUBSTAT) ter povprečne cene pregleda za prvi kurativni obisk v splošni ambulanti. Podatke zunajbolnišnične zdravstvene statistike na sekundarni ravni smo ovrednotili s ceno ZZZS za preglede v specialistični zunajbolnišnični dejavnosti. Zbirka SPP (Skupine primerljivih primerov) je služila, kot vir podatkov za število hospitalizacij oz. primerov in njihove uteži za izbrane diagnoze. Cena bolnišnične obravnave pacienta v psihiatrični dejavnosti v primeru demence je določena za primer hospitalizacije in je v izračunu upoštevana povprečna vrednost za obdobje 2020-2023. Pri izračunu stroškov demence so upoštevana zdravila, ki vsebujejo učinkovine donepezil, rivastigmin, galantamin in memantin. Pri izračunu mišično-skeletnih bolezni so upoštevana zdravila s protivnetnim in protirevmatičnim učinkom, zdravila za lokalno zdravljenje mišičnih in sklepnih bolečin, mišični relaksanti, zdravila za zdravljenje protina, zdravila za bolezni kosti in druga zdravila za zdravljenje motenj mišično-skeletnega sistema. Vir podatkov je bila Centralna baza zdravil (CBZ, 2024).

Na zgoraj opisan način, s pomočjo takšnih raziskav lahko ocenjujemo, kako bolezen vpliva na zdravstveni sistem ali celotno družbo in kaj to pomeni v ekonomskem smislu (Toth, 2004).

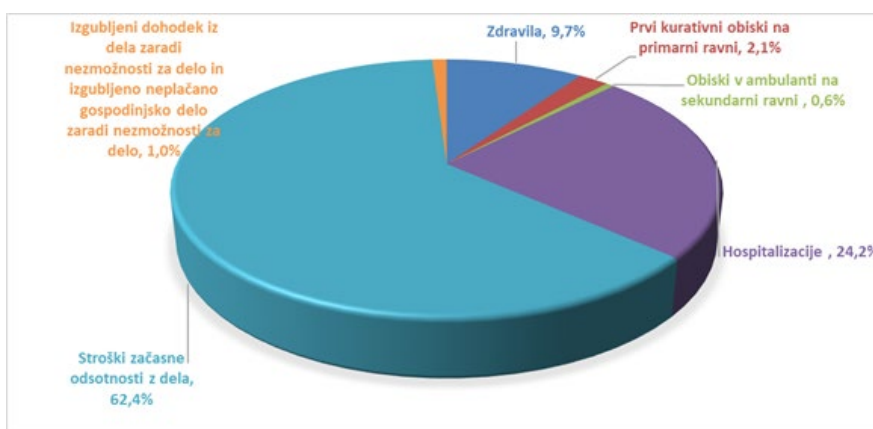
### **3 Rezultati**

#### **3.1 Skupno ekonomsko breme zaradi mišično-skeletnih bolezni in demence**

Raziskava je pokazala, da je bilo v Sloveniji, v obdobju 2020-2023, ocenjeno ekonomsko breme mišično-skeletnih bolezni in demence zelo visoko. Za mišično-skeletne bolezni je ocenjeno ekonomsko breme v povprečju na leto znašalo okoli

266 milijonov EUR oz. 5,2% vseh izdatkov za zdravstvo, kar predstavlja 0,5 % bruto domačega proizvoda v tem obdobju. Ocenjeno ekonomsko breme demence pa je v Sloveniji, po naših izračunih v obdobju 2020-2023 znašalo 11.195.132 EUR oz. 0,23% vseh izdatkov za zdravstvo.

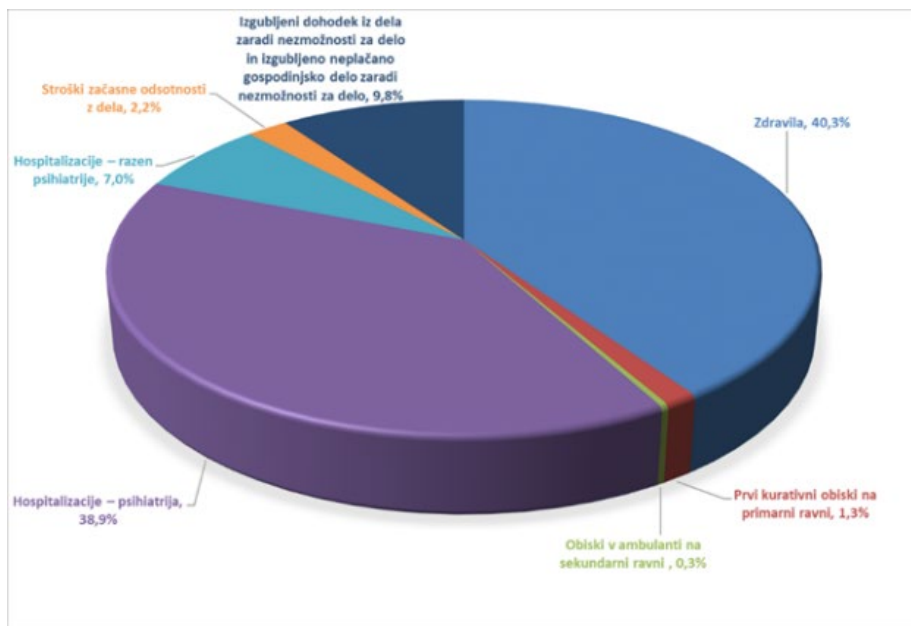
Neposredni stroški šestih izbranih diagnoz mišično-skeletnih bolezni za obdobje 2020-2023 znašajo 97,2 milijona EUR v povprečju oz. 1,9% vseh izdatkov za zdravstvo. Posredni stroški šestih izbranih diagnoz mišično-skeletnih bolezni pa znašajo 168,8 EUR v povprečju oz. 3,3% vseh izdatkov za zdravstvo. Skupno ekonomsko breme zaradi mišično-skeletnih bolezni, ki nastane na ravni enega leta in v proučevanem obdobju 2020-2023, v Sloveniji je prikazano na Sliki 1.



**Slika 1: Ocenjeno ekonomsko breme šestih izbranih diagnoz bolezni mišično-skeletnega sistema in vezivnega tkiva, po vrsti stroška, glede na celotno ocenjeno breme v obdobju 2020-2023, za Slovenijo**

Slika 2 prikazuje ocenjeno ekonomsko breme demence, po vrsti stroška, glede na celotno ocenjeno breme demence, v obdobju 2020-2023, za Slovenijo.

Neposredni stroški demence za obdobje 2020-2023 znašajo 9.846.326 EUR v povprečju oz. 0,2% vseh izdatkov za zdravstvo. Posredni stroški demence pa znašajo 1.348.806 EUR v povprečju oz. 0,03% vseh izdatkov za zdravstvo. So pa stroški močno podcenjeni, saj so v izračunu zajeti le rutinski podatki podatkovnih baz NIJZ.



Slika 2: Ocenjeno ekonomsko breme demence, po vrsti stroška, glede na celotno ocenjeno breme demence, v obdobju 2020-2023, za Slovenijo

### 3.2 Vpliv UI na različnih področjih zdravljenja bolezni

Uporaba UI v zdravstvu se hitro širi, saj UI zaradi svoje sposobnosti hitrega obdelovanja velikih količin podatkov ter zaznavanja kompleksnih vzorcev prinaša obetavne rešitve pri prepoznavanju, obravnavi in preprečevanju kroničnih bolezni, vključno z mišično-skeletnimi boleznimi in demenco. Obenem dokument Svetovne zdravstvene organizacije (WHO, 2021) opozarja na pomembnost etičnih in regulativnih vidikov pri uvajanju takšnih tehnologij. Koristi UI zasledimo na različnih področjih zdravljenja obeh skupin bolezni. Na področju zgodnjega odkrivanja bolezni in diagnostike, s pomočjo rentgenskih slik, magnetne resonance in drugih diagnostičnih pregledov oseb z mišično-skeletnimi boleznimi, lahko UI prispeva k zgodnjemu odkrivanju strukturnih sprememb v sklepih, kosteh in mišicah. Jiang in sod. poudarjajo, da UI algoritmi pogosto zaznajo subtilne znake bolezni, ki bi jih zdravnik pri običajnem pregledu lahko spregledal, s čimer se bistveno zmanjša tveganje za zaplete in dolgotrajno rehabilitacijo (Jiang in sod., 2017). Prav tako pri osebah z demenco lahko orodja za analizo nevro-slikovnih podatkov ter bioloških označevalcev pomagajo prepoznati začetne kognitivne

motnje, še preden se pojavijo jasni klinični znaki demence. Pravočasna diagnoza lahko prihrani tako stroške dolgotrajne oskrbe kot tudi nepotrebne dodatne diagnostične preglede (WHO, 2021). S tem pacienti in njihovi svojci pridobijo dragoceni čas za ustrezno načrtovanje in obravnavo te zahrbtnje bolezni. UI lahko tudi napoveduje potek bolezni in prilagodi zdravljenje posamezniku. Naslednji vpliv pozitivne uporabe UI je ocenjevanje tveganja in terapevtske izbire. UI na podlagi velikih podatkovnih zbirk, npr. podatkov o dednosti, življenjskem slogu, prejšnjih diagnozah, pomaga oceniti, kako se bo bolezen pri posamezniku razvijala. Zdravnikom to omogoča predpisovanje bolj ciljno usmerjenih zdravil in terapij, saj UI nudi analizo tveganj ter predlaga personalizirane rešitve, prilagojene posebnostim vsakega bolnika (Topol, 2019). Pri osebah z mišično-skeletnimi boleznimi so tudi napovedi UI o morebitnih komplikacijah natančnejše. Na primer pri poslabšanju artroze ali povečanem tveganju za zlom, lahko s pomočjo UI pravočasno določimo začetek fizioterapije ter drugih preventivnih ukrepov, kar zmanjšuje posredne stroške, kot sta bolniška odsotnost in prezgodnja upokojitev. Modeli UI lahko pri osebah z demenco sledijo kognitivnemu upadu in pravočasno opozorijo na napredovanje bolezni, s čimer lahko omilimo zaplete in zmanjšamo tveganje za poslabšanje splošnega zdravja. UI je lahko tudi podpora pri odločanju in optimizaciji obravnave mišično-skeletnih bolezni. Razvoj interaktivnih platform, ki temeljijo na UI, ponujajo zdravnikom priporočila o vrstah posegov (kirurških ali nekirurških), vrsti rehabilitacije in primernih ukrepih za preprečevanje napredovanja bolezni. S tem se poveča učinkovitost obravnave ter zmanjša preobremenjenost zdravstvenih delavcev, kar neposredno vpliva tudi na prihranke v zdravstvenem sistemu (Jiang in sod., 2017).

Pri demenci lahko UI spremlja vedenjske in kognitivne vzorce bolnikov ter na podlagi teh podatkov opozori na morebitne spremembe ali poslabšanje stanja. Takšna stalna podpora pri odločanju omogoča pravočasno prilagoditev terapevtskih pristopov in dolgotrajne oskrbe, kar prispeva k nižjim zdravstvenim stroškom na dolgi rok. Vse bolj se tudi uveljavlja UI na področju telemedicine in daljinskega spremljanja bolnikov. Rešitve za daljinsko spremljanje pacientov (preko pametnih naprav ali senzorjev) so še posebej uporabne pri osebah, ki imajo omejitve gibanja zaradi mišično-skeletnih bolezni pa tudi pri osebah z zmanjšano kognitivno sposobnostjo. Takšna oblika spremljanja ne izboljšuje le dostopa do zdravstvene oskrbe, temveč prispeva tudi k racionalnejši porabi sredstev, saj se zmanjša število nepotrebni fizičnih obiskov in hospitalizacij (WHO, 2021).

UI pa služi tudi kot podpora svojcem, negovalcem in zdravstvenemu osebju.

Napredne aplikacije, ki temeljijo na UI, lahko opozarjajo svojce na vedenjske spremembe ali nenadna poslabšanja bolnikovega stanja ter ponudijo predloge za ustrezno ukrepanje. To prispeva k zmanjšanju stresa negovalcev in k boljši kakovosti življenja bolnikov (Topol, 2019).

Osebe z mišično-skeletnimi boleznimi in njihovi svojci lahko preko mobilnih ali spletnih platform prejmejo navodila o vajah, prehrani in drugih pripomočkih za domačo rehabilitacijo. Na ta način se optimizira proces okrevanja ter razbremeni zdravstveno osebje, ki se lahko posveti najzahtevnejšim primerom. UI izboljšuje tudi diagnostično natančnost in učinkovitost.

Visoka diagnostična zanesljivost pomeni hitrejšo postavitve diagnoze ter boljšo usmeritev k optimalnemu zdravljenju, kar na sistemski ravni prinaša nižje neposredne in posredne stroške (McKinney in sod., 2020).

#### **4 Razprava in zaključek**

UI vedno bolj igra pomembno vlogo tudi v zdravstvu. Rezultati dveh analiz v Sloveniji sta pokazali, da je ekonomsko breme proučevanih javnozdravstvenih problemov zelo visoko, kar še dodatno poudarja nujnost iskanja novih pristopov. Zgodnje odkrivanje ter natančnejše diagnosticiranje bolezni, ki ga omogočajo algoritmi UI, lahko prispeva k pravočasnemu ukrepanju, preprečevanju dolgoročnih zapletov in zmanjšanju potrebe po dolgotrajni rehabilitaciji ali invazivnih kirurških posegih. S tem se ne le znižujejo stroški zdravstvenega sistema oz. ekonomsko breme bolezni, ampak se tudi povečuje kakovost življenja bolnikov. To pa pomeni zmanjšanje tako socialnega kot ekonomskega bremena družbe.

Svetovna zdravstvena organizacija poudarja, da morajo biti pri uporabi UI zagotovljeni ustrezni mehanizmi varovanja osebnih podatkov, etični standardi in transparentnost algoritmov. Le tako lahko korist, ki jo prinaša UI pri zgodnejši obravnavi mišično-skeletnih bolezni in demence, ostane v ravnovesju z zaščito pacientove zasebnosti in pravic (WHO, 2021)

Vse navedeno kaže, da je UI zmogljivo orodje za zmanjševanje tako neposrednih kot tudi posrednih stroškov, povezanih z mišično-skeletnimi boleznimi in demenco, ter za dvig kakovosti življenja bolnikov. Z upoštevanjem etičnih smernic, strokovnim sodelovanjem različnih strokovnjakov in ustrezno regulacijo lahko UI pomembno prispeva k boljšim izidom zdravljenja, racionalnejši uporabi zdravstvenih sredstev in nadaljnemu razvoju zdravstvenega sistema.

Kljub izjemni zmogljivosti UI je treba poudariti, da ta ne more nadomestiti zdravnikov in drugih zdravstvenih strokovnjakov. Ključno ostaja sodelovanje med tehnologijo, človekom in organizacijami, ki pacientom omogoča celostno obravnavo in ohranja človeški vidik zdravljenja.

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# SWOT ANALYSIS OF EARLY EXPOSURE TO ARTIFICIAL INTELLIGENCE COMPETENCIES, ILLUSTRATED BY AN EXAMPLE OF REINFORCEMENT LEARNING ACCESSIBLE TO LOWER SECONDARY SCHOOL STUDENTS

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This paper explores the process of early exposure to Artificial Intelligence (AI) competencies for students across various educational levels, focusing on its strengths, weaknesses, opportunities, and threats (SWOT). While the integration of AI into education presents both significant opportunities and challenges, its potential risks remain a critical area of ongoing research. In this contribution, we synthesize and explain findings from research on competencies, associated risks, and general experiences with AI in education at different levels, in order to develop a comprehensive SWOT analysis of the proposed process. The paper presents a lower secondary school research project as a case study, illustrating three key aspects: (1) the practical implementation of the proposed process, (2) competencies that students aged 12 to 18 can acquire through this method, and (3) the risks inherent in integrating AI into pedagogical practices. Additionally, we demonstrate the accessibility of reinforcement learning concepts to primary school students through an elementary example, showcasing how foundational AI principles can be effectively introduced at an early age. The findings highlight both the transformative potential and the challenges of equipping younger generations with essential AI competencies.

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## 1 Introduction

Artificial intelligence (AI) has become a cornerstone technology for science and industry (Samek & Müller, 2019; Huynh-The et al., 2023; EC, 2023). It is likely to have a profound impact on knowledge-driven processes in the coming years. As a result, it is essential to prepare future generations to engage with, utilize, and contribute to the development of AI technologies. Research into AI literacy in early education is gaining momentum, focusing on curriculum design, integrating AI tools in teaching, and creating pedagogical strategies, research methodologies, and evaluation frameworks (Su & Ng, 2023). Key challenges identified include insufficient teacher training, an underdeveloped curriculum, and a lack of clear pedagogical guidelines.

A crucial aspect of AI literacy is the development of digital competencies among educators and students. Digital competencies encompass not only technical skills but also pedagogical and ethical dimensions necessary for integrating AI effectively into education. Stojanov, Sekulić, and Risteski (2022) emphasize the importance of enhancing mathematics teachers' digital competencies, which can serve as a model for broader AI education initiatives. Additionally, Sekulić (2024) discusses the progress and future directions in digital competency development, highlighting the need for continuous professional training and policy support. Integrating digital competencies into AI education ensures that educators are prepared to guide students in responsible AI usage, fostering a more comprehensive understanding of technological impacts.

Research highlights the potential of AI to enhance individuals' well-being in education. Achieving this requires meaningful dialogue between researchers from diverse cultural and scientific backgrounds (Yang, Ogata, & Matsui, 2023), enabling AI to complement and amplify human intelligence - a concept referred to as human-centered AI. However, the integration of AI in education also comes with significant risks. A meta-study by Li and Gu (2023) reviewed these risks, categorizing them into eight distinct dimensions: misunderstanding of the human-centered AI concept, misuse of AI resources, mismatching of AI pedagogy, privacy security risk, transparency risk, accountability risk, bias risk, and perceived risk.

Concerning the competencies framework, for the purpose of this project, we consulted the UNESCO AI Competencies Framework for Students and Teachers, which provides a comprehensive structure for integrating AI literacy into educational systems (UNESCO, 2024). We used this framework to identify core competencies required to understand, apply, and critically assess AI technologies. Specifically, for students, it emphasizes foundational AI knowledge, ethical considerations, problem-solving, and adaptability. For teachers, it highlights instructional design, ethical leadership, and continuous professional development to support effective AI education. By leveraging this dual focus, we aimed to ensure that both educators and learners are equipped to navigate the evolving landscape of AI, fostering responsible and informed engagement with emerging technologies.

In what follows, we first overview the findings of the SWOT analysis in the form of an actionable list of projects that may develop relevant competencies of the students as well as illustrate the risks. We follow with a more detailed list of strengths, weaknesses, opportunities, and threats, and conclude with a list of possible further research identified but not yet analysed in this paper. We conclude with a summary of the findings.

## **2 Background research and methodology**

The core of the paper builds upon a lower secondary school student project that illustrated the ability of students at age 12 to understand and develop reinforcement learning algorithms for obtaining strategies for simple mathematics games. The paper refers to this project as "The NIM project." We have found no other similar published projects aimed at primary school students, but we have no doubt that the proposed process will stimulate their appearance.

### **2.1 A case study project: Reinforcement learning illustrated with the game of Nim**

The game of Nim is a simple mathematical game where players take one or two tokens per turn, with the player taking the last token losing. For a two-player game, there is an optimal strategy, which is proved by mathematical induction (Bokal, 2022). In a secondary school project, a student explored how effectively a computer could learn this strategy through reinforcement learning. Starting with random

moves, the computer adjusted its strategy after each game based on outcomes. Winning moves increased in probability, while losing moves decreased. Over time, the probabilities for optimal moves approached 1. However, the learning speed depended greatly on the opponent's playing style. The study analyzed various types of opponent players:

- Random player plays randomly, with equal probabilities of taking one or two tokens (unless only one token remains).
- Winning player follows the optimal strategy—takes two tokens for  $3n+3$  tokens, one for  $3n+2$  tokens, and always takes one for  $3n+1$  tokens (where winning is impossible if the opponent plays optimally).
- Winning randomized player follows the same strategy as the winning player, but for  $3n+1$  tokens, it chooses randomly between taking one or two tokens with equal probability.

The distance between the learning player's strategy and the optimal strategy was calculated after each game in 200 learning sessions. The average of 100 learning curves for a fixed number of starting tokens was computed, playing against the three fixed-strategy players with varying initial tokens (1 to 10). This allowed us to compare the ability to learn the optimal strategy and the learning speed when learning was possible.

Figure 1 displays the average distance to the optimal strategy for variants starting with 1 to 10 tokens in a random player game, averaged over 100 sessions of 200 games each. With fewer tokens, the learning player converges to the optimal strategy faster. Since the random player makes moves at random, the learning player can still win with suboptimal moves, which are rewarded in these cases, making learning slower.

Learning progresses faster when the learning player faces a winning randomized player. If the learning player makes a mistake, the winning player wins, helping the learner identify suboptimal moves. Figure 2 shows that for any number of tokens other than  $3n+1$ , the learning player quickly masters the optimal strategy, with the learning process being much faster than when playing against a random player.

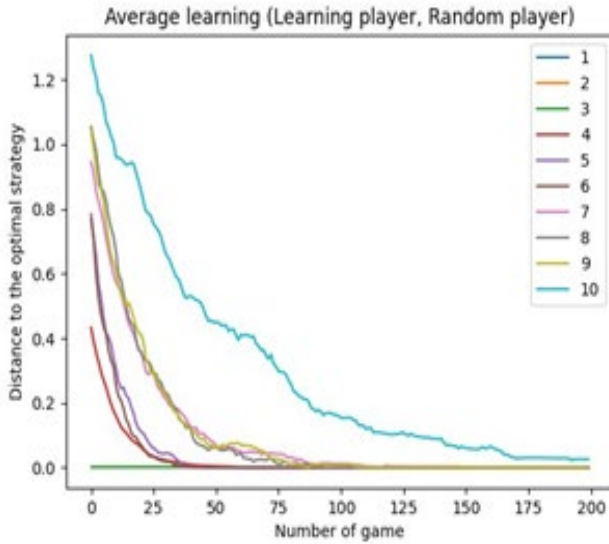


Figure 1: Average distance to optimal strategy learning against a random player  
Source: Jerebic et al., 2024

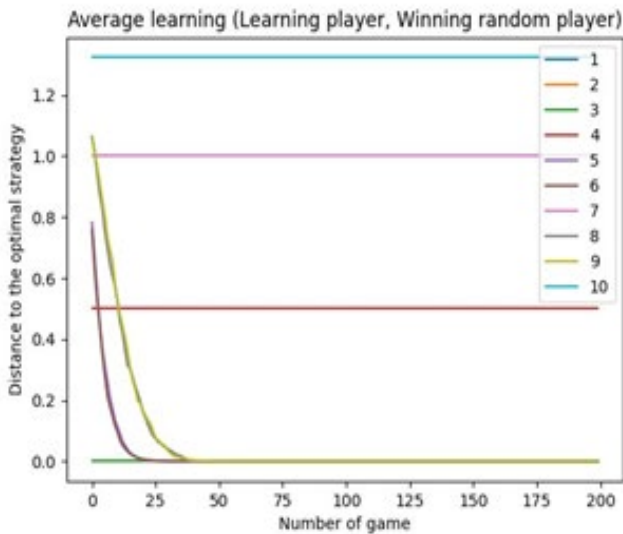


Figure 2: Average distance to optimal strategy learning against a winning randomized player  
Source: Jerebic et al., 2024

Although learning is faster, the learning player has an advantage against the random player. The optimal strategy is always reached because the learning player can exploit the random player's mistakes. However, in games with a winning randomized player and  $3n+1$  tokens, no mistakes are made, so the learning player gains no benefit.

One might expect learning against a winning player to be as fast or faster than against a winning randomized player, but this is not the case (see Figure 3). The learning player never faces certain situations because the winning player always takes one token when there are  $3n+1$  tokens. As a result, while the learning player develops a strategy to beat the winning player, it never fully converges to the optimal strategy. Without further learning, it would struggle against a winning randomized player and even more so against a winning player that adapts with complementary responses in losing situations.

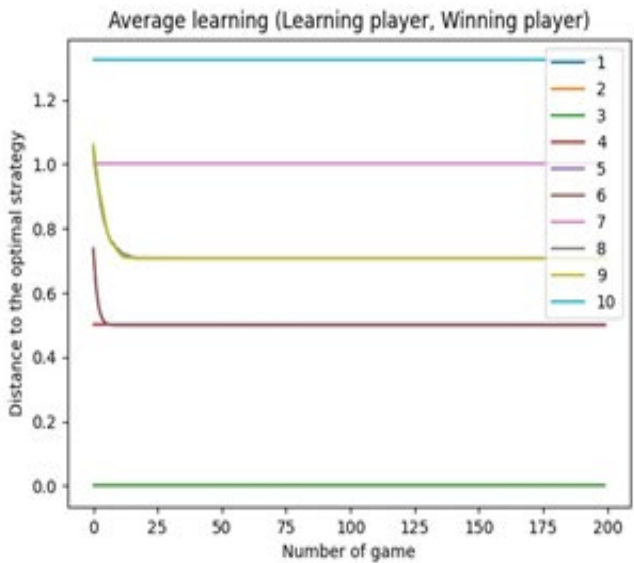


Figure 3: Average distance to optimal strategy learning against a winning player  
Source: Jerebic et al., 2024

### **3 The dynamic SWOT analysis approach**

Motivated by an opportunity presented by a lower secondary school student project (aged 12), we build upon competencies framework and illustrate which competencies were learned through the project, as well as through risk assessment based on Li & Gu (2023) and analysed in Jerebic et al. (2024), but extended by a wider bibliography review in the present contribution. We propose the following process of dynamically augmenting the presented SWOT analysis that can be applied whenever a new insight into SWOT elements is presented:

- identify a new source of information and its items,
- categorize the items of the source of information into strengths, weaknesses, opportunities and threats,
- associate the newly identified elements with the existing list of SWOT items,
- update the SWOT analysis,
- associate the newly discovered SWOT items with existing demonstration projects whenever possible,
- for the newly discovered SWOT items that cannot be associated with existing demonstration projects, develop new demonstration projects,
- disseminate the SWOT analysis and demonstration projects to interested parties.

This contribution is an intermediate report and a test of interest on using this process, for analysing the bibliography (Bacigalupo et al., 2016; Chiu et al., 2024; Filo et al., 2024; Jerebic et al., 2024; Li & Gu, 2023; Sattelmaier, Pawlowski, 2023; UNESCO, 2024; Zhang et al.; 2021). We intend to continue the research as proposed in the Future research section.

#### **3.1 Overview of SWOT analysis**

While the process from the previous section elaborates upon adding new SWOT elements or new illustrative projects to the body of knowledge on introducing AI into curriculum, in the following we list specific SWOT elements obtained in the process. They may serve as a list of reflection and learning opportunities to be discussed with the students after they either coded a selected project, or understood

the principle and outcomes, possibly illustrating the understanding using the learning bot (Bokal & Bokal, 2024).

### **3.2 Details on Strengths**

The dynamic inclusion of projects into a curriculum illustrating SWOT elements presents a basis for an up-to-date state-of-the-art curriculum that dynamically adjusts to the progress of respective fields and relevant discoveries. This key strength addresses the following other strengths of the approach, as taken from bibliography.

Ability to illustrate the effects of learning efficiency, authority and responsibility of the teacher. The NIM project demonstrates that the learning process is slow without authoritative and disciplined guidance (as when playing against a random player). However, in such a lost situation, the learner cannot acquire new knowledge, which can lead to apathy. If the teacher recognizes this danger, she can prevent it by deliberately making a mistake, thus allowing the students to take advantage of random opportunities to learn despite the potentially lost circumstances.

The integration of projects like the NIM project allows for dynamic adaptation and continuous curriculum updates, reflecting advancements in AI and pedagogy. The NIM project exemplifies how AI education can be integrated flexibly within existing curricula, allowing for real-time updates that reflect advancements in AI technologies and pedagogical strategies (Chiu, Ahmad, Ismailov, & Sanusi, 2024).

This project also demonstrates how different learning environments (e.g., random vs. optimal opponents) affect the efficiency and depth of learning. The project highlights the impact of different learning environments on student outcomes. For instance, facing optimal opponents accelerates the learning curve, offering insights into reinforcement learning dynamics.

Empowerment through practical application is reflected in gaining hands-on experience, not just theoretical knowledge, enhancing student's problem-solving and critical thinking skills. Students engage with AI concepts hands-on, moving beyond theoretical knowledge. This experiential learning fosters critical thinking, problem-solving, and a deeper understanding of AI principles.



The NIM project aligns with UNESCO's AI competencies framework by fostering foundational AI literacy, where students grasp core AI concepts such as reinforcement learning, decision-making algorithms, and probabilistic thinking (Filo, Rabin & Mor, 2024). It enhances critical thinking through the analysis of game outcomes, evaluation of strategies, and understanding of cause-effect relationships, thereby increasing cognitive flexibility. Furthermore, it promotes ethical awareness by introducing AI risks such as algorithmic bias and accountability, fostering early ethical considerations in technology use. Additionally, it cultivates human-centered AI understanding by enabling students to explore how AI can augment human decision-making rather than replace it, reinforcing the collaborative potential of AI-human interactions.

Teachers involved in the NIM project develop essential AI-related competencies as outlined by UNESCO AI Competencies Framework for Teachers, including pedagogical design for AI learning, ethical and inclusive AI education, and continuous professional development (UNESCO, 2024). This comprehensive development enables teachers to craft effective AI-integrated learning activities tailored to diverse educational contexts, promote fairness and inclusivity in AI instruction, and engage in lifelong learning to stay abreast of evolving AI technologies and pedagogical strategies.

The NIM project offers significant strengths in developing entrepreneurial competencies, particularly within the Ideas component, as outlined in the EntreComp Model (Bacigalupo et al., 2016). The project directly contributes to and highly supports the development of competencies such as spotting opportunities, vision, and valuing ideas. These competencies foster innovative thinking and strategic insight, equipping students with the ability to identify and capitalize on potential opportunities.

### **3.3 Details on Weaknesses**

The perceived risk of introducing AI in education is a vaguely defined meta-risk (Li & Gu, 2023). It will be necessary for policymakers to be empowered about the risks of AI in order to issue appropriate regulations and guidelines. Nevertheless, we expect only few of them will be empowered to develop AI and understand its underlying mechanisms. The NIM project illustrates that risks are easier to

understand but harder to mitigate. This is evident from the identified concepts needed to understand the reinforcement learning example, not included in the regular curriculum, compared to the actual implementation of the algorithms, which requires additional coding concepts (Jerebic et al., 2023).

The risk of mismatching of AI pedagogy. Learning materials, teaching concepts, and intelligent tools vary considerably between schools, leading to unsystematic pedagogy design (Zhang, Qin, Cheng, Marimuthu, and Kumar, 2021). Different approaches competing for resources further slow down the adoption of guidelines. The example of the NIM game illustrates that convergence towards the optimal strategy is slower. However, the diversity of approaches is not necessarily bad: if AI pedagogy converges too quickly, a uniform response could prevent the system from reaching the optimal strategy. Sharing best practices and comparing different approaches would be a reasonable compromise, as the game illustrates with the randomised winning player.

Accountability risks arise from weaknesses in the process of integrating AI into education. The responsibilities of educators, learners, and textbook publishers are unclear due to the dynamic nature of developing and managing AI models. Therefore, inefficient use of resources, extended learning periods, or insufficient strategies learned by learners can lead to unclear accountability. The NIM project highlights this by comparing (inefficient) learning against a random player with more efficient but potentially biased learning against a winning player, randomized or not.

Transparency risks represent a weakness, as shown by comparing the implementation of a winning player with that of a learning player. The winning player is programmed with optimal strategies, either clear decision rules or fixed probabilities. In contrast, the learning player must play numerous games to approximate these settings. Modern AI models rarely achieve such certainty or the explainability of clear decision rules, relying instead on less transparent probabilistic approximations. This vague encoding of decision rules highlights the risk of reduced transparency.

### **3.4 Details on Opportunities**

Early exposure to AI competencies through projects like NIM can foster a generation of students proficient in AI, bridging gaps in current educational systems. This can present transformative opportunities for education, fostering a generation well-equipped for the AI-driven future (Sattelmaier & Pawlowski, 2023).

By embedding AI literacy within the curriculum, students are positioned to become future innovators and leaders in technology, addressing existing gaps in digital fluency across educational systems. AI projects like NIM encourage and facilitate cross-curricular connections, integrating mathematics, computer science, ethics, and social studies to provide a holistic educational experience. The scalable nature of the NIM project offers a flexible model for global AI curricula, adaptable to diverse educational contexts and resource environments globally, promoting inclusivity in AI education.

Furthermore, aligning with UNESCO's AI competencies framework, these initiatives support the development of advanced AI proficiencies, transitioning learners from foundational concepts to more complex topics like neural networks and natural language processing. Integrating ethical reasoning into AI curricula fosters critical awareness of the societal impacts of technology, encouraging responsible and reflective AI development.

Collaborative problem-solving within AI projects not only enhances technical competencies but also cultivates teamwork and interdisciplinary skills vital for real-world applications. Additionally, nurturing adaptability, which is in the core of reinforcement learning, and a growth mindset prepares students for continuous learning, ensuring they remain resilient and capable in rapidly evolving technological landscapes.

For teachers, the NIM project offers opportunities to enhance AI instructional competencies by developing innovative teaching strategies that effectively integrate AI concepts, aligned with UNESCO's AI competencies framework for teachers, (UNESCO, 2024). Through reflection upon the process as exemplified in this analysis, It also enables educators to promote ethical AI leadership, becoming advocates for ethical AI practices in education while guiding students to consider

the broader social implications of technology. Moreover, teachers can engage in professional learning networks, participating in global communities of practice to exchange best practices and stay updated on AI educational trends. Ideating through the bot accompanying the theoretical analysis, the NIM project also offers significant opportunities for developing entrepreneurial competencies, (Bacigalupo et al., 2016, Bokal & Bokal, 2024). The opportunities are within the Actions component, and it promotes taking initiative, planning and management, and learning through experience. These competencies foster a mindset geared towards innovation and strategic thinking, providing students with practical skills and insights that are crucial for entrepreneurial success.

### **3.5 Details on Threats**

By having a dynamic shaping of a curriculum, the key threat addresses stability of the learning process that is permanently under risk of changing its contents. This threat was in the NIM project illustrated through slowness of learning with the randomized opponent - in the presence of high variability, learning as convergence to the optimal learning approach is slow. However, there is an opposing threat as learning needs diversity and monotonicity can lead to deception. If the responses are not randomized in losing situations, some scenarios never arise for the learner. As a result, the learner gains no knowledge of these situations and cannot respond effectively. To address this, learners should be exposed to diverse experiences to develop appropriate reactions.

A threat of misuse of AI resources by users has been identified in the meta-study by Li and Gu (2023). With the NIM project, it has the most clear illustration: suppose a student would need to learn the optimal strategy of the game of Nim. If the student relies on one of the (artificial) winning players to provide winning moves, instead of understanding and developing the optimal strategy themselves, this would represent a misuse of AI resources.

The risk of bias in introducing AI into education is better seen as a threat rather than a weakness. Biased education could endanger society by manipulating knowledge, allowing AI providers to shape the information passed to future generations in their favor, rather than for the benefit of society as a whole. The NIM project illustrates this by comparing learning while playing against the winning player and against the

randomized winning player. The former is biased, as it avoids exposing the mentee to certain situations, preventing them from developing proper responses. The latter exhibits self-centered authority, never allowing the mentee to win.

We interpret privacy security risks as threats: while low privacy security is a weakness, it is intimately related to malicious intents threatened by those with intent to abuse the weakness. The NIM project illustrates how learning bias limits the knowledge acquired, which is not initially perceived as a barrier by the mentee because it is not applied outside the narrow context of the learning context. However, when new contexts arise, the mentee's handicap results in inadequate responses, exposing the mentee to various risks, possibly including their safety or the safety of their activities.

Similarly, we interpret the risk of misunderstanding the concept of human-centered AI as a threat to the process. It is a meta-risk that encompasses the risks of bias, responsibility, transparency, safety, and privacy. These risks demonstrate how AI can deviate from serving humanity as a whole and instead cater to the narrow interests of certain individuals or groups. Mitigating these risks requires coordinated efforts from scholars, researchers, developers, educators, and users.

#### **4 Discussion**

AI being a state-of-the-art disruptive knowledge management and knowledge application technology is already showing a transformative impact on the education landscape, and there is no doubt it will significantly impact the careers of today's learners. Compartmentalising its aspects into competencies to learn and risks to avoid allows for a structural approach to mastering the body of knowledge required to navigate one's career in this landscape. Further dividing the competencies into strengths to apply and opportunities to seize allows the stakeholders of the education process to either seek opportunities given the strengths developed, or to develop strengths given the opportunities identified. Moreover, strengths and opportunities can be combined with individual interests, thereby allowing for personalised approaches to generally developed curricula.

Similarly, risks compartmentalized into weaknesses and threats can be considered as opportunities to either overcome by developing new knowledge or avoid by developing respective strengths. While some risks are generic to AI applications and

are highly recommended to be understood, others arise in specific circumstances or with specific combinations of mentors, mentees, and challenges worked on.

Illustrating the above by student-developed AI projects has the advantage of bringing elementary principles behind highly complex technology to students as playful toy examples, allowing them to comprehend technical aspects of implementation in a highly controlled environment of games they understand. Additionally, these projects may strengthen their coding, modeling and abstract thinking competencies that are relevant for both scientific discovery as well as many arising workplaces. Using AI as aid may even prove advantageous in both developing the interest as in learning efficiency.

## 5 Further research

As mentioned in the section describing the process, the corpus of research investigated in this paper is far from exhausted. We intend to expand it with other competence frameworks (specifically, DigiComp requires a significant amount of work), and with other risk analyses.

The above discussion identifies opportunities for future research. A key direction is to develop an easily presentable and specifically scalable framework that would allow to identify competencies as strengths and opportunities, and risks as weaknesses and threats, and link them to reflection upon completed projects. In discussion with education stakeholders, the use cases for such a framework and its role in the introduction of human centered AI into education need to emerge and be publicised.

The next direction is to develop opportunities for students to actually partake in such example projects as the Nim project. Collecting this experience and reflecting upon SWOT elements touched through the projects would inform the AI education process, help it grow and mature. Moreover, maturity models could be developed and applied to track maturity of our understanding of both specific identified elements of SWOT, as well as their interplay and interaction with proposed AI understanding projects.

## 6 Conclusions

This paper has explored the early exposure of students to AI competencies, focusing on the strengths, weaknesses, opportunities, and threats (SWOT) of integrating AI into education. Through our case study of reinforcement learning was applied in the lower secondary school setting, the potential for young learners to develop essential AI-related competencies is demonstrated, as well as the risks associated with AI integration into pedagogical practices.

Our analysis highlights key AI competencies gained through early exposure. Computational thinking is enhanced as students engage in reinforcement learning projects like NIM, fostering problem-solving and algorithmic reasoning. Critical thinking and decision-making abilities are strengthened through interaction with AI models, enabling students to analyze strategies and predict outcomes. Ethical awareness is cultivated by introducing students to AI biases and ethical considerations such as transparency and accountability. AI education also fosters interdisciplinary connections across mathematics, computer science, and social sciences while encouraging entrepreneurial and innovative thinking.

Despite these advantages, integrating AI into education presents several risks and challenges. Variations in teaching methods and AI tools create inconsistencies, potentially leading to fragmented learning experiences. Lack of clear accountability and transparency in AI-driven decision-making complicates educator's roles in guiding students. Bias in AI models can reinforce misconceptions, while security and privacy threats expose students to potential misuse of AI-generated data. Additionally, an evolving curriculum may disrupt structured learning, and over-reliance on AI assistance can obstruct independent problem-solving skills. To address these issues, we recommend a dynamic SWOT augmentation process that incorporates new insights and projects to maintain an up-to-date educational framework. Future research should focus on developing a scalable AI competency framework, expanding practical AI learning opportunities through projects like NIM across diverse student groups, and establishing maturity models to track AI competency development.

By continuing to refine AI education through dynamic SWOT analysis and practical engagement, we can ensure that future generations develop the knowledge and skills necessary to navigate an AI-driven world responsibly and effectively. A structured and adaptive approach will enhance AI curricula while addressing potential risks. Collaboration among scholars, educators, and policymakers will be essential in shaping AI education into an inclusive and impactful learning experience, preparing students for the opportunities and challenges ahead.

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# UPORABA UMETNE INTELIGENCE PRI IZOBRAŽEVANJU ŠTUDENTOV ZDRAVSTVENE NEGE

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Umetna inteligenca je s svojim razvojem doprinesla številne spremembe na različnih področjih, tudi na visokošolskem področju pri izobraževanju študentov zdravstvene nege. Prednosti uporabe umetne inteligence se kažejo kot bolj učinkovito in produktivno učenje, možnosti izobraževanja s simulacijo in s pomočjo robotike. Uporaba umetne inteligence sloni na etičnih načelih in standardih, kjer je največji poudarek na poštenosti, zasebnosti, varnosti, odgovornosti, nadzoru, dostopnosti, in preprečevanju škode. Uporaba spletnih orodij, kot je ChatGPT ima v izobraževanju študentov zdravstvene nege velike učinke na izide učenja v pedagoškem procesu. Zato je potrebno pozornost nameniti izobraževanju na področju pismenosti z umetno inteligenco, raziskovanju učinkovitih načinov za vzdrževanje digitalne pismenosti ter temeljnemu reševanju morebitnih tveganj in negativnih učinkov v procesu uporabe umetne inteligence.

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# THE USE OF ARTIFICIAL INTELLIGENCE IN THE EDUCATION OF NURSING STUDENTS

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Artificial intelligence has brought about many changes in various areas, including the education of nursing students in higher education. The benefits of using artificial intelligence are seen in more efficient and productive learning, the possibilities of training through simulation and robotics. The use of artificial intelligence is based on ethical principles and standards, with a focus on fairness, privacy, security, accountability, control, accessibility and the avoidance of harm. The use of online tools such as ChatGPT in the education of nursing students has had a significant impact on learning outcomes in the teaching process. Therefore, attention needs to be paid to teaching artificial intelligence skills, exploring effective ways to maintain digital literacy and fundamentally addressing the potential risks and negative impacts when using artificial intelligence.



## 1 Uvod

Umetna inteligenca (UI) je s svojim razvojem doprinesla številne spremembe na različnih področjih, tudi pri izobraževanju študentov zdravstvene nege. V okviru izobraževanja je postavljen velik potencial uporabe UI, vendar pa se postavljajo vprašanja etičnega vidika, kjer se izpostavlja zasebnost, nadzor, manipulacijo, avtomatizacijo, človeka – robota v interakciji, strojno etiko, idr. (Köbis & Mehner, 2021). Unesco poudarja tehnologijo kot temeljno vrednoto, kjer pa morajo biti orodja dostopna vsem enako, tako študentom kot učiteljem (Green, et al., 2022). Unesco (2023) navaja, da študent, ki bo uporabil programe UI za pisanje seminarskih nalog, ne bo pridobil enakega učnega učinka, kot če bo uporabil svoje besede. Prav tako nastaja večje tveganje za plagiat in nepoštenost v akademskem svetu (Köbis & Mehner, 2021). Prednosti uporabe UI so v prilagajanju izobraževalnega procesa ali personalizaciji, bolj učinkovitem in produktivnem učenju, možnosti uporabe simulacij ali dialoga na področju robotike, večje možnosti spremljanja napredka študenta z analizo podatkov v učenju. Slabosti, ki se kažejo pa so v osebni interakciji, pomanjkanju čustev, etičnosti, vprašanju zasebnosti in tehnične težave (Darmawansag, et al., 2024). Raziskava med študenti pri razumevanju UI in izkušenj z orodji UI je pokazala, da več kot 40 % študentov ni imelo teh izkušenj. Med študenti, ki so orodja uporabljali, pa je bil najbolj priljubljeni ChatGPT (DOBA fakulteta, 2023). Zhai (2023) navaja, da bi morali biti študenti sposobni uporabljati orodja UI, izobraževanje pa bi se moralo usmeriti na izboljšanje ustvarjalnosti in kritičnega mišljenja, ki je UI ne more nadomestiti, namesto na splošne spretnosti. Za doseganje učnih ciljev, bi se morale oblikovati naloge, ki vključujejo umetno inteligenco, da bi študente vključili v reševanje problemov iz resničnega sveta.

UI postaja vse bolj prisotna v našem vsakdanu, tudi v izobraževanju študentov zdravstvene nege. Proučevanje uporabe UI v izobraževanju študentov zdravstvene nege je ključno, saj nam omogoča, da razumemo potencial te tehnologije, prepoznamo morebitne izzive in se pripravimo na prihodnost, kjer bo UI neločljiv del izobraževalnega sistema.

## 2 Metode

Izvedli smo pregled literature iz podatkovnih baz Cobiss, Cinahl in PubMed. Pri pregledu literature smo izbrali vire, kjer je bilo besedilo dosegljivo v celoti in tema primerna, v angleškem in slovenskem jeziku ter v obdobju od 2014 do 2024. Uporabili smo naslednje kombinacije ključnih besed v slovenskem jeziku: umetna inteligenca, študenti zdravstvene nege, izobraževanje, etika, simulacije ter v angleškem jeziku: artificial intelligence, nursing students, education, ethics, simulations. Literaturo smo iskali v obdobju 7. 1. 2025 do 22. 1. 2025. V tabeli 1 prikazujemo rezultate pregleda literature po podatkovnih bazah, ključnih besedah, številu zadetkov in izbranih zadetkov za pregled v polnem besedilu. S pomočjo pregleda literature smo želeli raziskati uporabo umetne inteligence pri izobraževanju študentov zdravstvene nege.

Pri iskanju literature v podatkovnih bazah smo pregledali 157 člankov, vključili smo 4 članke, ki so bili recenzirani in dostopni v polnem besedilu in so ustrezali vsebini.

**Tabela 1: Rezultati pregleda literature (primeri podatkovnih baz)**

Podatkovna baza	Ključne besede	Število zadetkov	Izbrani zadetki za pregled v polnem besedilu
Cobiss	umetna inteligenca, študenti zdravstvene nege	30	0
Cinahl	artificial intelligence AND nursing students	18	1
PubMed	artificial intelligence AND nursing students	109	3
Skupaj		157	4

## 3 Rezultati pregleda literature

V tabeli 2 so prikazani rezultati po avtorju/jih, letu objave, uporabljeni metodologiji, vzorcu in ključnih ugotovitvah.

Tabela 2: Tabelarični prikaz rezultatov

Avtor /ji	Leto objave	Uporabljena metodologija	Vzorec (velikost in država)	Ključne ugotovitve
Amiri, et al.	2024	Sistematični pregled in metaanaliza	22 raziskav, 8491 udeležencev, Irak	Avtorji ugotavljajo pozitiven odnos študentov do sprejemanja UI. Obravnava pa se tudi izobraževanje o etiki v UI in vidiki sodelovanja med človekom in umetno inteligenco.
Tam, et al.	2023	Pregled literature	Ni podatka, Singapur	Klepetalni roboti z UI lahko pomagajo študentom zdravstvene nege in raziskovalcem premagati tehnične ovire v informatiki zdravstvene nege, s čimer povečajo dostopnost za posameznike brez tehničnega znanja.
Buchanan, et al.	2021	Pregled literature	27 člankov, Kanada	Avtorji so izpeljali dve ključni kategoriji: (1) vplivi umetne inteligence na izobraževanje zdravstvene nege v akademskih ustanovah in (2) vplivi umetne inteligence na izobraževanje zdravstvene nege v klinični praksi. Nujno je potrebna kurikularna reforma v izobraževalnih programih zdravstvene nege v akademskih ustanovah in okoljih klinične prakse, da bi medicinske sestre in študente zdravstvene nege pripravili na varno in učinkovito prakso v dobi IU.
Kong	2024	Kvalitativna raziskava	14 študentov, Kitajska	Ugotovitve raziskave so pokazale, da je najpomembnejše, da učitelj pokaže metode delovanja in odgovornosti uporabe umetne inteligence s praktičnimi aplikacijami, ki omogočijo razumevanje tehnologije in pomagajo pregnati strah pred neznanim.

## 4 Razprava

S pregledom literature smo ugotovili, da se uporaba umetne inteligence lahko uporablja za zagotavljanje izobraževalnih virov in podpore študentom, predvsem na področjih, kjer potekajo izobraževanja na daljavo (Qi, et al., 2023). Raziskave kažejo učinkovitejše učenje z uporabo umetne inteligence, hkrati pa pretirano odvisnost od nje. Pozornost je treba nameniti negovanju ustvarjalnosti, sodelovanja, komunikacije in kritičnega mišljenja, negovanju pismenosti z umetno inteligenco, raziskovanju učinkovitih načinov za negovanje digitalne pismenosti ter temeljnemu reševanju morebitnih tveganj in negativnih učinkov v procesu uporabe umetne inteligence. Poleg tega je treba študente usmerjati k spoštovanju družbene morale in etike, vedno k spoštovanju temeljnih vrednot in pravilni uporabi umetne inteligence (Daily, 2023).

Vključevanje UI v učni proces na visokošolskem izobraževanju izhaja iz sedemdesetih let prejšnjega stoletja in jo imenujemo digitalizacija (Molek, 2023). Uporaba orodij, kot je ChatGPT ima velike učinke na izide učenja in na pedagoški proces, kjer pogosto ni jasno, kdo je ustvaril besedilo, človek ali stroj (Perkins, 2023). Etična uporaba UI sloni na etičnih načelih in standardih, pri uporabi je poudarek na poštenosti, zasebnosti, varnosti, odgovornosti, nadzoru, dostopnosti, in preprečevanju škode (Molek, 2023). Zawacki-Richter, et al. (2019) poudarjajo vzpostavljane etičnih smernic, kjer morajo biti vključeni pedagoški delavci. Sama tehnologija ima tudi negativne posledice, ki se kažejo na svobodomiselnosti, ustvarjalnosti in avtonomiji posameznika. Raziskava med 22 učitelji iz Mehike, Peruja in Španije je pokazala štiri glavne pomene pri uporabi UI, ki so: opolnomočenje študentov pri uporabi UI (zagotavljanje strogosti, zvestobo in prilagodljivost informacij, ki jih daje umetna inteligenca zahteva aktivno vključevanje učiteljev), vzpostavitev etičnih praks (spodbujanje študentov k samorefleksiji pri uporabi UI in lastnem prispevku, časovno načrtovanje uporabe in način uporabe), spodbujanje ustvarjalnega in strateškega razvoja (ekperimentiranje z UI), spodbujanje skupnega učenja in odgovornosti učiteljev (sledenje razvoju umetne inteligence) (Mateus, et al., 2024). V raziskavi avtorjev Hvalič Touzery in Skinder Savič (2014), so rezultati pokazali, da je pripravljenost študentov na e- izobraževanje zelo pomembna ter, da je odnos do e- izobraževanja statistično značilno povezano z znanjem študentov s tega področja in njegovimi prednostmi. Glede na razvoj področja digitalizacije v zdravstvu, kjer imajo medicinske sestre pomembno vlogo



pri uporabi nove tehnologije in programov, bi bilo potrebno vključiti vsebine digitalizacije v učne načrte visokošolskih inštitucij in kontinuirano obogatiti znanja in spretnosti zaposlenih medicinskih sester v kliničnem okolju (Hvalič Touzery & Šetinc, 2015). Na področju izobraževanja se uporablja virtualna simulacija, ki izboljša znanje in učinkovitost študentov zdravstvene nege, predvsem pri reševanju poslabšanja stanja pri pacientu, pri nenadnih nepričakovanih dogodkih, kjer je potrebno hitro ukrepanje in izkazovanje znanja. V raziskavi pri študentih zdravstvene nege v 2. in 3. letniku, kjer so merili znanje pred simulacijo dogodka in po simulaciji, so ugotovili pomembno izboljšanje znanja. Virtualna simulacija redkih dogodkov pomaga nadgrajevati znanje študentov in ponuja ponovljivost dogodkov za utrditev znanja in kritičnega razmišljanja (Sapiano, et al., 2018). Glede na pomen kritičnega mišljenja v zdravstveni negi bi morali v izobraževanju medicinskih sester uporabljati metode poučevanja, ki lahko spodbujajo to sposobnost pri študentih zdravstvene nege (Shin, et al., 2015). Več raziskav je pokazalo, da ima simulacija pozitiven učinek na kritično mišljenje (Adib- Hajbaghery & Sharifi, 2016).

## 5 Zaključek

Umetna inteligenca je naraščajoči pojav, ki bo kmalu omogočila obsežne spremembe v številnih poklicih, pomembno vlogo pa naj bi imela tudi na področju izobraževanja. Raziskave so z uporabo umetne inteligence pokazale razvoj nekaterih veščin kot so komunikacija, kritično razmišljanje in odločanje. Prav tako so študenti pridobili na samozavesti, saj so jim simulacije omogočile večkratno ponovitev scenarija in razmišljanje o njihovi uspešnosti (Teixeira, 2024). Integracija umetne inteligence in izobraževanja bo vodila do novega modela razvoja izobraževanja in spodbujala boljše izobraževanje. Pozornost je treba nameniti izobraževanju na področju pismenosti z umetno inteligenco, raziskovanju učinkovitih načinov za vzdrževanje digitalne pismenosti ter temeljnemu reševanju morebitnih tveganj in negativnih učinkov v procesu uporabe umetne inteligence.

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# ENHANCING STUDENT MOBILITY IN HIGHER EDUCATION: A CASE STUDY ON APPLICATION ARCHITECTURE AND DIGITAL SERVICES SUPPORTING PROCESSES AND TRANSACTIONS

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Enabling student mobility within higher education involves complex, interconnected processes that are supported by various digital tools and applications. This study focuses on these processes at the University of Zagreb, Faculty of Organization and Informatics, conducting a detailed case study to analyse the existing digital services that facilitate student mobility. It aims to define and discuss the application architecture of an integrated system and explore how these services can be further developed by integrating legacy components, open services, and open-source elements. The proposed application architecture should support basic transactions, workflows and the need for data storage and analysis, thereby enhancing system interoperability and simplifying processes for all stakeholders involved—including students, international relations officers, and academic advisors. By proposing further digitalisation, this paper contributes to simplifying and improving of the mobility process, making it more accessible and efficient for the international education community.

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## 1 Introduction

Digitalisation has influenced organizations across various sizes and sectors, including higher education (HE), which is no exception. Digitalisation (known as well as digital transformation) involves the development and implementation of digital tools and services aimed at improving processes, focusing both on leveraging digital technologies and enhancing user experience (Henriette et al., 2016). While digitalisation offers numerous benefits to organisations, introducing diverse information systems (IS) also presents challenges. Over time, these systems often require redesigns, functional improvements, updates to their architecture or technology, and integration with other IS, ensuring interoperability at different levels (European Commission, 2017).

Fernández et al. (2023) highlight that digital transformation initiatives in education primarily focus on delivering quality and competitive education (24% of 184 initiatives across 39 universities). However, 16% of efforts address optimising information security and maintaining business continuity, including secure information sharing and centralising services and data sources. Hassani and Mansouri (2017) point out that digitalisation can create challenges, such as data desynchronisation across university systems, forcing users to re-enter the same information in multiple platforms—an issue that increases the risk of errors. For higher education institutions (HEIs), establishing reliable processes while safeguarding data is essential. These challenges are particularly critical in the higher education ecosystem, where effective data exchange is essential. Student mobility is one of the key aspects where such issues are highly significant, as the credit mobility process involves numerous interconnected processes and stakeholders (Tomičić Furjan et al., 2022), requiring seamless coordination among entities such as the home institution, the home university (if applicable), and the host institution.

This study focuses on student mobility processes at the University of Zagreb, Faculty of Organization and Informatics (UNIZG FOI), conducting a case study to analyse the existing digital services that facilitate student mobility. It aims to define and discuss the application architecture of an integrated student mobility support system (SMSS) and explore how these services can be further developed through the integration of legacy components, open services, and open-source elements.

## **2 Student mobility processes at the University of Zagreb, Faculty of Organization and Informatics: a digital transition**

The student mobility process often requires navigating various digital systems and platforms. At the University of Zagreb, the application procedure has been digitalized through the "Move On" platform. This system allows students to submit a single application form, which includes all required documents uploaded as attachments. However, the application form itself must be printed, signed, and subsequently submitted in its final form (to the international office of the student's faculty). Once (digitally) submitted, the application cannot be modified. Failure to follow all procedural steps—such as submitting multiple applications, excluding required documents or late submission—results in automatic rejection. Following the announcement of results, the International Relations Office at the University of Zagreb faculties nominates students for a semester at the host institution, often through digital platforms. While email was the primary tool for student nominations a few years ago, its usage is gradually being phased out in favour of more automated systems, reducing personal interaction between international offices.

Upon nomination, students typically receive detailed email instructions regarding the application process at the host institution. This communication often includes a fact sheet or information guide outlining essential details, particularly for the Erasmus Without Paper (EWP) Dashboard and the Online Learning Agreement (OLA). Students may be required to upload a signed PDF version of the OLA from their home institution. Alternatively, some host institutions mandate using their internal platforms for course selection, supplementing the OLA. Accommodation applications are frequently integrated into these systems, though in some cases, they are handled separately.

During their mobility period, students utilise the EWP Dashboard to make any necessary changes to their learning agreements. Upon concluding their mobility, students often engage with additional digital platforms to access grade transcripts or transcripts of records. Increasingly, these documents are distributed through online systems rather than traditional email communication. Upon return, students from the University of Zagreb's Faculty of Organization and Informatics utilize the FOI Forms platform to submit grade transcripts and other documentation for course

recognition. The final set of required documents is then emailed to the University's central International Relations Office.

To illustrate the overlap in the data that students must re-enter across different systems during the mobility application process, the authors analysed the application form within the MoveON platform (Sveučilište u Zagrebu, 2024) and the Digital Erasmus+ Learning Agreements within the EWP platform (European Commission, 2023). Students must repeatedly enter the same information into both systems, including:

- **Student identity:** First name, Last name, Birth date, Gender, Nationality, Field of education (ISCED) / ISCED code, Level of education
- **Receiving institution:** Name (Institution), Faculty/Department, Country
- **Language:** Language of instruction/Teaching language, Language competence
- **Estimated duration:** From – month, From – year, To – month, To – year

Additionally, within EWP, students must provide details about administrative and responsible persons at the host institution. They are also required to input comprehensive data related to the learning agreement, including Courses at the Host Institution (Component code, Component title, Term, Number of ECTS credits (or equivalent) to be awarded upon successful completion, and Web link to the course catalogue describing the learning outcomes) and Courses at the Sending Institution (Component title, Term, Number of ECTS credits, Automatic recognition, and Provisions for incomplete educational components).

This redundancy and manual entering of data available in different systems not only complicates and prolongs the application process but also increases the potential for errors, underscoring the need for better integration and synchronisation of these systems.

## 2.1 Problem domain

The development of a student mobility support system (SMSS) requires a well-designed architecture that covers core functionalities and ensures openness and interoperability with other systems, such as student records, university enterprise



resource planning (ERP), e-learning platforms, etc. A proposal for core functionalities, following the main processes of student mobility as performed in practice, is below:

- a) Stakeholder register and contact management
  - Records of partner institutions and contact persons
  - Connecting stakeholders to mobility programs
  - Management of bilateral agreements and their conditions
- b) Program and call management
  - Registry of programs (Erasmus mobility for studies, short intensive programmes, bilateral cooperation, internships, etc.)
  - Connecting programs with stakeholders (institutions, agencies, companies)
  - Generating and managing calls (deadlines, conditions, documentation)
  - Monitoring student applications throughout the entire workflow (application, selection, evaluation)
- c) Student mobility management
  - Monitoring applications and mobility status for each student
  - Automatic allocation according to transparent criteria (equality, non-discrimination)
  - Generation of mobility contracts with customisable items
  - Monitoring of cash flows and calculation according to grant schemes
- d) Recognition of achievements
  - Registry of equivalences between incoming and outgoing institutions
  - Automation of the process of recognition of achieved achievements (ECTS credits, grades)
  - Interoperability with existing academic systems
- e) Information portal for students
  - Chatbot for support and FAQ (e.g. for information on competitions, deadlines, conditions)
  - Thematic forums and groups for the exchange of experiences among students
  - Notifications and personalised information system
- f) Financial monitoring and reporting
  - Records of mobility-related transactions (scholarships, grants)

- Automation of calculations according to grant schemes
  - Preparation of financial reports
- g) Interoperability with the study support system
- Integration with existing systems for recording students, courses, and grades (e.g. ISVU or similar systems)
  - Data exchange through standardised protocols (e.g. EWP - Erasmus Without Paper).

### **3 Methodological framework for building a system based on the integration of legacy and new components**

The case discussed in this paper (Student Mobility Support System – SMSS) is typical for all business problem domains and all organisations that have been operating for a certain time and have some kind of legacy information systems. A significant redesign or improvement of the functionality, architecture or technology of an information system is a complex undertaking that requires an appropriate methodological framework (Sommerville, (2020); Wieringa, 2014), i.e. a structured description of the approaches, principles, processes, methods, techniques and tools used to solve a particular class of problems in some scientific or professional field, together with instructions for their application in various problem situations. An important part of the methodological framework is the development cycle and process patterns, which describe which phases, processes, and activities comprise the development cycle, how they are interrelated and which are conditions for their initiation or completion. The life cycle is a broader concept because, in addition to the phases of the development cycle, it includes the planning phases that precede the development, and the implementation, use, maintenance and continuous improvement of the system.

Different scenarios for building such a system are possible:

1. Finding a new ready-made parameterised system that entirely or to a considerable extent solves existing problems and satisfies needs;
2. Building a new custom system based on your own requirement specifications;

3. Improving or replacing existing "legacy" application components, and integrating with ready-made or customised components that cover missing functionalities.

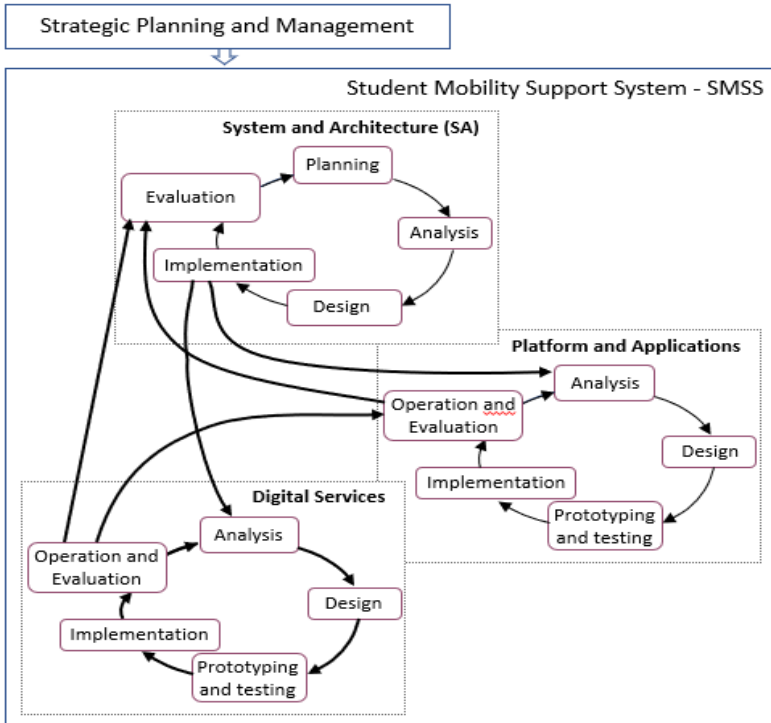


Figure 1: Life cycle applicable to the Student Mobility Support System

Source: Own

The first and second scenarios are relatively rarely encountered in practice today. The third scenario is likely. For development based on the improvement of existing components and integration with new components, a development cycle, as shown in the Figure 1, is proposed. The initiation of the new development cycle is in the area of Strategic Planning and Management, where the influence of computer applications, digital services and other technologies on the achievement of the organization's strategy and business model is analysed, feasibility is studied, and strategic projects related to IS are planned and launched.

The Figure 1. shows that the proposed life cycle is not monolithic, but incorporates three interconnected life cycles: System and Architecture, Platform and Applications and Digital Services. Each of them proceeds through several phases.

**The System and Architecture (SA) life cycle** includes the phases in which the SMSS as a whole is conceived and planned and provides the methodological and architectural framework for the platform, application and services. Its Planning phase includes defining the project's purpose, objectives and scope, success indicators, project structure and time frame, resources, etc.

The Analysis phase of the SA life cycle has two groups of activities (Gunawardhana, 2019; Catanio, 2006):

#### 1. Requirements Analysis

- Contextual requirements analysis – identifying and analysing requirements arising from strategies, policies, business models and other higher-level documents, legal and regulatory requirements, etc.
- Business process and functionality identification – describing and analysing “as-is” business processes, data sets, services and other functionalities covered by the legacy system and identifying missing or inadequate (pains and gains analysis, etc.).
- Technical analysis – analysing the existing architecture, infrastructure, platforms, applications and other system components and defining possible improvements in the existing context
- Defining functional and non-functional requirements – defining the properties and requirements the “to-be” system must meet (functionality, data, performance, security, scalability, user interface, etc.)

#### 2. Evaluation and Selection

- Research of available components – identifying and analysing existing legacy components and available new components that meet functional requirements (open-source, commercial off-the-shelf – COTS), where platforms such as GitHub, SourceForge and Docker Hub can be useful.

- Evaluation of potential solutions – mapping to functional and non-functional requirements and comparing components based on functionality, adaptability, licensing, security, community support, etc.
- Gap analysis – identification of functional and non-functional requirements that are not covered by any component and defining how to satisfy them, including development based on the requirements.
- Technical evaluation – technical verification, considering the results of the technical analysis and compatibility with the legacy system.
- Proposal of technical options – make or buy analysis, selection and argumentation of the architecture and components that best meet the requirements.

The analysis involves intensive iteration with relevant stakeholders to ensure that the requirements specification includes various aspects and comprehensive, relevant information.

Design at the SA level includes:

- Architecture and integration design - listing legacy and new system components, defining the integration of different applications and other components to communicate and exchange data using APIs, middleware, microservices, message brokers, adapters, etc.
- Data design - logical design of a standard data model
- Adaptation planning - defining the adaptation of each legacy and new component.
- Orchestration and integration planning - defining the management of the order and manner in which different components interact to achieve more complex processes or workflows.

The Implementation of what is planned, analysed and designed in the SA life cycle is actually realised in the life cycles of Platforms and Applications and Digital Services.

**The Platform and Applications lifecycle** is common for application systems and includes the phases of Analysis, Design, Prototyping and Testing, and Implementation, which are the usual phases of the software development cycle. Operation and Evaluation of Platform and Applications includes their maintenance and upgrades, as is common for applications and information systems.

**The Digital Services lifecycle** may include the phases shown in the Figure 1, or any other arrangement of phases according to some service development methodology.

Although it works on three life cycles with distinct phases, development in each of the life cycles can be performed incrementally and iteratively, according to agile principles. If evaluation during operational use of a platform, application or digital service indicates that significant changes are needed, a new development cycle for that resource is initiated either at the System and Architecture level.

#### 4 Selected methods of analysis, evaluation and selection of application components

The chosen approach to building SMSS is improving or replacing existing legacy application components and integrating them with ready-made or customised components that cover missing functionalities. The relevant literature describes different methodological approaches, which are discussed below.

Reference application models at an abstract level represent the structure, functionality, and behaviour that can be considered a standard or a good reference practice in a particular application area. They serve as a guide or foundation for understanding and structuring complex systems, defining requirements, comparing and evaluating applications, aligning with industry standards, etc. (Scheer et al. 2002). It is important that there are methods for similarity measurements of application component models and reference models expressed by using UML diagrams (Triandini et al. 2022; Adamu et al. 2019). Metamodels are "models of models", i.e. abstract representations of concepts, structures and rules for building specific models. They define the language and rules for creating specific models. In software architecture, they facilitate the understanding and specification of model concepts and their interrelationships. The already mentioned Triandini et al. (2022) research

is also useful in determining the similarity of metamodels to each other and metamodels and models. Ontologies are formal specifications of knowledge domains, which define, structure and classify concepts, their properties and relationships between them. They enable a consistent and precise interpretation of terms in an application domain and an automated search and selection of software solutions based on a semantic understanding of the problem, as well as analysis of enterprise architecture (EA) models, particularly addressing the challenges of syntax, structure, and semantic heterogeneities (Bakhshandeh et al. 2016).

Table 1. summarizes the advantages and disadvantages of using reference models, metamodels, and ontologies for evaluating application components in the context of modernizing a legacy system and integrating new components.

**Table 1: Comparison of reference models, metamodels, and ontologies for evaluating application components**

Approach	Advantages	Disadvantages
Reference Models	<ul style="list-style-type: none"> <li>- provide insight into best practices and standards in an application area</li> <li>- facilitate design, compliance verification, evaluation and component selection by aligning with proven approaches</li> <li>- help identify gaps in functionality or compliance.</li> </ul>	<ul style="list-style-type: none"> <li>- they are generic in nature</li> <li>- are not flexible and require efforts in tailoring, supplementing and adapting to domain-specific or highly customized requirements</li> <li>- reflect existing and may lag behind technological advances.</li> </ul>
Metamodels	<ul style="list-style-type: none"> <li>- provide a high-level abstraction for understanding the structure and relationships of application components</li> <li>- support systematic comparison and evaluation of components</li> <li>- can support architectural consistency and model-driven development (MDD)</li> </ul>	<ul style="list-style-type: none"> <li>- require time and expert knowledge to develop, interpret and apply effectively,</li> <li>- they are focused on structure rather than functionality and behavior,</li> <li>- it can be difficult to map to concrete implementations in legacy systems.</li> </ul>
Ontologies	<ul style="list-style-type: none"> <li>- provide a formalism for the definition, representation, classification and understanding of concepts, relations and rules in the domain,</li> <li>- enable semantic reasoning to identify overlaps, dependencies, and inconsistencies among components,</li> <li>- support semantic interoperability and integration of heterogeneous components.</li> </ul>	<ul style="list-style-type: none"> <li>- development of domain-specific ontologies is time-consuming for complex applications,</li> <li>- require significant expertise in both domain and ontology design,</li> <li>- there is a gap in the implementation of ontologies</li> <li>- difficulties in integrating with legacy systems not designed for semantic structures.</li> </ul>

## 5 Conclusion

This paper presents the authors' initial steps in designing a digital Student Mobility Support System (SMSS), based on the case study from the UNIZG FOI. The presented Methodological framework set a basis for further endeavours in creating a sustainable SMSS aimed at supporting and simplifying student mobility process.

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# MANAGING INNOVATION IN THE MODERN BUSINESS ENVIRONMENT

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The evolution of digital communication tools has significantly transformed interactions within organizations, fostering innovation and redefining management practices in modern business contexts. This research examines the adoption, challenges, and opportunities of digital communication tools, emphasizing their role in enhancing productivity, global connectivity, and interpersonal relationships. A survey conducted among students and professionals revealed high adoption rates of digital tools. Respondents identified key benefits, including speed, efficiency, and accessibility, while also highlighting concerns regarding security, privacy, and technical reliability. These findings emphasize the necessity for innovative management strategies to optimize the selection and integration of digital tools, addressing both functional and security challenges. By effectively navigating these complexities, organizations can leverage digital tools to foster innovation, streamline operations, and enhance collaboration. This study provides valuable insights into the intersection of innovation and management, guiding strategic decisions and future research initiatives.

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## 1 Introduction

Technological advancements in communication have continually transformed from speech and writing to sophisticated digital systems enabling instant global connectivity. The modern digital environment integrates diverse platforms, including social media, applications, and artificial intelligence. This research examines the transition from traditional methods to contemporary digital tools, focusing on text-oriented communication and hybrid platforms like multifunctional social networks. It explores how these tools reshape communication and redefine business processes, highlighting both their benefits and challenges. A survey conducted among computer science and informatics students and professionals in the state of Croatia provides insights into the use of digital tools in personal and professional contexts. The study aims to elucidate the role of digital tools in shaping modern business and society, offering strategies to enhance organizational communication, boost productivity, and improve interpersonal relationships in the digital age.

## 2 Communication tools

Communication tools enable the exchange of information and have evolved significantly. Traditional methods, such as speech, writing, and nonverbal cues, rely on human interaction with minimal technological support. Speech forms the foundation of communication, while writing allows for documentation of information. Nonverbal communication, including gestures and facial expressions, complements or substitutes verbal methods (Argyle, 1988; Fiske, 1990).

Technological tools revolutionized communication by enabling interaction across distances. Early innovations like the telephone, radio, and television provided voice transmission, audio broadcasts, and combined sound with visuals (McQuail, 2010). The Internet, developed through ARPANET in the 1960s, and the World Wide Web in the 1990s, introduced global connectivity, facilitating instant digital communication (Berners-Lee and Fischetti, 2024).

Digital communication encompasses diverse formats, such as text, voice, video, and hybrid multifunctional platforms. Social media tools integrate content types, creating enriched, interactive experiences. Advanced technologies like virtual reality (VR) and

augmented reality (AR) enhance communication through immersive alternative environments (Billingshurst, Clark, and Lee, 2015).

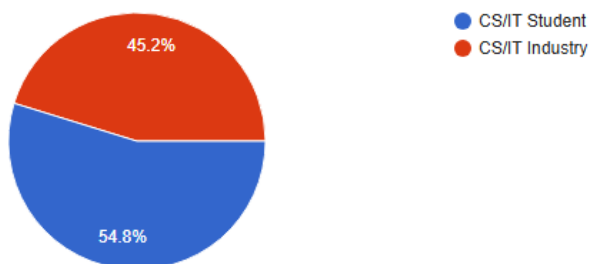
Text-based tools remain vital in modern communication. Email services like Gmail and Outlook offer professional and personal functionalities, including integrated calendars, document sharing and editing, and security and teamwork features (Google, 2024; Microsoft, 2023). SMS ensures reliable communication without the need for Internet access, making it effective in emergencies and quick business interactions (Textline, 2024). Messaging apps such as WhatsApp, Telegram, and Facebook Messenger support multimedia sharing, various types of advertisement and real-time communication but face challenges regarding privacy and security (Rottermanner et al., 2015; WhatsApp Privacy Policy, n.d.; Messenger, 2024).

Multifunctional social media platforms, such as Facebook, Instagram, and TikTok, facilitate diverse content sharing and participatory communication through features like polls, live events, and multimedia posts. Facebook integrates text, images, and group interactions, although its history includes privacy issues like the Cambridge Analytica scandal (Cadwalladr & Graham-Harrison, 2018). Instagram, once photo-centric, now prioritizes short-form videos like Stories and Reels, engaging younger users (Forbes Agency Council, 2024; Instagram, 2024). TikTok specializes in dynamic, short videos with interactive features, such as Duet and Stitch, and uses an algorithm-driven feed tailored to user engagement (Influencer Marketing Hub, 2024).

### **3 Survey**

For the purpose of this research, a Google Forms survey was designed to examine the ways in which digital communication tools are used and to explore user experiences in this context. The survey was specifically targeted at students and employees in the fields of informatics and computer science in Croatia, they were chosen as survey population because these professions heavily rely on digital tools in their daily professional and educational activities. The distribution of the survey was carried out through the author's personal contacts within the industry, with the expectation that participants would share the survey within their own networks. Due to this specific approach and the guarantee of participant anonymity, precise tracking of the number of invitations sent and calculation of the response rate was not

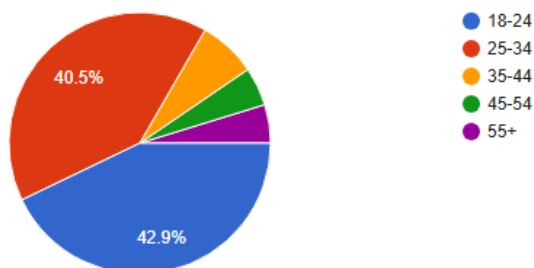
feasible. However, the survey was distributed to five companies with approximately one hundred employees in the sector, as well as to senior-year computer science students at the Faculty of Engineering, Juraj Dobrila University of Pula. A total of 42 responses were collected, representing an estimated response rate of about 20%. Additional insights were gathered through private discussions with few participants, contributing to the formulation of the final conclusions.



**Figure 1: Occupation**

Source: Own

Among the respondents, 55% were students, and 45% were employees in the sector.

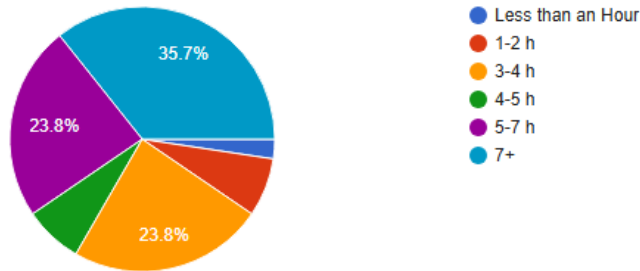


**Figure 2: Age groups**

Source: Own

The age classification of the participants was structured into five groups: 18-24, 25-34, 35-44, 45-54 and over 55 years. This classification made it possible to obtain a comprehensive insight into the demographic composition of the respondents, thus

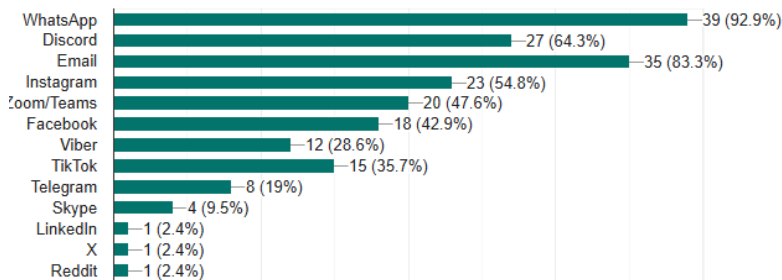
providing a reliable basis for making relevant conclusions about the use of digital communication tools. According to the collected data, more than 80% of respondents are younger than 35.



**Figure 3: Usage time of digital communication tools**

Source: Own

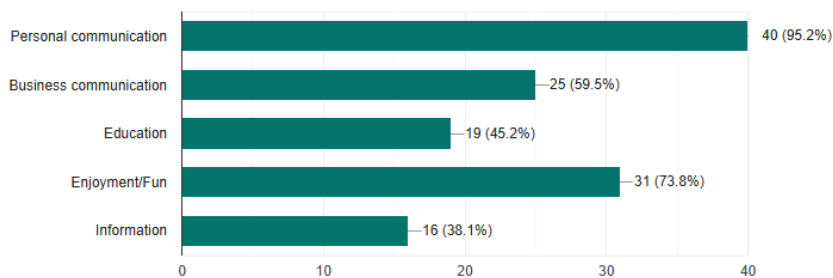
A survey question was posed about the average daily use of digital communication tools among participants. The results showed that nearly 60% of participants use digital communication tools for 5 or more hours a day. Therefore, digital communication tools have become an extremely important part of everyday life. Considering that the average person sleeps about 8 hours a day and is awake for approximately 16 hours, the use of digital communication tools takes up a significant portion of this waking time. The majority of respondents use these tools for almost half of their waking hours, including time spent at work or studying, as well as during leisure activities.



**Figure 4: Preferred choices of digital communication tools by usage**

Source: Own

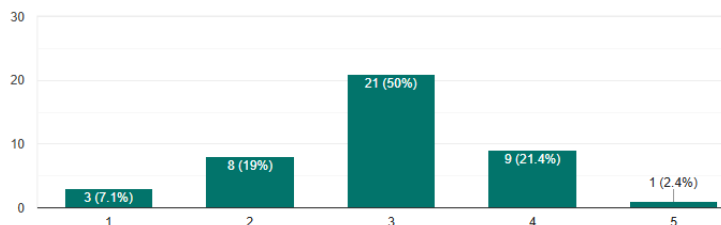
The survey identified WhatsApp (93%), email services (83%), and Discord (64%) as the most frequently used digital communication tools. Instagram and video conferencing platforms like Zoom and Teams were used by approximately 50% of respondents, while Facebook, Viber, Telegram, and TikTok were less common. These preferences, predominantly reflecting younger users, highlight a preference for tools enabling fast, engaging communication. WhatsApp's simplicity and efficiency, Discord's visual interface and community focus, and email's importance for formal and academic communication were emphasized, particularly by students, who rely on email for academic interactions.



**Figure 5: Primary Purposes for using Digital Communication Tools**

Source: Own

A question was asked about the primary purposes for using digital communication tools. Almost all respondents confirmed that they use these tools for personal communication. Additionally, a significant percentage reported using them for entertainment and business communication. These results highlight the multifunctional nature of digital communication tools, emphasizing their versatility in supporting both personal and professional interactions.

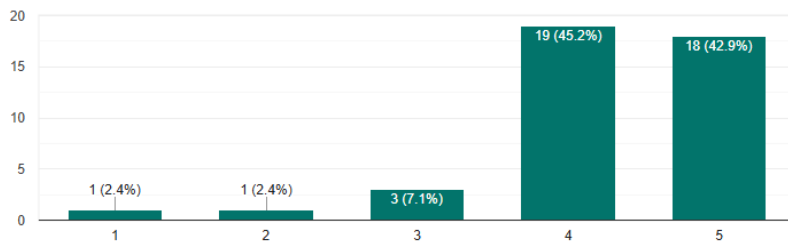


**Figure 6: Satisfaction with the security and privacy**

Source: Own



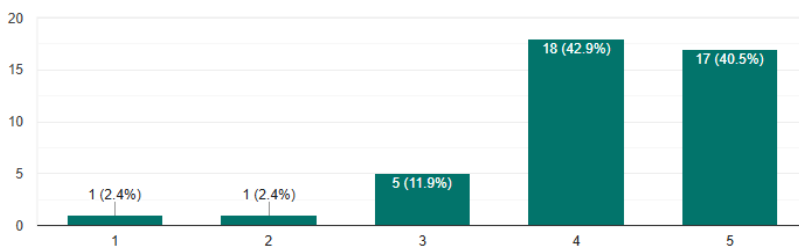
Next question addressed participants' satisfaction with the security and privacy of the digital communication tools they use. The majority of respondents reported a neutral perspective, with an average rating of 3 on a 5-point scale. This outcome indicates a moderate level of satisfaction while simultaneously reflecting underlying concerns and uncertainties regarding the security and privacy measures of these tools.



**Figure 7: Importance of communication speed in digital environments**

Source: Own

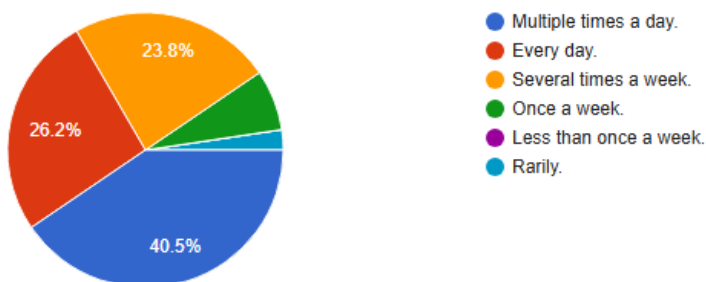
Subsequently, a question was posed regarding the importance of communication speed in digital environments. The objective of this inquiry was to assess the extent to which communication speed influences participants' decisions when selecting and utilizing digital communication tools. The results indicate that communication speed is a critical factor significantly influencing the respondents' experience.



**Figure 8: Importance of UI design in digital environments**

Source: Own

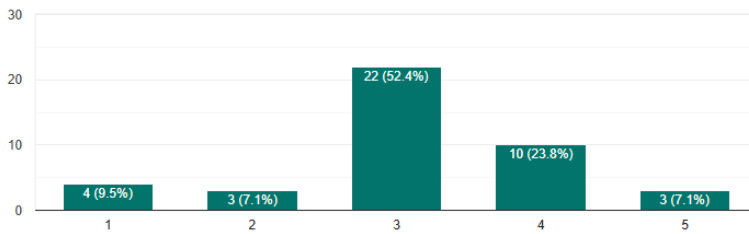
The following question focused on the importance of the user interface (UI) design of digital tools. The aim was to determine the extent to which visual aspects influence the selection of digital communication tools. The results indicate that the majority of participants consider an aesthetically appealing interface to be important. Specifically, 43% of respondents rated the importance of the interface with a score of 4, while 40% assigned a score of 5.



**Figure 9: Usage time of digital tools for group communication**

Source: Own

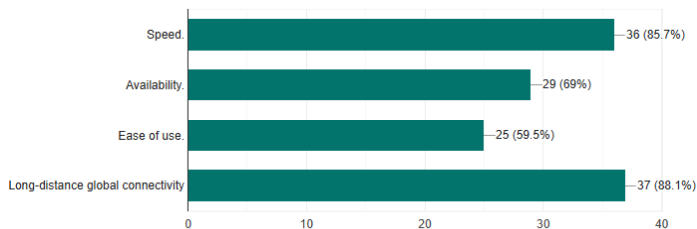
The next query in the survey addressed the daily use of digital tools for group communication, with a focus on message exchange. The objective of this question was to assess how frequently respondents use these tools and the role they play in their everyday lives. Previous results indicated that the majority of respondents use digital communication tools for five or more hours daily, including specific tools for group communication (e.g., WhatsApp, Discord, and others). Specifically, 40% of respondents reported using these tools multiple times per day, while 26% indicated daily usage. Additionally, 24% of participants stated that they use these tools several times a week. These results reflect the widespread use of digital communication tools in participants' daily lives, particularly for group communication. The findings confirm that group communication plays a central role in the respondents' experiences with digital tools, especially in the context of organizing and coordinating team activities. This is particularly significant, as half of the participants are employees for whom efficient group communication is essential.



**Figure 10: Quality of communication via digital tools compared to face-to-face**

Source: Own

The survey also asked participants to evaluate the quality of communication via digital tools compared to face-to-face communication. The majority of respondents expressed a neutral (rating 3) or relatively satisfied (rating 4) stance, with an average rating of 3 on a 5-point scale. While digital tools were praised for their efficiency and speed, respondents did not consider them fully comparable to the quality of in-person communication.



**Figure 11: Main advantages of digital communication**

Source: Own

The next question addressed the main advantages of digital communication. Participants highlighted speed and the ability to communicate remotely (long-distance global connectivity) as key benefits. This perception of speed aligns with previous findings that emphasize its importance in the digital communication experience. Additionally, many respondents mentioned accessibility as a significant advantage, preferring tools that can be accessed regardless of location, time, or platform.



**Figure 11: Main advantages of digital communication**

Source: Own

The final question addressed the main disadvantages of digital communication. The most frequently cited drawbacks were security risks and technical issues. Security threats, such as hacking and privacy breaches, were identified as potential causes of loss of private and sensitive information. Technical obstacles, such as network issues, system compatibility, or overload, can hinder effective communication through digital tools.

#### 4 Conclusion

This paper provides a detailed exploration and analysis of various communication tools, with a particular focus on the digital environment. Initially, a historical overview of communication methods was presented, laying the groundwork for understanding the evolution of communication technologies. Through an analysis of digital tools and platforms, the study highlights how digital innovations have dramatically transformed communication paradigms, particularly in the business sector, where social media, content marketing, messaging apps, and video conferencing platforms have become indispensable tools. The research conducted among students and IT professionals in the state of Croatia demonstrates that participants recognize speed, visual appeal, and efficiency as the key advantages of these digital tools. The findings show that participants value tools that enable quick, visually engaging, and efficient information exchange, dedicating a significant portion of their daily time to these tools—many up to one-third of their day. However, alongside the evident benefits, the results also point to challenges, particularly in data protection and privacy. These concerns create apprehension among users who, while willing to dedicate substantial time to these tools, remain

aware of the risks posed by the digital environment. Most participants use digital tools for personal communication, business communication, and entertainment. These findings require the need for further adaptation of business strategies to meet increasingly complex user demands in the digital age. Based on the evaluated findings, this research opens numerous avenues for further study, emphasizing the complexity of digital tools' impact on communication structures in social and professional contexts. Key latent questions include the ambiguous paths of future digital communication development amid technological advancements. As digital infrastructure expands, new "opportunities" and "challenges" will inevitably arise, prompting re-evaluation of the trade-offs between communication accessibility and user privacy. Targeted research could also focus on specific user subgroups to better understand and anticipate the effects and efficiency of digital communication tools across various professional sectors and to guide tool evolution based on user feedback. Additionally, with the rapid growth and expanding application of generative artificial intelligence and automation, it is crucial to consider how these advanced technologies transform not only the user experience but also the very structure of communication norms and standards. This paper also aims to serve as a possible starting point for future research in the field of modern business communication and its (innovative) management, providing valuable insights into key aspects of innovation and challenges within the digital environment.

### **Acknowledgment**

I would like to thank all the participants, especially the students and IT professionals in Croatia, for their valuable insights. Sincere gratitude goes to the academic advisor doc. dr. sc. Rozana Veselica Celić for her guidance.

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### **Summary**

This paper analyzes the evolution of communication tools, focusing on digital platforms' impact, particularly in business. It highlights how tools like social media, messaging apps, and video conferencing have transformed communication. A study in Croatia reveals that speed, visual appeal, and efficiency are valued by users, who dedicate significant time to these tools, yet remain concerned about privacy and data protection. While digital tools are widely used for personal, professional, and entertainment purposes, the study underscores the need for businesses to adapt to digital demands and explore further research into user preferences and the impact of emerging technologies like AI on communication norms.

# UMETNA INTELIGENCA IN NJEN VPLIV NA BOLNIŠKI STALEŽ

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Sodobni svet se sooča z intenzivnimi spremembami, ki jih prinašajo tehnološke inovacije, pri čemer umetna inteligenca (UI) izstopa kot ključno orodje za optimizacijo organizacijskih procesov. Ena izmed pomembnih aplikacij UI je obvladovanje bolniškega staleža (BS), ki ima daljnosežne posledice za zdravje zaposlenih, produktivnost, stroškovno učinkovitost organizacij in splošno družbeno blaginjo. Analiza podatkov o bolniškem staležu (BS) v Republiki Sloveniji (RS) za obdobje 2019–2023 je pokazala, da je indeks frekvence (IF), ki meri število primerov odsotnosti z dela na 100 zaposlenih, v vseh analiziranih letih dosledno višji pri ženskah kot pri moških. Izračun izgubljenih koledarskih dni na zaposlenega je razkril, da so v letu 2022 k visokemu obsegu bolniških odsotnosti največ prispevale infekcijske in parazitarne bolezni, medtem ko so v celotnem obravnavanem obdobju prevladovali bolezni mišično-skeletnega sistema in vezivnega tkiva. Prispevek preučuje, kako lahko UI prispeva k zmanjšanju BS prek naprednega predvidevanja bolezni, personaliziranimi intervencijami in administrativno optimizacijo, pri čemer ohranja osrednjo vlogo človeka v odločanju in podpori, ter skrbi za zaposlene. Vendar mora UI delovati le kot dopolnilo človeškemu delu, pri čemer se ohranja empatijo in etičnost v procesih odločanja.

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človek,  
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# ARTIFICIAL INTELLIGENCE AND ITS IMPACT ON SICK LEAVE

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The modern world is experiencing rapid changes driven by technological innovations, with artificial intelligence (AI) emerging as a key tool for optimizing organizational processes. One of the significant applications of AI is in managing sick leave (SL), which has far-reaching implications for employee health, productivity, cost-efficiency of organizations, and overall societal well-being. An analysis of sick leave (SL) data in the Republic of Slovenia (RS) for the period 2019–2023 revealed that the frequency index (FI), measuring the number of sick leave cases per 100 employees, was consistently higher among women than men across all analyzed years. The calculation of lost calendar days per employee showed that, in 2022, infectious and parasitic diseases contributed the most to the high volume of sick leave. However, throughout the analyzed period, musculoskeletal system and connective tissue disorders remained the predominant causes of absence. This study examines how AI can contribute to reducing sick leave through advanced disease prediction, personalized interventions, and administrative optimization, while preserving the central role of human decision-making and support, as well as care for employees. However, AI should function solely as a complement to human work, ensuring empathy and ethical considerations remain integral to decision-making processes.



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## 1 Uvod

Človek ohranja osrednjo vlogo v organizacijah kot vir ustvarjalnosti, etičnega razmisleka in strateškega odločanja. UI sicer omogoča avtomatizacijo rutinskih nalog, vendar ne more nadomestiti človeške empatije in sposobnosti intuitivnega razmišljanja (Brynjolfsson E., McAfee A, 2014). Ključno vprašanje je, kako prilagoditi človeške veščine za sodelovanje z UI. Študije kažejo, da so t.i. mehke veščine, kot so komunikacija, reševanje konfliktov in timsko delo, ključne za uspešno integracijo (Wilson HJ, Daugherty PR, 2018). UI v organizacijah ni le tehnološka rešitev, temveč sredstvo za preoblikovanje poslovnih procesov. Njena uporaba sega od analize velikega števila podatkov do izboljšanja produktivnosti prek avtomatizacije delovnih tokov. Na primer, algoritmi UI lahko optimizirajo oskrbovalne verige ali izboljšajo uporabniško izkušnjo z napovedovanjem potreb strank (Davenport TH, Kirby J, 2016). Poleg koristi se pojavljajo tudi izzivi, zlasti etični. Algoritmi so lahko pristranski, če temeljijo na nepopolnih ali diskriminatornih podatkih. Zato je pomembno, da organizacije vzpostavijo jasna pravila glede uporabe UI in odgovornost za njene posledice (Floridi L., Sanders JW, 2004).

Danes lahko umetno inteligenco opredelimo kot vejo računalniške znanosti, ki proučuje naprave, sposobne posnemati človekovo razmišljanje, in vključuje npr. sklepanje, planiranje, učenje, znanje, komuniciranje ali percepcijo. Te naprave so sposobne samostojnega učenja in prilagajanja spremembam, prav tako lahko napovejo vedenjske vzorce. Metode umetne inteligence lahko na podlagi zbiranja in urejanja nabora podatkov ustvarijo ustrezen napovedni model ter ga ovrednotijo in izpopolnijo. UI je osnovana na podlagi algoritmov, ki si jih lahko predstavljamo kot postopke ali pravila, na podlagi katerih računalniki rešujejo probleme. Vodilna metoda za gradnjo sistemov na podlagi UI je strojno učenje (Bat'ková & Kos, 2021). Tako imenovana digitalna transformacija pa ne pomeni le uvedbe novih tehnologij, ampak predvsem nove načine delovanja organizacije, od sprememb načinov vodenja do spodbujanja inovacij in agilnosti. Z ustrezno digitalno transformacijo bo lažje doseči učinkovite in kakovostne zdravstvene storitve z razumnimi stroški, ki jih potrebuje približno 7,5 milijarde ljudi. Vendar pa področje zdravstva po ugotovitvah komercialnih raziskav na globalni ravni zaostaja za drugimi panogami glede modernizacije in digitalne transformacije ((Rožanec & Lahajnar, 2019).

BS je za posameznike, organizacije in zdravstvene sisteme velik izziv. Pomeni izgubo produktivnosti, povečane stroške zdravstvene oskrbe in delodajalcem povzroča organizacijske težave. V zadnjih letih UI ponuja nove pristope k obravnavi tega kompleksnega problema. Njene aplikacije segajo od zgodnjega napovedovanja tveganj za bolezni do personaliziranih rehabilitacijskih programov in podpornih rešitev za vračanje na delo.

## 2 Umetna inteligenca in napovedovanje bolniškega staleža

Zgodnje napovedovanje bolezni in tveganj za dolgotrajni bolniški stalež je eno ključnih področij, kjer UI ponuja dodano vrednost. Analiza podatkov z algoritmi UI lahko obdelajo velike količine podatkov, kot so zgodovina odsotnosti, zdravstvene anamneze, delovni pogoji in celo vedenjski podatki. Na podlagi teh analiz lahko prepoznajo vzorce, ki kažejo na povečano verjetnost za odsotnost zaradi bolezni. Študija, izvedena v skandinavskih državah, je pokazala, da modeli strojnega učenja učinkovito napovedujejo dolgotrajno odsotnost zaradi stresa in izgorelosti na podlagi podatkov o delovni obremenitvi in zgodovinskih trendih (Eriksson et al., 2020). Integracija UI in zgodnje napovedi omogočajo delodajalcem uvedbo preventivnih ukrepov, kot so prilagoditev delovnega mesta, ponujanje svetovalnih storitev ali usmerjanje zaposlenih v preventivne zdravstvene programe. S tem lahko delovne skupine ohranijo produktivnost tudi ob večji obremenitvi zdravstvenega sistema, kar je bilo še posebej izrazito v obdobju pandemije COVID-19.

Uporaba UI za optimizacijo procesov ob tem odpira vprašanja etične narave, saj so podatki o zdravstvenem stanju in bolniških odsotnostih med najbolj občutljivejšimi osebni podatki. Zagotavljanje zasebnosti, zaščita pred zlorabo informacij ter skladnost z zakonodajnimi okvirji, kot je Splošna uredba o varstvu podatkov (GDPR), so ključni pogoji za odgovorno implementacijo UI. Kljub tehnološkemu napredku mora ostati človek pomemben dejavnik v procesih odločanja. Tam, kjer je UI učinkovitejša od človeka, na primer pri analizah velikih podatkovnih nizov ali napovedovanju trendov, lahko razbremeni strokovnjake in omogoči osredotočanje na bolj kompleksne primere, ki zahtevajo strokovno presojo (Frey & Osborne, 2017). Sinergija med UI in zdravstvenimi delavci tako prinaša koristi, kot so podpora pri kliničnih odločitvah, izboljšanje kakovosti oskrbe in boljše izkušnje pacienta. Prav tako omogoča znižanje stroškov ter optimizacijo razporejanja virov v zdravstvenem sistemu.

Priporočljivo je, da organizacije pristopijo k implementaciji UI s preišljenimi strategijami, ki ne vključujejo zgolj tehnoloških inovacij, temveč tudi izobraževanje zaposlenih in krepitev njihovega zaupanja v tehnološke rešitve. S tem se zagotavlja uspešna integracija, ki prinaša dolgoročne koristi, kot so napovedovanje in preprečevanje neželenih zdravstvenih dogodkov, lažje spremljanje zdravstvenega stanja prebivalstva ter podpora pacientovi samooskrbi prek digitalnih orodij (Chen & Decary, 2020).

Digitalna transformacija lahko tako izboljša učinkovitost delovnih procesov ter poveča dostopnost in kakovost zdravstvenih storitev, ob tem pa zagotavlja, da tehnološke inovacije dopolnjujejo, ne pa nadomeščajo, ključne elemente zdravstvene oskrbe, kot so empatija, komunikacija in neposreden stik s pacientom (Rožanec & Lahajnar, 2019).

### 3 Analiza podatkov BS v RS od leta 2019 do leta 2023

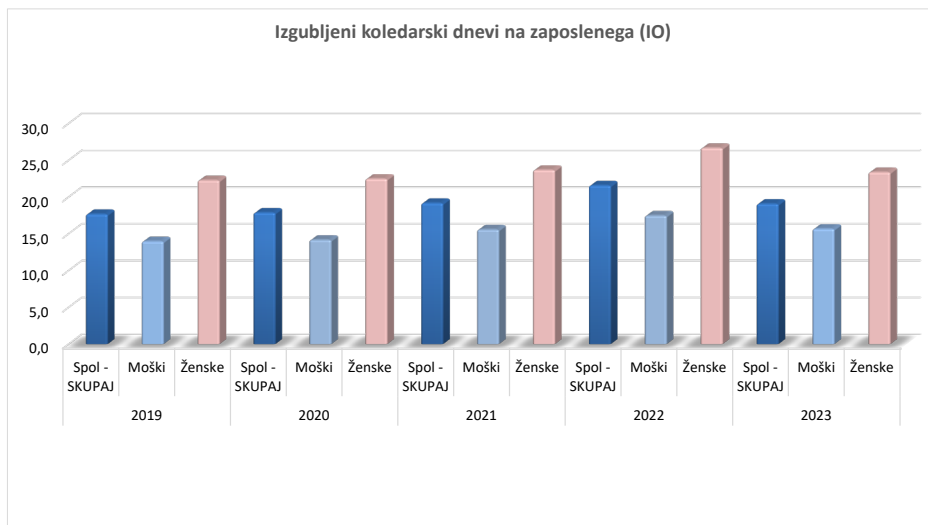
Analizirali smo podatke, pridobljene iz Nacionalnega inštituta za javno zdravje (NIJZ) za obdobje petih let, pri čemer so bile obravnavane bolniške odsotnosti glede na spol in diagnoze po MKB 10 - AM (verzija 11). Podatki so izračunani po metodologiji:

- INDEKS ONESPOSABLJANJA (IO) – To je število izgubljenih koledarskih dni na enega zaposlenega delavca.
- INDEKS FREKVENCE (IF) – Število primerov odsotnosti z dela zaradi bolniškega staleža na 100 zaposlenih v 1 letu (NIJZ, 2024).

Najvišje število izgubljenih koledarskih dni na enega zaposlenega IO je bilo v letu 2022 pri ženskah, kjer je znašalo kar 26,7 koledarskih dni, medtem ko je bilo to število pri moških znatno nižje, in sicer 17,5 koledarskih dni. To sovпада z obdobjem, ko so bili učinki pandemije COVID-19 še izrazito prisotni. Analiza vseh obravnavanih let dosledno kaže, da so ženske v primerjavi z moškimi beležile višje število IO zaradi odsotnosti z dela kar je prikazano v sliki 1.

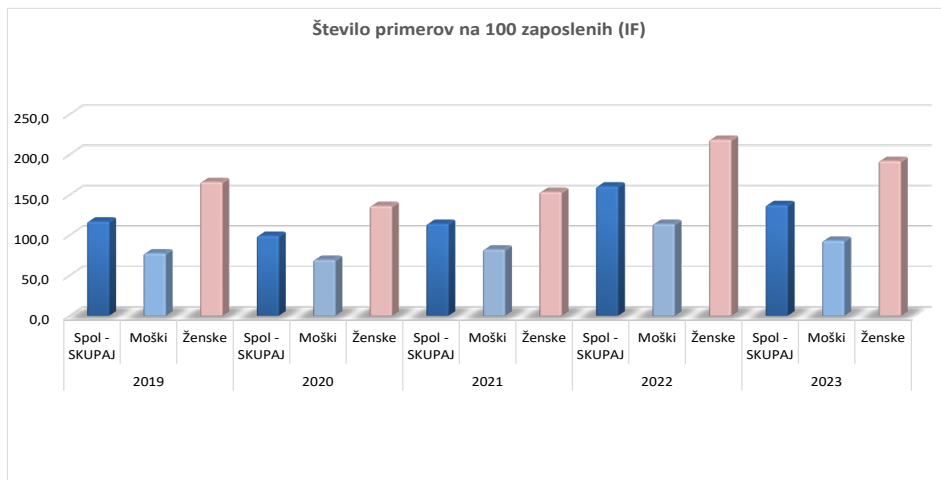
Tudi IF, ki meri število zadržanosti z dela na 100 zaposlenih, jasno kaže, da so ženske v vseh analiziranih letih beležile precej večjo odsotnost z dela kot moški. V letu 2022 je IF pri ženskah dosegel vrednost 218,5, pri moških pa je bil bistveno nižji in je

znašal 114. Tudi v drugih analiziranih letih so bile vrednosti IF pri moških nekoliko nižje, vendar so razlike med spoloma ostale izrazite in konstantne (slika 2).



**Slika 1: Število izgubljenih koledarskih dni (IO), glede na spol v opazovanem obdobju**

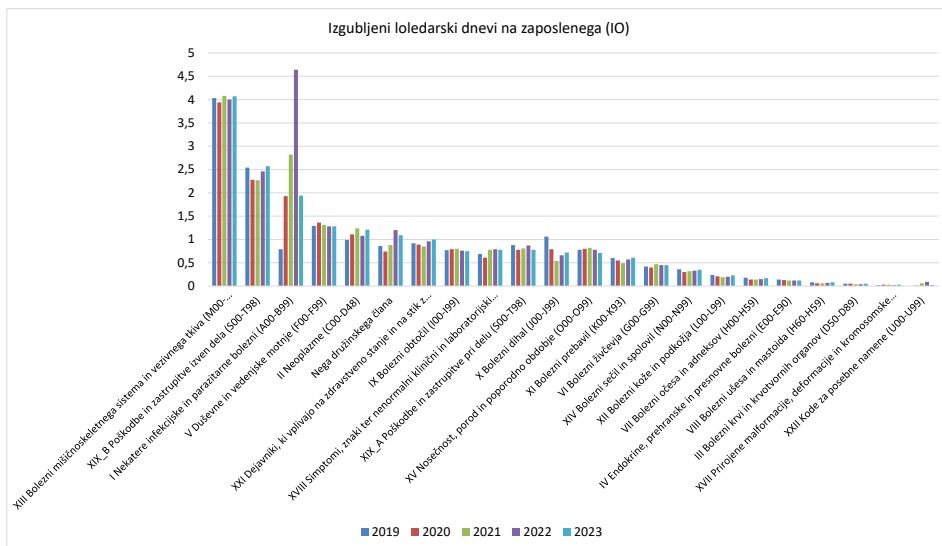
Vir: Lasten



**Slika 2: Število primerov odsotnosti z dela zaradi BS na 100 zaposlenih (IF), po spolu v opazovanem obdobju**

Vir: Lasten

Tudi IF, ki meri število zadržanosti z dela na 100 zaposlenih, jasno kaže, da so ženske v vseh analiziranih letih beležile precej večjo odsotnost z dela kot moški. V letu 2022 je IF pri ženskah dosegel vrednost 218,5, pri moških pa je bil bistveno nižji in je znašal 114. Tudi v drugih analiziranih letih so bile vrednosti IF pri moških nekoliko nižje, vendar so razlike med spoloma ostale izrazite in konstantne (slika 2).



Slika 3: Izgubljeni koledarski dnevi na zaposlenega (IO), po diagnozah MKB 10-AM (verzija 11) v opazovanem obdobju

Vir: Lasten

Analiza bolniških odsotnosti po diagnozah, razvrščenih po MKB-10-AM (11. izdaja), je pokazala, da so najvišje vrednosti IO beležile infektivne in parazitarne bolezni v letu 2022. Sledile so bolezni mišičnoskeletnega sistema in vezivnega tkiva kot pogost vzrok odsotnosti ter poškodbe in zastrupitve, ki so povezane z nezgodami zunaj delovnega okolja. Duševne in vedenjske motnje odražajo naraščajoče težave z duševnim zdravjem, medtem ko so neoplazme pomemben dejavnik zaradi resnosti bolezni in dolgotrajnega zdravljenja (slika 3).

## 4 Razprava in zaključek

UI ponuja obsežne možnosti za izboljšanje upravljanja BS, zlasti v primerih dolgotrajne odsotnosti z dela, vendar njena uspešna implementacija zahteva celovit in premišljen pristop. Ključni elementi za učinkovito uporabo UI na tem področju vključujejo zgodnje napovedovanje tveganj, oblikovanje prilagojenih rehabilitacijskih programov, zagotavljanje varstva podatkov ter aktivno vključevanje delodajalcev v celoten proces. Algoritmi strojnega učenja omogočajo napredno analizo zdravstvenih podatkov, kar lahko izboljša sposobnost prepoznavanja zgodnjih znakov zdravstvenih težav ter omogoči pravočasne intervencije. S tem se lahko preprečijo resnejša obolenja ter skrajša čas okrevanja zaposlenih. Kljub visoki stopnji avtomatizacije in personalizacije, ki jo prinaša UI, mora človek ostati osrednji dejavnik v procesu odločanja in izvajanja zdravstvene oskrbe. Empatičen pristop, celostno razumevanje pacientovih potreb in zmožnost kontekstualnega odločanja so elementi, ki jih tehnologija ne more nadomestiti, temveč le podpreti. Sinergija med človekom in UI lahko tako pomembno izboljša zdravstvene izide ter poveča organizacijsko učinkovitost, saj omogoča boljše prilagajanje storitev specifičnim potrebam zaposlenih.

Implementacija UI v upravljanje BS pa ni zgolj tehnološki izziv, temveč tudi organizacijski. Le s sistematičnim pristopom k implementaciji UI je mogoče zagotoviti, da bodo koristi digitalizacije dejansko prinesle dodano vrednost v obliki krajših odsotnosti, višje kakovosti zdravstvene obravnave in večje organizacijske uspešnosti.

Na podlagi analize podatkov pridobljenih iz NIJZ za obdobje med leti 2019 do 2023, ter ugotovljenih kazalnikov bolniških odsotnosti, UI predlaga naslednje ukrepe za zmanjšanje BS z implementacijo:

### a) zgodnje napovedovanje in preprečevanje zdravstvenih težav

- **modeli napovedovanja tveganj:** UI lahko na podlagi zgodovinskih podatkov o zdravstvenem stanju in delovnih obremenitvah napoveduje posameznike z visokim tveganjem za razvoj dolgotrajne bolniške odsotnosti.

- **personalizirana obvestila:** Sistem lahko posameznike opozarja na preventivne ukrepe, ko se povečajo dejavniki tveganja za obolevnost, še posebej za infekcijske bolezni ter bolezni mišično-skeletnega sistema.
  - **nosljive naprave in UI:** Pametne ure in drugi nosljivi senzori zbirajo podatke o telesni aktivnosti, kakovosti spanja in srčnem utripu. Ti podatki pomagajo pri spremljanju okrevanja in prilagoditvi rehabilitacijskih programov v realnem času (Khosla et al., 2021).
- b) prilagojeni programi za zmanjšanje odsotnosti zaradi bolezni mišično-skeletnega sistema**
- **priporočila za ergonomijo delovnega mesta:** S pomočjo UI lahko analiziramo delovno okolje in podamo prilagojena priporočila za izboljšanje ergonomije ter zmanjšanje tveganja za poškodbe.
  - **spremljanje vadbenih rutin:** UI lahko spremlja izpolnjevanje priporočenih vaj ter spodbuja preventivne aktivnosti, kar pomaga pri preprečevanju bolečin in poškodb.
- c) obvladovanje psihosocialnih dejavnikov in duševnih motenj**
- **identifikacija zgodnjih znakov izgorelosti:** S prepoznavanjem vzorcev, ki kažejo na povečano obremenjenost, lahko UI predlaga intervencije, kot so sprostitvene tehnike ali krajšanje delovnega časa in drugo.
  - **digitalna podpora duševnemu zdravju:** Aplikacije na osnovi UI lahko zaposlenim nudijo vodenje skozi tehnike za obvladovanje stresa ter dostop do virtualnih svetovalcev.

**d) učinkovito upravljanje sezonskih okužb**

- **napovedovanje epidemioloških vrhov:** Napovedni modeli lahko identificirajo obdobja povečanega tveganja za infekcijske bolezni, kot so viroze in gripa, kar omogoča pravočasno izvajanje preventivnih ukrepov, kot so kampanje cepljenja ter obveščanje in ozaveščanje zaposlenih.
- **telemedicinske storitve:** Implementacija virtualnih posvetov omogoča hitro diagnostiko in zmanjšuje potrebo po dolgotrajni odsotnosti z dela zaradi lažjih obolenj.

**e) optimizacija upravljanja bolniških zahtevkov in postopkov**

- **avtomatizacija administrativnih procesov:** UI lahko zmanjša čas obdelave bolniških zahtevkov z avtomatizacijo vnosov in preverjanj.
- **prilagojena priporočila:** Na podlagi obdelanih podatkov lahko sistemi UI priporočajo najboljše prakse za skrajšanje obdobja okrevanja.

**f) sodelovanje z delodajalci in spodbujanje zdravega delovnega okolja**

- **analiza vzorcev BS:** UI omogoča delodajalcem prepoznavanje specifičnih vzrokov za odsotnosti z dela (kratkotrajnih kot dolgotrajnih) ter oblikovanje ciljno usmerjenih preventivnih programov.
- **programi za promocijo zdravja:** Sistem UI lahko spremlja učinkovitost programov za zdravje na delovnem mestu ter predlaga prilagoditve glede na zdravstvene izide.

S premišljeno implementacijo UI je mogoče vzpostaviti personalizirane preventivne programe, izboljšati prepoznavanje dejavnikov tveganja in skrajšati obdobje okrevanja. Ključ do uspeha je kombinacija napredne tehnologije, učinkovite organizacijske podpore ter usposobljenega kadra, ki razume in učinkovito uporablja UI kot podporo pri svojem delu (Raisch & Krakowski, 2021). Le z integriranim pristopom je mogoče doseči dolgoročno zmanjšanje BS ter izboljšanje kakovosti zdravstvene obravnave. Napredek umetne inteligence lahko spremeni številne vidike zdravstvenega varstva in omogoči prihodnost, ki bo bolj prilagojena, natančna, predvidljiva in prenosljiva (Baywa et.al., 2021).



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# AGILNO MODELIRANJE LASTNE CENE S PRILAGODLJIVO NATANČNOSTJO

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Digitalizacija in optimizacija procesov v podjetjih zadnja leta pridobivata na svoji popularnosti. Vendar je le majhen del celotne promocije namenjen ozaveščanju o dejanskih modelih in natančno ocenjenih koristih optimizacije procesov za podjetja. Konkretni vpogledi v proces modeliranja so pogosto prikriti zaradi zaščite konkurenčnih prednosti, medtem ko so metodologije za ocenjevanje njihove vrednosti ali celo natančni prihranki težko dostopni. Predstavljamo uspešno študijo primera optimizacije procesov, izvedeno v podjetju Exoterm-IT d.o.o. Osnova za optimizacijo procesov je izračun lastne cene izdelkov podjetja. V prispevku predstavimo iterativni proces modeliranja skupaj z indikatorji dodane vrednosti, ki jih prinaša naraščajoča kompleksnost modela v trenutni in naslednjih iteracijah. Ta proces podjetju omogoča kompromis med natančnostjo in kompleksnostjo modela, ki ga uporablja pri odločanju, hkrati pa identificira relevantnost posameznih segmentov proizvodnih stroškov za morebitno optimizacijo.

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#### Ključne besede:

lastna cena,  
optimizacija poslovnih  
procesov,  
stroški podjetja,  
sistem produkta,  
univerzalni model procesa



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# AGILE MODELING OF PRODUCTION PRICE WITH ADAPTIVE PRECISION

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## Keywords:

production price,  
optimization of business  
processes,  
business expenses,  
product system,  
universal process model

Digitalization and process optimization in companies are increasingly popular. However, only a small part of the overall promotion is dedicated to raising awareness of the actual models and accurately valued benefits of process optimization for businesses. Specific insights into the modelling process seem to be obscured by protecting competitive advantages. Methodology of assessment of their value or even just accurate savings are hard to come by. We present a successful case study of process optimization conducted at Exoterm-IT d.o.o. The foundation for process optimization is the calculation of the company's products production price. We present an iterative modeling process together with indicators of value added by growing model complexity in current and subsequent iteration. This process allows the company to compromise in accuracy vs. complexity of the model they apply for their decision making, as well as identifies relevance of the segments of production cost for possible optimisation.



## 1 Uvod

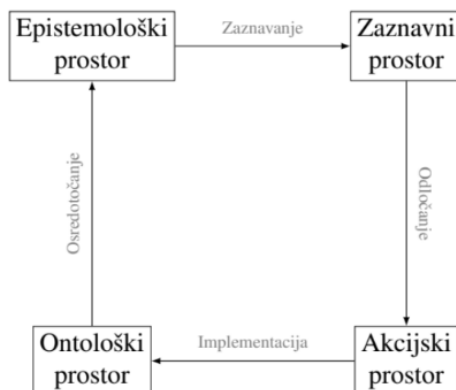
Promocija digitalne in zelene transformacije je s pomočjo subvencij in objav po tiskanih in digitalnih medijih ter socialnih omrežjih dosegla svoj vrhunec. Priložnosti zelene in digitalne transformacije pa tičijo v procesih, ki so več kot le razogljičenje ali digitalizacija nekega procesa. Ključno je, da podjetje zahteve zelene in digitalne transformacije obrne sebi v prid. Torej, podjetje naj ne vpeljuje tehnologije ali optimizira procesa zaradi izpolnitve nekih pogojev ali pa ker so to utečene prakse v branži. Smiselno je, da to počne, ker je prepoznalo in ovrednotilo dodano vrednost v svojih podatkih in lahko z ustrezno manipulacijo procesov, ki podatke generirajo, sledi svojim strateškim ciljem. Eden izmed načinov kako lahko podatki o stroških postanejo sredstvo in ne le obveznost, ki jo je treba poročati na letnih poročilih, je model lastne cene. Modeli lastne cene lahko upoštevajo različne nivoje stroškov podjetja. Najmanj natančen model je stroškovno računovodstvo, kjer je pomemben le skupen dobiček podjetja, ki ga generirajo vsi izdelki in storitve. Najbolj natančen pa je model, kjer za vsako enoto vsakega porabljenega vira natančno vemo, kateremu izdelku ga lahko pripišemo. Prvi je najcenejši, a ne omogoča optimizacije, drugi je najdražji, a omogoča poljubno natančno spremljanje porabe virov in posledično optimizacijo. V prispevku poročamo o študiji primera podjetja Exoterm-IT d.o.o., kjer smo dinamično spremljali natančnost modela lastne cene za dva izdelka, ki predstavljata različni pakiranji jeklarskega naogljijevalca. V drugem razdelku prispevka predstavimo metodologijo za izračun lastne cene in kazalnike vrednotenja le te. V tretjem razdelku predstavimo rezultate modelov lastne cene, ki iterativno vedno bolj podrobno opredelijo odnos med produkti in segmenti stroškov. V zadnjem poglavju prispevka so zbrani izzivi, s katerimi smo se srečevali, in možnost nadaljnjih raziskav.

## 2 Metodologija: Univerzalni model procesa in natančnost lastne cene

V razdelku opišemo univerzalni model procesa, ki poda metodologijo za modeliranje procesov podjetij. Model je bil prvič uporabljen v (Fic, Bokal, 2019), kasneje pa še v (Bokal et al, 2019), (Fic et al, 2019), (Fic et al, 2021), (Bokal et al, 2024). Ti procesi so ključnega pomena za izračun lastne cene, saj določajo sistem produkta, ki ga opišemo v nadaljevanju tega poglavja. Prav tako v nadaljevanju omenimo osnovne metodologije za izračun lastne cene. Vzporednice, ki jih lahko zaznamo med LCA (analiza življenjskega cikla produkta) analizo in izračunom lastne cene uporabimo v

naši metodologiji izračuna lastne cene. Na koncu predstavimo kazalnike, ki bodo opisano metodologijo vrednotili.

## 2.1 Univerzalni model procesa za modeliranje lastne cene



Slika 1 : Diagram univerzalnega modela procesa

Vir: Lasten

Univerzalni model procesa sledi spoznavnemu modelu, ki korake razdeli na *ontološki prostor* stanj sveta - realnosti, ki dejansko obstaja, *epistemološki prostor* modelov stanj sveta - pogledov na realnost, ki jih privzamemo v obravnavo, *zaznavni prostor* podatkov, ki jih zberemo na osnovi izbrane epistemologije in predstavljajo dejanske slike sveta ter *akcijski prostor* odločitev, s katerimi bomo nadaljevali razvoj modela lastne cene ali njegovo uporabo.

Pri modeliranju lastne cene ontološki prostor predstavlja realnost podjetja, njegovih deležnikov, materialov, izdelkov, predvsem pa njegovih nabavnih, proizvodnih in prodajnih procesov.

Epistemološki prostor v najširšem pogledu predstavlja informacijsko - dokumentarno - regulatorna infrastruktura podjetja, iz katere lahko črpamo koncepte, informacije, podatke, ki jih potrebujemo za izdelavo modela lastne cene. V ožjem smislu pa epistemološki prostor predstavljajo možni modeli lastne cene.

Njihove strukture ne bomo formalno omejili, se ji pa posvetimo v razdelku o podatkih.

Zaznavni prostor predstavljajo podatki modela izbranega iz epistemološkega prostora. Če je izbran model opredeljen z entitetno-relacijskim diagramom, je njegov zaznavni prostor opredeljen s konkretno nabirko podatkov za izbran entitetno-relacijski diagram, ki ga upoštevamo pri računanju lastne cene.

Bistven v procesu modeliranja pa je akcijski prostor, ki določa proces in uporabo izbranega modela lastne cene. Bolj kompleksni modeli predstavljajo večji strošek razvoja, vzdrževanja in večje tveganje za napačne podatke, po drugi strani pa bolj natančni modeli predstavljajo večje priložnosti za optimizacijo. Zato s spretnim izborom aktivnosti v modeliranju iščemo kompromis med natančnostjo in uporabnostjo modela.

Aktivnosti tako opredelimo kot:

- “uporabljam”, kar pomeni, da je model dovolj kakovosten, da se ga uporabi v poslovnih procesih,
- “preveri”, kar pomeni, da je potrebno v model dodati preverjanje, ki bo zagotavljalo njegovo verodostojnost,
- “popravi”, kar pomeni, da je bila pri preverjanju odkrita napaka, ki jo je treba odpraviti,
- “razišči”, kar pomeni, da z modelom ne moremo odgovoriti na določeno vprašanje in ga je potrebno zato nadgraditi,
- “izostri”, kar pomeni, da modelu dodamo nove podrobnosti, s katerimi bomo dvignili njegovo kakovost in omogočili odgovarjanje na nova vprašanja.

## 2.2 Osnovna struktura modelov lastne cene

Modeli lastne cene nam omogočajo, da produkt proizvedemo ali projekt izvajamo na način, ki je utemeljen na podatkih o stroških proizvodnje ali projekta.

Modeli izračuna lastnih ali proizvodnih cen so raznoliki in prilagojeni specifičnim potrebam industrije, pri čemer vključujejo dejavnike, kot so občutljivost povpraševanja, tržna dinamika in proizvodni stroški. S pomočjo različnih matematičnih in računalniških tehnik kot so mehki modeli povpraševanja (Kundu et al, 2017), EPQ modeli (Teng & Chang, 2005), modeli izračuna stroškov (PMC) (Batlle, & Barquín, 2005), optimiziramo cenovne in proizvodne strategije, s končnim ciljem maksimizacije dobička in učinkovitosti v različnih tržnih pogojih.

Z izborom odločitev, ki minimizirajo prej omenjene stroške, lahko s produktom/projektom ustvarjamo dobiček. Modeli lastne cene se ukvarjajo s stroški, ki nastanejo v življenjskem ciklu produkta/projekta. Tega lahko uporabimo kot orodje v fazi načrtovanja novega produkta ali projekta ali med samo proizvodnjo produkta ali tekom projekta. Ključen pri analizi lastnih cen oziroma analize stroškov življenjskega cikla je nabor alternativnih odločitev, ki vplivajo na življenjski cikel produkta ali projekta. Te lahko predstavljajo tudi odločitve, ki jih moramo v življenjskem ciklu produkta ali projekta sprejeti, saj nas zanimajo predvsem finančne posledice teh odločitev. Zanima nas, kaj v življenjskem ciklu produkta je smiselno optimizirati, da bo imelo kar največji vpliv na donosnost produkta.

V življenjskem ciklu projekta/produkta srečamo več tipov stroškov (Matthews et al, 2015). Ti so:

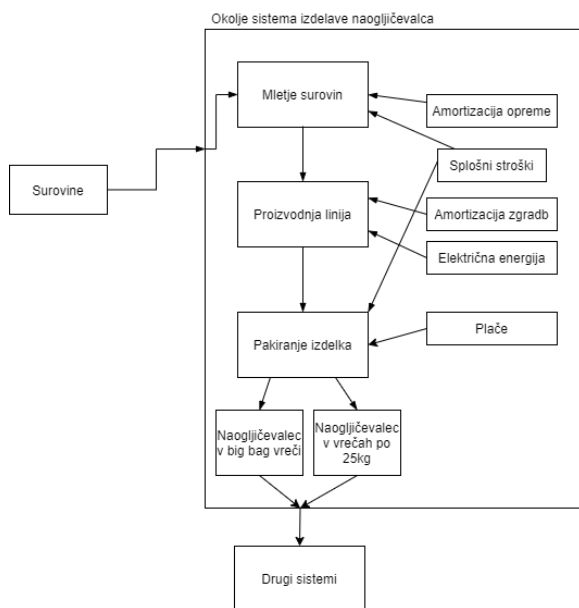
- prvi ali začetni stroški (ang. first, initial cost): Stroški, ki nastanejo ob začetku proizvodnje produkta ali začetku projekta. Ne upoštevajo se stroški načrtovanja in razvoja produkta. Na te stroške se ne bomo osredotočali, saj imajo ti stroški večjo težo pri enkratnih projektih, za katere se nameni fiksni proračun.
- prihodnji stroški (ang. future costs): So stroški, ki bodo nastali po izdelavi produkta ali zaključku projekta. Tudi na to vrsto stroškov se ne bomo osredotočali, saj te stroške, ki se dogodijo po izdelavi produkta, nosi kupec.
- ponavljajoči stroški (ang. recurring cost): Stroški, ki nastajajo v življenjskem ciklu projekta, v nekem ponavljajočem se časovnem okvirju, recimo letno ali mesečno. Na ta tip stroškov se osredotočimo v naši metodologiji, saj imajo ti stroški v našem uporabniškem primeru največjo težo. Razlog je, da podjetje izbrana produkta izdeluje konstantno in zanj porablja vire, ki jih stroškovno spremlja na mesečnem nivoju.



- nepovratni stroški (ang. sunk cost): Investicijski stroški ob začetku proizvodnje/projekta, ki jih ne štejemo k modelu lastne cene.

Predstavitve metodologije za izračun lastne cene bomo izvedli na primeru dveh produktov, ki ju proizvaja podjetje Exoterm d.o.o. Prvi produkt je paleta naogljicevalca v big bag vreči, drugi produkt je paleta naogljicevalca v vrečah po 25 kilogramov. Oba produkta imata zelo podoben življenjski cikel, ki se razlikuje le v nekaj detajlih. Tega opišemo s pomočjo slike 2, katere strukturo smo jo povzeli po (Matthews et al, 2015). Stroškov, ki nastanejo z nabavo in pripravo surovin, ne predstavljamo, saj so te ključna konkurenčna prednost podjetja.

Prvi proces čez katerega potujejo surovine, da nastaneta omenjena produkta je mletje. V tem procesu se surovine zmelje na kose ustrezne granulacije. Pri tem procesu se uporablja oprema podjetja, zato bo ta proces nosil stroške amortizacije opreme. Prav tako se porabljajo določeni ostali viri, katerih stroški se beležijo na splošne stroške. Kosi surovin za naogljicevalec potujejo po proizvodnji liniji, ki mora biti postavljena v nekem prostoru, za katerega podjetje plačuje najemnino.



Slika 2: Sistem produktov naogljicevalca v big bag vreči in naogljicevalca v vrečah po 25 kg

Vir: Lasten

Zato se na ta proces beležijo stroški amortizacije zgradb in porabljena električna energija. Na koncu se naogljičevalec pakira, kjer nastaneta dva produkta, ki končata na paletah. Prvi produkt je naogljičevalec, ki se pakira v vrečo big bag in se postavi na paleto. Drug produkt je naogljičevalec, ki se pakira v vreče po 25 kg in se zlagajo na paleto. Oba produkta se naprej vodita po drugih sistemih, ki niso del tega izračuna lastne cene. Proces pakiranja ni v celoti avtomatiziran, zato morajo za pakiranje skrbeti zaposleni. Tako se na ta proces beleži stroške plač zaposlenih in dodatne stroške, ki se jih vodi kot splošne stroške. Ker se splošne stroške beleži na proces mletja in pakiranja, te delimo v razmerju 50:50.

### 2.3 Kazalniki natančnosti modela lastne cene

Navedeni nabor aktivnosti predpostavlja vrsto lastnosti modelov, katerih teoretična obravnava je še v razvoju. V danem prispevku se osredotočimo na koncept kakovosti modelov. Zanj definiramo več kazalnikov, s katerimi obravnavamo predvsem natančnost modela lastne cene. Podrobneje jih predstavimo v naslednjem razdelku.

Na osnovi strukture podatkov iz prejšnjega razdelka uvedemo naslednje kazalnike natančnosti modelov lastne cene:

- Segmentiranost stroškov je količnik med vsoto stroškov, ki imajo opredeljen segment (torej ne pripadajo skupini ‘Splošni stroški’) in vsemi stroški poslovnega procesa izdelave izdelka. Kazalnik lahko zavzema vrednosti iz intervala  $[0,1]$ .
- Zgornja občutljivost je količnik med najmanjšo vsoto stroškov katerega od uporabljenih segmentov, ki jih uporabimo v modelu in vsemi stroški poslovnega procesa izdelave izdelka. Kazalnik lahko zavzema vrednosti iz intervala  $[0,1]$ .
- Spodnja občutljivost je količnik med največjo vsoto stroškov katerega od ne-uporabljenih segmentov, ki jih uporabimo v modelu in vsemi stroški poslovnega procesa izdelave izdelka. Kazalnik lahko zavzema vrednosti iz intervala  $[0,1]$ .
- Skok modela je maksimalna absolutna sprememba lastne cene do prejšnjega modela, ki je pomnožena s količino izdelanih izdelkov. Pri izračunu kazalnika

zmnožimo spremembo lastne cene, ki je v  $\frac{EUR}{\text{tona izdelka}}$ , z izdelanimi količinami izdelkov, ki so v tona. Tako je enota skoka modela enaka EUR.

- Ocena tvegane vrednosti je vsota po izdelkih, kjer seštejemo absolutne vrednosti produkta spremembe lastne cene produkta do prejšnjega modela in njegove izdelane količine. Vrednost kazalnika nam pove, koliko napake tvegamo, če uporabimo manj natančen model. Podobno kot pri kazalniku skok modela je tudi enota kazalnika enaka EUR.

Kazalnike se uporabi v procesu iterativnega izboljševanja modela, ki je opisan v naslednjem razdelku. Pri vsaki iteraciji modela segmentiranost stroškov naraste, skok modela in ocena tvegane vrednosti padata, zgornja in spodnja občutljivost pa se ne povečata.

## 2.4 Iterativni pristop k modelu lastne cene

Iterativni pristop izboljševanja modelov lastne cene izvajamo na naslednji način:

- Zberemo podatke o vseh izdelkih izbranega oddelka in vseh segmentih stroškov, ki jih oddelku lahko neposredno pripišemo. Po potrebi si pomagamo z delilnimi ključi, ki agregirane stroške s faktur pripišejo posameznim oddelkom.
- Stroške vseh segmentov uredimo padajoče po znesku, pri čemer “splošne stroške” izločimo iz zaporedja in jih vodimo ločeno.
- Izračunamo materialne stroške vsakega izdelka; proporcionalno z materialnimi stroški in količinami izdelkom pripišemo ustrezen delež vseh preostalih stroškov poslovnega procesa. Tako dobimo prvo, materialno oceno lastne cene izdelkov.
- V obravnavo vzamemo največji segment stroškov, ki ni splošni strošek, in ponavljamo v zanki:
  - Obravnavan strošek razdelimo med izdelke oddelka sorazmerno glede na porabo v poslovnem procesu.
  - Vse še nerazporejene stroške prištejemo splošnim stroškom.
  - Izračunamo ocene lastnih cen izdelkov, spremembe do prejšnje ocene, ter vse kazalnike natančnosti modela.

- Če je natančnost modela ustrezna, zaključimo, sicer ponovimo obravnavo s po velikosti naslednjim segmentom stroškov. S tem prilagajamo natančnost izračuna lastne cene, ki jo dobimo na vsaki iteraciji modela.

Materialna lastna cena izdelkov je kot prva ocena lastne cene tipično precej nezanesljiva. Naslednje ocene vedno bolj natančno upoštevajo poslovni proces in so zato vedno natančnejše. Zato lahko ob doseženi ustrezni natančnosti izboljševanje modela ustavimo; bolj natančen model bo zahteval več vzdrževanja, a dodana natančnost pa na končni finančni izid podjetja ne bo bistveno vplivala. Tako, lahko izračun lastne cene prilagajamo glede na uporabnikove želje. Tipično izboljševanje modela ustavimo, ko je maksimalna sprememba lastne cene izdelka za en ali dva reda velikosti manjša od marže, ki jo nad lastno ceno do prodajne cene lahko doda podjetje.

Kot ustrezno natančnost modela lahko smatramo dovolj majhno spremembo v lastnih cenah izdelkov, dovolj majhno zgornjo ali spodnjo občutljivost, ali dovolj veliko segmentiranost stroškov. Omeniti velja, da segmentiranost vedno narašča. Vse te količine so povezane z dovolj majhno tvegano vrednostjo, ki jo uporabnik modela ovrednoti v spremenljivem znesku tveganja. Ob predpostavki padajoče urejenosti obravnavanih segmentov stroškov je prirast segmentiranosti v izbranem koraku procesa enak zgornji občutljivosti, prirast segmentiranosti v naslednjem koraku pa bo enak spodnji občutljivosti. Obe občutljivosti ob predpostavki urejenosti padata od koraka do koraka, pri čemer je zgornja vedno večja od spodnje. Navedene monotonosti ne veljajo za razliko v lastnih cenah izdelkov med posameznimi koraki. Zaradi sorazmernega dodeljevanja glede na porabo v procesih je sprememba lastne cene odvisna od deleža stroška posameznega segmenta, ki se pripiše izdelku.

Pri izbranem oddelku, ki proizvaja produkte za naogljičevanje, so stroški segmentov padajoče urejeni v zaporedju stroški dela, stroški amortizacije zgradb, stroški energentov, stroški amortizacije opreme. Vsak nabor izmed omenjenih segmentov bo predstavljal alternativno odločitev v procesu izračuna lastne cene. V tem vrstnem redu tudi v naslednjem razdelku predstavimo zaporedje postopoma natančnejših modelov.

### 3 Rezultati in indikatorji napredka

V razdelku predstavimo zaporedje modelov lastne cene, od katerih je vsak natančnejši od prejšnjega. Vsak model je predstavljen v svojem razdelku. Podatkov o vrednosti lastne cene za palete naogljičevalca z vrečami po 25 kg in palete naogljičevalca z big bag vrečo ne razkrijemo, saj s tem podjetje ohranja svojo konkurenčno prednost pred podjetji v branži. Vsak model izračuna lastne cene bo imel tabelo, kjer so predstavljena zakrita lastna cena produkta in procentualna razlika do prejšnjega modela, ki je ne zakrivamo. Vrednosti lastnih cen zakrijemo tako, da števke nadomestimo z znaki +, - ali \*. Če se je številka v primerjavi s prejšnjim modelom spremenila za več kot ena, ta dobi vrednost + ali -, glede na to ali se je ta številka povečala (+) ali zmanjšala (-). Če pa se številka ni spremenila, jo nadomestimo z znakom \*. Števke zakrivamo po vrsti od leve proti desni. Ko pridemo do številke, ki jo nadomestimo z znakom + ali -, potem vse naslednje števke nadomestimo s tem izbranim znakom.

#### 3.1 Stroškovni model lastne cene

Kot omenjeno v razdelku 2.2, bomo v lastni ceni upoštevali le ponovljive stroške v življenjskem ciklu produkta. Ti stroški so povezani s procesi življenjskega cikla obeh produktov na sliki 2. Zato je izračun lastne cene podrejen tem procesom. Lastna cena izdelave obeh produktov v izbranem obdobju se izračuna kot vsota stroškov, ki jih v tem obdobju povzročijo omenjeni procesi. Formula za izračun lastne cene produkta naogljičevalca v big bag vreči in lastne cene palete naogljičevalca v vrečah po 25 kg je:

$$\textit{lastna cena} = \textit{strošek linije} + \textit{strošek pakiranja} + \textit{strošek mletja}.$$

Stroška linije in pakiranja sta vezana na čas, ki ga produkt preživi na liniji oziroma se ga pakira, medtem, ko je strošek mletja vezan na količino zmletega materiala. Tako stroške v zgornji vsoti izračunamo kot ceno tega stroška, ki ga delimo ali pomnožimo z ustreznim porabljenih časom ali izdelanimi količinami produkta. Strošek linije se izračuna kot

$$\text{strošek linije} = \frac{\text{cena stroška linije} * \text{čas produkta na liniji}}{\sum_{\text{po produktih}} \text{čas produkta na liniji} * \text{izdelane tone produkta}}$$

Strošek pakiranja se izračuna kot

$$\text{strošek pakiranja} = \frac{\text{cena pakiranja} * \text{čas pakiranja produkta}}{\sum_{\text{po produktih}} \text{čas pakiranja produkta} * \text{izdelane tone produkta}}$$

Pri strošku linije in pakiranja moramo deliti z vsoto produktov časa in izdelane količine, saj v nasprotnem primeru stroške razdelimo proporcionalno samo na en produkt. Nazadnje pogledjmo še formulo za izračun stroška mletja

$$\text{strošek mletja} = \frac{\text{cena mletja}}{\sum_{\text{po produktih}} \text{izdelane tone produkta}}$$

Časi pakiranja in časi na liniji so konstantni za oba produkta in so bili ocenjeni s strani podjetja Exoterm-IT d.o.o. Čas pakiranja in čas na liniji za naogljicevalec v vreči big bag znašata 25 min. Čas pakiranja in čas na liniji za naogljicevalec v vrečah po 25 kg znašata 50 min. Časa pakiranja in čas na liniji sta enaka, ker se procesa odvijata sočasno. Podatkov o izdelanih količinah obeh produktov zaradi varovanja poslovnih skrivnosti ne razkrijemo, lahko pa povemo, da je količina naogljicevalca v vrečah po 25 kg bistveno višja od količina naogljicevalca v big bag vrečah, kar se odraža v predstavljenih rezultatih.

Do tega nivoja podrobnosti je model izračuna lastne cene za oba produkta iz naogljicevalca enak za vse nadaljnje modele. Kar se bo spreminjalo, so spremenljivke cena mletja, cena pakiranja in cena stroška linije. Te spremenljivke so odvisne od različnih segmentov stroškov, kot je bilo predstavljeno na sliki 2.

Po procesu, ki je bil predstavljen v razdelku 2.4, bo prvi model izračunal materialno lastno ceno izdelkov, kjer se bodo upoštevali le splošni stroški. V vsak naslednji model bomo dodajali preostale stroške v padajočem vrstnem redu: plače, amortizacija zgradb, električna energija in amortizacija opreme. S tem bomo videli, do katerega nivoja se nam splača deliti stroške, saj se v nekem trenutku lastna cena ne bo več bistveno spremenila.

V tem modelu uporabimo le splošne stroške, ki jim prištejemo tudi vse preostale segmente stroškov:

$$\text{splošni stroški}_1 = \text{splošni stroški} + \text{plače} + \text{amortizacija zgradb} + \text{električna energija} + \text{amortizacija opreme}.$$

Poglejmo formule za spremenljivke

$$\text{cena mletja} = 0,5 * \text{splošni stroški}_1, \text{cena pakiranja} = 0,5 * \text{splošni stroški}_1, \text{cena stroška linije} = 0.$$

Cena stroška linije je v tem modelu enaka 0, saj je odvisna od segmenta stroškov amortizacije zgradb in električne energije, ki sta v tem modelu prišteta v splošne stroške. Rezultatov prvega modela nismo prikazali v tabeli, saj še ne moremo izračunati razlike do prejšnjega modela, saj je to prvi model, za katerega izračunavamo lastno ceno. Kot je bilo opisano v razdelku 2.3, smo za vsak model izračunali tudi vse kazalnike. V spodnji tabeli so prikazane izračunane vrednosti kazalnikov. Iz tabele razberemo, da je segmentiranost enaka 0, saj v modelu vse stroške obravnavamo kot splošne stroške. Iz istega razloga niso definirani tudi zgornja občutljivost, skok modela in ocena tvegane vrednosti.

Tabela 1: Izračunani kazalniki za model tega razdelka

Segmentiranost	Zgornja občutljivost	Spodnja občutljivost	Skok modela	Ocena tvegane vrednosti
0	/	0,2445	/	/

Vir: lasten

### 3.2 Upoštevanje dela

Prejšnji model nadgradimo tako, da iz splošnih stroškov izdvojimo stroške plač. V tem modelu se splošne stroške prištejejo le naslednji segmenti stroškov:

$$\text{splošni stroški}_2 = \text{splošni stroški} + \text{amortizacija zgradb} + \text{električna energija} + \text{amortizacija opreme}.$$

Poglejmo, kako to vpliva na formule za spremenljivke:

$$\text{cena mletja} = 0,5 * \text{splošni stroški}_2, \text{cena pakiranja} = \text{plače} + 0,5 * \text{splošni stroški}_2, \text{cena stroška linije} = 0.$$

Kot vidimo, je do spremembe prišlo pri ceni pakiranja, kjer smo v vsoto dodali strošek plač. Tudi v tem modelu je cena stroška linije enaka 0. S tem modelom dobimo rezultate izračuna lastnih cen, ki so prikazani v tabeli 2.

**Tabela 2: Rezultati lastnih cen za oba produkta po stroškovnem modelu, kjer upoštevamo segment splošnih stroškov in plač**

	Vrednost [EUR]	Razlika do prejšnjega modela [%]
Lastna cena naogljičevalca v vrečah po 25kg	**+,++++	(+) 0,7932
Lastna cena naogljičevalca v vreči big bag	**,-,----	(-) 7,7209

Vir: lasten

Z dodajanjem segmenta plač smo za 7,72 % zmanjšali lastno ceno naogljičevalca v vreči big bag, medtem ko smo lastno ceno naogljičevalca v vrečah po 25 kg povečali le za slabih 0,8 %. V tem primeru se je vrednost lastne cene spremenila le na enicah vrednosti in za decimalno vejico. Kot vidimo v tabeli 3 sta segmentiranost in spodnja občutljivost enaki, saj obe v tem primeru nanaša na enak segment stroškov in to so plače. Skok modela in ocena tvegane vrednosti imata najvišjo vrednost glede na preostale modele.

**Tabela 3: Tabela: Izračunani kazalniki za model tega razdelka**

Segmentiranost	Zgornja občutljivost	Spodnja občutljivost	Skok modela	Ocena tvegane vrednosti
0,2445	0,2445	0,1966	279,7775	559,5549

Vir: lasten

### 3.3 Upoštevanje amortizacije zgradb

Prejšnjemu modelu dodamo stroške amortizacije zgradb, kar pomeni, da ta segment izdvojimo iz splošnih stroškov. V tem modelu se v splošne stroške prištejejo le naslednji segmenti stroškov:



$$\text{splošni stroški}_3 = \text{splošni stroški} + \text{električna energija} + \text{amortizacija opreme.}$$

Poglejmo, kako to vpliva na formule za spremenljivke:

$$\text{cena mletja} = 0,5 * \text{splošni stroški}_3, \text{cena pakiranja} = \text{plače} + 0,5 * \text{splošni stroški}_3, \text{cena stroška linije} = \text{amortizacija zgradb.}$$

Opazimo, da strošek linije ni več enak 0, ampak je enak stroškom amortizacije zgradb. S tem modelom dobimo rezultate izračuna lastnih cen, ki so prikazani v tabeli 4.

**Tabela 4: Rezultati lastnih cen za oba produkta po stroškovnem modelu, kjer upoštevamo segment splošnih stroškov, plač in amortizacije zgradb**

	Vrednost [EUR]	Razlika do prejšnjega modela [%]
Lastna cena naogljicevalca v vrečah po 25kg	***,++++	(+) 0,6335
Lastna cena naogljicevalca v vreči big bag	*-,----	(-) 6,6751

Vir: lasten.

Z dodajanjem segmenta amortizacije zgradb smo za 6,68 % zmanjšali lastno ceno naogljicevalca v vreči big bag, medtem ko smo lastno ceno naogljicevalca v vrečah po 25 kg povečali le za dobrih 0,6 %. V tem primeru se je vrednost lastne cene spremenila le na enicah vrednosti in za decimalno vejico. Če primerjamo kazalnike s prejšnjim modelom vidimo, da segmentiranost pričakovano raste, medtem ko se spodnja in zgornja občutljivost zmanjšujeta [5]. Prav tako, da sta nekoliko zmanjšala kazalnika skok modela in ocena tvegane vrednosti.

**Tabela 5: Izračunani kazalniki za model tega razdelka**

Segmentiranost	Zgornja občutljivost	Spodnja občutljivost	Skok modela	Ocena tvegane vrednosti
0,4411	0,1967	0,0199	255,0343	450,0687

Vir: lasten.

### 3.4 Upoštevanje električne energije

Prejšnjemu modelu dodamo stroške električne energije, kar pomeni, da ta segment izdvojimo iz splošnih stroškov. V tem modelu se v splošne stroške prišteje le še en segment:

$$\text{splošni stroški}_4 = \text{splošni stroški} + \text{amortizacija opreme}.$$

Poglejmo, kako to vpliva na formule za spremenljivke:

$$\begin{aligned} \text{cena mletja} &= 0,5 * \text{splošni stroški}_4, \text{ cena pakiranja} = \text{plače} + 0,5 * \\ &\text{splošni stroški}_4, \text{ cena stroška linije} = \text{amortizacija zgradb} + \\ &\text{električna energija}. \end{aligned}$$

Vidimo, da se znova spremeni strošek linije, ki se poveča za stroške električne energije. S tem modelom dobimo rezultate izračuna lastnih cen, ki so prikazani v tabeli 6.

**Tabela 6: Rezultati lastnih cen za oba produkta po stroškovnem modelu, kjer upoštevamo segment splošnih stroškov, plač, amortizacije zgradb in električne energije**

	Vrednost [EUR]	Razlika do prejšnjega modela [%]
Lastna cena naogljjičevalca v vrečah po 25kg	***,++++	(+) 0,0638
Lastna cena naogljjičevalca v vreči big bag	**,-,----	(-) 0,7003

Vir: lasten.

Z dodajanjem segmenta stroškov za električno energijo smo spreminjanje lastne cene obeh produktov umirili. To se odraža v razlikah do prejšnjega modela. Tako smo za 0,7 % zmanjšali lastno ceno naogljjičevalca v vreči big bag, medtem ko smo lastno ceno naogljjičevalca v vrečah po 25 kg povečali le za 0,06 %. V tem primeru se je vrednost lastne cene naogljjičevalca v vrečah po 25 kg spremenila le za decimalno vejico.

Podobno kot je veljajo za prejšnji model se segmentiranost zvišuje, čeprav za veliko manj kot prej. Spodnja, zgornja občutljivost, skok modela ter ocena tvegane vrednosti pa še naprej manjšat kar se sovpada z umiranjem vrednosti lastnih cen. Skok modela in ocena tvegane vrednosti sta se zmanjšala za 90 % [7].

Tabela 7: Izračunani kazalniki za model tega razdelka

Segmentiranost	Zgornja občutljivost	Spodnja občutljivost	Skok modela	Ocena tvegane vrednosti
0,4610	0,0199	0,0058	22,742	45,4841

Vir: lasten.

### 3.5 Upoštevanje amortizacije opreme

Prejšnjemu modelu dodamo stroške amortizacije opreme, kar pomeni, da ta segment izdvojimo iz splošnih stroškov. V tem modelu k splošnim stroškom ne prištevamo več nobenega drugega segmenta. Poglejmo, kako to vpliva na formule za spremenljivke:

$$\begin{aligned} \text{cena mletja} &= 0,5 * \text{splošni stroški} + \text{amortizacija opreme}, \\ \text{cena pakiranja} &= \text{plače} + 0,5 * \text{splošni stroški}, \text{cena stroška linije} = \\ &\text{amortizacija zgradb} + \text{električna energija}. \end{aligned}$$

Vidimo, da se je spremenila le cena mletja, k kateri smo prišteli amortizacijo opreme. S tem modelom dobimo rezultate izračuna lastnih cen, ki so prikazani v tabeli 8.

Tabela 1: Rezultati lastnih cen za oba produkta po stroškovnem modelu, kjer upoštevamo segment splošnih stroškov, plač, amortizacije zgradb, električne energije in amortizacijo opreme

	Vrednost [EUR]	Razlika do prejšnjega modela [%]
Lastna cena naogljjičevalca v vrečah po 25kg	***,*--	(-) 0,0185
Lastna cena naogljjičevalca v vreči big bag	***,++++	(+) 0,2033

Vir: lasten.

Z dodajanjem segmenta stroškov za amortizacijo opreme smo naredili le še majhno spremembo v lastni ceni obeh produktov, saj se ta premija le še za decimalno vejico. Tako smo za 0,2 % povečali lastno ceno naogljjičevalca v vreči big bag, medtem ko

smo lastno ceno naogljicevalca v vrečah po 25 kg zmanjšali le za 0,018 %. V primeru obeh produktov se je vrednost lastne cene spremenila le za decimalno vejico oziroma v primeru naogljicevalca v vrečah po 25 kg le na drugem mestu za decimalno vejico. Opazimo, da se segmentiranost spremeni le na tretji decimalki, zgornja občutljivost pa se še dodatno zmanjša. Spodnja občutljivost ni definirana, ker smo obravnavali vse relevantne segmente stroškov. Skok modela in ocena tvegane vrednosti sta se še dodatno zmanjšali in dosegli najnižjo vrednost glede na preostale modele [9].

**Tabela 2: Izračunani kazalniki za model tega razdelka**

Segmentiranost	Zgornja občutljivost	Spodnja občutljivost	Skok modela	Ocena tvegane vrednosti
0,4668	<b>0,0058</b>	/	6,5851	13,1701

Vir: lasten.

#### 4 Zaključki in nadaljnje raziskave

Ključni rezultati, ki jih v tem prispevku predstavimo, se dotikajo načina izračuna lastne cene produktov. Ilustriramo jih na primeru izračuna lastne cene naogljicevalca. Najpomembnejša ugotovitev je, da bi izračun lastne cene lahko pripravili samo do nivoja upoštevanja stroškov električne energije, ker se ob upoštevanju segmenta stroškov amortizacije opreme lastne cene obeh produktov spremenijo le še minimalno. To je spoznanje je ključno za podjetje s tem dobi informacijo do kakšnega zneska stroškov se jim splača ukvarjati s podatki o teh stroških. Kot običajno je tudi v tem primeru bil izziv priprava podatkov, saj je za sam izračun lastne cene podjetje Exoterm-IT d.o.o. pripravilo in zbralo kar znatne količine podatkov.

V nadaljnjih raziskavah bi bilo zanimivo razširiti nabor kazalnikov, ki so bili predstavljeni v razdelku 2.3. Raziskavo bi usmerili v kazalnike in norme, ki bi dajale rezultate, na podlagi katerih bi lahko optimizirali poslovne procese.

#### Priznanje

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# INNOVATION AND OVERVIEW OF TECHNOLOGIES IN THE OPEN EDUCATIONAL RESOURCES

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This paper presents the collaborative efforts of researchers and educators from Albania, Croatia, Slovenia, and North Macedonia in updating a tutorial for Open Educational Resources (OER) as part of the Integrating Digital Content and Digitalization of High Schools (iDADOHS) project. Brainstorming sessions generated 46 ideas for enhancing OER tutorials, which were prioritized based on their potential impact. The focus was on digital content creation, interactive tools like GeoGebra, PhET, Kahoot, and Padlet, and an OER repository. Selected ideas shaped a comprehensive tutorial on Google Sites, providing technical guidance and innovative methodologies for classroom use. Advanced analysis techniques, including Latent Dirichlet Allocation (LDA) and Non-negative Matrix Factorization (NMF), categorized suggestions, ensuring a structured integration of digital tools. This initiative advances digital literacy and educational quality through collaborative, technology-driven solutions.

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## 1 Collecting Innovative Ideas for the Development of OER Tutorial

There are many tutorials on the design of digital content within Open Educational Resources (OER) framework. However, because the technology is constantly changing, a constant "update" of the tutorials' is needed. To achieve this task a group of researchers and teachers from Albania, Croatia, Slovenia and The Republic of North Macedonia universities and high schools was formed in project called "Integrating Digital Content and Digitalization of High Schools" (iDADOHS). The project was conducted from 2021 to 2023. The consortium has prepared the tutorial adapted to the current trends in the technology. Based on our previously conducted analysis and recommendations, the needs of the teachers in high schools have been considered at the tutorial preparation. The tutorial consists of technical instructions for the design of Open Educational Resources and ideas for their use in the classroom by using modern technologies and methodologies. In the first phase, the innovative ideas regarding the development of the tutorial were gathered from the iDADOHS expert group. Later on, the gathered ideas were analysed, and the Tutorial was prepared on the Google Sites platform.



**Figure 1: Brainstorming process of the iDADOHS consortium members on the topic of «OER Tutorial» at the University of Maribor, Faculty of Organizational Sciences**

Source: Own



In the initial phase of the OER Tutorial development the members of the consortium participated at the providing the ideas on the topic: “Open Educational Resources Tutorial”. There were 11 participants engaged at the idea generation process applying principles of brainstorming at the University of Maribor, Faculty of Organizational Sciences in Kranj, shown in Figure 1.

In the 30 min time, the 11 members of the consortium generated 46 ideas. These were later on evaluated according to the five-point scale where the criterium was the usefulness for the project tutorial implementation.

## 2 Results of Idea generation Session

Generated ideas according to rank with the sum of collected points on 5-point scale (Sum), average (Avg) and Standard Deviation (SD) are shown in Table 1. Here the first part, 23 out of 46 ideas are shown. As the most important topic the following idea emerged: “Courses (online) for teaching staff, how to create digital content”. This is general goal of the project, however, the emphasis is on “digital content”. The second in rank was “Geogebra <https://www.geogebra.org/?lang=en>, Phet animations and tools: (experiment, virtual lab, measurments) <https://phet.colorado.edu/en/simulations/filter?type=html,prototype>, Kahoot tests <https://kahoot.com/> Padlet - collaboration: <https://padlet.com/>” providing the possibilities to use several packages at the development of content. Additional top ranked ideas were to use synthesiy.io tool as well as to provide the repository of OER material. The provided top ideas were used as the guideline in further development.

Table 2 shows the additional 23 generated ideas according to rank, i.e. from rank 24 to 46 with Sum of collected points on 5-point scale (Sum), average (Avg) and Standard Deviation (SD). Here one of the repeating ideas were to provide the feedback systems (Škraba et al., 2003) in order to improve learning and teaching experiences.

**Table 1: First 23 generated ideas according to rank with Sum of collected points on 5-point scale (Sum), average (Avg) and Standard Deviation (SD)**

Rank	Ideas - Open Educational Resources	Sum	Avg	SD
1	Courses (online) for teaching staf, how to create digital content	49	4.455	0.688
2	Geogebra <a href="https://www.geogebra.org/?lang=en">https://www.geogebra.org/?lang=en</a> , Phet animations and tools: (experiment, virtual lab, measurments) <a href="https://phet.colorado.edu/en/simulations/filter?type=html,prototype">https://phet.colorado.edu/en/simulations/filter?type=html,prototype</a> , Kahoot tests <a href="https://kahoot.com/">https://kahoot.com/</a> Padlet - colaboration: <a href="https://padlet.com/">https://padlet.com/</a>	46	4.182	0.982
3	Creating repository for OERs / diferent fields/subjects	45	4.091	0.944
4	Use <a href="http://www.synthesia.io">www.synthesia.io</a> to convert automatically lecture text to video	45	4.091	0.944
5	Many Short Videos with external subtitles so video can be used in different languages	44	4.000	0.894
6	Digital library	44	4.000	0.775
7	Sharing best experiances of using OER	44	4.000	0.775
8	Re-use Respoitorium of OER - <a href="https://pitt.libguides.com/openeducation/biglist">https://pitt.libguides.com/openeducation/biglist</a>	44	4.000	1.095
9	creation of video digital materials for the realization of practical exercises in professional subjects	44	4.000	1.000
10	E lessons for school subjects	43	3.909	1.044
11	Study animation as at: <a href="https://www.3blue1brown.com/">https://www.3blue1brown.com/</a>	43	3.909	1.044
12	WebWorK <a href="https://webwork.maa.org/intro.html">https://webwork.maa.org/intro.html</a> open-source online homework system for math and science courses.	43	3.909	0.831
13	Free tools for recording screen on computer/laptop	43	3.909	1.136
14	Creating e-learning system with OERs	42	3.818	0.982
15	Electronic lessons for tehnicla subjects and practice in simulator/s	42	3.818	1.168
16	Creating videos and using Handbrake to convert the videos in any format ( <a href="https://handbrake.fr/">https://handbrake.fr/</a> )	42	3.818	0.982
17	OBS Studio for Videos	41	3.727	1.272
18	OERs with different localizations	41	3.727	1.421
19	creation of a link of textbooks for professional subjects at the European level or members of this project with the possibility of access without restriction of contents.	41	3.727	1.104
20	creation of video materials for technical schools in terms of professional textbooks	40	3.636	0.809
21	Creating different Animations " <a href="http://www.OpenToonz.github.io/e/">www.OpenToonz.github.io/e/</a> " to be used for lectures	40	3.636	1.206
22	Formation of a group for exchange of ideas and digital contents	40	3.636	0.809
23	Google Forms <a href="http://www.forms.google.com">www.forms.google.com</a> for Automated Knowledge testing - Quiz	40	3.636	0.924

Sorource: Own

Gathered ideas from the expert group provides good overview of the OER technologies and concepts, that should be incorporated at the Tutorial design.

**Table 2: Additional 23 generated ideas according to rank, i.e. from rank 24 to 46 with Sum of collected points on 5-point scale (Sum), average (Avg) and Standard Deviation (SD)**

Rank	Ideas - Open Educational Resources	Sum	Avg	SD
24	Creating exams with <a href="https://exam.net/">https://exam.net/</a>	40	3.636	1.027
25	A handbook of technical (digital) vocabulary in the target languages	40	3.636	0.924
26	Online workshops	40	3.636	1.433
27	Connection with github - webpage + code + yt video.	39	3.545	0.934
28	Hints/tips/troubleshooting working online	38	3.455	0.820
29	A short technical Slovenian/Macedonian/Croatian/Albanian dictionary	38	3.455	1.293
30	open source/free tools for making movies	38	3.455	1.440
31	System for performing quizzes for students.	38	3.455	0.934
32	Creating open source application which aggregates OERs from different sources	38	3.455	1.293
33	Movie maker	37	3.364	1.206
34	Using WIKIS <a href="http://www.m.mediawiki.org">www.m.mediawiki.org</a> as collaboration document to write lecture content and later others extend and modify	37	3.364	0.924
35	Online exams, quizzes ...	36	3.273	1.104
36	Define the hardware for video web server - not to be hosted only on yt.	36	3.273	1.104
37	Include packages - javascript html <a href="https://h5p.org/">https://h5p.org/</a>	35	3.182	1.471
38	Develop the simple feedback system that can be used in the classroom	35	3.182	1.079
39	Creating new standard for distribution of OERs	35	3.182	1.328
40	Recording Online video guide	35	3.182	0.982
41	Online voting	34	3.091	1.044
42	Providing the OER material for the IoT based on esp32	34	3.091	0.944
43	Define the software / hardware stack for OER - which software packets would be most usefull.	34	3.091	1.044
44	Develop the system to comment videos like on yt.	34	3.091	1.136
45	Online self-assessment	32	2.909	0.831
46	Online feedback	31	2.818	0.874

Source: Own

The ideas proposed by the expert group on "Open Educational Resources" cover a wide range of tools and strategies for creating and sharing digital educational content. To define short, aggregated description were generated by OpenAI (OpenAI 2023). Result was list of 38 suggestions.

Overall, provided ideas from the expert group showcase various strategies and tools that can enhance the creation, distribution, and utilization of Open Educational Resources (OERs) in diverse educational contexts.

According to the provided ideas the following list of the technologies has been compiled which is shown in Table 3. The short description of the proposed technology is provided as well as the web link.

**Table 3: The set of extracted technologies proposed by the expert group**

Short description	Links
Interactive Simulations - Phet	<a href="https://phet.colorado.edu/en/">https://phet.colorado.edu/en/</a>
Online game-based learning - Kahoot	<a href="https://kahoot.com/">https://kahoot.com/</a>
Collaborative Web Platform - Padlet	<a href="https://padlet.com/">https://padlet.com/</a>
AI Video creation tool - Synthesia	<a href="https://www.synthesia.io/">https://www.synthesia.io/</a>
OER Resources	<a href="https://pitt.libguides.com/openeducation/find">https://pitt.libguides.com/openeducation/find</a>
Engine for precise programmatic animations - Manim / 3Blue1Brown	<a href="https://www.3blue1brown.com/">https://www.3blue1brown.com/</a> <a href="https://github.com/3b1b/manim">https://github.com/3b1b/manim</a>
Online Homework System	<a href="https://webwork.maa.org/intro.html">https://webwork.maa.org/intro.html</a>
Online Exams	<a href="https://exam.net/">https://exam.net/</a>
Collaboration and Documentation Platform	<a href="https://www.mediawiki.org/wiki/MediaWiki">https://www.mediawiki.org/wiki/MediaWiki</a>
Content Collaboration Framework	<a href="https://h5p.org/">https://h5p.org/</a>
Video Sharing	<a href="https://www.youtube.com/">https://www.youtube.com/</a> <a href="https://vimeo.com/">https://vimeo.com/</a>
Public digital library of open educational resources	<a href="https://oercommons.org/">https://oercommons.org/</a>
Interactive geometry, algebra, statistics and calculus toolset - GeoGebra	<a href="https://www.geogebra.org/">https://www.geogebra.org/</a>

Source: Own

### 3 Methodology – Analysis of the Ideas Set

To categorize the generated ideas, we employed Latent Dirichlet Allocation (LDA) (Blei et al., 2001, 2003; Lavrič & Škraba 2023a, 2023b) and Non-negative Matrix Factorization (NMF) (Lee & Seung, 1999) methods, implemented using python libraries (Sievert et al., 2016; Mabey, 2021) and python (Portilla, 2023) respectively. The goal is to identify appropriate categories that will later be assigned suitable names by experts. The number of categories, which will be a user-defined input, has been set to seven (7).

For the analysis, we utilized Non-negative Matrix Factorization in conjunction with Term Frequency-Inverse Document Frequency (TF-IDF) algorithms. TF-IDF algorithms leverage word frequency to determine the relevance of words to specific categories. NMF is an unsupervised algorithm that enables dimensionality reduction and clustering. The document-term matrix (DTM), serving as the basis, was applied.

DTM is a matrix that describes the frequency of terms within individual generated ideas. Rows correspond to ideas, and columns correspond to terms.

The first step involved generating a vector space model for the ideas, including stopword filtering, resulting in the DTM matrix  $A$ . TF-IDF term weight normalization was performed on matrix  $A$ . Factors were initialized using non-negative double singular value decomposition (NNDsv). Projected gradient NMF was then applied to matrix  $A$ . The basis vectors provide the categories for the generated ideas, while the coefficient matrix offers the category membership weights for clustering the ideas.

Figure 2 presents a word cloud generated from the 46 ideas proposed by the expert group. The word cloud visually represents the most frequently occurring terms, with the size of each word indicating its relative prominence in the dataset.

A closer examination of the word cloud reveals key themes centered around “creating,” “online,” “videos,” “system,” and “OERs.” These dominant terms suggest a strong emphasis on the development of digital educational content, particularly through online video creation and Open Educational Resources (OER). Additionally, words such as “digital,” “hardware,” “software,” “professional,” “subjects,” “Geogebra,” “quizzes,” and “feedback” indicate a broader scope of ideas related to digital learning tools, multimedia integration, and interactive educational methods. Based on this analysis, the overarching focus of the expert group’s ideas can be summarized as “Creation of Online Videos and OERs”, highlighting the growing importance of video-based instructional materials and digital platforms in modern education.

In Figure 3, we can observe the visualization generated by pyLDAvis (Sievert et al., 2016; Mabey, 2021), which serves as a valuable tool for exploring and effectively categorizing ideas. When dealing with a substantial number of generated ideas, this task can prove to be challenging.



The interactive nature of the pyLDAvis tool facilitates a deeper understanding of the interplay between categories and ideas.

Table 4 presents topics identified using Latent Dirichlet Allocation (LDA) and their corresponding short, aggregated descriptions. The analysis focused on extracting the most relevant terms associated with each topic to determine key themes.

Upon inspecting these topmost relevant terms across all categories, a recurring concept emerged: “Video-Creating-Online-System.” This suggests a strong emphasis on video content creation and online systems as essential components in the development of Open Educational Resources (OER).

The expert group highlighted the significance of this finding, recognizing that video-based instructional materials—whether in the form of recorded lectures, interactive demonstrations, or software-assisted content creation—play a crucial role in modern OER production. Additionally, the presence of terms related to software, hardware, and online platforms further reinforces the growing reliance on digital tools for educational content development.

**Table 4: Topics indicated by LDA and short, aggregated description**

Topic #	Topmost relevant terms for particular topic	Description
1	Video, different, source, creating, material, lecture, OERs	Video lecture creation
2	http, video, using, geogebra	Geogebra online video
3	Video, software, online, define, hardware, OERs, creating	SW/HW for video creation
4	System, online, http, webwork	Online system
5	Video, subject	Video subject content
6	Textbook, creation, professional	Profession textbook creation
7	Form, tool, google, free, online, digital	Free online tools

Source: Own

By identifying these core themes, the analysis underscores the necessity of robust, accessible, and user-friendly online video creation systems to enhance the quality and accessibility of OER. This insight aligns with broader trends in digital education,

where multimedia resources are increasingly being integrated into teaching and learning frameworks.

## 4 Conclusion

In conclusion, the OER Tutorial was a collaborative effort by the iDADOHS expert group, aimed at providing technical instructions and ideas for effective OER use. Roles were assigned based on expertise in areas like virtual reality and gaming solutions. The tutorial development began with a brainstorming session, leading to the creation of online courses and a repository for OERs, among other ideas. Focusing on high school teachers and emerging technology trends, the tutorial emphasized digital content creation and interactive resources. By incorporating suggested ideas and leveraging various technologies, it aimed to empower educators and improve learning experiences. The tutorial stressed accessibility, multilingual support, and the reusability of OERs, while recognizing the value of practical exercises and online assessment tools.

Overall, the creation of the OER Tutorial showcased iDADOHS team's commitment to adapting to educational technology changes. By equipping teachers with skills and knowledge, the tutorial aimed to enhance education quality and promote OER usage. The collaborative effort and expertise of iDADOHS team members ensured a comprehensive resource for educators seeking guidance in OER implementation.

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### End notes

This study presents the collaborative efforts of the iDADOHS consortium, comprising researchers and educators from Albania, Croatia, Slovenia, and North Macedonia, in developing an updated Open Educational Resources (OER) tutorial. Through brainstorming sessions, 46 ideas were generated, prioritized, and analyzed using Latent Dirichlet Allocation (LDA) and Non-negative Matrix Factorization (NMF). The final tutorial, hosted on Google Sites, provides technical guidance and methodologies for OER implementation, focusing on digital content creation and interactive learning



tools. The initiative underscores the importance of structured, technology-driven approaches in enhancing digital literacy and education quality.

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# CULTIVATING A SUSTAINABLE MINDSET IN HIGHER EDUCATION

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Recognizing the critical role that sustainability plays in shaping the future, this study examines various strategies for embedding sustainability into extracurricular programs to enhance student awareness, engagement, and action. This paper highlights successful initiatives that promote environmental stewardship and social responsibility, demonstrating that incorporating sustainability into extracurricular activities not only enriches the educational experience but also nurtures a generation of mindful and proactive leaders. By fostering and encouraging thereby cross-disciplinary collaborations, educators are called to action to prioritize sustainable development in different aspects and areas, ensuring the next generation is equipped to tackle global challenges and contribute to a sustainable future.

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## 1 Introduction

Sustainability is no longer a peripheral concern but a central tenet that shapes the future of our society. Higher education institutions (HEIs), as the breeding grounds for future leaders, play a pivotal role in integrating sustainability into various aspects of student life (Hrustek et al., 2024). Although there is an expectation to focus heavily on incorporating sustainability into academic curricula, many higher education institutions (HEIs) - especially if sustainability related topics are not their primary field of education - may perceive this as a lengthy and exhausting process that involves changing study programs and implementing extensive accreditation procedures. On the other hand, creating and conducting extracurricular activities offers a unique and impactful approach to integrating new research and study areas, such as environmental and social responsibility, into the learning process in a much simpler and faster way.

Integration of sustainability principles into extracurricular programs at higher education institutions, aims to elevate student awareness, engagement, and proactive action towards a sustainable future. By embedding sustainability into extracurricular activities, institutions can cultivate a mindset that values environmental stewardship and social responsibility, providing students with practical and collaborative experiences that complement their academic knowledge (Filho et al., 2019).

This paper firstly provides a background of existing research dealing with the role and importance of incorporating sustainable principles in in the context of higher education. Afterwards, three successful examples are presented, highlighting the transformative potential of extracurricular activities in shaping a sustainable mindset. By fostering thereby cross-disciplinary collaborations and encouraging innovative approaches, the goal is to equip the next generation with the skills, knowledge, and values necessary to address global challenges and contribute meaningfully to a sustainable and equitable future.

In concluding remarks, an overview is given on lessons learned, emphasizing that initiatives like described experiences can ensure long-term benefits and create ideas for new initiatives and projects.

## **2 Background**

Sustainability and integrating sustainable practices into business and social systems are crucial for modern progress. The 1987 Our Common Future report (United Nations (1)), defines sustainability as meeting today's needs without compromising future generations' ability to meet theirs. This calls for a shift in awareness and practices among all stakeholders. As a follow-up to the initiative, in 2015, United Nations Member States adopted the 2030 Agenda for Sustainable Development (United Nations (2)), which outlines 17 Sustainable Development Goals (SDGs) to guide global peace and prosperity. These goals are meant to be integrated into the activities of individuals, companies, public institutions, and governments, encouraging collective action to reduce poverty, improve health and education, reduce inequality, stimulate economic growth, and address climate change (United Nations, n.d.).

The concept of Environment, Social, and Governance (ESG) encompasses aspects of responsible governance, including environmental, social, and corporate governance issues, and is used to assess the sustainability and ethical impact of companies and institutions (Usak et al., 2021).

The European Commission's Recommendation on Learning for the Green Transition highlights the importance of integrating sustainability into education and training (European Union, n.d.). Key actions, such as prioritizing green education, advancing research, and investing in sustainable resources, enable HEIs to create practical, interdisciplinary learning environments that prepare individuals to implement sustainable practices and foster a culture of sustainability.

## **3 Examples on how to implement Sustainability into Extracurricular activities**

Extracurricular activities play a vital role in the holistic development of students. They offer opportunities for personal growth, skill development, and social engagement outside the traditional academic curriculum. By participating in these activities, students can explore their interests, develop leadership and teamwork skills, and build a sense of community. Extracurricular activities also provide a

practical context for applying academic knowledge, fostering a well-rounded educational experience that prepares students for future challenges.

In the next subsections, three examples are presented, showing how extracurricular activities can be created and performed, encompassing sustainable principles.

### 3.1 Student Competition on solving Sustainability Challenges

A student competition was conducted in May 2024 in Varaždin, Croatia, as part of a broader initiative, entitled Global Goals Jam (Global Goals Jam, n.d.), where makers and designers create impactful solutions for the Sustainable Development Goals. In this initiatives, local organizers, such as universities and NGOs, can host a Jam and collaborate with industry partners to tackle global challenges (Digital Society School, n.d.). A toolkit and online training to guide the design process is provided, as presented in Figure 1.



**Figure 1: Tools for the design process**

Source: (A Green Step Forward, 2024)

The competition was organized as an intensive two-day event, during which students collaborated to develop sustainable and socially responsible concepts. Students were organized into teams of four and given a task to identify a local community problem. Each team was required to analyze and discuss the issue, and then propose a solution. The competition focused on developing innovative ideas and concepts that integrate sustainable development principles and social responsibility. Teams were encouraged to use digital technologies to enhance efficiency, drive innovation, and

deliver meaningful value to stakeholders. Learning outcomes for students were as follows, derived from (Mintz & Tal, 2014), (Abo-Khalil, 2024):

- Development of Professional Competencies: Acquire knowledge of sustainability principles, social responsibility, as well as digital technologies, and learn to integrate these concepts into business processes.
- Practical Skill Enhancement: Apply theoretical knowledge to real-world problems by analyzing challenges and designing sustainable solutions.; Strengthen presentation skills through structured prototyping and pitching of solutions.
- Fostering Creativity and Innovation: Develop innovative ideas using digital tools and physical prototyping techniques to solve complex issues effectively.
- Improvement of Teamwork and Collaboration: Collaborate effectively with peers, leveraging diverse skills and perspectives to achieve common goals.
- Increased Social Awareness: Gain a deeper understanding of local community challenges and the importance of contributing to society through sustainable and socially responsible.

The competition was structured into four sprints, each lasting 1 hour and 30 minutes. The sprints and the elements of each sprint are listed and explained below:

Sprint 1: Explore it! Do a datajam! → (a) Problem clarification, (b) Data insights into the problem, (c) Visualization of the problem, (d) Sustainability Impact, (e) Comparison with others.

Sprint 2: Respond to it! Create a lo-fi prototype! → (a) Create a sketch or visualization of the problem data related to sustainability and community (infographic, sketch, prototype), (b) Quickly brainstorm how to make your key insight visible or tangible, (c) Develop a quick draft prototype of your idea, (d) Ask another team to test your provocative prototype and gather feedback.

Sprint 3: Make it! Make your final idea tangible! → (a) Create a new version of your prototype, making it as realistic as possible, (b) Think about how you will share your final object with others to create a meaningful experience.

Sprint 4: Share it! Document your process and share your object! → (a) Prepare for presentation, (b) Present or pitch your solution, (c) Identify the Sustainable Development Goals your solution supports, (d) Explain benefits for the community gained from your proposed solution (Sugita, 2018).

At the end of the sprints, teams presented their work in a brief pitch lasting 5 to 8 minutes, which was thoroughly reviewed and evaluated by a panel of judges based on predefined criteria.

The mini-competition provided students with hands-on experience in applying sustainability principles to real-world challenges and collaborating in teams to generate creative solutions. This approach ensured a comprehensive learning experience, combining theoretical knowledge with practical application to empower students as future leaders in sustainable business practices.

### **3.2 Erasmus Blended Intensive Program on Sustainable development**

The Erasmus+ program for the period 2021-2027 is offering a funding opportunity for development of Blended Intensive Programs (BIPs) (European Commission, n.d.). BIPs, in order to be eligible for funding, have to include a minimum of 3 international partners, a minimum of 15 international learners from participating partners (and beyond), have to be performed as a combination of online and onsite classes, and address an emerging topic not already included in study programs offered by partners (For the 2nd Time FOI Teachers Organized an Erasmus+ Blended Intensive Program (BIP) „Transform to Sustain, 2023).

A BIP entitled: “Transform to sustain: Sustainable future enabled by digital transformation” was held twice, in May and June, 2022 and 2023, through 5 weeks of online classes, and one week of onsite classes, in Split, Croatia, end of June 2022 and 2023, as presented in Figure 2.

The program aimed to familiarize students with creative methods and techniques for analyzing customer needs, identifying opportunities for change, and enhancing business by designing new sustainable models. The focus was on developing



innovative ideas through modern digital technologies, driving digital business transformation.



**Figure 2: Transform2Sustain BIP**

Source: (For the 2nd Time FOI Teachers Organized an Erasmus+ Blended Intensive Program (BIP) „Transform to Sustain, 2023)

The goals were achieved by integrating four key concepts: digital transformation, sustainable development, digital technologies (including AI and robotics), and the management of organizational and business processes. The program utilized creative and modern teaching methods such as problem-based learning, gamification, teamwork, and project tasks to foster a collaborative environment where students could learn from both lecturers and each other. Learning outcomes for students were:

- Comprehend and enforce creative methods, techniques and tools for customer needs analysis and innovative ideas creation.
- Understand and apply the basic concepts of artificial intelligence.
- Propose a new digital and sustainable business model of an organization.

The intensive program's online sessions were held every Monday and Thursday evening. By the second week, students were grouped into international, multidisciplinary teams, working on practical tasks, case studies, and a team project to develop an innovative, sustainable digital solution to an SDG-related problem.

During the onsite week, students continued team collaboration through interactive workshops provided by partner institutions, enhancing online knowledge with creative teamwork. They also tested their skills and gained knowledge on a real-life example in an unfamiliar Croatian island location, addressing EU-relevant challenges. At the program's end, teams presented their solutions and received feedback from teachers and peers on the successful realization of the program's learning outcomes.

The vision for this BIP was to pursue innovative strategies for a sustainable future through co-creation. It gave the opportunity to build great international networks, extending beyond the program.

### **3.3 Cross-disciplinary collaboration for World Environment Day**

Three faculties of the University of Zagreb - Faculty of Geotechnical Engineering (GFV), Faculty of Textile Technology (TTF) and Faculty of Organization and Informatics (FOI), - celebrated World Environment Day together in Varaždin, as presented in Figure 3.

The event, named "Our Country. Our Future. We are #GenerationRestoration", centered around land restoration, combating desertification, and drought resistance. It was designed to educate people of all ages, especially children and young people, about environmental protection through a variety of engaging activities such as educational content, interactive quizzes, and experiments. Graduates also had the chance to explore further education opportunities in Varaždin.

During the two-day event (June 4-5, 2024), participants of all ages gained insights into the importance of bees, eco-friendly cleaning methods using natural materials, and constructing earthquake-resistant buildings. Students and teachers from GFV shared their research on individual contributions to environmental protection. TTF students' exhibits, created in collaboration with industry partners in Footwear Design, attracted significant interest. TTF also highlighted projects through workshops and demonstrations of eco-friendly sports shoes. FOI showcased its dedication to environmental protection by presenting students' innovative ideas from the "Global Goals Jam" competition and promoting sustainable practices. Young attendees enjoyed playing video games focused on sustainability.



**Figure 3: World Environment Day together in Varaždin**

Source: (Three Faculties of the University of Zagreb Together for Environmental Protection, 2024)

World Environment Day, organized by the United Nations Environment Program (UNEP), has been celebrated annually on June 5 since 1973 and has become one of the largest global platforms for environmental protection. Each year, millions of people participate both online and in-person to promote environmental action worldwide.

#### **4 Conclusion**

HEIs play a key role in this transformation by preparing future generations for life and work. Traditionally, HEIs focus on responding to employer and market needs. However, they must now integrate sustainability into their learning programs to address emerging challenges effectively.

Good practices can and should be adapted to educational and scientific institutions by incorporating the concepts of sustainability into the curriculum or additional extracurricular activities. It is desirable that teachers in their specific educational and scientific domains consider how, through the development of knowledge, skills and experience, they can contribute to the achievement of economic, environmental and social sustainability and social responsibility towards all stakeholders in the community. In the long term, through such activities, students would be taught that as future creators of solutions in the market, they develop sustainable solutions tailored to all stakeholders in the community. All such solutions should target the contribution to the economic, environmental and social goals of sustainable development.

Integrating sustainability and fostering a mindset of respect for it within higher education institutions (HEIs) can be achieved through various methods. Lessons learned from presented experiences in this paper, which should guide future endeavors, are:

- Incorporate sustainability into a variety of programs and disciplines for ensuring that all students, regardless of their field of study, are exposed to sustainability principles
- Adapt learning activities to align them with the specific needs and goals of different educational and scientific domains
- Encourage collaboration between different departments or institutions to create interdisciplinary projects, enabling students to apply sustainability concepts in different contexts
- Focus on alignment with the Sustainable Concepts: Developing projects that are explicitly aligned with specific SDGs or other sustainable practices, enabling students to address global challenges in a structured way
- Promote awareness on how different disciplines can contribute to economic, environmental, and social sustainability
- Involve community stakeholders (city, county, organizations) in defining project problems, ensuring that solutions are directly relevant and useful to the local context
- Use feedback loops from stakeholders to improve learning practices
- Track and evaluate the results of implemented solutions over time, creating case studies or best practice guides for future iterations
- Include reflective exercises, where students analyze the sustainability and adaptability of their solutions over the long term
- Encourage students to view sustainability as a continuous learning process that goes beyond their academic journey, preparing them to be adaptable and responsible professionals
- Encourage teacher participation and recognize and reward educators who successfully integrate sustainable and adaptive practices into their teaching
- Create a network of institutions and educators who share best practices, resources, and experiences to continuously improve the adaptability and sustainability of such approaches (implementation in the next period)

- Organize regular conferences, webinars, or hackathons focused on sustainability in education.

These ideas aim to make practices not only adaptable across contexts, but also sustainable in terms of long-term educational and societal impact. By bridging the gap between theory and practice, this study underscores the importance of an integrated educational experience that nurtures mindful and proactive leaders. It is through such holistic approaches that higher education institutions can truly champion sustainability and inspire students to become catalysts for positive change in their communities and beyond.

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### Summary

The integration of sustainability and sustainable practices into higher education institutions is essential for fostering student awareness and comprehension of the critical need to create a better future. This encompasses efforts to reduce poverty, protect natural resources and biodiversity, mitigate climate change, improve health and education services, and address other vital aspects of economic, ecological, and social sustainability. Sustainability should be integrated into the curriculum and activities of all educational institutions as an interdisciplinary framework that complements and enriches every discipline. Extracurricular programs significantly enhance this endeavor, offering distinctive opportunities for active engagement and practical application. This paper presents initiatives of how higher education institutions can effectively incorporate sustainability into their teaching practices. Initiatives such as a short competition conducted over four sprints, a blended intensive program (BIP), and cross-disciplinary collaboration for World Environment Day were presented. These initiatives illustrate how sustainability education equips students with discipline-specific knowledge and skills while promoting a comprehensive understanding of sustainable development.

# GREEN GDP VS. GREEN GROWTH INDEX: COMPARATIVE INSIGHTS FOR SUSTAINABLE DEVELOPMENT METRICS

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Green GDP and the Green growth index have emerged as important indicators for evaluating the alignment of economic progress with environmental sustainability. While Green GDP integrates environmental degradation and resource depletion into traditional GDP calculations, the Green growth index reflects a multidimensional approach, incorporating economic, social, and environmental sustainability criteria. This study provides a comparative analysis of these two metrics, focusing on their temporal dynamics and alignment across European countries. Employing cyclical extraction and cross-correlation analysis, the results uncover significant differences in the dynamics of these two indicators, raising questions about their compatibility and reliability for cross-country analysis of green economic progress. Our findings reveal that both indicators, despite their conceptual and methodological differences on one side and similarity in reflecting consistent global patterns of green economy on the other, in fact have different focus, methodology and application possibilities behind them.

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## 1 Introduction

Green GDP and the Green growth index have emerged as important indicators for evaluating the alignment of economic progress with environmental sustainability. While Green GDP integrates environmental degradation and resource depletion into traditional GDP calculations, the Green growth index reflects a multidimensional approach, incorporating economic, social, and environmental sustainability criteria. While not without its shortcomings, Green GDP and Green growth index serve as a pivotal advancement in rethinking how we measure economic progress. By addressing the inherent limitations of traditional indicators, they integrate various important factors into economic analysis. This shift represents a crucial step toward promoting a more sustainable global economy, where long-term ecological health and societal well-being are valued alongside financial growth.

This study provides a comparative analysis of these two metrics, focusing on their temporal dynamics and alignment across European countries. Employing cyclical extraction and cross-correlation analysis, the results uncover significant differences in the dynamics of these two indicators, raising questions about their compatibility and reliability for cross-country analysis of green economic progress. Findings reveal that both indicators, despite their conceptual and methodological differences on one side and similarity in reflecting consistent global patterns of green economy on the other, in fact have different focus, methodology and application possibilities behind them. Nonetheless, our deductions imply their complementary roles in advancing green economic perspectives. Their collective insights contribute not only to economic and environmental discourse, but also to social, political, philosophical, and methodological debates, particularly concerning the integration of sustainability metrics into decision-making frameworks. By highlighting the interplay and versatility of these measures across diverse national contexts, this research emphasizes their utility in monitoring and steering sustainable development goals.

The structure of the paper is as follows. After a brief introduction, Section 2 surveys the main characteristics of two indicators. Section 3 provides a comprehensive perspective on the analytical part by describing the methods and data used, as well as presenting the results, whereas Section 4 explains the research implications. Section 5 offers some concluding remarks.



## 2 Comparison of Green GDP and GGI indicators

The **Green growth index** or **GGI** provides a robust framework for evaluating a country's progress toward achieving key sustainability objectives, including the Sustainable Development Goals (SDGs), the Paris Climate Agreement, and the Aichi Biodiversity Targets (Global Green Growth Institute, 2024).

	Dimensions [Goals]	Indicator categories [Pillars]	Indicators [metrics]
Green Growth Index	Efficient and sustainable resource use	Efficient and sustainable energy	EE1 Ratio of total primary energy supply to GDP (MJ per \$2011 PPP GDP)
			EE2 Share of renewables to total final energy consumption (Percent)
		Efficient and sustainable water use	EW1 Water use efficiency (USD per m <sup>3</sup> )
			EW2 Share of freshwater withdrawal to available freshwater resources (Percent)
		Sustainable land use	SL1 Average soil organic carbon content (Tons per hectare)
			SL2 Share of organic agriculture to total agricultural land area (Percent)
	Material use efficiency	ME1 Total domestic material consumption (DMC) per unit of GDP (DMC kg per GDP)	
		ME2 Total material footprint (MF) per capita (MF tons per capita)	
	Natural capital protection	Environmental quality	EQ1 PM2.5 air pollution, mean annual population-weighted exposure (Micrograms per m <sup>3</sup> )
			EQ2 DALY rate as affected by unsafe water sources (DALY lost per 100,000 persons)
			EQ3 Municipal solid waste (MSW) generation per capita (Tons per year per capita)
		Greenhouse gas emissions reductions	GE1 Ratio of CO <sub>2</sub> emissions, excluding AFOLU to population (Metric tons per capita)
			GE2 Ratio of non-CO <sub>2</sub> emissions excluding AFOLU to population (Tons per capita)
			GE3 Ratio of non-CO <sub>2</sub> emissions in agriculture to population (Gigagrams per 1,000 persons)
		Biodiversity and ecosystem protection	BE1 Average proportion of Key Biodiversity Areas covered by protected areas (Percent)
			BE2 Share of forest area to total land area (Percent)
			BE3 Soil biodiversity, potential level of diversity living in soils (Index)
		Cultural and social value	CV1 Red list index (Index)
	CV2 Tourism and recreation in coastal and marine areas (Score)		
	CV3 Share of terrestrial and marine protected areas to total territorial areas (Percent)		
Green economic opportunities	Green investment	GV1 Adjusted net savings, minus natural resources and pollution damages (Percent GNI)	
	Green trade	GT1 Share of export of environmental goods (OECD and APEC class.) to total export (Percent)	
	Green employment	GJ1 Share of green employment in total manufacturing employment (Percent)	
	Green innovation	GN1 Share of patent publications in environmental technology to total patents (Percent)	
Social inclusion	Access to basic services and resources	AB1 Population with access to safely managed water and sanitation (Percent)	
		AB2 Population with access to electricity and clean fuels/technology (Percent)	
		AB3 Fixed Internet broadband and mobile cellular subscriptions (Number per 100 people)	
	Gender balance	GB1 Proportion of seats held by women in national parliaments (Percent)	
		GB2 Ratio of female to male with account in financial institution, age 15+ (Percent)	
		GB3 Getting paid, covering laws and regulations for equal gender pay (Score)	
	Social equity	SE1 Inequality in income based on Atkinson (Index)	
		SE2 Ratio of urban to rural, access to safely managed water/sanitation and electricity (Percent)	
		SE3 Share of youth not in education, employment or training, aged 15-24 years (Percent)	
Social protection	SP1 Proportion of population above statutory pensionable age receiving pension (Percent)		
	SP2 Healthcare access and quality index (Index)		
	SP3 Proportion of urban population living in slums (Percent)		

Figure 1: Green growth index dimensions, pillars and metrics

Source: Global Green Growth Index, 2024.

It assesses performance across four critical dimensions of green growth: efficient and sustainable resource use, protection of natural capital, promotion of green economic opportunities, and fostering social inclusion (Figure 1). The index is

quantified on a scale from 1 to 100, where scores are categorized into five performance levels: very low (1–20), low (21–40), moderate (41–60), high (61–80), and very high (81–100). A score of 100 represents the full attainment of sustainability targets, as the indicators used in the index are benchmarked against these targets. As a composite index, GGI synthesizes diverse indicators spanning economic, environmental, and social dimensions. It integrates both quantitative metrics and qualitative analyses to deliver a broad, comprehensive and ‘global’ assessment of a country’s green growth trajectory. By providing insights into progress and gaps, the index supports the evaluation and refinement of sustainable development policies. Furthermore, it facilitates cross-country comparisons, enabling policymakers to identify best practices, leverage synergies, and address areas requiring additional focus to accelerate green growth (Tomić, 2024).

Further, **Green GDP** or **GGDP** is a refined measure of economic performance that adjusts traditional GDP by incorporating the costs of environmental degradation and the depletion of natural resources. This metric provides a more comprehensive and realistic depiction of economic growth by internalizing ecological costs often overlooked in conventional GDP calculations (Alfsen et al., 2006). The methodological framework for GGDP involves systematically subtracting estimated costs associated with CO<sub>2</sub> emissions, soil erosion, biodiversity loss, and resource depletion from traditional GDP. This approach relies on robust statistical data that integrates both economic and environmental parameters, thereby enhancing its relevance in the context of sustainable development. Research highlights that GGDP serves as a critical indicator of economic sustainability, offering insights into the extent to which environmental costs are embedded within economic activities (Veklych and Shlapak, 2013). By reflecting the ecological consequences of growth, this metric empowers policymakers to formulate strategies that mitigate environmental harm, promote sustainable resource management, and ensure the preservation of natural capital for future generations. Consequently, GGDP aligns economic development with the principles of sustainability, fostering long-term ecological and economic resilience Vimochana (2017).

An indicator that we used within this study is presented by Stjepanović, Tomić, and Škare (2017) in which  $GGDP = GDP - (CO_2 \text{ emissions in kt} \times \text{total CDM in average prices for kt}) - (t \text{ of waste} \times 74 \text{ kWh of electrical energy} \times \text{price for 1 kWh of electrical energy}) - (GNI/100 \times \text{natural resources depletion \% of GNI})$ . Basically,

this specific indicator is an environmentally adjusted version of conventional GDP, expressed in current U.S. dollars, designed to account for environmental factors. Carbon dioxide ( $CO_2$ ) emissions, measured in kilotons ( $Kt$ ), encompass all emissions resulting from the combustion of fossil fuels and other energy sources. The term  $CDM$  refers to the average weighted carbon price expressed in purchasing power parity ( $PPP$ ). Total commercial and industrial waste, measured in tonnes, is denoted as " $Waste$ ," and kilowatts ( $kW$ ) per ton of waste represent the energy potential recoverable from waste. Research indicates that one ton of waste can generate approximately 74 kilowatt-hours of electricity, illustrating the energy recovery potential of waste management. The price of electricity ( $Pelect$ ), expressed in  $PPP$  per kilowatt-hour, is calculated as the average commercial and industrial electricity price within a given country. Gross national income ( $GNI$ ) is defined as the total value added by domestic producers, including taxes on goods (excluding subsidies not included in production valuation), combined with net receipts from primary income (such as employee compensation and property income) from abroad. Natural resource depletion adjusted savings ( $NRD$ ) measures the depletion of natural resources by summing the net depletion of minerals, energy resources, and forests as a percentage of  $GNI$ . This indicator provides a comprehensive view of resource sustainability within a nation's economy (Stjepanović, Tomić, and Škare, 2022).

**Table 1: Key differences between Green Growth Index and Green GDP**

Characteristic	Green Growth Index	Green GDP
Focus	Green growth and sustainable development	Economic growth adjusted for ecological costs
Methodology	Composite index with multiple indicators	Adjusted GDP reduced by ecological costs
Application	Comparative analysis and evaluation of green policies	Analysis of economic growth with ecological adjustments

Source: Tomić (2024).

A comparative analysis of these indicators in 2017 and 2019, as well as longitudinal trends, reveals a substantial similarity in their assessments across countries, reflecting consistent global patterns. Developed nations, particularly those in Europe and North America, exhibit consistently higher performance on both the  $GGI$  and  $GGDP$ . These countries benefit from greater financial and institutional capacity to invest in clean technologies, enforce rigorous environmental regulations, and promote sustainable practices. In contrast, developing and underdeveloped countries display lower scores on these indicators due to their reliance on natural

resource exploitation as a primary driver of economic growth. This reliance often results from limited access to alternative technologies and resources necessary for fostering sustainable development. The disparity highlights a persistent global inequality: affluent nations generally achieve higher levels of environmental sustainability, while less affluent countries grapple with the dual challenges of economic development and ecological preservation (Tomić, 2024). Despite the differences in the focus, methodology and application of GGDP and GGI (Table 1), the global view on environmental focus and sustainability issues seems to be consistent over these two indicators. The difference in the basic methodology on one side and the analogy in portraying the global green situation, gives us reasonable doubt to question the (di)similarity in the dynamics of these two green indicators.

### 3 Methodology

#### 3.1 Research design and methods

By employing cyclical extraction and cross-correlation analysis, we would like to uncover resemblance or dissimilarity in the behaviour of these two important green economy indicators. In addition, we will obtain bivariate (pairwise) Granger causalities to eliminate any possible doubts on the subject.

Due to its vast utilization we opted to use the Hodrick-Prescott (HP) filter for the extraction of cyclical components of the variables. Many researchers frequently use the HP filter due to its simplicity and ease of interpretation. It provides a straightforward way to decompose a time series into trend and cyclical components, making it accessible for various applications, particularly in macroeconomics. However, it is not the only filter available; alternatives like the Baxter-King filter, Christiano-Fitzgerald filter, or band-pass filters can also be used, each with distinct strengths and weaknesses. The choice of filter often depends on the specific characteristics of the data and the research objectives (Tomić and Demanuele, 2017). The prevalence of the HP filter in detrending time series is undoubtedly due to its simplicity in estimation and comprehension. Hodrick and Prescott's (1997) analysis assumed that time series are consisted of cyclical and growth components, so if growth accounting can provide estimates of growth components with errors that are small relative to the cyclical component, computing the cyclical component is just a matter of calculating the difference between the observed value and the growth

component. It resulted in the creation of the filter that became the most popular method for removing long-run movements from the time series within the business cycle analyses. The HP filter focuses on removing a smooth trend  $\tau_t$  from some given data  $y_t$  by solving next equation:

$$\min_t \sum_{t=1} ((y_t - \tau_t)^2 + \lambda((\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1}))^2) \quad (1)$$

therefore, the residual  $y_t - \tau_t$  is then commonly referred to as the business cycle component. This is actually a linear filter that requires previous specification of a parameter known as lambda ( $\lambda$ ). Given the form of the observation this parameter tunes the smoothness of the trend i.e. penalizes the acceleration in the trend component relative to the cycle component. Furthermore, the HP filter's parameter lambda allows users to adjust the sensitivity of the filter to fluctuations, enabling customization for different data frequencies (e.g., quarterly, annual). However, while the HP filter is effective, users must be cautious of potential boundary issues and the choice of lambda, as these can influence the results. Regardless of its simplicity and its methodological constraints, the HP filter has been applied in a number of relevant studies so far.

In order to evaluate the nature of the relationship between the variables, we introduced cross-correlation analysis based on the studies from Stock and Watson (1998) and Napoletano, Roventini and Sapio (2005), who imply that co-movements between variables are revealed through the cross-correlation of the cyclical component of each series with the cyclical component of a benchmark variable. This is the correlation between  $x_t$  and  $y_{t+k}$ , where  $x_t$  is the filtered series and  $y_{t+k}$  is the  $k$ -quarter lead of the filtered benchmark variable. A large positive correlation at  $k = 0$  (i.e. around lag zero) indicates the pro-cyclical behaviour of the series; a large negative correlation at  $k = 0$  indicates counter-cyclical behaviour; and no correlation indicates acyclical behaviour of the series. A maximum correlation at, for example,  $k = -1$  indicates that the cyclical component of the variable tends to lag the aggregate business cycle by one quarter. In other words, if the absolute maximum (or minimum) is achieved at some benchmark variable lead, then the variable is denoted as *leading*, whereas it is called *lagging* in the opposite case. Finally, *coincident* variables are those displaying the bulk of their cross-correlation with the benchmark variable at lag zero.

For correlation itself does not necessarily imply causation in any meaningful sense, we decided to refine our study by introducing Granger causality (1969) which questions whether variable  $x$  causes variable  $y$ , as well as how much of the current  $y$  can be explained by past values of  $y$  and then to see if adding the lagged values of  $x$  can improve conclusions. Thus,  $y$  is said to be Granger-caused by  $x$  if  $x$  can help in predicting  $y$  or if coefficients on the lagged  $x$  are statistically significant. We have to emphasize that the statement ‘Granger-cause’ does not imply that one variable is the effect of the result of the other, because Granger causality measures precedence and information content, but does not indicate causality in the more common use. We use bivariate (pairwise) regression of this form to test Granger causality between the observed green variables based on the Granger approach:

$$y_t = a_0 + a_1 y_{t-1} + \dots + a_l y_{t-l} + b_1 x_{t-1} + \dots + b_l x_{t-l} + e_t \quad (2)$$

$$x_t = a_0 + a_1 x_{t-1} + \dots + a_l x_{t-l} + b_1 y_{t-1} + \dots + b_l y_{t-l} + u_t \quad (3)$$

The null hypothesis is that  $x$  does not Granger-cause  $y$  in the equation (2) and that  $y$  does not Granger-cause  $x$  in the equation (3). The F-statistics and supporting probabilities are used for evaluation of joint hypotheses (Benazić and Tomić, 2014).

### 3.2 Data

This study provides a comparative analysis of two green indicators, namely Green GDP (GGDP) and Green growth index (GGI), focusing on their temporal dynamics and alignment across countries.

Annual data on green variables were collected from the Global Green Growth Institute database for the GGI variable and methodology offered by Stjepanović, Tomić and Škare (2017, 2022: database) for the GGDP variable utilizing the period 2010 – 2022. Our study covers representative sample of 20 European (more precise EU) countries (Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, Netherlands, Poland, Portugal and Spain); as an initial research platform for more extended study on green metrics across different set of countries. In addition, several other, highly industrialized and green weighted countries are included in the partial analysis as a validation of the results. Green variables for all the countries have been put in their logarithm form in order to stabilize the variance and normalize skewed

data. To extract the business cycle component that represents the stationary cycle of the variable, we used the conventional value of 100 for the smoothing parameter, which corresponds to yearly frequencies. To test the integration properties, we analyzed graphical displays of the variables and conducted Augmented Dickey Fuller unit root test (Table 2). Visual introspection and tests (both constant and constant plus trend cases) strongly confirmed the absence of a unit root in the observed variables i.e. countries in their levels, which is an important property of cyclical components. Thus, we obtained the variables; *cycle\_GGDP* and *cycle\_GGI*.

**Table 2: Augmented Dickey-Fuller unit root test (ADF test) in levels**

Countries	<i>Constant Prob.</i>	<i>constant + trend Prob.</i>
<i>Austria</i>	0.00	0.00
<i>Belgium</i>	0.00	0.00
<i>Bulgaria</i>	0.01	0.01
<i>Croatia</i>	0.00	0.00
<i>Cyprus</i>	0.00	0.00
<i>Czechia</i>	0.00	0.00
<i>Denmark</i>	0.02	0.00
<i>Estonia</i>	0.00	0.00
<i>France</i>	0.00	0.00
<i>Germany</i>	0.00	0.00
<i>Greece</i>	0.00	0.00
<i>Hungary</i>	0.00	0.00
<i>Ireland</i>	0.00	0.00
<i>Italy</i>	0.00	0.00
<i>Lithuania</i>	0.01	0.00
<i>Luxembourg</i>	0.00	0.00
<i>Netherlands</i>	0.01	0.01
<i>Poland</i>	0.01	0.02
<i>Portugal</i>	0.00	0.00
<i>Spain</i>	0.00	0.03

Source: Authors' calculation (in EViews 13).

### 3.3 The results of the study

Cyclical dynamics of the variables, presented through cross-correlation analysis, across all the countries is displayed in Table 3. When we observe cross-correlation coefficients among all European countries, we can notice a relatively weak temporal relationship between these two green indicators. We found for only 4 countries

(Bulgaria, Cyprus, Netherlands and Spain) medium correlation between the green indicators. The other interesting deduction is that most of the higher correlation coefficients (especially those ranging from -0.40 to -0.60.) indicating some kind of weak to medium correlation) are displaying negative sign, suggesting that *cycle\_GGI* is countercyclical with mostly leading patterns to *cycle\_GGDP* variable in most of the countries involved. Generally, we can reason that correlation coefficients are shown to be relatively low, meaning that this nexus could be economically insignificant.

**Table 3: Cross-correlation *cycle\_GGDP* and *cycle\_GGI* with lags and leads up to 3 periods**

Variables	<i>t-3</i>	<i>t-2</i>	<i>t-1</i>	<i>t-0</i>	<i>t+1</i>	<i>t+2</i>	<i>t+3</i>
<i>Austria</i>	-0.05	0.48	0.27	-0.36	-0.19	-0.34	-0.07
<i>Belgium</i>	0.01	0.06	-0.10	0.23	0.06	0.14	0.09
<i>Bulgaria</i>	0.52	0.05	0.05	-0.43	-0.60	-0.02	-0.12
<i>Croatia</i>	-0.18	-0.15	-0.22	0.16	0.22	0.32	0.02
<i>Cyprus</i>	0.33	0.33	0.50	0.44	-0.08	-0.46	-0.08
<i>Czechia</i>	-0.19	-0.00	0.34	0.46	-0.09	0.34	-0.17
<i>Denmark</i>	-0.29	0.18	0.31	-0.19	-0.30	-0.05	0.12
<i>Estonia</i>	0.12	0.42	0.22	-0.12	-0.24	-0.18	0.24
<i>France</i>	0.34	0.41	0.21	-0.21	-0.17	0.18	0.08
<i>Germany</i>	0.15	0.02	-0.02	0.04	-0.15	0.40	0.32
<i>Greece</i>	0.05	0.40	0.22	0.30	-0.42	-0.03	0.02
<i>Hungary</i>	-0.04	-0.06	0.03	0.02	-0.09	0.21	0.27
<i>Ireland</i>	-0.15	-0.19	-0.40	-0.23	-0.15	0.16	0.10
<i>Italy</i>	-0.02	-0.16	0.07	-0.10	-0.39	0.11	0.07
<i>Lithuania</i>	0.30	0.33	0.11	-0.27	-0.35	-0.01	0.02
<i>Luxembourg</i>	-0.24	-0.47	-0.24	0.39	-0.07	-0.14	0.06
<i>Netherlands</i>	0.19	-0.36	-0.56	-0.37	-0.01	0.35	0.23
<i>Poland</i>	0.30	0.52	0.33	-0.16	-0.59	-0.23	-0.20
<i>Portugal</i>	0.03	-0.05	-0.30	0.01	-0.08	-0.42	-0.29
<i>Spain</i>	-0.01	-0.03	-0.05	-0.46	-0.46	0.04	0.09

Source: Authors' calculation (in EViews 13).

To confirm of conclusions on the divergent cyclical behaviour of variables *cycle\_GGDP* and *cycle\_GGI*, we made additional estimations of cross-correlation coefficients with lags and leads for 6 highly industrialized countries (Australia, Brazil, China, India, Japan and USA) with large effect on green economy (through high CO<sub>2</sub> emissions, high energy and carbon intensity, large population, high GDP, intensive environmental depletion through resource extraction etc.). The results



(Table 4) are very similar to those of the European countries, however only in the question of the direction of the relationship. For all the countries, except China, we found medium and negative cross-correlations with a leading pattern of *cycle\_GGI* variable, indicating again the divergent cyclical behaviour of these two green indicators. These results give us an incentive to carry out more extensive (longitudinal and cross-sectional) research in the future to confirm our hypothesis about the different cyclical behaviour of different green data.

**Table 4: Cross-correlation *cycle\_GGDP* and *cycle\_GGI* with lags and leads up to 3 periods (other countries)**

Variables	<i>t-3</i>	<i>t-2</i>	<i>t-1</i>	<i>t-0</i>	<i>t+1</i>	<i>t+2</i>	<i>t+3</i>
<i>Australia</i>	0.23	0.10	-0.28	-0.46	-0.56	0.12	0.46
<i>Brazil</i>	-0.16	0.23	0.62	0.50	-0.62	0.22	-0.16
<i>China</i>	-0.34	-0.37	-0.18	-0.21	0.07	0.35	0.28
<i>India</i>	0.30	-0.24	-0.66	-0.40	-0.03	0.21	0.50
<i>Japan</i>	0.26	0.15	-0.40	-0.66	-0.71	-0.02	0.42
<i>USA</i>	-0.03	0.13	-0.26	-0.61	-0.37	0.18	0.18

Source: Authors' calculation (in EViews 13).

While the Granger causality tests (Table 5) do provide additional evidence on the relationship and possible causality between the variables, we found that there exists no mutual causality between the variables *cycle\_GGDP* and *cycle\_GGI*, across all the observed countries with partial causality just for 4 countries (Bulgaria, Netherlands, Poland and Spain), which does not provide enough evidence on the general Granger causality between these two green indicators.

The majority of correlation coefficients are low to moderate in strength, indicating that the cyclical behaviour of the *cycle\_GGI* does not have to be precisely tied to neither current nor to past (lagging) or future (leading) developments of the *cycle\_GGDP*. Therefore, the usage of these green indicators does not need to represent the current state of green economy aspirations in the observed countries.

**Table 5: Granger causality tests**

Variables	Null hypothesis:	F-Stat.	Prob.
<i>Austria</i>	cycle_GGDP does not Granger cause cycle_GGI	0.80	0.40
	cycle_GGI does not Granger cause cycle_GGDP	0.08	0.79
<i>Belgium</i>	cycle_GGDP does not Granger cause cycle_GGI	0.12	0.73
	cycle_GGI does not Granger cause cycle_GGDP	0.00	0.97
<i>Bulgaria</i>	cycle_GGDP does not Granger cause cycle_GGI	0.07	0.80
	cycle_GGI does not Granger cause cycle_GGDP	4.63	0.06
<i>Croatia</i>	cycle_GGDP does not Granger cause cycle_GGI	0.65	0.44
	cycle_GGI does not Granger cause cycle_GGDP	0.81	0.39
<i>Cyprus</i>	cycle_GGDP does not Granger cause cycle_GGI	2.61	0.14
	cycle_GGI does not Granger cause cycle_GGDP	0.92	0.36
<i>Czechia</i>	cycle_GGDP does not Granger cause cycle_GGI	1.23	0.30
	cycle_GGI does not Granger cause cycle_GGDP	0.59	0.46
<i>Denmark</i>	cycle_GGDP does not Granger cause cycle_GGI	1.02	0.34
	cycle_GGI does not Granger cause cycle_GGDP	0.85	0.38
<i>Estonia</i>	cycle_GGDP does not Granger cause cycle_GGI	0.64	0.44
	cycle_GGI does not Granger cause cycle_GGDP	0.39	0.85
<i>France</i>	cycle_GGDP does not Granger cause cycle_GGI	0.48	0.51
	cycle_GGI does not Granger cause cycle_GGDP	0.36	0.56
<i>Germany</i>	cycle_GGDP does not Granger cause cycle_GGI	0.00	0.99
	cycle_GGI does not Granger cause cycle_GGDP	0.25	0.63
<i>Greece</i>	cycle_GGDP does not Granger cause cycle_GGI	0.25	0.63
	cycle_GGI does not Granger cause cycle_GGDP	1.65	0.23
<i>Hungary</i>	cycle_GGDP does not Granger cause cycle_GGI	0.01	0.92
	cycle_GGI does not Granger cause cycle_GGDP	0.11	0.75
<i>Ireland</i>	cycle_GGDP does not Granger cause cycle_GGI	1.70	0.22
	cycle_GGI does not Granger cause cycle_GGDP	0.32	0.58
<i>Italy</i>	cycle_GGDP does not Granger cause cycle_GGI	0.04	0.84
	cycle_GGI does not Granger cause cycle_GGDP	2.05	0.19
<i>Lithuania</i>	cycle_GGDP does not Granger cause cycle_GGI	0.14	0.72
	cycle_GGI does not Granger cause cycle_GGDP	0.93	0.36
<i>Luxembourg</i>	cycle_GGDP does not Granger cause cycle_GGI	0.22	0.65
	cycle_GGI does not Granger cause cycle_GGDP	0.82	0.39
<i>Netherlands</i>	cycle_GGDP does not Granger cause cycle_GGI	6.88	0.03
	cycle_GGI does not Granger cause cycle_GGDP	1.77	0.22
<i>Poland</i>	cycle_GGDP does not Granger cause cycle_GGI	1.09	0.32
	cycle_GGI does not Granger cause cycle_GGDP	5.00	0.05
<i>Portugal</i>	cycle_GGDP does not Granger cause cycle_GGI	1.47	0.26
	cycle_GGI does not Granger cause cycle_GGDP	0.01	0.94
<i>Spain</i>	cycle_GGDP does not Granger cause cycle_GGI	0.00	0.99
	cycle_GGI does not Granger cause cycle_GGDP	3.66	0.09

Source: Authors' calculation (in EViews 13).

More interestingly, most of the higher correlation coefficients were of negative sign, indicating that these two green indicators are *de facto* moving and/or fluctuating differently, which is another important deduction on the inconsistency in analogy between these two metrics and its usage for a cross-country comparison.

#### 4 Research implications

The divergence between the GGI and Green GDP can be explained by several factors that influence their dynamics and cyclical fluctuations.

*First*, there is a difference in measurement components. As we already mentioned, the GGI measures a broader spectrum of sustainable development indicators, including renewable energy, energy efficiency, pollution levels, biodiversity, social inclusion, and policy frameworks that support sustainability; therefore, this index emphasizes qualitative aspects of development and is often independent of total economic output. On the other hand, GGDP is a modification of traditional GDP that subtracts the economic costs of environmental degradation and adds the benefits of conserving natural resources, hence its dynamics are more closely tied to economic activities and their environmental impact. Due to their differing focuses (qualitative vs. quantitative indicators), fluctuations in one metric may not proportionally reflect changes in the other (Tomić, 2024). *Second*, there is a differing time horizon of effects. While the GGI is often based on long-term policies and investments in sustainability, with effects that manifest gradually and are less sensitive to short-term economic shocks, the GGDP can respond more quickly to changes in economic activity, such as recessions or recoveries, since the costs of environmental degradation may rise or fall sharply with shifts in industrial activity. *Third*, there is the influence of external factors. Changes in the prices of oil, gas, or renewable energy resources can directly affect GGDP but have varying effects on the GGI, depending on the share of technologies and resources employed. Extreme weather events or natural disasters can reduce GGDP due to increased restoration costs, while their effects on the GGI may be subtler or negligible in the short term. *Fourth*, there is a question of what happens when we have transitioning economies. In economies transitioning toward greener practices, temporary discrepancies may arise as GGDP may increase if environmental degradation decreases (Rauch and Chi, 2010), while the GGI could stagnate due to slow adoption of innovations and sustainable development policies. Conversely, an increase in the GGI (for example

through subsidies for renewable energy) may lead to temporary economic costs, reducing GGDP in the short term. And *fifth*, there is a divergence between short-term economic vs. long-term sustainability goals. Short-term economic stimulus measures (namely subsidies for high-emission industries) may boost GGDP, but reduce the GGI due to increased pollution. Conversely, stricter environmental policies may improve the GGI but temporarily slow GGDP due to the costs of adaptation.

Despite this disparity and nonconformity of these two important green variables, the usage and cross-country comparison of the GGDP and GGI as a vague (and maybe accurate) metrics of welfare with other green metrics and socio-economic indicators could be interesting from the theoretical (economic modelling) and practical (policy) perspective.

## 5 Beyond conclusion

The findings indicate that the correlation between the cyclical components of the GGDP and GGI for European (20 EU) countries is generally weak to moderate, suggesting limited alignment between these two indicators across different timeframes. This implies that the two metrics may capture distinct aspects of green economic performance, and their usage does not necessarily reflect the present state of green economy aspirations in the analyzed countries. Notably, the predominance of negative correlations highlights that fluctuations between GGDP and GGI often move in opposite directions, reinforcing the notion that these indicators may represent fundamentally different dynamics. This inconsistency raises questions about their comparability and reliability for cross-country analyses of green economic progress. Consequently, policymakers and researchers should exercise caution when interpreting these metrics together and consider their unique methodological and conceptual frameworks.

The lack of correlation between the dynamics of the GGI and GGDP arises from differences in their foundations, methodologies, and temporal sensitivities. While GGDP primarily reflects current economic activities and their direct environmental impacts, the GGI emphasizes structural and qualitative aspects of sustainable development, which are not necessarily tied to cyclical changes in the economy.

There are few shortcomings of this paper that a reader may detect. First is the relatively short time series and second is the generalizability of some conclusions. Both can impose scantiness in economic reasoning, however we find this argument as an incentive for further research that might include more complex methods of analysis and international comparison, especially for the whole EU community and on a larger global cross-country scale. Not being evasive towards limitations, we believe that our conclusions could bear important implications for a reasoning in interpretation of green economy indicators, for economic modelling, as well as for economic policy and environmental programme developments. Furthermore, the perspective that economic development and growth will ultimately result in environmental sustainability, coupled with the observation that developed countries consume more resources per capita than developing countries and that ecological and economic impacts often occur beyond their borders, underscores the potential of GGDP and GGI as a metric for sustainable progress. It can also serve as a tool for assessing the effectiveness of implementation strategies aimed at promoting pro-environmental initiatives (Stjepanović, Tomić, and Škare, 2019).

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# ADAPTIVE NEURAL NETWORK MODELS FOR TOURISM PREFERENCE PREDICTION: A CASE STUDY IN SERRES

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This study presents the development of a tourist preference prediction system for the Municipality of Serres, based on data collected from visitor questionnaires. The system utilizes 14 neural networks, one for each potential destination or activity, to predict the likelihood of new visitors engaging with them. The models consist of four hidden layers with 16 neurons each, employing ReLU activation functions, and a sigmoid output layer for probability predictions. The binary\_crossentropy function is used for error estimation. Categorical data, such as gender, country of origin, and mode of transport, are encoded using one-hot encoding, and the training process is implemented with the TensorFlow/Keras library. To deploy the system, an API built with FastAPI provides predictions based on visitor data. Additionally, users can provide feedback on actual visits or activities, enabling the retraining of models to enhance prediction accuracy. This dynamic system adapts to user input, improving over time.

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dynamic systems

## 1 Introduction

Tourism is an important economic sector that has a big impact on sustainability and regional development. However, as global tourism patterns evolve due to shifting traveler preferences, destinations face increasing challenges in maintaining competitiveness and ensuring visitor satisfaction, (Xiang & Fesenmaier, 2016). In order to improve visitor experiences and allocate available resources as efficiently as possible, data-driven methods have become essential in understanding and predicting visitor preferences, (Claveria, Monte, & Torra, 2015), (Law, Li, Fong, & Han, 2019). In this context, machine learning techniques, particularly artificial neural networks, offer promising solutions for personalizing recommendations and improving tourism management strategies, (Shrestha, Wenan, Shrestha, Rajkarnikar, & Jeong, 2024), (Azevedo, Fernandes, Teixeira, & Ferreira, 2011).

The municipality of Serres is a location rich in historical, cultural and natural attractions, that each year attracts thousands of tourists. However, due to the dynamic nature of visitor preferences and the continuously evolving tourism landscape, modern tools are required to sustain visitor interest and enhance service effectiveness, (Çuhadar, Cogurcu, & Kukrer, 2014). While surveys and statistical analyses remain valuable, they are unable to fully capture the complexity of tourism patterns on their own, (Palmer, Montaña, & Sesé, 2006). In order to overcome these limitations, this research proposes a tourism preferences prediction system, that utilizes neural networks to forecast the destinations and activities most suitable for each individual visitor, based on their unique characteristics and preferences.

In this study, a tourism preferences prediction system is created, which provides personalized suggestions for activities and destinations based on each visitor's individual interests. To achieve this, the system utilizes user-inputted data to tailor recommendations more effectively. When users access the system via the Tourism Prediction System, they are prompted to complete a questionnaire that collects important data such as gender, age, means of transportation (car, public transportation, other), travel style (solo, family, friends) and travel period (Winter, Spring, Summer, Autumn). Additionally, users are asked to rate various aspects of interest on a scale from 1 to 5, including nature, history, culture, gastronomy, entertainment and motor sports. Using this information, the system makes tailored



suggestions, aiming to improve the visitor's experience by aligning recommended activities to personal preferences.

To further support decision-making, users can access the [Tourism Statistics Portal](#), which provides descriptive analytics on visitor trends. The platform offers insights into gender distribution among visitors, the most popular travel periods, preferred modes of travel (individual, group, or family), and the primary means of transportation used. By analyzing these factors, stakeholders and visitors alike gain a clearer understanding of tourism patterns in Serres. Additionally, the system incorporates a feedback mechanism, allowing visitors to rate and review the recommended locations after their visit. This feedback not only validates the initial recommendations but also enables the system to refine its predictive accuracy through continuous retraining. As a result, the algorithm evolves dynamically, improving future recommendations and ensuring greater alignment with visitor expectations.

The rest of the paper is structured as follows: Section 2 describes the employed methodology and Section 3 presents the results. Finally, Section 4 provides the conclusions.

## **2 Methodology**

This section presents the methodology followed for the development of the tourism preference prediction system. The process began with the creation of an initial dataset through structured questionnaires distributed to tourists. Data collection was conducted through Google Forms, allowing responses to be efficiently collected from a diverse group of travelers.

The initial dataset consists of 600 samples with 11 features each. These features include gender, age, means of transportation (car, public transportation, other), travel style (solo, family, friends), and travel period (Winter, Spring, Summer, Autumn). Additionally, the dataset contains ratings on a scale from 1 to 5 for various aspects of interest, including nature-related activities, history, culture, gastronomy, entertainment, and motor sports. Subsequently, due to the structure of the algorithm, which undergoes continuous retraining, the dataset is enriched with an additional number of samples collected from tourists who complete the

questionnaire. The data was processed anonymously, respecting the privacy of all tourists.

Based on this dataset, a neural network-based algorithm was developed to generate personalized recommendations. The system utilizes 14 neural networks, one for each potential destination or activity, to predict the likelihood of new visitors engaging with them. Each model consists of four hidden layers with 16 neurons per layer, employing ReLU activation functions and a sigmoid output layer for probability predictions, (Goodfellow, Bengio, & Courville, 2016), (Rasamoelina, Adjailia, & Sincak, 2020). The `binary_crossentropy` function is used for error estimation. Categorical data, such as gender, means of transportation, travel style and travel period, are encoded using one-hot encoding, ensuring compatibility with the neural network architecture. The training process is conducted using the TensorFlow/Keras library, which provides efficient deep learning model development and optimization, (Chollet, 2017).

To make predictions accessible and user-friendly, the system is deployed through an API built with FastAPI. This allows visitors to receive real-time recommendations based on their provided information. The recommendations include local gastronomy options such as souvlaki, bougatsa, and akanes, as well as notable attractions like the Xenakis Museum, the Old Metropolis, Freedom Square, and the Serres Circuit. Additionally, other recommended locations include Agios Prodromos, the Acropolis of Serres, the Valley of Agii Anargyri, Lailias, the Historic Center and pedestrian streets, Agios Ioannis, and the Archaeological Museum. The probability scores generated by the neural networks reflect the likelihood that a user will engage with a particular destination based on their input preferences. These scores are computed using a sigmoid activation function in the final layer, producing values between 0 and 1. The higher the probability score, the stronger the match between the user's preferences and the destination's attributes.

Furthermore, the system incorporates a feedback mechanism where users can rate their experiences after visiting recommended locations. This feedback is integrated into the model, enabling retraining and continuous optimization of prediction accuracy. The dynamic nature of this system ensures it evolves over time, improving the relevance and precision of its recommendations.

### 3 Results

The tourism preference prediction system begins with a structured questionnaire (See Figure. 1), where users provide demographic and travel-related data. As shown in the image, users input their age, gender, travel style (solo, family, or friends), mode of transportation, and travel period. Additionally, they rate their interests in nature-related activities, history, culture, gastronomy, entertainment, and motor sports on a scale from 1 to 5. This structured input enables the system to generate personalized recommendations.

The questionnaire is displayed in a light gray container. It contains the following elements:

- Ηλικία \***: Text input field containing the number 32.
- Φύλο \***: Dropdown menu with the selected option "Αντρας".
- Ταξιδεύετε μόνος/η, με την οικογένεια ή με φίλους \***: Dropdown menu with the selected option "Με φίλους".
- Τρόπος μετακίνησης \***: Dropdown menu with the selected option "Αυτοκίνητο".
- Περίοδος ταξιδιού \***: Dropdown menu with the selected option "Άνοιξη".
- Ενδιαφέρον για δραστηριότητες στη φύση (Πεζοπορία, ποδηλασία, περίπατοι κτλ) \***: Radio button group with options 1, 2, 3, 4 (selected), and 5.
- Ενδιαφέρον για ιστορία \***: Radio button group with options 1, 2, 3 (selected), 4, and 5.
- Ενδιαφέρον για πολιτισμό \***: Radio button group with options 1, 2, 3 (selected), 4, and 5.
- Ενδιαφέρον για γαστρονομία \***: Radio button group with options 1, 2, 3, 4 (selected), and 5.
- Ενδιαφέρον για διασκέδαση \***: Radio button group with options 1, 2, 3, 4, and 5 (selected).
- Ενδιαφέρον για μηχανοκίνητο αθλητισμό \***: Radio button group with options 1, 2, 3, 4, and 5 (selected).
- ΥΠΟΒΟΛΗ**: A green button at the bottom left.

Figure 1: Questionnaire

Source: Own

After completing the questionnaire, the system processes the data and provides customized recommendations. As seen in the results interface, the AI model suggests destinations and activities with corresponding relevance scores. In this

example, suggested locations include Agios Prodromos, the Xenakis Museum, Bougatsa, Freedom Square, and Souvlaki. These recommendations are based on the user's preferences and previous visitor trends. Five out of fourteen possible destinations are selected to ensure that users receive a manageable and meaningful set of recommendations without overwhelming them with too many choices.

Each recommendation is associated with a confidence score, indicating the likelihood that the suggested location or experience aligns with the user's preferences. For example, in the results displayed, Agios Prodromos has a 72.35% probability, making it the most relevant suggestion. Xenakis Museum follows with a 60.35% probability, indicating a strong cultural interest. Bougatsa (44.82%) and Souvlaki (25.28%) suggest a moderate preference for local gastronomy. Freedom Square (36.87%) is also highlighted as a significant cultural or social attraction.



**Figure 2: Recommendations**

Source: Own

These probabilities are dynamically adjusted based on user feedback and evolving dataset trends, ensuring that recommendations become increasingly accurate over time. By analyzing probability scores, users can prioritize activities and locations that best align with their personal interests, leading to an optimized travel experience. This is considered essential as tourist preferences are initially assessed through

structured questions based on their stated interests. However, in reality, a visitor may find something they initially considered uninteresting to be highly enjoyable, or vice versa. Since tourism is dynamic and influenced by mood and external factors, incorporating feedback is essential. This allows the algorithm to adjust recommendations not only based on initial preferences but also on post-visit evaluations, ensuring a more accurate and personalized experience.

As mentioned above, in order to further support decision-making, users can access the Tourism Statistics Portal, which provides descriptive analytics on visitor trends. The platform offers insights into gender distribution among visitors, the most popular travel periods, preferred modes of travel (individual, group, or family), and the primary means of transportation used. By analyzing these factors, stakeholders and visitors alike gain a clearer understanding of tourism patterns in Serres. Although many factors were examined, we highlight a few significant patterns that highlight the system's significance and impact.

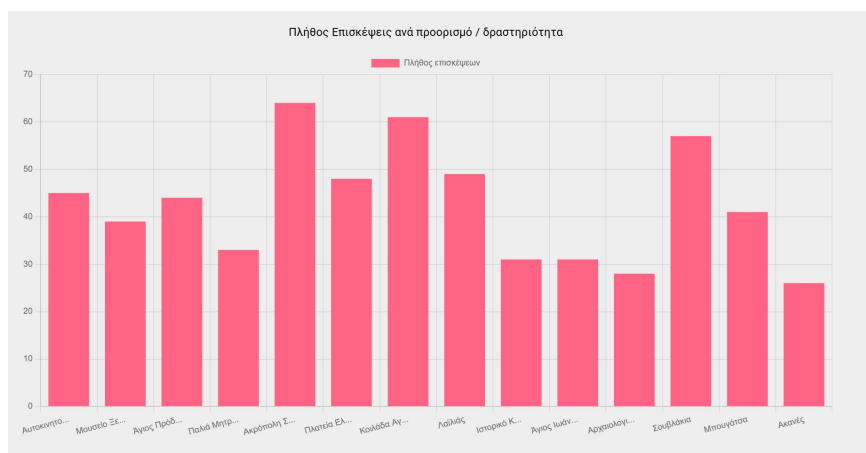


Figure 3: Visit Frequency by destination or activity

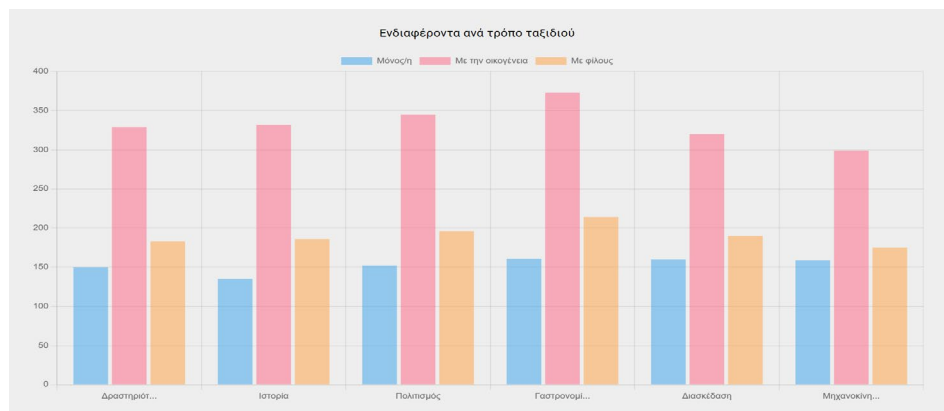
Source: Own

An example of such an analysis is presented in Figure 3, which illustrates the number of visits per destination or activity. This bar chart highlights locations such as Agios Prodromos, the Serres Circuit, and Lailias as some of the most popular among tourists. Furthermore, the data indicates a strong preference for local cuisine, as

reflected by the high level of interest in culinary experiences like Bougatsa and Souvlaki.

The bar chart presented in Figure 4, illustrates visitor interests depending on travel style (solo travelers, family travelers, and groups of friends). It highlights how different types of travelers prioritize various experiences. A key observation is that gastronomy receives the highest level of interest across all groups, indicating its universal appeal among tourists. However, preferences for the second most preferred activity vary. Family travelers and groups of friends show a greater preference for cultural activities, making it their second-highest priority. Solo travelers, on the other hand, rank entertainment as their second choice, demonstrating a distinct preference for social and recreational experiences over cultural ones.

Finally, the bar chart in Figure 5 illustrates seasonal variations in visitor interests, segmented by autumn, winter, spring, and summer. The data suggests that gastronomy consistently attracts the highest interest across all seasons, highlighting the role of local cuisine in tourism. Interestingly, nature-related activities show increased popularity among travelers in autumn. Additionally, entertainment remains consistently high during spring, summer, and winter, indicating its broad appeal across different seasons.



**Figure 4: Visitors interests by travel style**

Source: Own

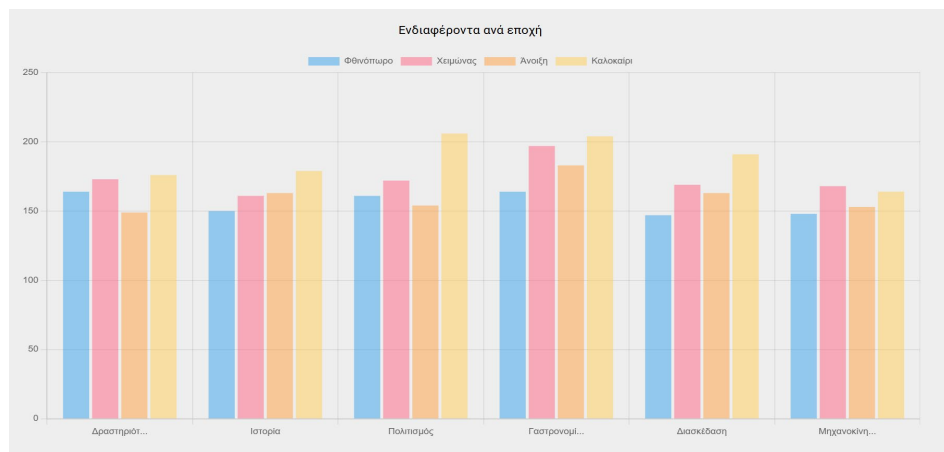


Figure 5. Seasonal interests

## 4 Conclusion

This study introduced a tourism preference prediction system that uses neural networks to generate personalized recommendations for visitors to the Municipality of Serres. Using the responses collected from visitor questionnaires, the system generates personalized recommendations by selecting five out of a total of fourteen possible destinations or activities. These recommendations are determined based on a probability score, which reflects how well each option aligns with the visitor's preferences. The predictive model ensures that the suggested destinations or activities are tailored to individual interests, enhancing the overall tourism experience while continuously improving through user feedback. To further support decision-making, users can access a portal, which provides descriptive analytics on visitor trends. The platform offers insights into gender distribution among visitors, the most popular travel periods, preferred modes of travel (individual, group, or family), and the primary means of transportation used. By analyzing these factors, stakeholders and visitors alike gain a clearer understanding of tourism patterns in Serres. Future work could focus on expanding the dataset, both in terms of sample size and questionnaire scope, while ensuring the survey remains concise and user-friendly. Additionally, increasing the number of recommendations provided, would enhance the system's ability to offer more diverse and specialized suggestions. These improvements would contribute to a more comprehensive, adaptable, and personalized tourism experience, further refining the system's ability to support data-driven decision-making in tourism management.

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# DATA-CENTRIC APPROACH TO SHORT-TERM WATER DEMAND PREDICTION USING BIG DATA AND DEEP LEARNING TECHNIQUES

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This study introduces a data-centric approach to short-term water demand forecasting, utilizing univariate time series data from water reservoir levels in Eastern Thessaloniki. The dataset, collected over 15 months via a SCADA system, includes water level recordings from 21 reservoirs, generating a substantial Big Data resource. Key components of the methodology include data preprocessing, anomaly detection using techniques like the Interquartile Range method and moving standard deviation, and the application of predictive models. Missing data is addressed with LSTM networks optimized via the Optuna framework, enhancing data quality and improving model accuracy. This approach is particularly valuable in regions where reservoirs are the primary water source, and flow meter readings alone cannot determine demand distribution. By integrating deep learning techniques, such as LSTM models, with traditional statistical methods, the study achieves improved accuracy and reliability in water demand predictions, offering a robust framework for efficient water resource management.

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big data,  
deep learning,  
LSTM networks,  
anomaly detection

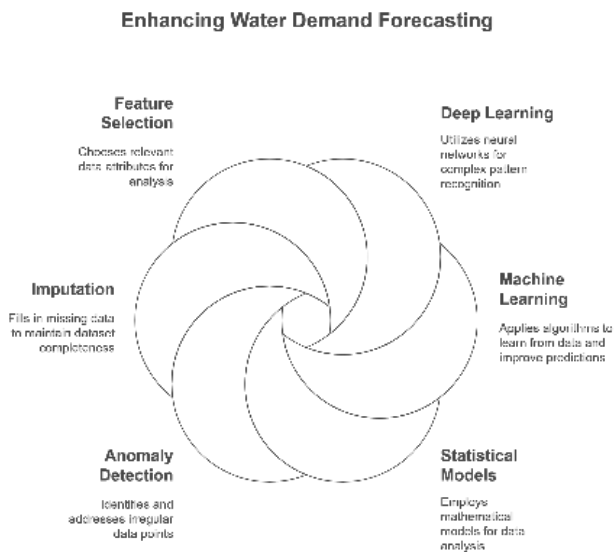
## 1 Introduction

Water demand forecasting is crucial for sustainable urban water management, particularly amid climate change and urbanization (Wilson, 2016). Regulatory frameworks, such as the EU's Water Framework Directive (Directive - 2000/60 - EN - Water Framework Directive - EUR-Lex, n.d.), emphasize efficient water use and waste prevention. Utility managers rely on short-term forecasts to optimize distribution and meet sustainability targets.

Traditional time series models like ARIMA and SARIMA effectively capture linear trends but struggle with non-linearities and sudden fluctuations in water consumption due to weather variations and sensor malfunctions (Wang et al., 2023). Deep learning models, particularly Long Short-Term Memory (LSTM) networks, offer a superior alternative by capturing long-term dependencies and complex temporal relationships (Hochreiter & Schmidhuber, 1997). Optimizing model performance requires a data-centric approach, focusing on preprocessing, cleaning, and augmentation to improve data quality (Wang et al., 2023).

Given real-world data anomalies—such as sudden spikes from sensor malfunctions—proper preprocessing enhances model reliability. Well-preprocessed datasets consistently yield better forecasts than raw data (Shan et al., 2023). This study evaluates imputation methods, including bi-directional LSTM, linear and polynomial interpolation, mean imputation, and K-Nearest Neighbors (KNN), to determine their impact on forecasting accuracy (Liu et al., 2023).

By integrating deep learning, machine learning, and statistical models, this research aims to enhance water demand forecasting, particularly in reservoir-based systems by analyzing tank levels instead of flow measurements. Advanced preprocessing techniques, including anomaly detection, imputation, and feature selection, improve data integrity, ensuring more accurate short-term forecasts and effective water resource management (Wang et al., 2023).



**Figure 1: Research aim**

Source: Own

## 2 Materials and Methods

The dataset consists of water level recordings from 21 reservoirs in Eastern Thessaloniki, covering 85 km<sup>2</sup>, provided by EYATH S.A. and collected via a SCADA system at one-minute intervals over 15 months (November 1, 2022 – March 30, 2024), resulting in 13.9 billion high-resolution measurements. While geographically focused, the dataset captures diverse reservoirs in suburban areas with varying population densities, land use, and water consumption behaviors. It includes storage reservoirs, which directly supply residential, commercial, and industrial areas, and intermediary reservoirs, which transfer water without direct end-user supply. To analyze water level dynamics, k-means clustering grouped reservoirs into four categories: (Cluster1) stable water levels with minimal seasonal variation, (Cluster 2) moderate seasonal variation reflecting changing consumption patterns, (Cluster 3) high fluctuations indicating significant usage variability, and (Cluster 4) pronounced seasonal trends, primarily intermediary stations (Figure 2). This clustering enhances understanding of water distribution and consumption patterns, offering insights into operational strategies and optimization (Osman et al., 2018).

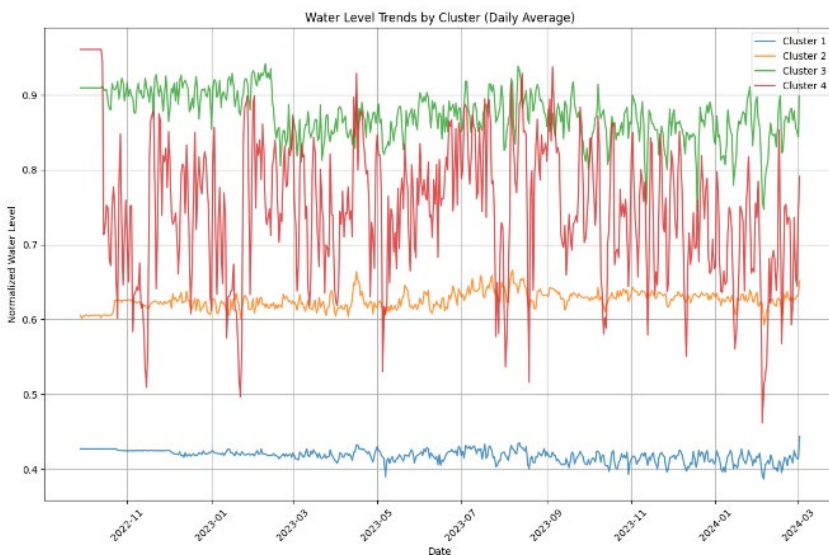


Figure 2: Water Level Trends By Cluster (Daily Average)

Source: Own

## 2.1 Methodology

The study focused on the following research areas, as seen in Figure 3:

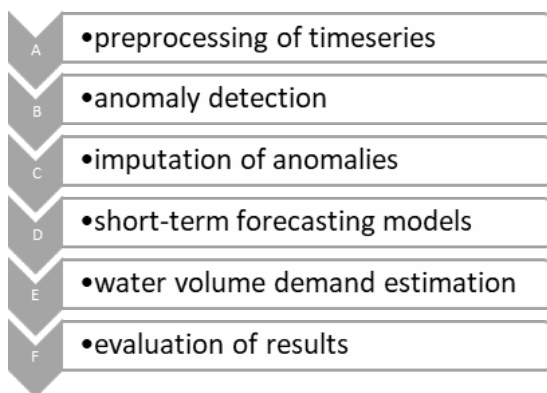


Figure 3: Short-term time series forecasting methodology applied to water tanks level data

Source: Own

Figure 4 presents the workflow of the data formatting at each step of the applied methodology.

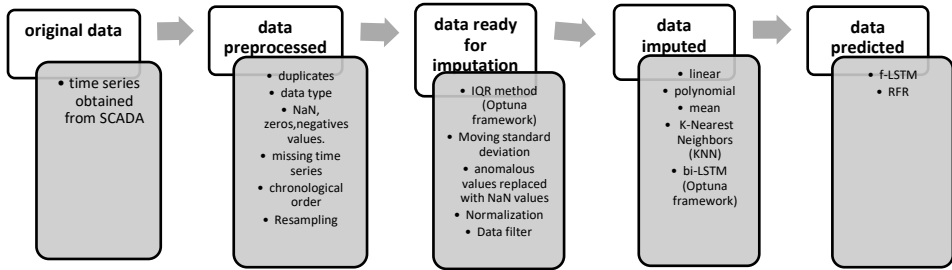


Figure 4: Short-term time series forecasting methodology applied to water tanks level data  
Source: Own

## 2.2 Anomaly Detection

Accurate anomaly detection in time series data is crucial for effective correction and forecasting. Anomalies fall into three categories: contextual anomalies, point anomalies, and collective anomalies (Arslan et al., 2024). This study primarily focuses on detecting point and collective anomalies, as they directly affect data integrity and predictive accuracy, while contextual anomalies have been manually adjusted based on expert knowledge. To identify anomalies in time-series data, point anomalies are detected using the IQR method enhanced with the Optuna framework, while collective anomalies are identified using the moving standard deviation method.

To enhance the IQR measure, Optuna is employed for automated outlier detection optimization by selecting the best lower and upper bounds within predefined quantile ranges (0.01–0.25 for lower, 0.75–0.99 for upper). The objective function minimizes the negative sum of detected outliers, optimizing the inclusion of valid values while excluding anomalies (Niknam et al., 2022). The optimization process, performed using the Tree-structured Parzen Estimator (TPE) algorithm, models good and bad parameter distributions by computing probability densities  $l(x)$  and  $g(x)$ , guiding the search towards optimal bounds via the ratio  $l(x)/g(x)$ . The densities, estimated using kernel density estimators (KDEs), refine the decision space iteratively (James et al., 2023). The function seeks to minimize detected outliers through the equation (1)

$$f(x,l,u)=1 \text{ if } x<l \text{ or } x>u, \text{ otherwise } 0 \tag{1}$$

and evaluates the bounds by maximizing equation (2).

$$P(l,u)=-\sum_{x \in D} f(x,l,u) \tag{2}$$

The final optimization goal (Equation 3) maximizes

$$\max_{l,u} P(l,u) \tag{3}$$

ensuring optimal bounds that improve data quality and reduce false anomaly detection, providing a robust framework for outlier detection and dataset integrity enhancement .

### 2.3 Data Imputation

Various imputation techniques were employed to restore missing data, including linear and polynomial interpolation, which assume simple relationships between data points but may not handle complex patterns, mean imputation, which replaces missing values with the average but struggles with non-random gaps, and K-Nearest Neighbors (KNN) imputation, which leverages nearby data points but deteriorates with high missing data percentages. Additionally, bi-directional LSTM (bi-LSTM) imputation, leveraging both past and future temporal dependencies, provides a more robust approach for time-series data.

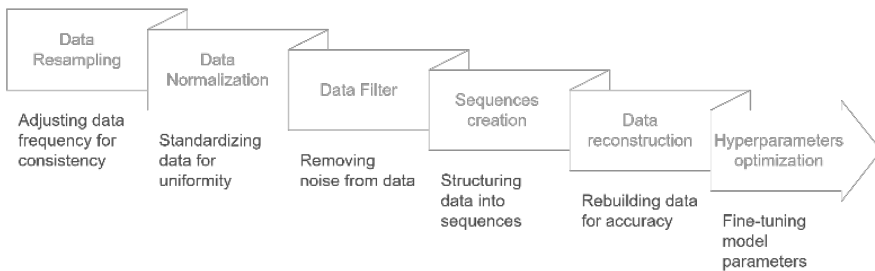


Figure 5 Process of bi-LSTM data imputation method

Source: Own

**Bi-LSTM Imputation:** This advanced method utilizes a bi-directional Long Short-Term Memory network to learn from data sequences in both forward and backward directions, providing a comprehensive understanding of the temporal dynamics. It is particularly effective for time-series data where capturing temporal dependencies is crucial. Figure 5 illustrates the process followed to impute data for NaN (Not a Number) values.

**Data reconstruction:** An enhanced approach is employed, interpolating normalized sequence values trained on a bi-LSTM model to reconstruct missing data. This method ensures adequate sequence length for each NaN value, preventing short or insufficient sequences and avoiding issues related to time-dependent indices. By carefully calibrating missing value predictions to prevent overlap with existing data, the approach preserves the temporal integrity of the time series, allowing the model to capture event sequences accurately—critical for time-series forecasting. Unlike traditional methods that disrupt temporal coherence and fail to account for non-linear dependencies, bi-LSTM-based imputation maintains the natural flow of time-series data by learning from both past and future values. This innovative strategy enhances the model’s ability to generalize from incomplete datasets, leading to more reliable predictions, particularly in datasets with anomalies and irregular consumption patterns.

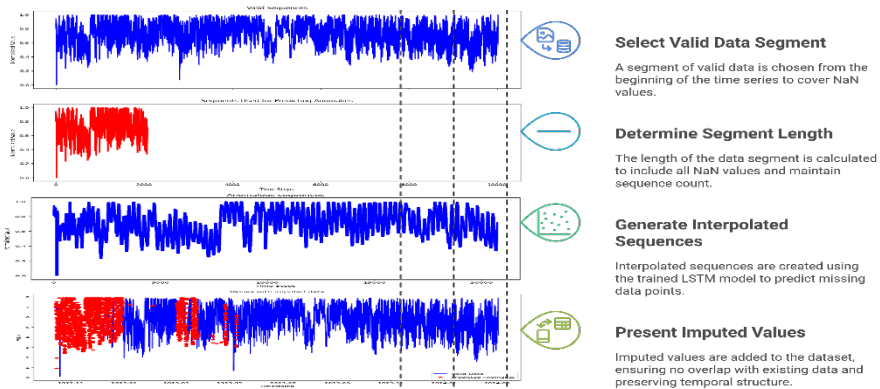


Figure 6 Time series Data imputation process

Source: Own

In Figure 6, the data prepared for imputation includes only valid observations used for training and validating the model. A segment of valid data is selected from the beginning of the time series, with its length carefully determined to cover the total NaN values in the anomaly set while ensuring an appropriate number of sequences. Subsequently, the interpolated sequences for the NaN values are generated, utilizing the trained LSTM model to predict missing data points. Finally, the imputed values are presented, ensuring no overlap with existing valid observations and preserving the temporal structure and continuity within the time series. This approach enhances the accuracy of imputation while maintaining the integrity of the dataset for subsequent forecasting analysis.

**Bi-LSTM Hyperparameters Optimization:** The Optuna framework is employed for selecting the optimal hyperparameters, which are parameters that define the bi-LSTM structure and are learned during training. These hyperparameters include sequence length, LSTM units, activation function, optimizer, learning rate, additional dense layers, dropout rate, batch size, and the appropriate objective function that best fits training the bi-LSTM model. Sampling techniques such as Random sampling and Tree Parzen Estimator (TPE) were also used. The range of hyperparameters considered is as follows:

- Sequence length: sampled as an integer between 3 and 20,
- LSTM units: sampled as an integer between 20 and 100,
- Activation function: sampled from ['relu', 'tanh', 'sigmoid'],
- Optimizer: sampled from ['adam', 'rmsprop', 'sgd'],
- Learning rate: logarithmically sampled between 0.0001 and 0.01,
- Additional dense layers: sampled as a boolean,
- Dropout rate: sampled between 0.0009 and 0.4274,
- Batch size: sampled from a predefined list of values [16, 32, 64].

## 3 Results

### 3.1 Data Imputation performance

The effectiveness of these methods was assessed using Mean Squared Error (MSE), Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and the coefficient of determination ( $R^2$ ) to evaluate their impact on the forecasting accuracy



of f-LSTM, Random Forest models, ensuring high-quality data reconstruction for improved predictive performance (Figure 7).

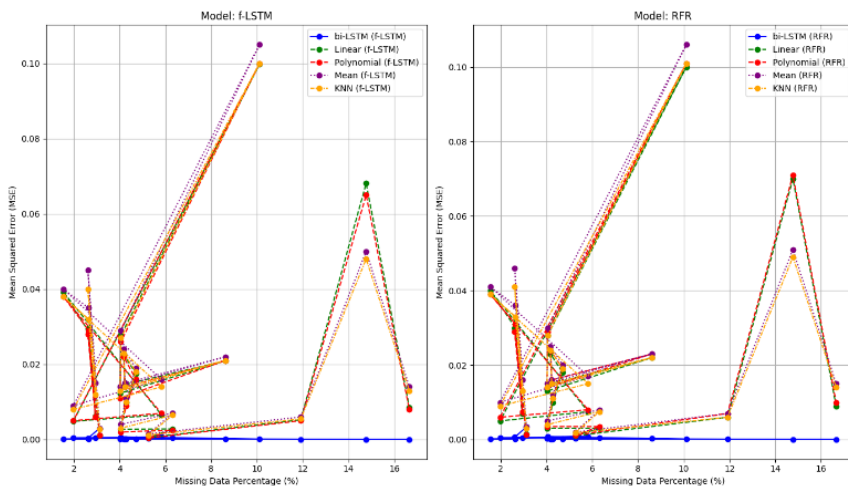


Figure 7: Sensitivity Analysis of Different Imputation Methods per model

Source: Own

Table 1: Analysis of forecasting models with different imputation methods

Model	MSE_ bi-LSTM	MSE_ Linear	MSE_ Polynomial	MSE_ Mean	MSE_ KNN
f-LSTM	0.0003	0.0242	0.0048	0.0206	0.0209
RFR	0.0029	0.0010	0.0015	0.0027	0.0027

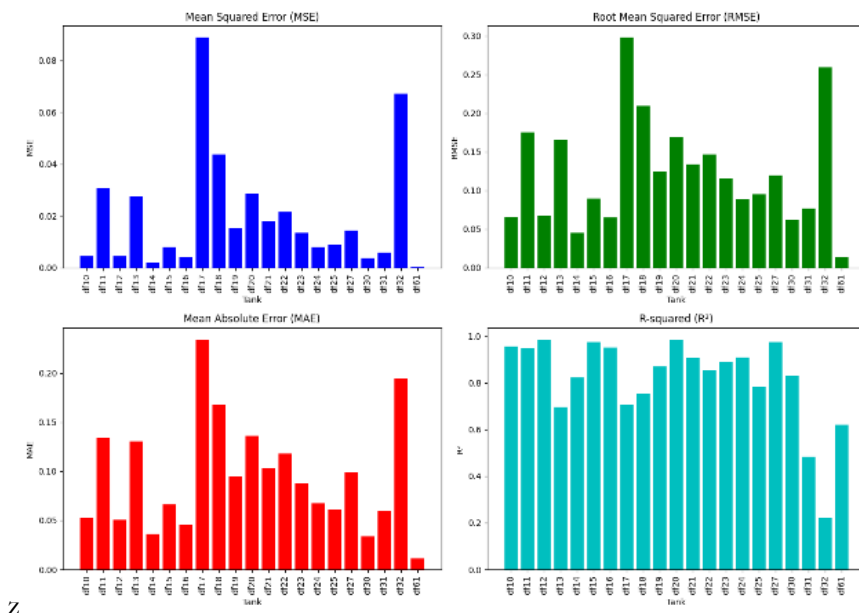
Source: Own

In Figure 8 presented the visualizations for the bi-LSTM imputation accuracy performance metrics (MSE, RMSE, MAE, and R<sup>2</sup>) for each tank.

### 3.2 Water Demand models Forecasting Performance

The Random Forest Regressor (RFR) method predicts water demand using an ensemble of decision trees, where each tree independently partitions the feature space and generates a prediction . Key parameters include n\_estimators, determining the number of trees, and random\_state, ensuring reproducibility. Each tree is trained on a random subset of data (bootstrap sampling), enhancing accuracy and reducing variance and overfitting. Mean Squared Error (MSE) is used to optimize tree splits

for maximum node purity (Breiman, 2001). The dataset undergoes preprocessing, where date-time columns are transformed into time labels, and lag features are introduced to capture temporal dependencies. The data is split into training (70%), validation (15%), and test sets (15%). The RFR is trained on the training set, validated on unseen data, and tested for predictive accuracy. The final prediction  $\hat{y}(X, D)$  for an input  $X$  after training on dataset  $D$  is computed as the average prediction across all trees, reducing variability and improving forecasting reliability.



**Figure 8: bi-LSTM imputation accuracy performance metrics for each tank**  
Source: Own

The f-LSTM-based water demand prediction method incorporates temporal features such as year, month, day, and hour to capture seasonal and temporal trends. These features are added as new columns, enabling the model to analyze long-term variations, seasonal patterns, and intra-day fluctuations, improving predictive accuracy (Niknam et al., 2022). The input and output data are normalized to the range (0,1) for optimized training, and the dataset is split into training (70%), validation (15%), and test sets (15%). The prediction model consists of an LSTM layer with 44 units, a ReLU activation function, a dropout layer (0.2) to prevent overfitting, and a Dense output layer for the final prediction. The model is trained

using the Adam optimizer and MSE loss function, with evaluation conducted on the test set. This approach ensures optimal model performance, effectively leveraging temporal dependencies and seasonal variations to enhance forecasting accuracy.

After the application of the bi-LSTM imputation method to the data, the f-LSTM model's performance was compared with RFR model for time series forecasting. Figure 8 presents the comparison focused on the same evaluation metrics (MSE, RMSE, MAE, and R2) to test sets.

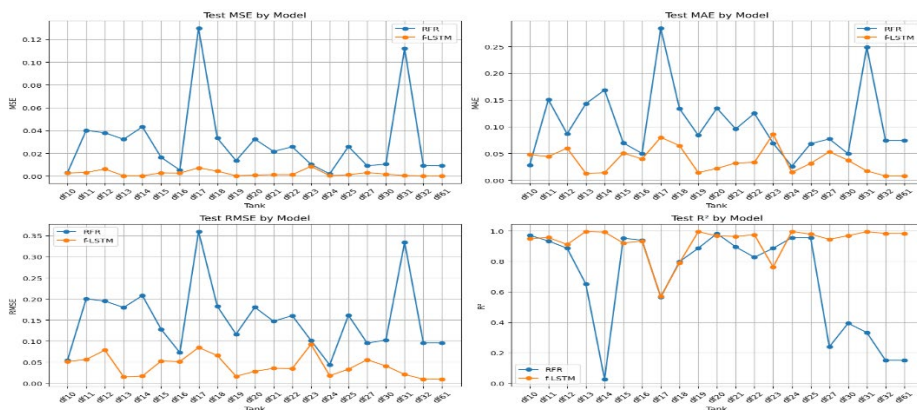


Figure 9: Forecasting performance of test data by model and tank

Source: Own

Table 3: Model comparison forecasting average performance in test sets

Model	Avg_Test_MSE	Avg_Test_MAE	Avg_Test_RMSE	Avg_Test_R2
RFR	0.0228	0.0960	0.1340	0.7199
f-LSTM	0.0002	0.0124	0.0150	0.9921

Source: Own

Table 4: Performance f-LSTM metrics for different imputation methods per cluster

Tank	Model	Missing %	MSE_bi-STM	MSE_Linear	MSE_Polynomial	MSE_Mean	MSE_KNN
df10	f-LSTM	3.12	0.0030	0.0011	0.0012	0.0030	0.0028
df11	f-LSTM	2.61	0.0003	0.0294	0.0280	0.0450	0.0400
df31	f-LSTM	11.91	0.0001	0.0052	0.0050	0.0060	0.0055
df32	f-LSTM	14.77	0.0001	0.0681	0.0650	0.0500	0.0480

Source: Own

## 4 Conclusions

This study aimed to improve the accuracy and reliability of short-term water demand forecasting by integrating deep learning and machine learning models with traditional statistical approaches. Advanced imputation methods, particularly the bi-directional Long Short-Term Memory (bi-LSTM) network, significantly enhanced forecasting performance, especially in cases with high percentages of missing data. Cluster analysis further revealed that water level dynamics influenced model effectiveness and hyperparameter optimization via Optuna. Simpler models performed well in stable water levels (Cluster 1), while reservoirs with moderate to high seasonal variations (Clusters 2 and 3) required advanced hyperparameters, such as increased LSTM units and varied learning rates, to improve accuracy. Highly dynamic reservoirs (Cluster 4) demonstrated that only deep learning models like forecasting LSTM (f-LSTM) consistently captured complexities, whereas traditional methods struggled. Bi-LSTM consistently outperformed traditional imputation methods, such as linear, polynomial, mean, and K-Nearest Neighbors (KNN) imputation, achieving lower Mean Squared Error (MSE) and higher  $R^2$  values, indicating its superior ability to handle complex temporal dependencies. It reduced forecasting errors by 15–20% in datasets with over 10% missing data, though increased prediction errors were observed in datasets with extreme irregularities or sudden spikes, with MSE values reaching 0.045 in such cases compared to 0.0025 in more stable datasets. Model effectiveness was found to be context-dependent, with f-LSTM demonstrating the highest robustness and accuracy, particularly in scenarios with non-linear dependencies and significant data irregularities, achieving an MSE as low as 0.0026, significantly outperforming traditional machine learning models. The Random Forest Regressor (RFR) effectively handled noisy and imprecise data, with MSE values between 0.015 and 0.050 in high-variability datasets, highlighting its strength in short-term forecasting but limitations in capturing long-term dependencies. Overall, f-LSTM excelled in modeling complex temporal relationships, while RFR offered strong noise tolerance, making both models highly effective in real-world water demand forecasting. Future research should focus on validating these models across diverse operational conditions, refining hyperparameter optimization, incorporating contextual data, and scaling them to larger datasets. Further advancements in real-time data integration, anomaly detection, and imputation techniques will enhance forecasting accuracy. Additionally, practical implementation should prioritize integrating these models

into operational water management systems, developing user-friendly interfaces for utility managers, and aligning model outputs with regulatory frameworks to ensure real-world applicability and adoption.

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# IZBOLJŠANJE PODJETNIŠKE IZKUŠNJE: PODPORNO OKOLJE ZA TRAJNOSTNI RAZVOJ PODJETNIŠTVA V SLOVENIJI

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V prispevku obravnavamo krepitev podjetniške izkušnje prek učinkovitega podpornega okolja, ki ga omogoča Republika Slovenija. V sodelovanju z Regionalno razvojno agencijo Ljubljanske urbane regije (RRA LUR) smo raziskali obstoječi projekt PONI, ki spodbuja podjetništvo. RRA LUR kot povezovalna agencija osrednjeslovenskih občin prispeva k usklajenemu gospodarskemu razvoju, trajnostni mobilnosti in učinkoviti rabi virov. Skozi pregled učinkov projekta PONI, ki deluje v okviru RRA LUR in katerega cilj je ustanovitev novih podjetij, ki jih bodo preko podjetniškega usposabljanja realizirale osebe s podjetniško idejo podpornega okolja za podjetništvo, smo prikazali rešitve za učinkovitejšo podporo poslovnim začetnikom. V prispevku poudarjamo pomen ustvarjanja spodbudnejšega podjetniškega okolja, ki olajša začetek poslovanja in pospeši gospodarski razvoj Slovenije. V zaključku spodbujamo nadaljnji razvoj znanj in spretnosti, potrebnih za industrijske spremembe in trajnostni napredek.

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# ENHANCING THE ENTREPRENEURIAL EXPERIENCE: A SUPPORTIVE ENVIRONMENT FOR SUSTAINABLE ENTREPRENEURSHIP DEVELOPMENT IN SLOVENIA

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**Keywords:**  
entrepreneurship,  
business management,  
support environment,  
RRA LUR,  
HRM

The paper discusses the strengthening of entrepreneurial experience through an effective supportive environment provided by the Republic of Slovenia. In cooperation with the Regional Development Agency of the Ljubljana Urban Region (RRA LUR), we investigated the existing PONI project, which promotes entrepreneurship. RRA LUR, as a coordinating agency of central Slovenian municipalities, contributes to coordinated economic development, sustainable mobility and efficient use of resources. By reviewing the effects of the PONI project, which operates within the framework of RRA LUR and aims to establish new companies that will be realized through entrepreneurial training by people with an entrepreneurial idea and a supportive environment for entrepreneurship, we have presented solutions for more effective support for business start-ups. The paper emphasizes the importance of creating a more stimulating entrepreneurial environment that facilitates starting a business and accelerates the economic development of Slovenia. In conclusion, we encourage the further development of knowledge and skills necessary for industrial change and sustainable progress.





## 1 Uvod

Podjetništvo je ključna gonilna sila gospodarskega razvoja, saj prinaša inovacije, odpira nova delovna mesta in krepi konkurenčnost na trgu (Ruzzier et al., 2008; Rebernik et al., 2017). Uspešen podjetniški proces pa zahteva več kot le individualno zavzetost in inovativnost. Ključno je tudi podporno okolje, ki podjetnikom nudi storitve in vire, potrebne za premagovanje izzivov v začetnih in nadaljnjih fazah podjetniškega cikla (Lah, 2009; Matko, 2020).

V prispevku proučujemo podporno okolje za razvoj podjetništva v Sloveniji, zlasti v sodelovanju z Regionalno razvojno agencijo Ljubljanske urbane regije (RRA LUR). RRA LUR je razvojna agencija, ki povezuje 25 osrednjeslovenskih občin, med njimi glavno mesto Ljubljana, zaradi svoje povezovalne vloge pa ima pozitiven vpliv tudi zunaj regije. Z različnimi aktivnostmi in projekti omogoča premik na boljše širokemu krogu lokalnih, regionalnih, nacionalnih in evropskih deležnikov. Posebej se bomo osredotočili na njihov projekt PONI, na sodelujoče na projektu in na končni učinek projekta.

Skozi prispevek zasledujemo cilj prikazati uspešnost podpornega okolja na primeru RRA LUR in njihovega projekta PONI ter izpostaviti pomen učinkovite podpore podjetnikom, še posebej začetnikom. V razpravi poudarimo pomen inovacij, trajnostnega razvoja in digitalne preobrazbe, kar so po našem prepričanju ključni dejavniki za izboljšanje slovenskega podjetniškega ekosistema. Ob zaključku v prispevku predstavimo usmeritve za nadaljnji razvoj znanj in spretnosti, ki so nujne za uspešno prilagajanje industrijskim spremembam in trajnostnemu napredku Slovenije.

## 2 Pregled literature

Ruzzier, Antončič, Bratkovič in Hisrich (2008) podjetništvo opredeljujejo kot proces ustvarjanja nečesa novega in vrednega, ki ga spremlja prevzem tveganja z namenom doseganja osebnega in družbenega napredka. Kot poudarjajo Vidic, Vadnjal in Knez (2008), podjetništvo presega osebni interes podjetnika in postaja temeljni dejavnik gospodarskega razvoja, saj prispeva k ustvarjanju delovnih mest in povečanju bruto domačega proizvoda (BDP).

Podporno okolje za razvoj podjetništva se osredotoča na zagotavljanje infrastrukture, finančne podpore in mentorstva za podjetnike. Rebernik in Jaklič (2014) menita, da je podporno okolje v Sloveniji sicer zasnovano široko, vendar pogosto ne upošteva raznolikih potreb podjetnikov v različnih fazah razvoja, zato predlagata bolj usmerjene politike, ki bi podpirale specifične potrebe različnih vrst podjetij.

V Sloveniji podporno okolje vključuje več institucij, med katerimi so ključne Regionalne razvojne agencije (RRA), univerzitetni in podjetniški inkubatorji ter tehnološki parki (Kunšek, 2018). RRA LUR deluje kot povezovalna institucija, ki podpira usklajen gospodarski razvoj in trajnostne pobude v osrednji Sloveniji (Matko, 2020). Njihovo delo vključuje koordinacijo projektov trajnostne mobilnosti in spodbujanje učinkovite rabe virov, kar posredno izboljšuje tudi pogoje za podjetništvo.

Subjekti inovativnega okolja, kot so tehnološki parki in inkubatorji, igrajo ključno vlogo pri razvoju novih podjetij. Tehnološki parki omogočajo dostop do raziskovalnih kapacitet in naprednih tehnologij, medtem ko inkubatorji nudijo podporo pri začetnih korakih podjetniškega procesa (Pravilnik o vodenju evidence subjektov inovativnega okolja, 2008). Podjetniški pospeševalniki pa se osredotočajo na hitrejšo rast že obstoječih podjetij (Blakely, 2021).

Kljub obstoječim mehanizmom so prisotni izzivi, kot so pomanjkanje enotne podjetniške politike, omejeni finančni viri in neenakomerna dostopnost podpornih storitev. Eden izmed ključnih izzivov je zagotavljanje dolgotrajne finančne stabilnosti za institucije, ki podpirajo podjetništvo (Lah, 2009), temu pa sledi potreba po usklajevanju politik za učinkovitejšo podporo podjetjem v težavah (Rebernik et al., 2021).

Inovacije, trajnostni razvoj in digitalizacija so osrednji dejavniki, ki vplivajo na uspešnost podjetniškega okolja. Inovacije namreč povečujejo konkurenčnost podjetij in pospešujejo gospodarski razvoj (Crnogaj in Rebernik, 2013). Trajnostni prehod, ki vključuje učinkovito rabo virov in zmanjševanje okoljskega odtisa, postaja vse pomembnejši del podjetniških strategij (Šuštar, 2011). Digitalna transformacija odpira nove možnosti za mala in srednje velika podjetja, vendar zahteva ustrezno podporo pri razvoju digitalnih veščin in infrastrukture (OECD, 2021).

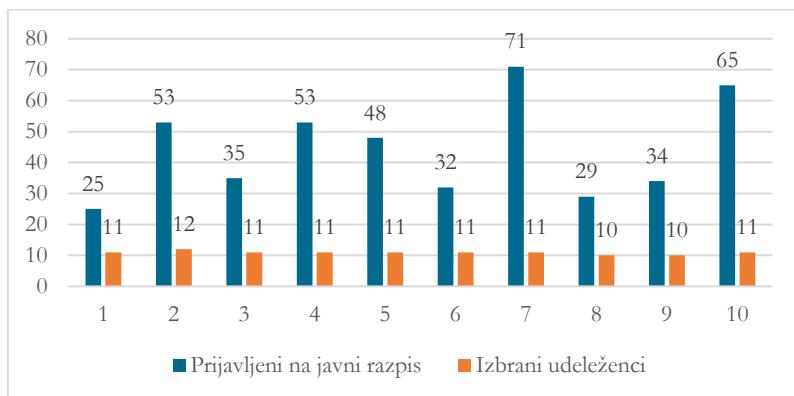
Podporno okolje za razvoj podjetništva v Sloveniji ponuja številne mehanizme in storitve za podporo podjetjem, vendar se sooča z izzivi, ki jih je mogoče premagati z boljšim usklajevanjem politik, povečano finančno podporo in strateškim usmerjanjem. Krepitev inovacij, trajnostni prehod in digitalna transformacija so ključni koraki za oblikovanje podjetniškega okolja, ki bo omogočalo rast in razvoj gospodarstva.

### **3 Podporno okolje na RRA LUR skozi projekt PONI**

RRA LUR je že od leta 2007 ključni deležnik podpornega okolja v osrednjeslovenski regiji, saj je tega leta začela z izvedbo programa »Podjetno v svet podjetništva« (PVSP). Namen projekta je bilo spodbujanje podjetništva med mlajšimi brezposelnimi z višjo ali visoko stopnjo izobrazbe in odpiranja novih delovnih mest. Zaradi velikega zanimanja in dobrih rezultatov se je v letu 2020 projekt preoblikoval in preimenoval v »Podjetno nad izzive« (PONI) in je tako postal vseslovenski projekt, ki ga izvaja vseh 12 regij v Sloveniji.

Glavni cilj projekta je ustanovitev novih podjetij, ki jih bodo preko podjetniškega usposabljanja realizirale osebe s podjetniško idejo. Za spodbuditev podjetniške aktivnosti in uspešen razvoj poslovnih idej je namreč v prvi fazi potrebna vsebinska podpora, ki jo udeležencem nudijo notranji in zunanji mentorji, zunanji strokovnjaki in podjetniki. Pričakovani rezultat projekta je od leta 2020 do 2028 izobraziti 184 bodočih potencialnih podjetnikov. Cilj pa je realizirati minimalno 30 % uspešnih izhodov v podjetništvo.

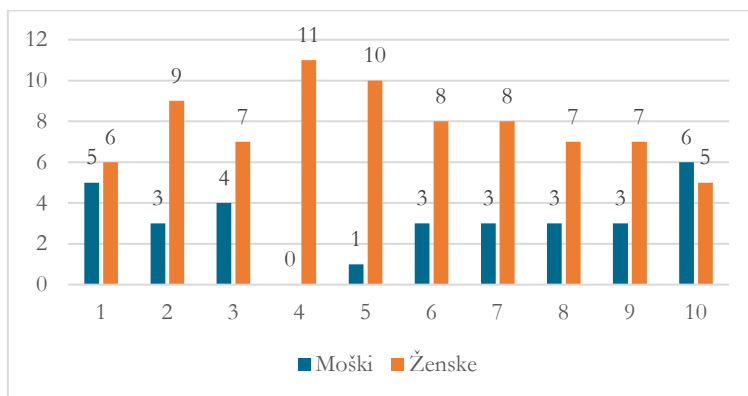
Slika 1 prikazuje število prijav na vseh 10 javnih razpisov, ki so bili razpisani od leta 2020 do konca leta 2024. Skupno je bilo izbranih v usposabljanje 109 udeležencev od 445 prijav. Skupine udeležencev so bile velike od 10 do 12 udeležencev na skupino. Najmanjše število prijav na javni razpis je bilo v prvem razpisu, samo 25, največji naval prijav pa pri sedmem javnem razpisu, saj se je prijavilo kar 71 kandidatov.



**Slika 1: Število prijav na vseh 10 javnih razpisov**

Vir: Lasten

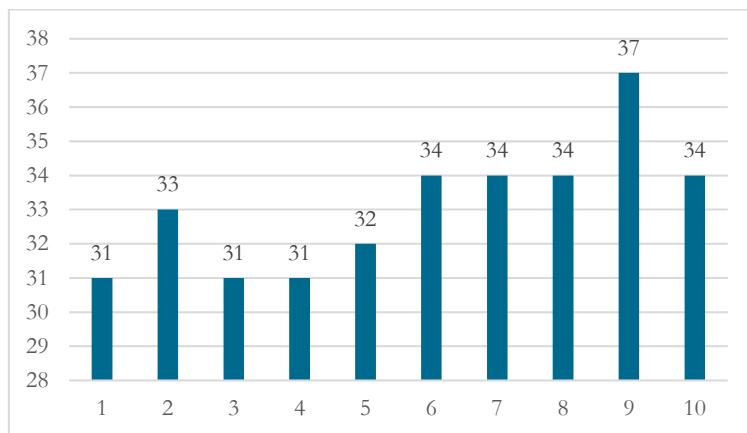
Slika 2 prikazuje razmerje po spolni strukturi v vseh skupinah. V celotnem obdobju izobraževanja se je izobrazilo 78 žensk in 31 moških. V prvih devetih skupinah so tako prevladovali ženske, v zadnji deseti skupini pa moški.



**Slika 2: Struktura udeležencev po spolu**

Vir: Lasten

Slika 3 prikazuje povprečno starostno strukturo udeležencev po vseh skupinah. Skupno v vseh desetih skupinah je bila povprečna starost 33 let. Najmlajša udeleženka, ki je bila sprejeta v program, je imela 21 let, najstarejša pa 52 let.



Slika 3: Povprečna starost udeležencev

Vir: Lasten

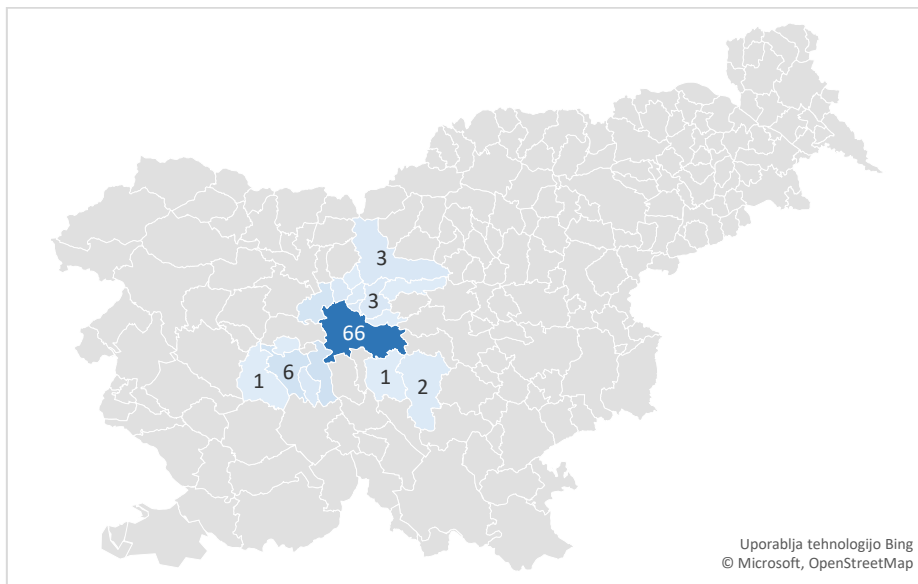
Največ udeležencev programa (Tabela 1) je prijahalo iz Ljubljane, kar 66, sledi ji občina Brezovica s 7 kandidati, nato Vrhnika s 6 kandidati, Medvode s 5 kandidati, po 3 kandidati so prihajali iz občin Domžale, Kamnik, Trzin, Borovnica in Vodice, po 2 kandidata iz Ivančne Gorice in Mengeša ter po 1 kandidat iz Dola pri Ljubljani, Grosuplje, Horjula, Komende, Logateca in Lukovice.

Tabela 1: Število kandidatov po občinah

Občina	Št. udeležencev
Ljubljana	66
Brezovica	7
Vrhnika	6
Medvode	5
Domžale	3
Kamnik	3
Trzin	3
Borovnica	3
Vodice	3
Ivančna Gorica	2
Mengeš	2
Dol pri Ljubljani	1
Grosuplje	1
Horjul	1
Komenda	1
Logatec	1
Lukovica	1

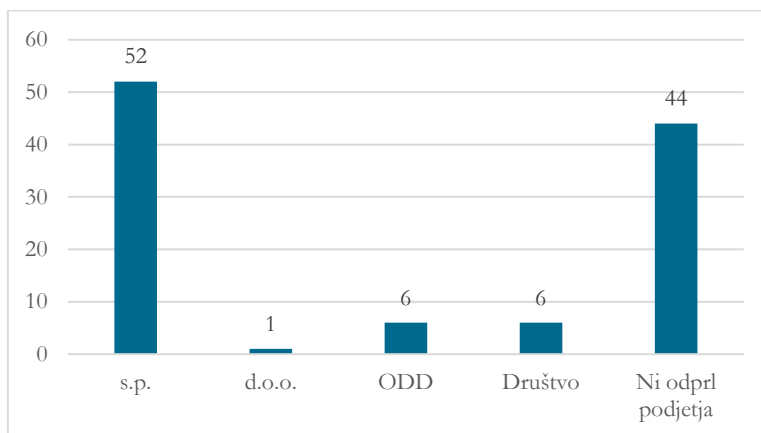
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RRA LUR pokriva osrednjeslovensko regijo, v katero je vključenih 25 občin. Kandidati, ki so bili vključeni v program PONI LUR, so prihajali iz 17 občin (Slika 4).



**Slika 4: Število kandidatov po občinah**

Vir: Lasten



**Slika 5: Število odprtih podjetij glede na pravno formalno obliko**

Vir: Lasten

Slika 5 prikazuje število odprtih podjetij glede na pravno formalno obliko. Kar 52 udeležencev je odprlo s. p. po končanem usposabljanju, 6 udeležencev društvo, 6 udeležencev osebno dopolnilno delo in 1 udeleženec d. o. o. 44 udeležencev pa trenutno še ni odprlo svojega podjetja.

#### 4 Diskusija o pomenu podpornega okolja za razvoj podjetništva

Podporno okolje za podjetništvo ima ključno vlogo pri spodbujanju gospodarskega razvoja, saj omogoča podjetnikom dostop do potrebnih virov, mentorstva in infrastrukture, kar olajša proces od ideje do uspešnega poslovanja. V kontekstu Slovenije podrobna analiza kaže, da so regionalni subjekti, kot je RRA LUR, ključni akterji pri povezovanju lokalnih gospodarskih interesov in trajnostnega razvoja (Kunšek, 2018; Matko, 2020). Sami smo prikazali uspešnost delovanja RRA LUR v njihovem delovanju skozi primer projekta PONI, ki pomaga začetnikom ustanoviti lastna podjetja.

Inovacije so eden najpomembnejših izidov učinkovitega podpornega okolja. Tehnološki parki, univerzitetni in podjetniški inkubatorji ter pospeševalniki igrajo ključno vlogo pri spodbujanju inovativnosti, saj podjetnikom omogočajo dostop do raziskovalnih kapacitet, znanja in tehnoloških rešitev (Pravilnik o vodenju evidence subjektov inovativnega okolja, 2008; Rebernik et al., 2021). Na primer, programi RRA LUR vključujejo elemente trajnostne mobilnosti in učinkovite rabe virov, kar posredno prispeva k razvoju okolju prijaznih poslovnih modelov. Kljub vsemu naštetemu vseeno ugotavljamo, da nekateri udeleženci kljub vsej tej podpori ne ustanovijo podjetij.

Trajnostni prehod je pomemben vidik slovenskega podjetniškega okolja, saj spodbuja usklajen razvoj, ki hkrati naslavlja ekonomske, družbene in okoljske izzive. Takšni prehodi ustvarjajo okolje, v katerem podjetja lahko razvijajo inovativne in trajnostne rešitve z minimalnim negativnim vplivom na okolje (Šuštar, 2011). Povezava med trajnostjo in podjetništvom je ključna za dolgoročni gospodarski napredek Slovenije.

Kljub napredku se podporno okolje v Sloveniji sooča z izzivi, ki vplivajo na njegovo učinkovitost. Pomanjkanje enotne podjetniške politike, fragmentacija financiranja in omejene zmogljivosti za specializirano podporo so ključne ovire (Rebernik in Jaklič,

2014; Lah, 2009). Financiranje inovativnih podjetij ostaja problematično, saj so dostop do tveganega kapitala in poslovni angeli v Sloveniji omejeni, kar vodi do odhoda perspektivnih podjetij v tujino (Blakely, 2021).

Poleg financiranja je treba več pozornosti nameniti digitalni transformaciji podjetij. Digitalizacija omogoča optimizacijo procesov in širjenje poslovanja na globalne trge, vendar zahteva usklajeno podporo pri razvoju digitalnih veščin in dostopu do ustrezne infrastrukture (OECD, 2021).

Podporno okolje mora biti prilagojeno specifičnim potrebam podjetnikov v različnih fazah njihovega razvoja. Medtem ko start-up podjetja potrebujejo inkubatorsko podporo, mentorstvo in dostop do osnovnih virov, pa po drugi strani rastoča podjetja zahtevajo podporo pri iskanju novih trgov in razvoju naprednih rešitev (Forrest, 2018). Tovrstna usmerjena podpora lahko poveča učinkovitost podjetniških politik in spodbudi boljši prenos znanja iz akademskih in raziskovalnih institucij v gospodarstvo (Kunšek, 2018).

Podporno okolje za razvoj podjetništva je v Sloveniji pomemben vzvod za krepitev inovativnosti, trajnosti in gospodarskega napredka. Prilagoditev politik, izboljšanje dostopa do financiranja ter pospeševanje digitalne transformacije so ključni koraki za izboljšanje trenutnega stanja. RRA LUR in podobne agencije podpornega okolja s svojim delovanjem kažejo, da je mogoče vzpostaviti učinkovite povezave med lokalnimi skupnostmi, podjetniki in državnimi pobudami, kar prispeva k celovitemu razvoju slovenskega podjetniškega ekosistema.

## 5 Zaključek

Podporno okolje za razvoj podjetništva je torej ključnega pomena za gospodarski napredek, saj podjetnikom nudi podporo pri premagovanju ovir, ki se pojavljajo na različnih stopnjah njihovega poslovnega cikla. Skozi pregled obstoječih podpornih mehanizmov, ki jih v Sloveniji zagotavlja podporno okolje, kot je RRA LUR, smo razkrili pomembno vlogo teh subjektov pri ustvarjanju spodbudnejšega podjetniškega okolja (Matko, 2020; Kunšek, 2018) skozi njihovo delovanje.



RRA LUR namreč s svojim projektom PONI, svojim usklajenim delovanjem na področju trajnostne mobilnosti, učinkovite rabe virov in gospodarskega razvoja prispeva k izboljšanju podjetniškega ekosistema, ki omogoča inovativnost in trajnostni prehod (Šuštar, 2011). V Sloveniji so prisotni še številni drugi subjekti, kot so tehnološki parki, inkubatorji in pospeševalniki, ki podjetnikom zagotavljajo dostop do mentorstva, financiranja in tehnoloških rešitev (Pravilnik o vodenju evidence subjektov inovativnega okolja, 2008), vendar pa je še vedno dovolj prostora za izboljšave.

Kljub vsem naštetim koristim se podporno okolje sooča s pomembnimi izzivi, kot so pomanjkljivosti v financiranju, neenakomerna dostopnost podpornih storitev ter potreba po večji usmerjenosti politik v spodbujanje trajnostnega in digitalnega prehoda (Rebernik in Jaklič, 2014; OECD, 2021). Menimo, da bi se lahko podjetniško okolje dodatno izboljšalo s krepitvijo povezav med raziskovalnimi institucijami in gospodarstvom ter večjo specializacijo podpornih subjektov za posamezne industrijske panoge (Forrest, 2018).

Krepitev podjetniške izkušnje je torej ključna za pospeševanje gospodarskega razvoja in trajnostnega napredka Slovenije. Uspešno podporno okolje zahteva usklajene napore različnih deležnikov, usmerjene v inovacije, digitalizacijo in trajnost. Z izboljšanjem dostopnosti podpornih storitev, usmerjeno podjetniško politiko in okrepljenim sodelovanjem med sektorji lahko v Sloveniji še naprej gradimo na svojih potencialih kot inovativno in podjetniško naravnano okolje.

## **Zahvala**

Prispevek je nastal v okviru projekta "Izboljševanje podjetniške izkušnje s pomočjo podpornega okolja v Ljubljanski urbani regiji" v okviru javnega razpisa z naslovom "Problemsko učenje študentov v delovno okolje: gospodarstvo, negospodarstvo in neprofitni sektor v lokalnem/regionalnem okolju 2024–2027", ki ga financirata Ministrstvo za visoko šolstvo, znanost in inovacije Republike Slovenije ter Evropski socialni sklad plus (ESS+) Evropske unije.

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## O avtorjih

Lea Ulčar zaključuje magistrski študijski program Organizacija in management kadrovskih in izobraževalnih sistemov na Fakulteti za organizacijske vede Univerze v Mariboru. Njeni raziskovalni interesi vključujejo področja podjetništva, projektnega vodenja, vodenja in organizacije. Praktične izkušnje pridobiva z delom na različnih projektih, svoje znanje pa je nadgradila z udeležbo na Erasmus+ usposabljanju za vodenje projektov in programu AmCham Young Professionals.

Dejan Marinčič, magister zdravstveno-socialnega managementa, je trenutno doktorski študent na Fakulteti za organizacijske vede Univerze v Mariboru. Zaposlen je kot svetovalec direktorice za podjetništvo in inovativnost na Regionalni razvojni agenciji Ljubljanske urbane regije (RRA LUR). Kot vodja projekta PONI LUR (Podjetno nad izzive) je ključni mentor za udeležence programa, ki jim pomaga pri razvoju podjetniških idej in vstopu na trg. Pod njegovim vodstvom je program dosegel visoko stopnjo uspešnosti, saj je od 98 udeležencev kar 43 ustanovilo lastno podjetje ali dejavnost. Dejan je aktiven tudi pri promociji podjetništva v regiji, kar vključuje sodelovanje na dogodkih, kot je Potujoča pisarna evropskih sredstev, kjer predstavlja uspešne zgodbe programa PONI. Njegova predanost in strokovnost sta pripomogli k razvoju številnih inovativnih podjetniških pobud v Ljubljanski urbani regiji.

Dr. Miha Marič je raziskovalec s področja vodenja, managementa in organizacijskih ved. Doktoriral je na Ekonomski fakulteti Univerze v Ljubljani. Trenutno je zaposlen kot izredni profesor na Fakulteti za organizacijske vede Univerze v Mariboru. Njegovi raziskovalni interesi so moč, vodenje, organizacijsko vodenje, kadrovski management, organizacija in management. Je avtor številnih izvirnih znanstvenih člankov, znanstvenih monografij in poglavij v znanstvenih monografijah ter strokovnih člankov in prispevkov na znanstvenih konferencah. Je član uredniških odborov revij, bil je urednik in recenzent ter član programskih odborov več mednarodnih konferenc. Sodeluje tudi pri raziskovalnih projektih in svetovalnem delu.

Dr. Maja Đurica je diplomirala na Ekonomski fakulteti Univerze v Beogradu, kjer je zaključila tudi magistrski študij in uspešno zagovarjala magistrsko nalogo z naslovom »Mednarodni direktni marketing«. Doktorsko disertacijo z naslovom »Strategije trženja finančnih storitev« je zagovarjala leta 2009 na Fakulteti za organizacijske vede v Beogradu, Srbija. Njeno raziskovalno področje obsega: marketing, marketing storitev, strateški marketing in digitalni marketing. Od leta 2004 je zaposlena kot profesorica na Visoki poslovni šoli za umetnost in poslovanje v Beogradu, ki se nahaja na Kraljice Marije 73 v Beogradu, Srbija. Samostojno in v soavtorstvu je objavila številne znanstvene članke v revijah in konferenčnih gradivih ter učbenike z naslovi: \*Marketing\* (Beograd, Srbija, Visoka poslovna in umetniška akademija aplikativnih študij, več izdaj učbenika), \*Marketing storitev\* (Beograd, Srbija, Visoka poslovna in umetniška akademija aplikativnih študij, več izdaj učbenika), \*Marketing v turizmu\* (Beograd, Srbija, Visoka poslovna in umetniška akademija aplikativnih študij, 2017) in \*Raziskava trga\* (Valjevo, Srbija, Visoka poslovna šola aplikativnih študij Valjevo, 2010).



# APPROACHES TO COMPREHENSIVE PERFORMANCE EVALUATION OF SOFTWARE APPLICATIONS: A SYSTEMATIC LITERATURE REVIEW

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Performance evaluation of modern software applications is necessary to optimize resources and improve the reliability of software applications, whose main problems are related to low throughput, long response times, and high support costs. Software Performance Engineering methodology provides early prediction and optimization using simulation, benchmarks and profiling. Analysis of publications revealed problems with data processing, lack of standardization of metrics and lack of effective application of analytical models, which complicate the process of evaluating the performance of information systems. Addressing these issues and standardizing approaches will help improve the processes for evaluating the performance and reliability of information systems that meet user and customer requirements.

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performance modeling,  
performance metrics,  
performance testing,  
performance prediction,  
benchmarks



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## 1 Introduction

Choosing the optimal configuration of computing resources for an application becomes a non-trivial task even for experienced developers (Cunha et al., 2013). To resolve these issues, software performance analysis and management techniques are actively used to identify bottlenecks, optimize resource utilization and reduce costs (Hsu & Devetsikiotis, 2007; Litoiu & Barna, 2013).

The performance of software applications depends on many factors, including component implementation, third-party services used, deployment platform, usage profile, and competition for resources (Danciu et al., 2015). An important aspect is to consider performance metrics not only at the infrastructure level, but also at the level of algorithms, applications, third-party components and services. This allows to comply with service level agreements (SLAs) and optimize the parameters of software applications (Streitz et al., 2018). Since the early 2000s, Software Performance Engineering (SPE) methodology has become an important tool for early prediction and management of software application performance throughout the entire development life cycle (Evangelin Geetha et al., 2011). However, the results of such modeling often do not correlate with real-world performance in the long term, making regular performance evaluation and testing an important part of the development process (Tsuji et al., 2017).

## 2 Methodology

We have performed a systematic literature review to explore the main directions and findings of previous research in the area of software application performance. The literature review procedure followed the basic steps of the Prisma 2020 methodology (Page et al., 2021).

To select appropriate keywords, we first defined a research question by clarifying the boundaries of our survey. The question was defined as follows: **RQ**: What metrics and monitoring techniques are used to evaluate the performance of software applications? The constraints were specified as:

- publication Years: 1990–2025,
- language: English,

- document Types/Source type: article, proceedings paper, review, early access, book chapter, editorial material, book review, book, discussion,
- categories/subject area: computer science theory methods, computer science information systems, computer science software engineering, computer science artificial intelligence, computer science interdisciplinary applications.

The search was performed using 34 combinations of search queries. Examples of search query combinations are as follows: "performance evaluation" AND "software", "performance evaluation" AND "application", "software performance" AND "evaluation", "performance assessment" AND "software systems".

The results of the initial search without cleaning are shown in Table 1.

**Table 1: Literature search results**

Web of Science	Scopus	ProQuest Dissertations & Theses	Total
works	works	works	works
9667	34619	1688	45974

The obtained results were merged into one data source, where duplicates were removed for records having the same DOI and title. In the next step, publications were selected where at least one of the key phrase combinations among the title or abstract was found: "performance assessment", "performance model", "performance evaluation", "performance testing", "performance measurement", "performance metrics". The final data source was reduced to 339 records. The primary manual analysis of the abstracts resulted in the removal of an additional 176 records (e.g., addressing hardware and network equipment performance issues). The text of 23 publications could not be accessed. The text of the remaining 134 publications was downloaded and analyzed.

### 3 Results

In the early 2000s, the process of evaluating the performance of software applications was conducted in three steps. First, components were described using Unified Modeling Language (UML) or Architecture Description Language (ADL) diagrams, then the project was transformed into an analytical model such as queueing networks (QN) or Stochastic Rendezvous Network (SRN) model. In the

final stage, the experimental results were used to refine the design (Yuan et al., 2006). Further development of techniques such as benchmark-based testing, profiling and prototyping have greatly simplified and accelerated the performance evaluation process (Hsu & Devetsikiotis, 2007).

### **3.1 Benchmarks**

Benchmarks are a key tool for evaluating the performance of software applications and configurations. Testing is performed in isolated environments to accurately analyze resources including CPU, memory, and networking (Chhetri et al., 2014; Peng et al., 2004; Podzimek & Chen, 2013). For example, the IBM Trade Performance Benchmark tool is designed to analyze all layers of enterprise application architecture, including client, server, and storage layers (Dube et al., 2007). In high performance computing (HPC), NASA uses specialized HPC benchmarks that enable deep analysis of systems (Mehrotra et al., 2012). Microbenchmark approaches evaluate individual components such as CPU and memory, while Macrobenchmarks measure system performance in real-world scenarios (Scheuner, 2022).

### **3.2 Performance monitoring of software applications**

Real application monitoring is an approach to performance evaluation based on analyzing system behavior through real or simplified versions of applications (Tsuji et al., 2021). Applications are instrumented to collect data on parameters such as resource utilization, task execution time, and access to shared resources, allowing workloads to be modeled for the target platform (Ittershagen et al., 2015). Basic monitoring techniques include tracing, logging, and the use of specialized tools that help collect data on function calls and other aspects of system behavior (Becker et al., 2008; Guo et al., 2015; Meyer et al., 2020; Saastamoinen & Kreku, 2011; Yao et al., 2018). Certain solutions use user agents to collect data, followed by processing and visualization of the results (Willnecker et al., 2015).

### **3.3 Key performance indicators**

Approaches to software application performance evaluation cover a wide range of metrics and techniques. Taking into account the interests of various stakeholders, including end users, testers, and developers, requires the selection of appropriate



techniques and metrics for performance evaluation. Users emphasize response time, while testers focus on throughput, reliability, maximum number of users, and fault tolerance (Devaraj et al., 2008; Guan et al., 2019; Li et al., 2019). Key metrics such as average response time and throughput are complemented by specific metrics such as Equivalent Instruction Count (EIC) and Normalized Equivalent Instruction Count (NEIC), which take into account “wait time”, CPU, memory and network usage (Meyer et al., 2020; Rupnow et al., 2010; Wang & Ying, 2018; Weyuker & Vokolos, 2001). Metrics of successful/failed requests and task timing characteristics are important for analyzing systems under load to improve scaling algorithms (Cholomskis et al., 2018).

### **3.4 Server hardware data collection tools**

Software application monitoring technologies have evolved from simple profiling tools to sophisticated solutions. The first tools, such as prof and gprof, captured function timestamps and became a standard for UNIX systems (Malony, 1990). Application performance management (APM) tools such as Dynatrace and AppDynamics monitor response times, resource usage and failure rates, with centralized data storage for analysis (Rabl et al., 2012). Cloud providers, including Amazon CloudWatch, provide CPU and memory utilization data (Podzimek & Chen, 2013), while the Ganglia and Nagios tools provide online access to server performance information (Yao et al., 2018).

### **3.5 Building performance models**

Building performance models is a key analysis step that allows us to predict and evaluate the behavior of systems early in the design process. Architectural models are used to plan capacity and automate resource management by considering metrics such as resource utilization, response time, and throughput (Eismann et al., 2018). Advanced approaches include analytical modeling, measurement, and simulation, where analytical models use mathematical expressions, measurements are applied to existing systems, and simulations create models for preliminary evaluation (Evangelin Geetha et al., 2011; Huang, 2004; Rupnow et al., 2010).

Automatic performance model generation from UML diagrams enables the use of Layered Queueing Networks (LQNs) and Petri nets for quantitative analysis (Campos & Merseguer, 2006; D'Ambrogio & Iazeolla, 2005; Gómez-Martínez & Merseguer, 2006; Pham & Nguyen, 2013; Tang et al., 2018). Markov models, which describe probabilistic transitions between system states, integrate with UML and stochastic process algebra, simplifying the prediction and analysis of complex systems (Sbeity & Dbouk, 2014; Tribastone & Gilmore, 2008).

Alternative approaches to software performance analysis and optimization cover UML diagram annotation, probabilistic methods, and specialized optimization tools. For example, the Software Performance MDA Framework methodology automates the transformation of UML diagrams into LQN models by extending the analysis of non-functional attributes (Di Marco & Mirandola, 2006). Other approaches, such as the AOP-based Performance Evaluation Framework, simplify the verification of performance requirements through aspects, and Response Surface Methodology optimizes the parameters of simulated applications in a cost-aware manner (Hsu & Devetsikiotis, 2007). Using Software Performance Curves and integrating workflows with UML through Directed Acyclic Graphs strengthens the connection between the design and analysis of software applications (Westermann & Momm, 2010; Zhang et al., 2011). Using UML-MARTE with LQN transformation and Genetic Search Algorithm allows to find optimal configurations of modeled applications (Amoozegar & Nezamabadi-pour, 2012). Polynomial Chaos Expansion methodology emphasize uncertainty accounting and self-adaptive performance (Aleti et al., 2018; Incerto et al., 2017). Another area is represented by analyzing dependencies between input parameters and performance characteristics using statistical models and machine learning (Aleti et al., 2018; Buneci, 2008; Happe et al., 2009; Moghadam, 2022; Yao et al., 2018).

### **3.6 Comprehensive application performance evaluation**

Integrated performance evaluation of software applications combines application, infrastructure, and user interaction data to provide a comprehensive analysis. This approach, which began by describing systems as vector characteristics of basic operations such as I/O and processor commands (Xiaolong, 2001), has evolved with the introduction of the Apdex index, which converts response time data into a measure of user satisfaction (Chhetri et al., 2014). Methods such as Statistical

Learning Theory evaluate the average response time and its deviations to identify problems (Wang & Ying, 2018), while analyzing the optimal and maximum number of users determines the stability and reliability of the system (Li et al., 2019). Data integration, including response time, throughput, CPU and memory usage, not only allows you to optimize resources, but also to predict system behavior under changing loads (Tsuiji et al., 2021).

## **Discussion**

The results of this research emphasize the importance of comprehensive methodologies for evaluating the performance of software applications operating in complex ecosystems. A review of existing literature reveals persistent challenges in standardizing performance metrics, optimizing resource utilization, and developing effective modeling techniques. Addressing these challenges is critical to ensure the reliability and efficiency of software applications that play a key role in modern organizational processes and user satisfaction. The use of SPE methodology has proven to be effective in the early stages of performance prediction and optimization.

Benchmarking continues to play a key role in evaluating infrastructure configurations, providing valuable data on the capabilities of systems under different load conditions. However, there is a need to improve benchmarking practices by integrating micro- and macro-level analyses for more detailed and comprehensive assessments.

Modern software application monitoring tools provide accurate data collection, but challenges remain in aggregating and interpreting data from various system components to derive actionable insights. The use of user-friendly visualization and analytics platforms based on artificial intelligence can greatly enhance the utility of monitoring solutions.

The research emphasizes the importance of selecting appropriate performance metrics in line with stakeholder goals. To bring these perspectives together, composite performance indicators that integrate user experience metrics with infrastructure metrics need to be developed.

The use of statistical and machine learning techniques shows potential in improving prediction accuracy while reducing reliance on big data.

Integrated performance measurement systems that combine application, infrastructure, and user interaction data open the door to comprehensive systems analysis.

## Conclusion

This research confirms the key role of performance evaluation in modern software development. Analysis of literature and practices demonstrates the need to standardize metrics, integrate monitoring data, and use modern models for performance analysis.

The future of software performance evaluation research involves the development of automation of monitoring processes, data collection and analysis, standardization of metrics and methodologies to unify approaches, and the use of hybrid modeling approaches that combine analytical and simulation techniques. These directions will ensure the creation of more reliable, scalable and efficient software solutions that meet user expectations and business requirements.

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# APPROACHES TO EVALUATING THE QUALITY OF IT PROJECT DOCUMENTATION: A SYSTEMATIC LITERATURE REVIEW

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This research presents the results of a literature review of methods and approaches to assessing the quality of documentation in IT projects. We conducted a systematic review of about 100 publications devoted to the description of tasks and key elements of project documentation. In this paper we tried to systematize and summarize a) the main approaches and methods used to assess the quality of documentation descriptions in IT projects, b) key criteria and metrics that determine the completeness and clarity of documentation descriptions, c) problems encountered in assessing the quality of documentation and textual descriptions of tasks in IT projects. The obtained results provide a basis for our further work aimed at improving the quality and efficiency of project documentation.

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## 1 Introduction

In an era of rapidly evolving technologies, one of the key factors for successful IT project implementation is the quality of project documentation. Documentation serves as the basis for coordination among team members, helps avoid miscommunication, and facilitates effective task management. Deficiencies in documentation quality, such as unclear or incomplete task descriptions, often lead to delays, increased costs, and reduced quality of the final product. Quality documentation helps developers, analysts, and testers to understand requirements more accurately, reduces the risks of errors, and promotes a clearer distribution of responsibilities. The documentation quality assessment is becoming especially relevant in the context of globalization and remote work, where proper understanding of tasks is critical.

Our goal is to investigate the literature sources that touch upon the problem of assessing the quality of IT project documentation, to identify gaps in research and to determine directions for further research. Therefore, the main research questions of our work will be the issues related to assessing the quality of documentation descriptions in IT projects. RQ1 - What approaches and methods are used to assess the quality of documentation descriptions in IT projects? This question aims to summarize the existing approaches and tools that are used to analyze and assess the quality of documentation in IT projects. RQ2 - What are the key criteria that determine the completeness and clarity of documentation descriptions? Here we focus on the characteristics that make task descriptions qualitative and usable. RQ3 - What are the challenges in assessing the quality of documentation and textual task descriptions in IT projects? This question seeks to identify key barriers to effective documentation quality assessment.

In this paper, we present the results of a literature review of methods, approaches and techniques for assessing the quality of task descriptions and key elements of IT project documentation. Approximately 100 articles covering current approaches to assessing the quality of documentation in IT projects were reviewed.

## 2 Methodology

We used a systematic literature review method (Kitchenham & Charters, 2007) to identify studies investigating the problems of quality assessment of design documentation. We followed a pre-designed research strategy. The research strategy was as follows:

1. Setting the purpose of the study (we defined the purpose in the introduction). We also identified the main directions of the research. We formulated three research questions RQ1, RQ2 and RQ3 (the questions were defined by us in the introduction). When formulating the research questions, we were oriented not only to make a comprehensive analysis on our topic, but also to identify the main gaps in the field of quality assessment of task descriptions and key elements of IT project documentation.
2. Resource selection for literature search. Bibliographic databases such as Web of Science, Scopus and ProQuest Dissertation & Theses were used for the review. These databases were chosen because of their wide coverage of scientific publications and the ability to filter materials by keywords, time of publication and other parameters.
3. Definition of search criteria. Publications were searched using keywords related to the topic of our research study. Some keywords were as follows: ‘IT task description’, ‘quality assessment’, ‘documentation standards’, ‘software project management’, etc. The search included articles published in the period from 1990 to the present time.
4. The implementation of the search itself. We have implemented the search as follows.
  - 4.1. Manual literature search on Web of Science, Scopus and ProQuest Dissertation & Theses. At once we selected articles on these resources by keywords. We ended up with 36 files with the search results for each source. Each file contained the following information about the literature sources found: Publication Type, Authors, Book Authors, Book Editors, Book Group Authors, Author Full Names, Article Title, Source Title, etc. (75 characteristics in total).
  - 4.2. Automatic processing of manual search results. Using a program written in Python we processed the manually found articles.

5. A Data analysis and systematization. All found articles were analyzed for the issues we studied: approaches and methods used to assess the quality of documentation descriptions in IT projects (RQ1), key criteria and metrics determining the completeness and clarity of documentation descriptions (RQ2), problems arising in assessing the quality of documentation and textual descriptions of tasks in IT projects (RQ3). The articles were summarized and systematized by us.

As mentioned above, to implement point 4.2 of our strategy, we wrote a Python program that helped us to choose the most suitable data from the data set obtained in point 4.1. The algorithm of the program was as follows, let's describe it step by step:

- step 1: Integration of all Web of Science, Scopus, ProQuest Dissertation & Theses search results into three Excel files (a different file was created for each search source). As output we got the files `webofscience_integration.xls`, `scopus_integration.xls`, `ProQuest_integration.xls`,
- step 2: Removing columns from the files obtained in the previous step that do not carry important information for our search. As a result, in each of the three files we left only the columns: Title, Abstract, DOI, Cited by, Year,
- step 3: Combining the three files `webofscience_integration.xls`, `scopus_integration.xls`, `ProQuest_integration.xls` into one file, while finding and removing duplicates by DOI. As an output we got the file `all_integration.xls`,
- step 4: Filtering the file `all_integration.xls` by our specified keywords. As a result, we got the file `all_integration_filtered.xls`.

The file `all_integration_filtered.xls` contained records with the topics set by the filter. There were already much fewer such records than there were originally. Next, we looked through the articles in this file and selected the ones that were suitable for us. The keywords to search for were: “Software requirements”, “Project documentation”, “Structural assessment of requirements”, “Software documentation”, “Text quality evaluation”, “Software requirements” AND “Quality metrics”, “Natural language processing”, “Structural assessment” AND “Requirements”, “Crowd” AND “Clarity description”, “Crowd” AND “Natural

language processing”, “Text quality” AND “Evaluation” AND “NLP”. These keywords were included in searches within the Title and within the Abstract of the article. We tried to use the same filters for Web of Science and for Scopus. English language search filters were also set. The selected literature spans a variety of approaches, from automated analysis tools (e.g., NLP models) to manual evaluation of task descriptions.

### 3 Results

As described in the Methodology section, our first step was to generate search queries on three search resources Web of Science, Scopus, and ProQuest Dissertation & Theses. The obtained search results are shown in Fig. 1.

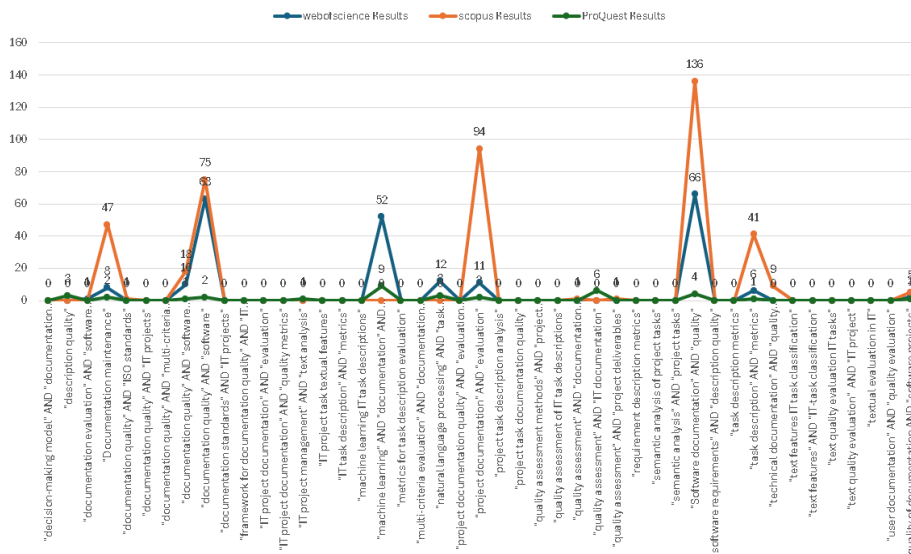


Figure 1: Search results (Y-axis) by queries (X-axis) for three search engines: Web of Science, Scopus, ProQuest Dissertation & Theses  
Source: Own

The figure shows that Scopus shows a significantly higher number of results for most search queries. For example, for the queries “documentation quality” AND “software”, “project documentation” AND “evaluation” and “software documentation” AND “quality”, 75, 94 and 136 publications were found, respectively. Web of Science showed fewer relevant publications, although for some

queries (e.g., “software documentation” AND “quality”) it provided 66 publications. ProQuest Dissertation & Theses has a limited number of results for all queries. In most cases, the results are either missing or minimal, indicating less complete coverage of the research topic by this platform.

### **3.1 Approaches and methods used to assess the quality of documentation descriptions in IT projects (RQ1)**

The literature review identified a variety of approaches to assessing the quality of documentation and textual descriptions of tasks in IT projects. We divided these approaches into four areas: automated methods, automated criteria and metrics, manual or semi-automated approaches, and standards-based approaches:

- use of automated methods. This can include the use of machine learning for classification tasks (Izadi idr., 2022; Rani idr., 2021), analyzing the vagueness or ambiguity of design problem descriptions (Nouri idr., 2021), estimating the structure of system requirements (Vierlboeck idr., 2024), and using graph metrics to estimate the complexity of system requirements (Aversano idr., 2017b),
- manual and semi-automated methods. These include informal and formal reviews (team discussions of documentation) (Bacchelli idr., 2012; Bettenburg & Premraj, 2024; Plösch idr., 2014), surveys of experts to identify key quality aspects (Plösch idr., 2014). Experts can also be involved to assess text quality criteria, e.g., Consistency (Aversano idr., 2017b; Plösch idr., 2014; Rani idr., 2023), Consistency to Standard (Aversano idr., 2017b; Ulan idr., 2018), Coherence (Pereira idr., 2024; Plösch idr., 2014; Rani idr., 2023; Treude idr., 2020; Zhi idr., 2015),
- use of criteria and metrics for assessing the quality of documentation. They are described in more detail in Table 1,
- using standards-based approaches. This can include standards-based qualitative models (e.g. ISO/IEC 25010 (Aversano idr., 2017b; Ulan idr., 2018) aimed at assessing the requirements captured in standards (functional suitability, reliability, usability and maintainability).

The identified approaches and metrics confirm that document quality assessment is a complex process requiring a combination of automation and expert analysis.

### **3.2 Key criteria and metrics that determine the completeness and clarity of documentation descriptions (RQ2)**

As a result of the study, we found that authors often use similar metrics and quality criteria in their works when assessing the quality of documentation in IT projects, despite the differences in approaches and analysis tools. We systematized these metrics and presented them in the form of a table 1, where each criterion is accompanied by references to literature sources.

It should be noted that most of the criteria discussed, such as readability, clarity, and structure, are used not only in the context of program documentation, but also to evaluate texts in general. For example, they are used in Crowdsourcing (Nouri idr., 2021, 2023; Yang idr., 2024). This suggests that the assessment of documentation quality is based on universal principles related to text properties. Automated readability Index and Fog Index are popular tools for readability assessment because they use objective text parameters (such as, average sentence length, average number of syllables in words) (Lehner, 1993). However, metrics such as Cohesion and Coherence are more often manually assessed (Treude idr., 2020).

Despite their universality, the criteria and metrics highlighted are poorly adapted directly to the project documentation. For example, in the context of software it is also essential to consider such aspects as the detailed description of functional requirements, the presence of use cases and test scenarios, as well as the completeness of the description of API interfaces. Existing metrics do not effectively measure how completely and accurately such elements are presented in the documentation. The criterion of compliance with technical standards requires a comprehensive analysis, including checking whether the structure and content of the documentation comply with the established standards. Automating such checks is difficult due to the diversity of standards and the difficulty in interpreting their requirements. Manual evaluation of some metrics makes the evaluation process labour-intensive, subjective and error-prone.

**Table 1: Most frequently mentioned criteria and metrics for the quality of text descriptions**

Quality criteria /metric	References to sources
<b>Criteria</b>	
Readability	(Aversano idr., 2017b, 2017a; Lehner, 1993; Nouri idr., 2021; Pereira idr., 2024; Plösch idr., 2014; Rani idr., 2023; Treude idr., 2020; Yang idr., 2024; Zhi idr., 2015)
Clarity	(Bacchelli idr., 2012; Ding idr., 2014; Nguyen idr., 2024; Nouri idr., 2023; Plösch idr., 2014; Treude idr., 2020)
Structuredness	(Aversano idr., 2017b, 2017a; Bettenburg & Premraj, 2024; Plösch idr., 2014)
Completeness	(Aversano idr., 2017b, 2017a; Nguyen idr., 2024; Rani idr., 2023; Zhi idr., 2015)
Specificity	(Izadi idr., 2022; Lehner, 1993; Nouri idr., 2021)
Alignment	(Aversano idr., 2017b; Pereira idr., 2024; Zhi idr., 2015)
Consistency to Standard	(Aversano idr., 2017b; Ulan idr., 2018)
Graphical Support	(Aversano idr., 2017a, 2017b; Vierlboeck idr., 2024; Yang idr., 2024)
Cohesion	(Treude idr., 2020)
Coherence	(Pereira idr., 2024; Plösch idr., 2014; Rani idr., 2023; Treude idr., 2020; Zhi idr., 2015)
Consistency	(Aversano idr., 2017b; Plösch idr., 2014; Rani idr., 2023)
<b>Metrics (used for automatically generated text)</b>	
ROUGE	(Nguyen idr., 2024; Pereira idr., 2024)
BERTScore	(Nguyen idr., 2024)
BLEU	(Nguyen idr., 2024; Pereira idr., 2024)
SummaC	(Nguyen idr., 2024)

Source: own

In view of the above, we believe that we need to focus our efforts on developing specialised metrics and algorithms that will take into account the unique properties of project documentation. These metrics should not only measure the quality of textual elements but also assess the alignment of documentation with functional, technical, and structural requirements. Additionally, creating automated tools to simplify the evaluation process will help reduce subjectivity and improve the efficiency of quality assessment.

### 3.3 Problems encountered in assessing the quality of documentation and textual descriptions of tasks in IT projects (RQ3)

Based on the literature review conducted within the framework of research question RQ3, it was possible to identify the main problems that the authors highlight in the context of quality assessment of documentation and textual descriptions of tasks in



IT projects. These problems cover both technical and organizational aspects that make it difficult to use and evaluate documentation effectively. We identified the following challenges:

- cluttered with nonnatural language artifacts. Code fragments, stack traces, log results and configuration files increase the size of documentation descriptions (Bettenburg & Premraj, 2024; Hirsch & Hofer, 2022). Sometimes it is necessary that all artifacts are removed from a text because they interfere with its evaluation (Calefato idr., 2019). However, there are works in which authors say that artifacts affect the performance of applying machine learning techniques (Hirsch & Hofer, 2022),
- problems in formatting. Tools such as Markdown allow documentation authors to format their textual descriptions. However, improper use of such tools makes texts difficult to read (Hirsch & Hofer, 2022),
- dependence on manual preprocessing of data. Many authors perform manual preprocessing for natural language, which requires additional expert resources and is not always economically feasible (Bacchelli idr., 2012; Bettenburg & Premraj, 2024; Izadi idr., 2022),
- lack of clarity in descriptions of textual tasks. These include: the desired solution is not stated, the wording is not easy to understand, potentially important terms are not defined, the presentation format is not specified in sufficient detail, acceptance criteria are not defined (Aversano idr., 2017b, 2017a; Lehner, 1993; Nguyen idr., 2024; Nouri idr., 2023; Rani idr., 2023; Wingkvist idr., 2010; Zhi idr., 2015),
- documentation problems. Unreliable, incomplete, or nonexistent documentation, undocumented changes to the software system, and lack of integrity and consistency in the documentation itself affect the results and quality of its processing (Cummaudo idr., 2024; Rani idr., 2023; Wingkvist idr., 2010; Zhi idr., 2015),
- problems in interpreting automatic text quality assessment metrics such as BLEU and ROUGE (Pereira idr., 2024). Automatic metrics are used for machine translation and summarization tasks, so they do not take into account specific features in IT task descriptions. Their effectiveness for analyzing the quality of project documentation also remains questionable,

- low level of task tagging practices in IT projects. Research shows that only 3% of repositories on GitHub use task tagging, and even in those repositories only 58% of tasks are tagged (Cabot idr., 2024). All of this affects the results of IT task processing.

The identified peculiarities emphasize that current methods of assessing the quality of documentation in IT projects require serious revision and adaptation. The solution to these issues involves the development of specialized tools and metrics adapted to the peculiarities of IT documentation.

#### 4 Conclusion

This study reviewed literature sources addressing the problem of assessing the quality of IT project documentation. We described the methodology and strategy of the study. The review showed a variety of approaches, methods, criteria and metrics used to assess the readability, structure, clarity, etc. of textual descriptions. The problems highlighted in the paper, such as cluttering of texts with artifacts, difficulty in interpreting metrics, lack of clarity of descriptions, etc., are indicative of the challenges faced by current analysis methods.

Our future research should focus on creating solutions that improve the effectiveness of quality assessment tools for project documentation. For example, it is possible to develop a model that can also consider both the completeness of the text description, its clarity, readability, and its relevance to the task at hand in the IT project. The application of machine learning methods for automatic evaluation of project documentation seems to be a promising direction for the realisation of this idea.

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# IZOBRAŽEVANJE NA PODROČJU GEOGRAFSKIH INFORMACIJSKIH SISTEMOV: IZKUŠNJE, PREDLOGI IN IZZIVI

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Prispevek obravnava izobraževanje na področju geografskih informacijskih sistemov na Fakulteti za organizacijske vede Univerze v Mariboru in sicer na študijskem programu Krizni management visokošolskega strokovnega študija. Geografski informacijski sistemi so eden izmed ključnih elementov vsake resne organizacije, ki obravnava krizne dogodke. Uporaba geografskih informacijskih sistemov zahteva veliko interdisciplinarnega znanja s področja informatike, baz podatkov, programiranja, statistike, kartografije in seveda s področja, kjer se ga uporablja. Zato je tudi izobraževanje s področja omenjenih sistemov zahtevno in dolgotrajno. Osnovni gradniki geografskih informacijskih sistemov so strojna in programska oprema, podatki, metodologija in ljudje. S premišljeno uporabo geografskih informacijskih sistemov lahko lažje in bolje razumemo dogodke pred, med in po kriznih situacijah in s tem tudi medsebojne povezave, vzorce in značilnosti. V prispevku so opisane značilnosti in predlogi, ki smo jih pridobili v izobraževalni praksi. Priporočila se nanašajo na delo s študenti, prikazani so preizkušeni pristopi in načini za izvajanje predavanj ter vaj ter priporočila za nameščanje, upravljanje in vzdrževanje samega sistema in drugo. Podani so nekateri predlogi za odpravljanje nelagodja pri študentih, saj se nekateri prvič srečujejo s tako kompleksnimi informacijskimi sistemi.

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# LEARNING IN THE FIELD OF GEOGRAPHIC INFORMATION SYSTEMS: EXPERIENCES, SUGGESTIONS AND CHALLENGES

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The article discusses learning in the field of geographic information systems at the Faculty of Organizational Sciences of the University of Maribor, namely in the Crisis Management study program of higher professional studies. Geographic information systems are one of the key elements of every serious organization that deals with crisis events. The use of geographic information systems requires a lot of interdisciplinary knowledge in the fields of informatics, databases, programming, statistics, cartography and, of course, the field in which it is used. Therefore, education in the field of the aforementioned systems is also demanding and long-term. The basic building blocks of geographic information systems are hardware and software, data, methodology and people. With the thoughtful use of geographic information systems, we can more easily and better understand events before, during and after crisis situations and thus also their mutual connections, patterns and characteristics. The article describes the characteristics and suggestions that we have acquired in educational practice. The recommendations relate to work with students, and show proven approaches and methods for conducting lectures and exercises, as well as recommendations for installing, managing and maintaining the system itself, and more. Some suggestions are given to eliminate students' discomfort, as some of them are encountering such complex information systems for the first time.



## 1 Uvod

Hiter razvoj in vsestranska uporaba informacijsko-komunikacijske tehnologije (IKT) je temeljito spremenila zasebna in poklicna življenja. Z uporabo omenjene tehnologije se hote ali nehoče ustvarja velike količine podatkov, ki jih organizacije in podjetja lahko zbirajo za svoje delovanje. Perkins (2010) navaja, da ima zaradi tehnologij kot so mobilni telefoni, GPS naprave, elektronsko cestninjenje in drugo, danes več kakor 95 % zbranih podatkov tudi karakteristike, ki so tako ali drugače vezane na prostor oz. lokacijo v prostoru. Omenjeno dejstvo v kombinaciji z naprednimi tehnologijami omogoča nove možnosti, analize in raziskave, ki si jih v preteklosti nismo mogli ali znali predstavljati. V tem kontekstu nikakor ne moremo mino geografskih informacijskih sistemov, ki se jih danes uporablja na različnih področjih. Feng in Wang (2011) opredeljujeta geografske informacijske sisteme (GIS) kot sisteme namenjene za shranjevanje podatkov, njihovo upravljanje, analiziranje, modeliranje in prikazovanje na zemljevidu v digitalni obliki.

Zaradi svojih karakteristik so se geografski informacijski sistemi zelo uveljavili tudi na področju kriznega managementa. NATO-ov priročnik o kriznem managementu opredeljuje krizni management kot »organizacijo, ureditve in ukrepe s ciljem obvladovanja krize s strani kriznih managerjev in oblikovanja prihodnjega poteka krize ter v tem smislu primerne rešitve« (Prezelj, 2005: 36). V razvitih državah, predvsem v državah zahodnega sveta, praktično ne obstaja nobene resne organizacije, ki deluje na področju kriznega managementa, ki pri svojem delu ne uporablja omenjenih sistemov. Takšne organizacije so najpogosteje vojska, policija, reševalne službe, bolnišnice, varnostne agencije ter organizacije in drugo. Namenska in učinkovita uporaba geografskih informacijskih sistemov zahteva določene elemente. Za delovanje vsakega resnega geografskega informacijskega mora organizacija ali podjetje, ki deluje na področju kriznega managementa zagotoviti sledeče elemente (GIS Folks Blog, 2015): ustrezno programsko in strojno opremo, postopke in procese (modeliranje, analiziranje, zbiranje podatkov, prikazovanje in drugo), ustrezne podatke (najpogosteje v obliki vektorskih ali rastrski podatkovnih tipov) ter ustrezno usposobljene ljudi. Prav ljudje pa predstavljajo ključen element, ki odloča o tem ali bodo iz nekega geografskega informacijskega sistema izkoriščene vse možnosti in prednosti, ki jih takšen sistem ponuja in omogoča. Izobraževanje ljudi za uporabo geografskih informacijskih sistemov igra pri tem pomembno vlogo.

Za razliko od večine programske opreme, pa je izobraževanje s področja geografskih informacijskih sistemov zelo zahtevno in kompleksno zaradi povezanosti in integracije interdisciplinarnih znanj in področij. Geografski informacijski sistemi zahtevajo znanja več področij, saj je programska oprema precej kompleksna. Uporabniki morajo poznati in obvladovati velike količine podatkov, ki jih geografski informacijski sistem potrebuje za svoje delovanje. Prav tako morajo uporabniki imeti razvito prostorsko predstavo in znanje o povezljivosti programske in strojne opreme. Izobraževanja s področja kriznega managementa in geografskih informacijskih sistemov se izvajajo predvsem v organizacijah, ki imajo že vzpostavljene omenjene sisteme, teh pa je zelo malo in so širši javnosti praktično nedostopna. Omenjen prispevek prikazuje izkušnje, izzive in predloge, ki smo jih pridobili z izvajanjem izobraževanja geografskega informacijskih sistemov na področju kriznega managementa na Fakulteti za organizacijske vede Univerze v Mariboru.

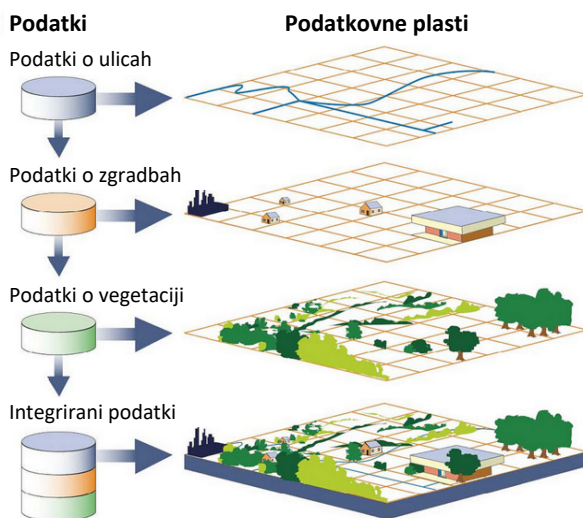
Prispevek je organiziran tako, da so v prvem delu predstavljene osnove geografskih informacijskih sistemov, kriznega managementa ter uporaba omenjenih sistemov v kontekstu kriznega managementa. Sledi predstavitev izkušenj in izzivov s katerimi smo se soočili na fakulteti pri izvedbi izobraževanja geografskih informacijskih sistemov na področju kriznega managementa. Na koncu sledijo predlogi za izvedbo izobraževanja s področja geografskih informacijskih sistemov.

## 2 Geografski informacijski sistemi

Resni začetki in poskusi komercialne in praktične rabe geografskih informacijskih sistemov segajo v začetek šestdesetih let prejšnjega stoletja. V tistem času so se začeli pojavljati prvi komercialno uporabni računalniki in računalniško podprta geografija in koncepti povezani s tem. Zhang in Drake (2014) opredeljujeta geografske informacijske sisteme kot skupek računalniških orodij, katerih namen je zajem, shranjevanje, generacija, analiza in prikazovanje geografskih podatkov. Geografske informacijske sisteme delimo na (Wikipedia, 2020): (1) komercialne: Autodesk, Bentley Systems, ENVI, ERDAS, ESRI, Intergraph, MapInfo, Smallworld in drugi ter (2) nekomercialne oz. odprtokodne in/ali brezplačne: GRASS GIS, gvSIG, ILWIS, JUMP GIS, MapWindow GIS, QGIS, SAGA GIS, uDig in drugi. Oboji, komercialni in nekomercialni, imajo svoje značilnosti, prednosti in slabosti.



Geografski informacijski sistemi sami po sebi niso zadostni pogoj za operativno delo in uporabo. Za izrabo vseh njihovih funkcij potrebujemo ustrezne podatke. Podatki se v geografskih informacijskih sistemih delijo na dve glavni veji in sicer na vektorske in rastrske. Geografski informacijski sistemi omogočajo prikazovanje več podatkov hkrati, kar daje takšnim sistemom velike možnosti kombiniranja različnih podatkov. To ima za posledico uvide in nova spoznanja, ki bi jih s klasičnimi analitičnimi metodami težko pridobili. Podatki se v geografskih informacijskih sistemih prikazujejo v obliki slojev. Prikazovanje podatkov v slojih ima številne prednosti (Haseeb, 2013): logična predstavitev podatkovnih vsebin na posamezni temi; prekrivanje omogočajo kombiniranjem tem; preučevanje povezav med temami in kreacija novih tem.



**Slika 1: Prikaz podatkovnega koncepta GIS-a**

Vir: DOF, 2014

Sodobni geografski informacijski sistemi so si precej podobni glede funkcij in grafičnega izgleda. Moderni geografski informacijski sistemi danes nudijo širok spekter možnosti in sicer od preprostega spletnega pregledovanja podatkov do zapletenih analiz, modeliranja, simulacij in drugih rešitev. Takšni sistemi uporabnikom omogočajo zbiranje in upravljanje lastnih podatkov, ustvarjanje zemljevidov ter ocenjevanje in sprejemanje odločitev (Harte, 2017). Napredek tehnologije in razvoj geografskih informacijskih sistemov sta zagotovila pomemben

prispevek pri upravljanju v kriznih situacijah, kjer izstopajo geografski informacijski sistemi kot orodje, ki uporabnikom omogoča zbiranje, upravljanje in analizo podatkov (Qutsiati Utami in Fatwa Ramdani, 2022).

### 3 Krizni management

V zasebnem in poslovnem življenju občasno prihaja tudi do neželenih dogodkov, ki se ponekod razvijejo tudi v krizne situacije. Poslovanje podjetji in organizacije je zaradi kriz lahko ogroženo ali vsaj oslabiljeno. Krizo lahko opredelimo kot (Kranjčec in Polič, 2002: 410): »situacijo, izhajajočo iz sprememb v skupnosti ali njenem okolju, ki jo označujejo dejanska in/ali zaznana grožnja osnovnim vrednotam, izgubljen nadzor nad situacijo, nujnost, negotovost in potreba po hitrem odločanju in ukrepanju«.

Fontanella (2022) navaja, da obstajajo sledeče krize in sicer: finančna kriza, kadrovska kriza, organizacijska kriza, tehnološka kriza, naravna kriza, kriza soočenja, kriza nasilja na delovnem mestu in kriza zlonamernosti. Vsaka izmed omenjenih kriz ima svoje značilnosti. Obstajajo tudi priporočila kako se spopasti z omenjenimi krizami. Namen kriznega managementa je predvidevanje in sanacija posledic kriz. Murphy (2007) je mnenja, da je obvladovanje kriz je zelo pomembno ter, da takšno delo zajema obvladovanje nesreč, obnovo, preprečevanje, odzivanje in pripravljenost na izredne razmere, ki vključuje varnostno usposabljanje in načrtovanje. Prezelj (2005) navaja mehanizme kriznega managementa, ki se delijo na: ocenjevanje ogrožanja varnosti, interesov in vrednot; krizno opozarjanje; krizno odločanje; načrtovanje kriznega managementa; izvajanje kriznega managementa in analize po krizi. Urh in Jereb (2022) omenjata, da večina organizacij in podjetij, ki se ukvarja s kriznim managementom potrebuje ali ustvarja podatke, ki so povezani z neko lokacijo v prostoru. Zaradi tega takšne organizacije ali podjetja pri svojem delu uporabljajo geografske informacijske sisteme, kar jim omogoča učinkovitejše odzivanje in preprečevanje kriz.

### 4 Krizni management in geografski informacijski sistemi

Vodilna organizacija na področju geografskih informacijskih sistemov (ESRI, 2024) navaja, da uporabniki in upravljavci geografskih informacijskih sistemov na področju kriznega managementa uporabljajo omenjene sisteme predvsem za pripravo na krizne dogodke, pomoč pri odzivanju in okrevanju po kriznih dogodkih.

Analiza objavljena s strani GrindGIS (2015) omenja, da se geografski informacijski sistemi na področju kriznega managementa uporabljajo za številne namene kot so: kartiranje in izdelava zemljevidov, analize nesreč in določevanje problematičnih lokacij, urbanistično načrtovanje, načrtovanje prometa, analiza vplivov na okolje, obvladovanje in blažitev nesreč, določevanje območja nevarnosti plazov, navigacija (usmerjanje in načrtovanje), ocene škode zaradi poplav, upravljanje naravnih virov, detekcija požarov v premogovnikih, upravljanje in vzdrževanje sredstev, načrtovanje in razvoj skupnosti, analiza razdalj do požarne opreme, svetovni potresni informacijski sistemi, identifikacija vulkanske nevarnosti, kartiranje območij nevarnosti gozdnih požarov, zatiranje škodljivcev, študije gostote prometa, preprečevanje nesreč in neprekinjenega poslovanja, razvoj javnih infrastrukturnih objektov, zbiranje informacij o geografskih značilnostih, javno zdravje, identifikacija specifičnih lokacij, sistemi za obrambne namene, razvoj infrastrukture, analiza kriminalitete, analiza pešpoti do šol, iskanje podzemnih cevi in kablov in drugo. Uporaba geografskih informacijskih sistemov na področju kriznega managementa omogoča različne primere uporabe. Dempsey (2019) omenja in navaja nekatere izmed teh: organiziranje logistične podpore ob naravnih nesrečah; preventiva pred škodljivimi učinki (npr.: onesnaženje); določevanje kritičnih območij, ki bi jih potencialno lahko prizadele nesreče (npr.: poplave); predvidevanje nastankov, vzrokov in vzorcev kriz.

## 5 Izkušnje, izzivi in predlogi

Program Krizni management, ki se izvaja na Fakulteti za organizacijske vede Univerze v Mariboru ponuja tudi predmet geografski informacijski sistemi. Študenti, ki se vpisujemo na omenjeni program prihajajo iz različnih okolij in z različnim predznanjem. Nekateri študenti so zaposleni, nekateri ne. Bistveno prednost glede razumevanja področja, ki se ga obravnava na študijskem programu imajo študenti, ki prihajajo iz organizacij ali podjetij, ki se vsebinsko v celoti ali vsaj delno navezujejo na smer študija (npr.: policija, vojska, reševalne službe, obveščevalne službe, ...). Izkušnje kažejo, da imajo študenti različne stopnje računalniške pismenosti in znanja informatike, ki je pri izobraževanju geografskih informacijskih sistemov zelo pomembna. Podobno je z znanjem angleškega jezika, ki se ga občasno potrebuje za razumevanje določenih funkcij in postopkov v geografskem informacijskem sistemu. Izkušnje z izobraževanjem geografskih informacijskih sistemov kažejo, da se velika večina študentov še nikoli ni srečala z omenjenimi sistemi, kar je povsem

razumljivo, ker so omenjeni sistemi zelo kompleksni in potrebujejo določene vire za svoje delovanje (programska oprema, strojna oprema, podatki, ...). Pri določenih študentih je opaziti tudi določeno mero strahu, ki verjetno izvira iz kompleksnosti narave geografskih informacijskih sistemov. S pedagoškega vidika ugotavljamo, da študenti bolje razumejo predstavljene vsebine, če le te temeljijo na realnih primerih ali če je naloga predstavljena kot študija primera. Glavne ugotovitve in izkušnje pa lahko strnemo v dve skupini, ki se delita na elemente povezane s človeškimi viri (študenti, profesorji, tehnična pomoč in vodstvo) in tehničnimi viri (tehnologija, programska oprema, strojna oprema, cena, učni načrti, tehnične težave in drugo).

Tako kot pri večini drugih predmetov se tudi pri izobraževanju geografskih informacijskih sistemov srečujemo z največ izzivi prav pri delu s študenti. Kot prvo moramo omeniti, da za delo z omenjenimi sistemi potrebujemo interdisciplinarna znanja, le teh pa vsi študenti nimajo. V tem kontekstu naj omenimo, da študentom primanjkuje znanja informatike, programiranja, baz podatkov geografije, kartografije in splošnega znanja o delu povezanim z e-izobraževanjem. Mnogi študenti še vedno niso večji s sistemi za podporo učenju (Moodle), kjer se v okviru predmeta nahaja večina gradiva. Z uporabo Moodla imajo študenti, ki so vpisani v letnik dostop do ustreznih gradiv kadarkoli in kjerkoli. V primeru pandemije kateri smo bili priča nekaj let nazaj je bilo prav e-izobraževanje podprto s sistemom za podporo učenju ključen dejavnik, da se je izobraževanje lahko nemoteno izvedlo. Zato je priporočljivo znanje o omenjenih sistemih, saj nimamo garancije, da se neljubi dogodki ne bodo ponovili. Nepoznavanje in manko znanja na določenih področjih lahko privedejo do upada motivacije za študij. S tem so povezani tudi izostanki, ki pa zaradi kompleksnosti sistema niso priporočljivi. Posledično je potrebno vložiti več prizadevanj, ki se pogosto izvedejo v obliki dodatnih govorilnih ur in konzultacij. Kot je bilo že omenjeno so na programu vpisani izredni študenti. Le ti pa imajo zaradi drugega dela (npr. službe) manj časa za študij, kot redno vpisani študenti. Druga težava, ki se občasno dogaja je tudi veliko vpisanih študentov. Več kot je študentov težje je izvajati vaje. Pri vajah se namreč dela na konkretnih primerih in rešuje določene študije primera. Za takšno delo pa je potrebno redno spremljati delo študentov in jim nuditi pomoč.

Za ustrezno predstavitev geografskih informacijski sistemov so izrednega pomena ustrezno usposobljeni in izobraženi profesorji in asistenti (izvajalci). Zaradi kompleksnosti sistemov je zelo priporočljivo, da imajo omenjeni ljudje tudi

praktične izkušnje s področja, ki se ga pokriva. Izvajalci izobraževanj se srečujejo z obsežno pripravo gradiv, ki se jih potrebuje za izobraževanje geografskih sistemov. Veliko časa je potrebnega za pripravo ustreznih podatkov in njihovo razumljivo namestitvev v sistem Moodle. Izvajalci morajo do potankosti poznati sistem na katerem izobraževanje poteka. Zaradi pogostih novih verzij programa (QGIS) pa je potrebno konstanto spremljanje in izobraževanje tudi na tem področju. V kolikor določeni študenti izostanejo s predavanj ali vaj, si mora izvajalec vzeti čas, da dodatno pojasni snov na govorilih urah oz. kako drugače.

Vpliv na izvedbo izobraževanja ima tudi Center za informatiko in informacijske tehnologije (CIIT), ki posredno sodeluje z izvajalci predmeta na način, da podpira tehnično delovanje geografskega informacijskega sistema. Njihova skrb se nanaša na zagotavljanje ustrezne strojne opreme, ki mora biti dovolj zmogljiva. Prav tako sodeluje pri namestitvi sistema. Ustrezna koordinacija pri namestitvi sistema zagotavlja, da se programi medsebojno ne ovirajo pri svojem izvajanju.

Pri izobraževanju geografskih informacijskih sistemov so zelo pomembni tudi ustrezni tehnični viri tako s strani fakultete kot tudi študentov. Na fakulteti je potrebo zagotoviti ustrezno strojno opremo in programsko opremo. Ta del procesa se izvaja v kombinaciji s CIIT-om. Večja težava je oprema, ki jo imajo študenti doma. Večina se ne zaveda, da je za resno delo potrebno imeti tudi ustrezno strojno opremo, ki jo moderni geografski informacijski sistem potrebujejo. Geografski informacijski sistemi potrebujejo za svoje delo tudi podatke. Če delo poteka od doma je prenos le teh včasih zamuden ali težaven v kolikor imajo študenti slabo internetno povezavo. S strani izvajalcev kot tudi študentov je potrebno redno spremljanje programske opreme, ki jo uporabljamo tekom izobraževanja (QGIS). Namen tega je zagotavljati enake verzije programa, saj se le tako lahko zagotovi, da so na voljo ustrezne funkcije, ki so predstavljene na predavalnih in vajah.

Izhajajoč iz izkušenj in izzivov, ki smo jim priča pri izobraževanju geografskih informacijskih sistemov v prispevku prikazujemo tudi predloge za nadaljnje delo. Največ opažanj se nanaša na študente in njihovo dojetje celotnega predmeta, tako s tehničnega kot, vsebinskega in pedagoškega vidika. Za lažje spremljanje predavanj in vaj priporočamo izdelavo video gradiv in lekcij s katerimi bi študenti, ki so zaradi takšnih in drugačnih razlogov izostanejo z določenih predavanj ali vaj lahko nadoknadijo zaostanek. Drug razlog za uporabo in izgradnjo video vsebin je

ta, da lahko študenti večkrat predvajajo vsebine in s tem dodatno utrdijo pridobljeno znanje.

Predavanja in vaje je priporočljivo oblikovati čim bolj modularno. To pomeni, da imamo veliko krajših nalog, ki se medsebojno navezujejo, vendar jih lahko študent opravi kar se da samostojno oz. brez veliko predhodnega znanja. To omogoča študentom bolj konstruirano delo, kar pa razbremeni tudi izvajalca predmeta. Izkušnje kažejo, da bi bilo dobro izdelati čim več vaj in predavanj v obliki študije primera, kjer se študenti srečajo z dejanskim problem, ki ga morajo rešiti s pomočjo geografskega informacijskega sistema. Le te so za študente bolj smiselne in posledično bolj razumljive. Naslednje priporočilo se na naša na organizacijo gradiv v sistemu Moodle. Predmet v Moodle-u naj bo čim bolj pregledno urejen. Vsako poglavje ali učna enota mora vsebovati minimalne standardne, ki jih zahteva izobraževanje. Gradivno naj bo organizirano tako, da ima veliko pojasnil, pomoči in vmesnih korakov, kar omogoča čim bolj jasno in razumljivo pot do dokončanja neke naloge.

Prav tako je priporočljivo ažurno urejati spletno učilnico Moodle in obveščati študente o aktualnih spremembah ali dopolnitvah gradiva (npr.: preko sporočil, foruma, ...). Za izboljšanje predmeta je priporočljivo spremljati in po potrebi implementirati opažanja, ki jih študenti podajo v anketi oz. drugih povratnih informacijah.

Narava geografskih informacijskih sistemov kompleksna in zahteva interdisciplinarno znanje. Zahteve za delovanje sistema glede strojne opreme so pa precej velike. Namestitve, vzdrževanje, posodobitve in informacijska varnost se naj izvaja v sodelovanju z informacijskim centrom (v našem primeru je to CIIT). S takšnim sodelovanjem se izognemo mnogim tehničnim težavam. Nujen pogoj pri delu z geografskimi informacijski sistemi je redno spremljanje trendov in smernic, ki se odvijajo na omenjenem področju. Pričakovati je, da se bo v tem kontekstu začela uporabljati umetna inteligenca, kar bo poenostavilo mnoge operacije in funkcije, ki so bile do sedaj precej zahtevne.

## 6 Zaključek

V prispevku so prikazane dosedanje izkušnje, predlogi za nadaljnje delo in izzivi s katerimi smo se in se srečujemo pri izobraževanju s področja geografskih informacijskih sistemov na Fakulteti za organizacijske vede Univerze v Mariboru. Geografski informacijski sistemi, kot nepogrešljivo orodje pri obvladovanju kriz, se na omenjeni fakulteti predavajo v okviru predmeta na študijskem programu Krizni management. Učinkovita uporaba geografskih informacijskih sistemov zahteva interdisciplinarno znanje in analitično razmišljanje. Naravo izzivov s katerimi se srečujemo pri omenjenem izobraževanju lahko v grobem razdelimo na dve skupini in sicer na človeške vire in tehnične vire. Vsi imajo svoje značilnosti in posledično načine s katerimi se lotimo reševanja določenega izziva.

Narava geografskih informacijskih sistemov je kompleksna in zahteva interdisciplinarno znanje. Zahteve za delovanje sistema glede strojne opreme so pa precej velike. Namestitve, vzdrževanje, posodobitve in informacijska varnost se naj izvaja v sodelovanju z informacijskim centrom. S takšnim sodelovanjem se izognemo mnogim tehničnim težavam. Nujen pogoj pri delu z geografskimi informacijski sistemi je redno spremljanje trendov in smernic, ki se odvijajo na omenjenem področju. Pričakovati je, da se bo v tem kontekstu začela vse bolj in bolj uporabljati umetna inteligenca, kar bo poenostavila mnoge operacije in funkcije, ki so bile do sedaj precej zahtevne.

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# IMPACT OF SERVICE QUALITY AND PRICING ON CUSTOMER SATISFACTION AND LOYALTY IN THE REAL ESTATE INDUSTRY IN CROATIA

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Purchasing real estate is one of life's major decisions due to the size of the investment and the complexity of the process. Rapid changes in the real estate market, including fluctuations in prices and property quality, as well as varying performance among agencies and agents, further complicate the process. The quality of service provided by real estate agencies and their agents plays a crucial role in meeting customer expectations, ensuring satisfaction, and building loyalty. High-quality service fosters trust, reduces transactional risks and costs, and enhances the agency's business success. This study examines the impact of service quality and pricing on customer satisfaction and loyalty in Croatia through an empirical survey analyzed with PLS methodology. Findings show that service quality significantly affects satisfaction and loyalty, while agency fees have a minor effect. Agencies should invest in professional agents who build trust and provide high-quality information, forming a foundation for long-term relationships.

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## 1 Introduction

Real estate transactions represent the process of buying or selling properties, where private users aim to meet their housing or investment needs when purchasing, while sellers seek to raise financial resources for various purposes. In Croatia, the real estate market recorded 116,961 transactions in 2023, with an average property price of €77,079. These transactions accounted for approximately 12% of GDP (Rašić, I. et al., 2023).

Given the complexity of real estate transactions and the high value of properties, successful transactions often require specialized legal, technical, marketing, and economic knowledge. For this reason, both buyers and sellers frequently use the services of real estate agencies and agents. Real estate agency services are intangible, high-contact services where users rely on the expertise and credibility of agents, particularly during the pre-purchase phase (Tuzovic, 2009).

Real estate agencies offer a range of services, such as property valuation and advertising, legal assistance with sales and ownership transfers, finding suitable properties for purchase or rent, and providing advice on property adaptation, construction, or financing. However, due to the intangible nature, non-storability, heterogeneity, and high level of interaction required between agents and clients, the use of agency services may create a high level of distrust and perceived risk among users regarding the suitability of the service in meeting their needs.

To reduce uncertainty and perceived risk, it is essential to provide high-quality services that users perceive as trustworthy. Service quality is a key factor in creating customer satisfaction, loyalty, and long-term relationships. High service quality typically enhances the agency's reputation and increases its overall revenue.

The importance of delivering high-quality services is further highlighted by data on real estate transactions facilitated by agencies in Croatia. In 2023, the share of agency revenue in GDP was 0.63%, significantly lower than the 12% share of real estate transactions in GDP. This share of revenue was generated by 1,972 entities engaged in real estate mediation, reflecting a high level of competition in the industry (FINA, 2024).

Another critical aspect of customer satisfaction with agency services relates to service pricing. Prices, including the commission, should be transparently determined and reflect the value provided to customers. Although service quality, customer satisfaction, pricing, and loyalty are recognized in international scientific literature as key factors in the competitiveness and success of real estate agencies, these aspects remain underexplored in Croatian scientific literature.

The aim of this study is to determine the impact of service quality and price satisfaction on overall customer satisfaction and loyalty in the context of the Croatian environment.

The paper consists of four chapters. Following the introduction, the literature review outlines existing research on the relationships between service quality, pricing, satisfaction, and loyalty and sets the hypotheses for the study. The next section presents the methodology for data collection and analysis. In the fourth chapter, the collected data are analyzed using the PLS method. The final chapter offers conclusions, outlines research limitations, and provides recommendations for future studies, along with practical implications for the marketing of real estate agencies.

## **2 Literature review and Hypotheses development**

In scientific literature, the relationship between service quality, customer satisfaction, and loyalty occupies an important place. Generally, service quality is defined as the difference between perceived and expected service performance (Parasuraman, Zeithaml, and Berry, 1988). Similarly, customer satisfaction is defined as the difference between expectations before using the service and the perceived service received. However, service quality is traditionally considered a global and relatively stable attitude of the customer, whereas satisfaction is typically transaction-specific (Oliver, 2010). Research generally confirms that service quality affects satisfaction and highlights that satisfied customers tend to be more loyal, spread positive word-of-mouth, provide service recommendations, use other company services, and are generally less sensitive to service prices (Zeithaml, Parasuraman, and Berry, 1996). Finally, higher levels of service quality and satisfaction often lead to greater economic success for companies (Meffert, Bruhn, and Hadwich, 2015).

Service quality can be measured using various models. One commonly used model across different service sectors is the SERVQUAL model (Parasuraman, Zeithaml, and Berry, 1988), which defines quality through five dimensions: tangibles, reliability, responsiveness, assurance, and empathy. In real estate agency services, this model has often been used to research and conceptualize service quality. For example, Seiler et al. (2008) tested a model with seven dimensions of quality—tangibles, reliability, responsiveness, assurance, empathy, professionalism, and availability—and their impact on overall quality perception, recommendation intention, and reuse intention. Their research found that only four quality dimensions (tangibles, reliability, responsiveness, empathy) had a significant impact on perceived overall quality and intentions to reuse the service and provide recommendations in the real estate mediation context. Additionally, perceived quality directly influenced intentions to reuse the service and provide recommendations. The authors compared their model with previous research results and concluded that perceptions of quality have changed over time.

Tuzovic (2009) conducted a qualitative study involving 27 participants. The study found that service users highly valued property photo quality, floor plans, search engine usability on websites, property location visibility, and agent traits such as kindness, credibility, responsiveness to requests, and the completeness and accuracy of information. These characteristics influenced users' likelihood of providing recommendations and reusing the same agent's services for future transactions.

A study by Araloyin and Olatoye (2011) highlighted the importance of various real estate agency service elements for customer satisfaction, including convenient operating hours, the use of modern equipment, qualified agents, the ability to secure deals at the best price, confidence, a clear understanding of customer needs, kindness, service reliability, frequent communication, and personalized attention. Research conducted by Seul and Kim (2023) found that response speed, affordability, location, and communication significantly influenced the reliability assessment of real estate agencies and customer satisfaction, which then affected service reuse and recommendations.

Furthermore, Ha and Huyen (2023) emphasized that brokers' competence significantly impacts customer satisfaction and intentions to renew contracts, indicating that knowledgeable and skilled agents enhance overall service quality

experienced by customers. On the other hand, Yeh et al. (2020) found that physical attractiveness and intellectual competence significantly affect customer satisfaction, trust, and loyalty toward the agent.

In addition to the importance of the quality of real estate agency services themselves, research has also highlighted the significance of customer follow-up after the conclusion of sales agreements. Research by Wahjudi et al. (2018) emphasized that after-sales service quality significantly impacts both customer satisfaction and loyalty, suggesting that satisfied customers are more likely to remain loyal to a service provider. The importance of the empathy dimension in real estate agency service quality was further highlighted by Akinwamide and Hahn (2022). The authors stressed that understanding and addressing customers' emotional needs can enhance service delivery and satisfaction, thereby fostering loyalty.

In conclusion, there is still no unified model of service quality for real estate agencies, and quality perceptions vary depending on the type of customer, context, or environment in which the service is provided. However, overall, the quality of service provided by agencies and agents is critical to creating customer satisfaction and loyalty.

Based on existing research, the following hypotheses are proposed:

- H1-2: The service quality of real estate mediation agencies directly and positively affects customer satisfaction and loyalty.
- H3: Customer satisfaction with the services of real estate mediation agencies positively affects customer loyalty.
- H4: Service quality indirectly affects customer loyalty through customer satisfaction.

The second part of the research focuses on the construct of price satisfaction. In real estate mediation services, the price represents the commission paid by the customer as a percentage of the property's transaction price (typically 5–6%). Thus, overall customer satisfaction is also influenced by satisfaction with the price of real estate mediation services. Price satisfaction is defined as the difference between customer expectations about the price and their perceptions of it and is generally a

multidimensional construct (Diller et al., 2021). Price satisfaction, as part of overall customer satisfaction, can influence customer loyalty.

The level and method of determining commissions, typically ranging from 5% to 6% of the transaction price, have been criticized in research due to their potential negative impact on customer perceptions and experiences (Tomal, 2024; Cunningham et al., 2022). The size of the commission and the agent's involvement in the transaction have also intensified the ownership effect and customers' negative perceptions of the commission. Furthermore, research has shown that perceptions of fair pricing, which represent a component of price satisfaction, influence customer satisfaction and loyalty (Homburg, 2015; Diller et al., 2019; Cunningham et al., 2022). When customers perceive that agency services do not correspond to the commission paid, their satisfaction decreases.

The following hypothesis is proposed:

- H5: Price satisfaction with real estate mediation services positively affects customer satisfaction.

The subsequent sections present the research methodology and analyze the results.

### **3 Research methodology and Sample**

The research on the quality and satisfaction of users of real estate agency services in Croatia was conducted through an online survey using Google Forms. Respondents, selected via social media, received an email with instructions for completing the questionnaire. Participants were informed that the survey was anonymous. The study included respondents who had used the services of real estate mediation agencies within a year prior to the research. A total of 86 correctly completed questionnaires were collected and used for data analysis.

Regarding gender, 40.7% of respondents were female, and 59.3% were male. Around 20.9% of respondents were aged 25–34, 32.5% were aged 35–44, 23.3% were aged 45–54, and 23% were over 54 years old. According to their highest level of education, 18.6% had completed secondary school, 13.9% had completed a higher education diploma, 52% had a university degree, and 14% had completed postgraduate studies or a doctorate.

In terms of employment, 16% were self-employed, 4.6% were unemployed, 24% were employed in public enterprises/institutions, and 48% were employed in private companies. Regarding average monthly gross income, 3.4% of respondents earned less than €1,000, 27.9% earned €1,000–1,999, 23.2% earned €2,000–2,999, 20.9% earned €3,000–3,999, 8% earned more than €4,000, while approximately 16% of respondents did not answer this question.

Regarding the purpose of agency services, 16.2% of respondents used them for both buying and selling properties, 55.8% used them exclusively for buying, and 28% used them exclusively for selling properties. In terms of property type, 29.3% of respondents used the services for buying or selling houses, 50% for apartments, 10% for purchasing building land, while the remaining respondents used agency services for multiple types of properties simultaneously.

The collected data were analyzed using descriptive statistical methods and the PLS (Partial Least Squares) method, which allows for the simultaneous examination of relationships between multiple theoretical constructs, as is the case in this study. Variables related to service quality, pricing, and customer satisfaction with real estate agencies were measured using seven-point Likert scales (1 = "not satisfied at all" to 7 = "completely satisfied").

Service quality variables included the following ten dimensions: explanation of procedures and processes during property purchase or sale, agency responsiveness to user requests, quality of property presentations, agent kindness, agent expertise, agent professionalism, agent availability, accuracy and completeness of information provided by the agent, the agent's effort to find the best solution for the customer, and the level of respect shown by the agent toward the customer. These variables were partially based on the SERVQUAL model of service quality (Zeithaml, Parasuraman, and Berry, 1988).

Price satisfaction and overall customer satisfaction with the agency were each measured with a single indicator. Customer loyalty was measured using two indicators: intentions to reuse the services of a real estate agency and intentions to recommend the agency's services to other potential customers. These two indicators were measured on a seven-point Likert scale (1 = "very unlikely" to 7 = "very likely")

and were partially based on the work of Zeithaml, Parasuraman, and Berry (1996). The following section presents the results of the data analysis.

#### 4 Data analysis and results

The collected data were analyzed using the PLS method with the statistical software SmartPLS 4.1.9 (Ringle, Wende, and Becker, 2024). The PLS method enables the estimation of models and testing of hypotheses regarding the interdependence between multiple constructs simultaneously. This method allows for a relatively reliable estimation of models using small samples and is fundamentally a non-parametric method independent of variable distribution. It is particularly suitable when the goal is the prediction of target constructs rather than theory testing (Hair et al., 2023).

Before analyzing the structural model required for hypothesis testing, the measurement scales for specific theoretical constructs—such as service quality and loyalty—were evaluated for internal indicator reliability, convergent validity, and discriminant validity. For this purpose, the bootstrapping technique was employed with 10,000 subsamples, in line with recommended practices (Hair et al., 2023). The results of the measurement model analysis are presented in Table 1.

Based on the results from Table 1, it can be concluded that respondents are generally satisfied ( $\bar{X} = 4.73$ ). Respondents expressed slightly higher satisfaction with the agency's responsiveness to customer requests, the courtesy of the agent, the respect shown by the agent, and the quality of the property presentation (average ratings ranging from 4.77 to 4.98). However, they were somewhat less satisfied with the professionalism, expertise, effort demonstrated by the agent, and the completeness of the information provided (average ratings ranging from 4.52 to 4.69).

Furthermore, all variables or indicators of the specific constructs of service quality and loyalty in real estate agencies show a satisfactory level of indicator reliability. All indicator values are statistically significant ( $p < 0.05$ ) and exceed the recommended value of 0.8.



**Table 1: Measurement model analysis**

Item	Label	Mean	Standard deviation	Item loadings	T-value	C.R.	AVE	VIF
<b>Service quality</b>								
Explanation of the procedure during property purchase or sale	SQ1	4,802	2,118	0,88*	33,14	0,98	0,86	2,25
Responsiveness of the agency to customer requests	SQ2	4,988	2,066	0,89*	40,37			
Quality of property offer presentations	SQ3	4,779	2,025	0,87*	27,56			
Courtesy of agents	SQ4	4,953	1,584	0,88*	25,26			
Professionalism of the agent	SG5	4,605	1,943	0,96*	107,47			
Expertise of the agent	SG6	4,640	1,880	0,96*	112,04			
Availability of the agent	SQ7	4,826	1,786	0,96	114,61			
Completeness and accuracy of information provided by the agent	SQ8	4,698	1,868	0,95*	64,02			
Effort made by the agent to find the optimal solution for the customer	SQ9	4,523	1,987	0,95*	72,49			
Respect shown by the agent toward the customer	SQ10	4,767	1,939	0,95*	79,13			
<b>Overall Satisfaction</b>	CSAT	4,733	2,170					4,80
<b>Price satisfaction</b>	PRICE	4,093	2,213					2,25
<b>Customer Loyalty</b>	CLOY							
Intentions to use the service again	INT	4,442	2,280	0,99	320,26	0,98	0,98	
Recommendations of the agency to other users	WR	4,430	2,305	0,99	310,63			

\*p<0,05

Source: Author's calculations

**Table 2. Structural model analysis**

Hypotheses		Original sample (O)	Standard deviation (STDEV)	T statistics ( O/STDEV )	R <sup>2</sup>	Hypotheses acceptance
	Direct effects					
H1	Service quality -> Customer satisfaction	0,747*	0,087	8,618	0,81	Accepted
H2	Service Quality -> Customer Loyalty	0,347*	0,141	2,457	0,75	Accepted
H3	Customer satisfaction -> Customer Loyalty	0,545*	0,136	3,995	0,75	Accepted
H5	Price Satisfaction-> Customer satisfaction	0,191**	0,098	1,959	0,81	Accepted at p<0,1
	Indirect effect					
H4	Service quality -> Customer satisfaction -> Customer Loyalty	0,407*	0,135	3,011	0,75	Accepted
	Price Satisfaction – Customer -> Satisfaction -> Customer Loyalty	0,104*	0,049	2,140	0,75	

\*p&lt;0,05, \*\*p&lt;0,10

Source: Author's calculation

The constructs of quality and loyalty also demonstrate an appropriate level of convergent validity. The C.R. (Composite Reliability) indicators exceed the recommended value of 0.8, while the AVE (Average Variance Extracted) indicators are greater than 0.5. Additionally, the Fornell-Larcker criterion (1981) is satisfied, as all square root AVE values are greater than the individual correlations among constructs. The HTMT (Heterotrait-Monotrait Ratio) criterion for all combinations of constructs was below 0.9, indicating a satisfactory level of discriminant validity.

The calculated VIF (Variance Inflation Factor) indices were below 5, suggesting no multicollinearity between the endogenous constructs of satisfaction and service quality.

Since the scales for individual constructs demonstrate a satisfactory level of indicator reliability, convergent validity, and discriminant validity, it is possible to proceed with the analysis of the structural model and test the proposed hypotheses. The results of the structural model analysis are presented in Table 2.

Based on the results of the analysis presented in Table 2, it can be concluded that the quality of services provided by real estate agencies has a positive and direct impact on customer satisfaction ( $\beta_1 = 0.747$ ;  $p < 0.05$ ) and loyalty ( $\beta_2 = 0.347$ ;  $p < 0.05$ ), thereby confirming hypotheses H1 and H2. Customer satisfaction with the service has a positive and statistically significant effect ( $\beta_3 = 0.545$ ;  $p < 0.05$ ) on customer loyalty, confirming hypothesis H3. Additionally, service quality indirectly influences customer loyalty through satisfaction ( $\beta_{\text{indirect}} = 0.407$ ;  $p < 0.05$ ), confirming hypothesis H4.

On the other hand, price satisfaction has a statistically significant positive direct effect at the 10% significance level on customer satisfaction ( $\beta_5 = 0.191$ ;  $p < 0.10$ ) and also a significant indirect effect on customer loyalty through satisfaction ( $\beta_{51} = 0.104$ ;  $p < 0.05$ ). In this sense, hypothesis H5 is only partially confirmed at the 10% significance level.

The proposed model explains a total of 81% of the variance in the satisfaction construct ( $R^2 = 0.81$ ) and 75% of the variance in the loyalty construct ( $R^2 = 0.75$ ). Overall, the model demonstrates a satisfactory level of predictive validity. The

implications of the research findings are discussed in more detail in the following sections.

## **5 Conclusion, research implications and discussion**

Real estate services are professional services used by customers during the purchase or sale of real estate to resolve housing needs or make investments. Typically, customers use the services of a real estate agency or agent because real estate transactions are generally high-value and highly complex processes, influenced by various legal, economic, and technical aspects related to the property itself. This is particularly true for the real estate market in Croatia, which is insufficiently legally regulated and controlled, resulting in significant unfair competition among agencies. Additionally, the lack of exclusive representation agreements during property transactions reduces the efforts of agencies to provide the best possible service to customers. The common practice of the same agency representing both the buyer and the seller is another factor that increases the perceived risk of using real estate mediation services. To reduce this perceived risk, it is essential to provide a high level of perceived service quality to achieve customer satisfaction and, ultimately, loyalty and long-term relationships with customers. This has been confirmed by empirical research on the impact of service quality and price satisfaction on customer satisfaction and loyalty in the context of the Croatian real estate market, which also represents the theoretical contribution of this study.

According to the research results, the quality of real estate mediation services has both a direct and indirect impact on customer loyalty through satisfaction. The findings are consistent with research conducted in other settings (Seiler, et. al., 2008, Lazovic, 2009, Araloy & Olatoye, 2011). Croatian customers were moderately satisfied with the services of real estate agencies. They were more satisfied with the completeness of information, property offer presentation, responsiveness, availability, effort, and respect shown by agents, while they were less satisfied with the expertise and professionalism of agents. On the other hand, satisfaction with agency service pricing was low to moderate. According to the research results, price satisfaction had a weaker direct and indirect effect on customer loyalty through satisfaction.

The conducted research has certain limitations that could serve as a foundation for future studies on the quality of real estate mediation services and customer satisfaction. A larger and more structured sample, considering specific socio-demographic characteristics, would allow for better generalization of the research results and more reliable findings. Furthermore, it would be beneficial to compare the results of this study with more detailed conceptualizations of service quality as a multidimensional construct, such as using specific models like SERVQUAL. This would provide deeper insights into the importance and impact of individual service quality dimensions on customer satisfaction and loyalty, and allow for better comparisons with studies conducted in other cultural contexts.

The research assumed a static linear relationship between quality, satisfaction, and loyalty. Future research should explore the existence of non-linear relationships between these constructs. Additionally, given the weak influence of price satisfaction on overall customer satisfaction and loyalty, future studies should consider price as a multidimensional construct and incorporate the concept of price fairness, which reflects ethical and fair pricing relative to the value provided by agency services.

Future studies should also investigate the moderating effects of variables such as demographics (e.g., gender, age, income, type of property, country of origin, and type of customer) between service quality and customer satisfaction. Other theoretical constructs, such as image and customer trust in agents, should also be examined.

Finally, the study overlooked the digital aspect of communication and relationships between agencies and customers. Future research should analyze and incorporate this aspect into service quality models. Research shows that digital intelligence in agencies, through the integration of innovative technologies (such as artificial intelligence, lease extraction technologies, the Internet of Things, property passports, machine learning, automated valuation models, blockchain, and smart contracts), improves service delivery and enhances customer experiences (Oluwatofunmi et al., 2021).

The adoption of digital platforms for real estate transactions can streamline processes, improve communication, and ultimately lead to higher levels of customer satisfaction and loyalty.

The results of the research provide numerous practical implications. The quality of real estate mediation services is a key factor in achieving customer satisfaction and loyalty. Agencies must pay special attention to recruiting and training agents who interact with customers.

Additionally, continuous investment in acquiring new knowledge, including collaboration with other stakeholders such as architects, lawyers, and construction professionals, is necessary. This would enable better, more complete, and more accurate customer information about specific properties, create realistic expectations about the sales process and pricing, and ensure greater transparency in property transactions.

To ensure high levels of satisfaction and customer loyalty, agencies must adopt a personalized approach tailored to customer needs and provide follow-up support after the property transaction.

Regarding pricing, agencies should transparently display the relationship between property prices and commission fees and clearly outline all the benefits and advantages customers receive by using their services.

Given the importance of service quality in creating satisfaction and long-term customer relationships, it is expected that real estate mediation agencies will need to establish systems for monitoring and researching service quality. This would help them meet customer expectations and create a competitive advantage in an increasingly dynamic real estate market.

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# SPODBUJEVALNI IN ZAVIRALNI DEJAVNIKI PRI ODPIRANJU PODATKOV V JAVNIH ORGANIZACIJAH

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Odpri podatki javnega sektorja (OPJS) so javno dobro, katerih vpliv presega okvir javnega sektorja ter lahko prispevajo k razvoju gospodarstva in družbeni blaginji. Vendar podatki sami po sebi ne ustvarjajo vrednosti, saj zgolj objava podatkov ne zagotavlja samodejnih pozitivnih učinkov in vpliva v praksi. Ključno vlogo pri tem imajo javne organizacije, ki morajo zagotavljati kakovostne, dostopne in pravočasno objavljene podatke ter konstruktivno sodelovati v širšem ekosistemu uporabnikov podatkov. Čeprav ima Slovenija ugoden zakonodajni in institucionalni okvir za OPJS, se največji izzivi pojavljajo na organizacijski ravni. Z namenom lažjega razumevanja teh izzivov in načinov, kako jih premagati, prispevek analizira znanstvene članke (iz baz WoS in Scopus) ter prepoznava spodbujevalne in zaviralne dejavnike znotraj javnih organizacij, ki vplivajo na odpiranje podatkov. Sistematični pregled teh »univerzalnih« dejavnikov ponuja osnovo za poglobljeno razumevanje slovenskih posebnosti in premagovanje izzivov pri odpiranju podatkov javnega sektorja.

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# OPEN DATA DRIVERS AND BARRIERS WITHIN PUBLIC ORGANISATIONS

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Open Government Data (OGD) is a public good whose impact extends beyond the public sector, contributing to economic development and societal well-being. However, data alone do not create value, as the mere publication of data does not guarantee automatic positive effects in practice. Public organisations play a key role in this process by ensuring the provision of high-quality, accessible, and timely data and actively engaging within the broader ecosystem of data users. Although Slovenia has a favourable legislative and institutional framework for OGD, significant challenges persist at the organisational level. To better understand these challenges and identify strategies for overcoming them, this paper analyses scientific articles (from the WoS and Scopus databases) and examines the drivers and barriers within public organisations that influence the opening of data. A systematic review of these "universal" factors provides a foundation for addressing Slovenia's specific challenges and advancing the successful implementation of OGD initiatives.



## 1 Uvod

Modeli zrelosti veljajo za odlično diagnostično orodje, saj zagotavljajo celovito sliko stanja znotraj organizacije z identifikacijo organizacijskih lastnosti, ki predstavljajo spodbujevalne ali zaviralne faktorje pri doseganju določenih strateških ciljev (Jukić et al., 2022). Ocenjevanje zrelosti lahko vodi v sistemsko preobrazbo organizacije in prispeva k maksimiranju organizacijskega potenciala pri implementaciji določene politike, strateškega cilja, javne storitve itd. Tako se je v okviru javnega sektorja koncept merjenja zrelosti uveljavil na področjih e-uprave (Layne & Lee, 2001; Andersen & Henriksen 2006; Valdés et al. 2011; Saha, 2012; Fath-Allah et al., 2014), strateškega menedžmenta (Demir, 2017; Demir, 2018), soustvarjanja (KPMG Global healthcare, 2014; Hržica et al. 2021; Jukić et al. 2022) in na področju odprtih podatkov (Solar et al. 2012; Open Data Institute 2015; Rahmatika et al. 2019; British Local Government Association, 2022; Krucoff 2022; New Zealand Government, 2022; Pirannejad & Ingrams, 2022). Pri tem je pomembno poudariti, da imajo pri razvoju modela, značilnosti (upravnega) okolja, v katerem bo razviti model zrelosti uporabljen, ključno vlogo.

V prispevku želimo nasloviti pomanjkanje sistematičnega in celovitega okvirja pripravljenosti javne organizacije za uspešno izvajanje odprtih podatkov javnega sektorja (v nadaljevanju OPJS; odprti podatki OP) na »mezo« (organizacijski) ravni, kar presega le odpiranje posameznih podatkovnih zbirk. Pri tem nas zanima vidik zagotavljanja visokokakovostnih podatkov ter spodbudno okolje za njihovo soustvarjalno in inovativno uporabo. Opredeliti želimo dejavnike, ki bi v modelu zrelosti kot glavno enoto ocenjevanja obravnavali organizacijo kot celoto, vključno z vsemi organizacijskimi vidiki, ki neposredno ali posredno vplivajo na OPJS.

## 2 Metodologija - vsebinska analiza člankov

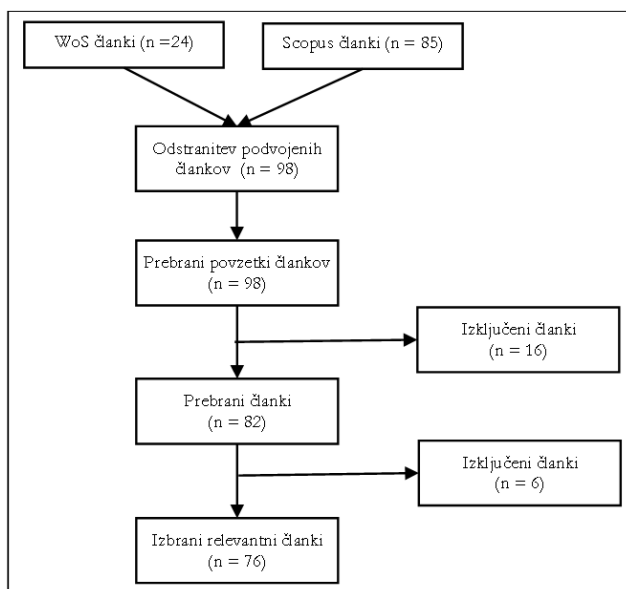
S pomočjo sistematične vsebinske analize relevantnih člankov so bili identificirani spodbujevalni in zaviralni dejavniki odpiranja podatkov v javnem sektorju. Sistematično iskanje relevantnih člankov v angleškem jeziku je bilo opravljeno v dveh bibliografskih bazah - Web of Science (WoS) in Scopus. Z namenom zajema čim večjega števila člankov, so bili identificirani sinonimi za najpogosteje uporabljena angleška termina »drivers« in »barriers«, iskalna strategija pa omejena na javno upravo oz. javni sektor (slika 1).

(Topic/Article title, Abstract, Key words = "open government data" AND "open data" AND (Topic/Article title, Abstract, Key words = drivers OR barriers OR motivators OR catalysts OR incentives OR enablers OR facilitators OR obstacles OR challenges OR hurdles OR impediments OR constraints OR limitations OR restraints))  
AND  
(All fields = "public administration" OR "public sector")  
AND  
DOCUMENT TYPE: (Article) AND LANGUAGE: (English)

**Slika 1: Iskalni niz relevantne literature**

Vir: Lasten

Na podlagi iskalne strategije in izbranih ključnih besed je bilo identificirani 109 člankov, 24 člankov iz baze WoS in 85 iz Scopusa. Po odstranitvi 11 podvojenih je sledilo prvo branje povzetkov, po katerem je bilo izključenih 16 člankov, ker se niso ukvarjali s spodbujevalnimi oz. zaviralnimi dejavniki OPJS ali pa se niso osredotočali na javne organizacije. Naslednji korak branja 82 člankov v celoti je izključil še 6 člankov kot neustreznih. V tretjem branju izbranih 76 člankov so bili identificirani spodbujevalni in zaviralni dejavniki OPJS (slika 2).



**Slika 2: PRISMA diagram**

Vir: Lasten

### 3 Rezultati vsebinske analize člankov

Tabela 1: Spodbujevalni in zaviralni dejavniki OPJS

Skupina	Dejavniki (spodbujevalni/zaviralni)	Viri
1 Strateška usmeritev organizacije	1.1 Pristojnost organizacije 1.2 Strateška umeščenost 1.3 Lastništvo nad podatki 1.4 Stopnja digitalizacije	Attard et al., 2015; Cahlikova & Mabillard, 2020; Kawashita et al., 2022; Ma & Lam, 2019; Mutambik et al., 2023 ; Najafabadi & Cronemberger, 2023; Izdebski et al., 2021; Ma & Lam, 2019; Mutambik et al., 2021; Natvig et al., 2021; Ruijer & Martinius, 2017; Ruijer & Meijer, 2020; Saxena, 2018; Wang et al., 2019; Yang et al., 2015; Zhang et al., 2022; Zhenbin et al., 2020; Zuiderwijk & de Reuver, 2021
2 Zunanji kontekst	2.1 Pravni okvir 2.2 Podpora 2.3 Pritiski	Attard et al., 2015; Cahlikova & Mabillard, 2020; Hogan et al., 2017; Kassen, 2019; Khurshid et al., 2019; Kim & Eom, 2019; Lee & Jun, 2021; Ma & Lam, 2019; Mustapa et al., 2019; Mutambik et al., 2021; Mutambik, Lee, Almuqrin, & Zhang, 2023; Natvig et al., 2021; Paige & Freund, 2019; Ruijer, Détienne et al., 2020; Ruijer, Grimmeliikhuijsen, et al., 2020; Ruijer & Meijer, 2020; Safarov, 2020; Welle Donker et al., 2017; Wen & Hwang, 2019; Wibowo, Sensuse, et al., 2023; Wu and Chan, 2012; Yang et al., 2015; Yang & Wu, 2016; Zhenbin et al., 2020; Zhang et al., 2022; Zuiderwijk & de Reuver, 2021;
3 Odnos do OP	3.1 Koristi 3.2 Izgube 3.3 Tveganja/strahovi 3.4 Vložen napor	Attard et al., 2015; Cahlikova & Mabillard, 2020; Donker & van Loenen, 2016; Hitz-Gamper et al., 2019; Hogan et al., 2017; Hossain et al., 2016; Jamieson et al., 2019; Khurshid et al., 2019; Kim & Eom, 2019; Ma & Lam, 2019; Mutambik et al., 2021; Mutambik, Lee, Almuqrin, & Zhang, 2023; Mustapa et al., 2019; Natvig et al., 2021; Paige & Freund, 2019; Ruijer & Meijer, 2020; Ruijer, Détienne, et al., 2020; Safarov, 2020; Shepherd et al., 2019; Wang et al., 2019; Welle Donker et al., 2017; Yang & Wu, 2016; Yang et al., 2015; Zhang et al., 2022;
4 Sistemski okvir	4.1 IT oddelek/sektor 4.2 Kompatibilnost 4.3 Sistem (4.3.1 Sistem upravljanja, 4.3.2 Silos, 4.3.3 Načrt, 4.3.4 Smernice, 4.3.5 Zunanje izvajanje, 4.3.6 Sistem	Attard et al., 2015; Cahlikova & Mabillard, 2020; Chatfield & Reddick, 2017; Cho & Lee, 2022; Dawes et al., 2016; Hogan et al., 2017; Hossain et al., 2016; Kassen, 2018; Kawashita et al., 2022; Kim & Eom, 2019; Kim, 2018; Ma & Lam, 2019; Masoumi et al., 2022; Mustapa et al., 2019; Mutambik et al., 2021; Mutambik, Lee, Almuqrin, & Zhang, 2023;

Skupina	Dejavniki (spodbujevalni/zaviralni)	Viri
	spodbud/nagrajevanja, 4.3.7 Promocija) 4.4 Viri (4.4.1 IT Viri, 4.4.2 Finančni viri, 4.4.3 Človeški viri) 4.5 Proces (4.5.1 Standardizacija, 4.5.2 Odgovorna oseba, 4.5.3 Kontaktna oseba, 4.5.4 Nadzor)	Paige & Freund, 2019; Park & Gil-Garcia, 2022; Purwanto et al., 2020; Ruijer & Meijer, 2020; Ruijer & Meijer, 2020; Ruijer, Détienne, et al., 2020; Saxena, 2018; Shepherd et al., 2019; Susha et al., 2015; Wang et al., 2019; Wibowo, Fadhil, et al., 2023; Wibowo, Sensuse, et al., 2023; Yang & Wu, 2016; Yang et al., 2015; Zhang et al., 2022; Zhenbin et al., 2020; Zuiderwijk et al., 2014
5 Organizacijska kultura	5.1 Ustrezna kultura 5.2 Sodelovanje (5.2.1 Profil uporabnikov, 5.2.2 Načini sodelovanja, 5.2.3 Skupnost uporabnikov, 5.2.4 Ekosistem OPJS)	Ahmad & Warriach, 2020; Cahlikova & Mabillard, 2020; Dawes et al., 2016; Hossain et al., 2016; Kawashita et al., 2022; Kim & Eom, 2019, Mustapa et al., 2019; Natvig et al., 2021; Purwanto et al., 2020; Susha et al., 2015; Vetrò et al., 2016; Wang et al., 2019; Wibowo, Sensuse, et al., 2023; Yang et al., 2015; Yang & Wu, 2016; Zhang et al., 2022; Zuiderwijk & de Reuver, 2021
6 Zaposleni	6.1 Poznavanje koncepta 6.2 Zavedanje koristi 6.3 Naloge 6.4 Zagovornik/ambasador odprtih podatkov 6.5 Zadovoljstvo 6.6 IT večšine 6.7 Podpora vodstva (6.7.1 Politično vodstvo, 6.7.2 Top management, 6.7.3 Srednji management)	Ahmad & Warriach, 2020; Attard et al., 2015; Avella et al., 2023; Cahlikova & Mabillard, 2020; Golub & Lund, 2021; Hogan et al., 2017; Hossain et al., 2016; Jamieson et al., 2019; Kawashita et al., 2022; Khayyat et al., 2022; Khurshid et al., 2019; Kim & Eom, 2019; Ma & Lam, 2019; Mustapa et al., 2019; Mutambik et al., 2021; Mutambik, Lee, Almuqrin, & Zhang, 2023; Mutambik, Lee, Almuqrin, et al., 2023; Park & Gil-Garcia, 2022; Ruijer & Meijer, 2020; Ruijer, Détienne, et al., 2020; Shepherd et al., 2019; Susha et al., 2015; Wang et al., 2019; Wen & Hwang, 2019; Wibowo, Fadhil et al., 2023; Wibowo, Sensuse, et al., 2023; Yang & Wu, 2016; Yang et al., 2015; Zhang et al., 2022;
7 Vrednost odprtih podatkov	7.1 Pravočasnost 7.2 Dostopnost brez omejitev 7.3 Strojna berljivost 7.4 Registracija 7.5 Brez plačila 7.6 Interoperabilnost 7.7 Povezljivost 7.8 Relevantnost 7.9 Granularnost 7.10 Verzioniranost	Attard et al., 2015; Izdebski et al., 2021; Jetzek, 2016; Maione et al., 2022; Susha et al., 2015; Vetrò et al., 2016

Vir: lasten

Skrben pregled literature s faktorji vpliva na OP ter specifike okolja javnega sektorja sta narekovala izbor relevantnih dejavnikov. Vsebinsko so dejavniki razvrščeni v sedem glavnih področij, znotraj katerih so spodbujevalni oz. zaviralni dejavniki pomenske skupine (tabela 1).

**Strateška usmeritev organizacije:** Javna organizacija ima pristojnost za odpiranje podatkov. Osnovni pogoj predstavlja digitalno usmerjena in razvita organizacija. Če naslavlja OP v svojih strateških dokumentih, pomeni, da je odpiranje podatkov visoka prioriteta za organizacijo. Kadar sta transparentnost in odgovornost ključni vrednoti organizacije, bo odpiranje podatkov prepoznano kot (dodatni) pristop k doseganju teh ciljev. Nepregledno lastništvo nad podatki predstavlja oviro pri njihovem odpiranju. Deljeno oz. nejasno lastništvo nad podatki med različnimi javnimi inštitucijami lahko privede do neuskkljenosti in negativno vpliva na konsistentnost podatkov.

**Zunanji kontekst:** Najmočnejši zunanji pritiski so običajno zakonske obveznosti, ki zahtevajo OP. Pri OPJS je pomembno, da obstoječa zakonodaja ne predstavlja ovir. Vendar tudi ko ni dejanskih pravnih ovir, se lahko zaradi kompleksnosti zakonodaje ustvari percepcija pravne oviranosti pri odpiranju podatkov. Strah pred pravno odgovornostjo zaradi (ne)kakovosti, zlorabe ali kršitve pravice do zasebnosti močno ovira javne organizacije pri odpiranju podatkov. Tveganja povezana z razkritjem občutljivih osebnih podatkov ali podatkov nacionalne varnosti so odvisna predvsem od področja javne politike. Obstoj mehanizma, protokola ali smernic, ki pomagajo pri odločitvi, ali lahko določene podatke odprejo ali ne, lahko prispeva pri odpravi omenjenih ovir. Pomemben dejavnik zunanjega pritiska je tudi povpraševanje javnosti in medijev po OP, kar je posledica ozaveščenosti širše družbe in običajno povezano z obstojem mrež neodvisnih skupnosti.

**Odnos do OP:** Motivacija in pripravljenost za izvajanje OP sta odvisni od združljivosti ciljev OP s poslanstvom organizacije, bojzani pred spremembami in ocene navora, ki ga mora organizacija vložiti. Pomemben dejavnik predstavlja prepoznavanje potencialnih koristi OPJS na gospodarstvo, okolje in družbo na sploh. Če javna organizacija prepozna OP kot pot do boljše uspešnosti organizacije, se kot posledica odpiranja podatkov lahko zniža transakcijske stroške poslovanja ali zagotovi »nagrade« - na primer pozitivne odzive/priznanje. Finančne izgube pa se lahko kažejo zaradi stroškov, ki jih ima organizacija z odpiranjem in vzdrževanjem

podatkov. Za javne organizacije, ki so v preteklosti prodajale podatke, politika OPJS predstavlja izgubo dodatnega prihodka. Poleg finančnih lahko javne organizacije utrpijo tudi nematerialne izgube, npr. konkurenčne prednosti pri razvoju aplikacij in storitev ali strah pred izgubo nadzora nad OP. Javne organizacije se bojijo, da bodo njihovi podatki zlorabljeni ali napačno interpretirani, ali da bi se razkrile napake, pri čemer se želijo izogniti kritičnim vprašanjem in izgubi javnega zaupanja. Pomemben dejavnik pri oblikovanju odnosa organizacije do OP je tudi ocena vloženega napora, tako z vidika časa in virov, kot sodelovanja z drugimi javnimi organizacijami.

**Sistemski okvir:** Obstoj IT oddelka znotraj organizacije se šteje za veliko prednost pri odpiranju podatkov. Hkrati morajo organizacije imeti tudi jasno formalizirana/institucionalizirana pravila, ki urejajo področje OP in razvoj/skrbnišтво sistema za upravljanje OP. Za organizacije, ki so ocenile, da nimajo zmogljivosti za odpiranje podatkov, je zunanje izvajanje legitimna odločitev. Vendar zunanje izvajanje lahko organizacije naredi preveč odvisne od zunanjih izvajalcev, saj lahko privede do situacije, ko organizacije ne bodo imele več pregleda nad nabori podatkov, ki so na voljo. Z vidika zaposlenih je močan dejavnik jasen in delujoč sistem spodbud, ki lahko zagotovi večjo pozornost in usmerjenost k nalogam, povezanih z OP, npr. tipične spodbude v javnem sektorju, kot napredovanja na podlagi ocene uspešnosti. Odnosi z javnostmi in promocija odpiranja podatkov sta dodatni značilnosti, ki ju mora sistem nasloviti, da lahko zagotovi širšo podporo in ozaveščanje javnosti glede OP. V tem kontekstu mora organizacija redno predstavljati dobre prakse objav podatkov in njihove uporabe, pri tem pa jasno izpostaviti pozitivne rezultate tovrstnih praks.

**Sistemski okvir>Viri:** Organizacije pogosto nimajo načrtovanih finančnih virov za zbiranje, vzdrževanje in odpiranje podatkov, kar predstavlja izziv zlasti v primeru manjših organizacij na lokalni ravni. Uspešna implementacija OPJS, temelji na sinergiji treh vrst virov. (1) IT viri, vključno z informacijskimi sistemi, veljajo za ključen spodbujevalni dejavnik inovacij v zvezi z OP (orodja, podatki in omrežna infrastruktura). Stroški tako izhajajo iz potrebe po investicijah v nove IT sisteme. (2) Finančna zmogljivost organizacije obsega vse finančne vire (proračunska sredstva, subvencije, itd.), ki so na voljo organizaciji za odpiranje podatkov. Ključno je, da proračun organizacije vključi jasne postavke za odpiranje podatkov, sicer bo to sprejeto kot dodatno breme, ki ne bo prejelo ustrezne pozornosti ali pa si bo moralo izboriti vire na račun drugih obstoječih dejavnosti organizacije. (3) Človeški



viri, in sicer zadostno število zaposlenih s potrebnim znanjem in kompetencami, so ključnega pomena za OP. Neprivlačen sistem spodbud/nagrad in pomanjkanje avtonomije zaposlenih ovirata javne organizacije pri zaposlovanju ustreznega kadra za izvajanje zahtevnih nalog, povezanih z odprtimi podatki. Kot rešitev izziva omejenih virov, določeni avtorji predlagajo sodelovanje z zunanjimi izvajalci in (vsaj delno) zanašanje na njihove vire.

**Sistemska okvir>Proces:** Uvedba sistema upravljanja z OP zahteva jasno določene procese, vloge in odgovornosti. Potrebna je standardizacija upravljanja in objavljanja podatkov. Za uspešen proces odpiranja podatkov je potrebno vzpostaviti razumno ravnovesje med sprejemanjem odločitev in sicer v kombinaciji centraliziranih in decentraliziranih operacij. Če so OP integrirani v splošno delovanje organizacije in njene procese, bodo zaposleni lažje sprejeli novo realnost. Glede na področje, na katerem se takšni podatki ustvarjajo, se tako proces odpiranja podatkov v primeru "občutljivih" javnih politik (npr. varnosti) razlikuje od procesa odpiranja "občutljivih" podatkov, povezanih z zasebnostjo, medtem ko je za neobčutljive podatke proces spet drugačen. Priporočljivo je, da je nadzor procesa odpiranja podatkov v rokah enega glavnega koordinatorja/skrbnika podatkov na ravni organizacije, ki bo med procesom večkrat spremljal napredek pri pripravi in objavi zbirk podatkov in komuniciral s koordinatorji oddelkov.

**Organizacijska kultura:** Poleg jasno določenih pristojnosti je organizacijska kultura eden najpomembnejši dejavnikov za uspešno OP. Birokratizacija in konservativna kultura, podrejena avtoriteti, ustvarjata med uradniki odpor do OP. Pomembna je sprememba miselnosti uradnikov in kot ključne se navaja (1) spoznanje in sprejetje, da javne uprave ne vedo vsega, in (2) končanje kulture tajnosti (*culture of secrecy*). Z vidika ustrezne organizacijske kulture sta sodelovanje z in vključevanje zunanjih akterjev prepoznana kot dejavnika, ki pripomoreta k objavi več in bolj kakovostnih podatkov. V ta namen organizacija uporablja različne kanale za komunikacijo in sodelovanje z uporabniki odprtih podatkov (npr. hackatoni) in posvetovanja o konkretnih namelih uporabe podatkov. Pomembno je vključevanje zunanjih deležnikov že v zgodnji fazi zbiranja podatkov omogoča javnim organizacijam, da spoznajo profil in potrebe uporabnikov svojih podatkov, ter vzdrževanje sodelovanja (posvetovanja, sestanki, delavnice, (virtualna ali fizična) srečanja). Prav tako je pomembno prizadevanje za ustvarjanje skupnosti uporabnikov OP in nudenje aktivne pomoči njihove uporabe.

**Zaposleni:** Glavna zaviralna dejavnika sta nezainteresiranost vodstvenega kadra za OP in neusposobljeno osebje. Med zaposlenim znotraj organizacije je pomembno promoviranje in spodbujanje uporabe OP, pri čemer imajo pomembno vlogo proaktivni posamezniki. Organizacija mora poskrbeti, da vzpostavi enostaven sistem upravljanja z OP in naslovi pogoste strahove med zaposlenimi pred povečanimi delovnimi obremenitvami. Pomanjkanje IT veščin je pogosta ovira pri izvajanju OP, zato so izobraževanja povezana z OP pomembna. Naloge, povezane z OP, morajo biti sprejete s strani zaposlenih kot redne obveznosti. Kot ključno oviro se omenja dodeljevanje dodatnih nalog povezani z OP zaposlenim, katerih delo pred uvajanjem iniciativ odprtih podatkov ni obsegalo tozadevnih nalog, in pomanjkanje sistematizacije delovnih mest, namenjenih izključno upravljanju z odprtimi podatki, ki jasno določajo odgovornosti OP. Pomembno vlogo imajo skrbniki podatkov z jasno določenimi odgovornostmi ter zavedanjem o koristih OP, ki potrebujejo IT veščine glede digitalnih podatkov in sistemov, strokovno znanje o IT varnosti, postopkih anonimizacije, podatkovni analizi, digitalni kuraciji in tehnologijah spletne semantike, pa tudi veščine upravljanja s tveganji (npr. glede zasebnosti) in ocenjevanja vpliva OP na širše družbeno okolje.

**Vrednost odprtih podatkov:** Javne organizacije morajo zagotoviti kakovostne podatke, ki imajo potencial pozitivnega vpliva na družbo v širšem pomenu. V tem kontekstu se pogosto sklicuje na naslednje lastnosti OP: (1) pravočasni podatki –na voljo čim hitreje po njihovem nastanku, (2) dostopni podatki – enostavno, dosledno in varno dostopni, prenosljivi ali pretočni, ter objavljeni pod odprtimi licencami (3) strojno berljivi podatki –strukturirani, pripravljeni in zapisani na način, da omogočajo avtomatizirano strojno obdelavo, (4) brez registracije –na voljo za uporabo vsakomur, brez zahtev po registraciji, (5) cenovna dostopnost –brezplačni oziroma je zaračunani strošek največ v višini marginalnih stroškov reprodukcije, (6) interoperabilnost – sintaksa podatkov je jasna, uporaba odprtih modelov, s standardiziranimi metapodatki in identifikatorji, da jih je mogoče enostavno povezovati z drugimi podatkovnimi zbirkami, (7) povezljivost –povezani z drugimi sorodnimi zbirkami podatkov, (8) relevantnost – pomembnost objavljenih podatkov, (9) granularnost - zbrani pri viru, z najvišjo možno stopnjo podrobnosti in ne v zbirnih ali spremenjenih oblikah, (10) verzioniranost – beleženje verzij podatkovnih zbirk .

## 4 Zaključek

Namen tega prispevka je ponuditi jedrnat, a hkrati celovit pregled spodbujevalnih in zaviralnih dejavnikov, ki vplivajo na odpiranje podatkov z vidika javnih organizacij. Pregled temelji na metodologiji sistematičnega pregleda literature iz dveh ključnih znanstvenih baz, WoS in Scopus. Na podlagi analize lahko trdimo, da prispevek zajema večino »univerzalnih« dejavnikov na »mezo« ravni, ki bodisi ovirajo bodisi spodbujajo odpiranje podatkov, ne glede na nacionalni, upravni ali organizacijski kontekst.

Zaključki te analize ponujajo trdno osnovo za razvoj večparametrskega odločitvenega modela, namenjenega merjenju organizacijske pripravljenosti za odpiranje podatkov, prilagojenega slovenskemu javnemu sektorju. Prav ta prilagoditev predstavlja ključno pridobitev in dodano vrednost v primerjavi z obstoječimi modeli merjenja zrelosti OPJS. Modeli zrelosti se uveljavljajo kot učinkovito diagnostično orodje, saj zagotavljajo celovit vpogled v stanje organizacije in omogočajo identifikacijo lastnosti, ki bodisi spodbujajo bodisi zavirajo njena prizadevanja pri doseganju strateških ciljev – v tem primeru odpiranja podatkov javnega sektorja.

V naslednjem koraku smo ugotovitve, predstavljene v tem prispevku, verificirali v slovenskem kontekstu, jih nadgradili, operacionalizirali in jim določili uteži. Čeprav podrobna predstavitev teh rezultatov in strukture modela presega obseg tega prispevka, je treba poudariti, da smo na tej osnovi razvili praktično orodje za slovenske javne organizacije. Z razvojem tega orodja naslavljamo pomanjkanje sistematičnega pristopa k reševanju izzivov odpiranja podatkov na »mezo« (organizacijski) ravni. Poleg tega orodje prispeva k vzpostavitvi "privzete" organizacijske pripravljenosti, ki presega trenutni "ad hoc" pristop k odpiranju posameznih podatkovnih zbirk in omogoča bolj strukturirano podporo slovenskim javnim organizacijam.

Poleg prispevkov ima raziskava tudi nekatere omejitve. Osredotoča se zgolj na spodbujevalne in zaviralne dejavnike z vidika javnih organizacij, čeprav na politiko OPJS vplivajo tudi drugi dejavniki, kot so odnos objaviteljev in uporabnikov ter specifične lastnosti slednjih. Prav tako obravnava le dejavnike, povezane s procesom odpiranja podatkov, medtem ko vprašanje njihove ponovne uporabe ostaja predmet prihodnjih raziskav.

## Opomba

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# CENOVNA OBČUTLJIVOST PRI NAKUPU SMUČARSKIH KART: PRIMERJALNA ANALIZA SLOVENSКИH IN TUJIH SMUČIŠČ

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Smučanje je med Slovenci bilo od vedno priljubljeno. Vendar se v zadnjih letih srečujemo z vedno bolj zelenimi zimami, kar pa draži ceno smučarskih vozovnic. Vsled tega nas je zanimalo, ali rast cen na slovenskih smučiščih zaostaja za konkurenčnimi smučišči v Italiji in Avstriji ter kako spol, starost in dohodek vplivajo na cenovno elastičnost koristnikov smučarskih storitev. Z uporabo zgodovinske metode smo analizirali podatke o gibanju cen smučarskih vozovnic in ugotovili, da se smučarske vozovnice v Sloveniji ne dražijo nič več, kot v Italiji in Avstriji. Poleg tega smo izvedli spletno anketo s 536 udeleženci. Ugotovili smo, da so se drobnoprodajne cene od leta 2006 zvišale za 60 %. Analiza je pokazala, da se slovenski smučarji niso pripravljene odpovedati smučanju, četudi bi se cene še dodatno povišale.

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# PRICE SENSITIVITY AND SKI PASS PURCHASES: A COMPARISON ACROSS SLOVENIAN AND INTERNATIONAL RESORTS

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Skiing has always been popular among Slovenians. However, in recent years, we have been experiencing increasingly greener winters, which in turn has made the price of ski passes more expensive. As a result, we wanted to determine whether price increases at Slovenian ski resorts are lagging behind those of competitors in Italy and Austria, and how gender, age, and income affect the price elasticity of ski users. Using a historical method, we analysed data on the evolution of ski pass prices and found that ski passes in Slovenia are no more expensive than in Italy and Austria. In addition, we conducted an online survey with 536 participants. We found that retail prices have increased by 60% since 2006. The analysis showed that Slovenian skiers are not willing to give up skiing, even if prices were to increase further.



## 1 Uvod

Smučanje je priljubljena zimska dejavnost, ki jo uživajo ljudje vseh starosti in z različnimi ravnmi izkušenj. Vendar pa je lahko tudi precej drag šport, zlasti če upoštevamo stroške vozovnic, opreme in prenočišč. V zadnjih letih so se cene smučarskih vozovnic znatno povešale, kar je sprožilo vprašanje, ali to vpliva na odločitve ljudi o tem, ali bodo šli smučati.

Skozi stoletja smo Slovenci do gora razvili svojstven odnos, ki se je utrdil predvsem od 19. stoletja dalje, zato so se gore usidrale tudi v narodno zavest in identiteto (Mikša et al., 2017) kot pomemben simbol naše kulturne dediščine, ponosa in pripadnosti domovini. Z gorami pa je povezano tudi smučanje. In zgodovina smučanja na Slovenskem je bila doslej predmet poljudnih raziskav, obenem pa se je o njem pretirano pisalo in gradilo mite. Na začetku 20. stoletja se je v naših krajih poleg starosvetnega bloškega smučanja, ki ga opisuje že Valvazor, smučanje začelo v večjem obsegu uveljavljati tudi kot športna (Atelšek, 2022) in kasneje prostočasna disciplina. Podjetja so gradila smučarske proge in objekte, s čimer so smučanje približala delovnemu narodu ter mu omogočila dostopnejšo rekreacijo in sprostitvev v gorskem okolju, s tem pa je naraščalo tudi število mednarodnih športnih uspehov. Tako se je izoblikovala kolektivna identifikacija Slovencev s smučanjem, izum slovenske smučarske tradicije je zaznamoval naš narod, smučarske prireditve so pri nas največji nacionalni prazniki (Savenc, 2010). Vsled tega smo se Slovenci za vedno zapisali kot smučarski narod.

Vendar pa se je z leti ta odnos močno spremenil, predvsem zaradi več gospodarskih in finančnih kriz. V zadnjih tridesetih letih so mile zime dodatno zmanjšale zanimanje za smučanje, obenem pa so stroški tega športa občutno narasli. Spremenil se je tudi življenjski standard – le redki se zadovoljijo s cenovno ugodno smučarsko opremo, tudi če obiščejo le lokalno smučišče. S pojavom družbenih medijev je smučanje postalo tudi priložnost za samoprezentacijo. Dan smučanja na slovenskih smučiščih, zgolj za nakup celodnevni kart za štiri člansko družino, stane okrog 150 EUR. Z družinskim popustom pa 130 EUR. Če k temu dodamo še najem opreme, ki se začne pri 24 evrih (17 EUR za otroke) za paket smuči, palic in čevljev, je skupni dnevni strošek smučanja takoj čez 200 EUR, brez hrane, oblačil ter prevoza do smučišča. V kolikor pa opremo kupimo, čeprav rabljeno in jo uporabimo več let, pa so vstopni oziroma začetni stroški visoki (Rabuz, 2023) in si ta strošek le malokdo

lahko privoščiti. Še nekoliko dražje je smučanje, če se odpravimo v tujino. Enotedenski najem apartmaja za štiri osebe je več kot 1.000 EUR. Dnevna karta ob nakupu za cel teden znaša dobrih 52 EUR na odraslega in 26 EUR na otroka. Skupni tedenski strošek za apartma in štiri tedenske smučarske vozovnice je tako okrog 1.800 EUR. Če za primerjavo vzamemo neto plačo za zadnje dostopno tromesečje na statističnem uradu, ki znaša 1.364,29 EUR, potem teden smučanja v Avstriji v mesečnem proračunu štiričlanske družine (2.728 EUR) predstavlja zajetnih 65 odstotkov. Seveda je smučanje v Sloveniji cenejše, bivamo lahko doma in se odpravimo na dnevne smuke. Relativna bližina smučarskih središč v Avstriji in Italiji, ki nudijo daljše proge in drugačno izkušnjo ('Smo Slovenci še smučarski narod?', 2024), ter večja zagotovitev, da bo dovolj snežne odeje, pa sta motivacija za nakup smučarskih vozovnic in odhod na smučanje v tujino.

V prispevku bomo analizirali vpliv spremembe cen smučarskih vozovnic na odločitve anketirancev glede obiska smučišč. Osredotočili se bomo na to, ali bi zmanjšali obisk smučišč, ali se celo povsem odpovedali smučanju, če bi se cene vozovnic povišale. Naše raziskovalno vprašanje se glasi: **Ali rast cen na slovenskih smučiščih zaostaja za konkurenčnimi smučišči v Italiji in Avstriji ter kako spol, starost in dohodek vplivajo na cenovno elastičnost uporabnikov smučarskih storitev?**

## 2 Teoretično ozadje

### 2.1 Smučanje

Raziskave o smučanju in smučarskih vozovnicah so identificirale različne dejavnike, ki vplivajo na vedenje smučarjev in optimalno ceno smučarskih vozovnic. Na vzorce obiska vplivajo dejavniki, kot so dan v tednu, prazniki in vremenske razmere, z različnimi učinki na različne vrste smučarskih vozovnic (Malasevska & Haugom, 2018). Programi sezonskih vozovnic z velikimi popusti znatno vplivajo na zvestobo smučarjev do posameznega smučarskega letovišča (Perdue, 2002). Tudi na področje smučarske industrije vstopa Yield management. Optimalno oblikovanje cen smučarskih vozovnic mora upoštevati dejavnike, kot sta gneča in zmanjšana zmogljivost smučanja (Haugom et al., 2020). Izzivi pa še vedno obstajajo v ponudbi vremenskih popustov, z najnižjo pripravljenostjo plačati za smučanje v snežnem metežu, dežju in kadar je odprtih manj kot 50 % prog (Malasevska et al., 2017). To

bi smučičem lahko omogočilo dodatne prihodke. Vendar pa so določeni izzivi povezani z varnostjo.

Kaj žene smučarje na smučišča? Raziskave motivacije in preferenc smučarjev razkrivajo kompleksen preplet psiholoških, socialnih in statusnih dejavnikov (Mladenović & Jovanović, 2019). Te motivacije se lahko sčasoma spreminjajo, pri čemer sta posebej pomembna druženje in vključevanje v dejavnosti, ki temeljijo na spretnostih (White & Pennington-Gray, 2002). Vsekakor ima smučanje, od svojega utilitarnega izvora do preoblikovanja v rekreativno in tekmovalno dejavnost, velike kulturne in družbene vplive na šport (Allen, 1993). Smučarji so običajno mladi in neporočeni ki imajo višje dohodke od povprečja, pri čemer sta bližina in fizična kakovost smučišč ključna dejavnika pri izbiri destinacije (Leuschner & Herrington, 1971). Kljub vsemu pa praviloma velja, da bo tisti, ki se je v mladih letih začel ukvarjati s tem športom, to počel tudi v zrelih letih. Če le mu bodo finance in zdravje dopuščali. Na udeležbo pri smučanju, razvoj spretnosti in porabo vplivajo različni dejavniki, kot so stopnja zavzetosti, vpliv družine ter želja po vznemirjenju (Hungenberg et al., 2013). Preden se odpravimo na smučanje se moramo ustrezno pripraviti. Smučanje je fizično zahteven šport, ki zahteva kombinacijo moči, gibljivosti in biomehanskega ravnotežja spodnjih okončin (Ross, 2010). Zato je potrebna tudi celoletna fizična pripravljenost. Tudi gibanje v visokogorju, kjer ima sonce večjo moč, ima svoje vplive. Potrebna je zaščita s kremami proti opeklinam. Kljub dobremu namenu uporabe krem za sončenje, se mnogi smučarji pred soncem ne zaščitijo ustrezno, pri čemer so še posebej ogroženi moški in mlajši smučarji (Janssen et al., 2015). Šport je povezan tudi z velikim tveganjem za travmatske poškodbe, zlasti med vrhunskimi smučarji (Saragaglia et al., 2021) in tistimi, ki se na smučanje odpravijo fizično nepripravljene.

## **2.2 Odločanje potrošnika in njegova izbira**

Na odločitev o nakupu smučarske vozovnice vpliva vrsta dejavnikov. Večja verjetnost je, da bodo smučarji kupili sezonsko vozovnico, če lahko smučajo dovolj krat in da prejmejo 50-odstotni popust na ceno dnevne vozovnice (Holmgren et al., 2016). Kakovost snega in raznolikost terena sta ključna dejavnika pri izbiri destinacije britanskih smučarjev v Kanadi (Godfrey, 1999). Vendar pa vplivata tudi gneča in zmanjšane smučarske zmogljivosti, na optimalno ceno smučarskih vozovnic (Haugom et al., 2020).

V kolikor povzamemo ključne ugotovitve, na odločitev o nakupu smučarske karte vpliva veliko dejavnikov, med katerimi so:

- Cena: Cena smučarske karte je eden najpomembnejših dejavnikov, ki vpliva na odločitev o nakupu. Ljudje so bolj nagnjeni k nakupu, če je cena ugodna, zato kupujejo karte v predprodaji ali ko so promocijski popusti.
- Dolžina bivanja: Ljudje, ki nameravajo smučati dlje časa, so bolj nagnjeni k nakupu kot tisti, ki nameravajo smučati le nekaj dni. Praviloma tovrstni smučarji prihajajo v družbi prijateljev ali družinskih članov.
- Raven smučanja: Ljudje, ki so bolj izkušeni smučarji, so bolj nagnjeni k nakupu smučarske karte, ki jim omogoča dostop do vseh smučarskih prog. Posegajo po smučarskih kartah, ki združujejo več smučišč.
- Vreme: Ljudje so bolj nagnjeni k nakupu smučarske karte, če je napovedano lepo vreme. Tako je ob lepem vremenu vedno več smučarjev na smučišču, kar posledično prinaša tudi prenatrpanost in slabo voljo, v primeru, da na smučišču ni dovolj kapacitet.
- Razpoložljivost: Ljudje so bolj nagnjeni k nakupu smučarske karte, če je na voljo dovolj smučarskih prog in če ni pričakovane prevelike gneče za čakanje na gondolo ali sedežnico.
- Dodatne ponudbe: Ljudje so bolj nagnjeni k nakupu smučarske karte, če so vključene dodatne ponudbe, kot so na primer brezplačno parkiranje ali popusti na smučarsko opremo.
- Osebne preference: Ljudje se pri nakupu smučarske karte odločajo tudi na podlagi svojih osebnih preferenc, kot so na primer velikost smučišča, raznolikost smučarskih prog, možnost nočnega smučanja in ponudba gostinskih objektov. Praviloma se večkrat vračajo na isto smučišče.

Poleg omenjenih dejavnikov, lahko na nakup smučarske karte vplivajo tudi drugi dejavniki, kot so družbeni trendi, lokacija smučišča, dostopnost z javnim prevozom, priporočila prijateljev in znancev ter v zadnjem času tudi priporočila influencerjev.

Te študije skupaj kažejo, da so cena, kakovost snega, raznolikost terena in splošna smučarska izkušnja, pomembni dejavniki pri odločitvi za nakup smučarske vozovnice.

### 2.3 Ključne teorije, ki vplivajo na odločite potrošnika za nakup smučarske karte

Na samo povpraševanje po smučarskih kartah, vpliva cenovna politika. Ta je odvisna od standarda v državi in razvitosti smučišč. Raziskave cen smučarskih vozovnic in povprečnih plač razkriva več ključnih ugotovitev. Obstajajo mednarodne razlike v cenah vozovnic za žičnice, saj so francoske in avstrijske vozovnice v povprečju nižje od švicarskih (Falk, 2011). Še nižje so v Sloveniji, Bosni in Hercegovini, Srbiji in Bolgariji. Tako so cene vozovnic za žičnico nižje v Pirenejih in Južnih Alpah, v primerjavi s Severnimi Alpami (Wolff, 2014). Na cene smučarskih vozovnic vpliva dolžina smučarskih prog, prevozne zmogljivosti na smučišču in garantirane snežne razmere (Falk, 2008). Vendar se danes zaradi milih zim ne moremo več zanašati zgolj na naraven sneg. Pomembno je tudi zgodnje zasneževanje, da ne bi prihajalo do upada prodaje vozovnic (Falk & Hagsten, 2016) in odhoda na druga smučišča. Te študije skupaj kažejo, da na cene vozovnic za žičnice vpliva vrsta dejavnikov, vključno z geografsko lokacijo, značilnostmi letovišča in snežnimi razmerami.

#### Teorija koristnosti

Teorija koristnosti (ang. »Theory of utility«) predpostavlja, da potrošniki izbirajo blago in storitve na podlagi njihove koristnosti in cene (Jevons, 1886). Potrošnik bo izbral blago ali storitev, ki mu prinaša največjo koristnost glede na ceno. Če se cena blaga ali storitve poveča, se lahko zgodi, da bo potrošnik raje izbral cenejšo alternativo, ali pa se povsem odpovedal nakupu.

Kaj razumemo pod »koristnostjo«? Jevons pravi: *»Koristnost... ne predstavlja resnične lastnosti stvari. Bolje rečeno, izraža odnos med človekovimi potrebami in stvarjo, s katero naj bi te potrebe zadovoljeval«. Z besedo koristnost torej označujemo zadovoljstvo. Bolj natančno, koristnost označuje, kako potrošniki vrednotijo različne dobrine in storitve. Če ima za nekoga košarica »A« večjo koristnost, kot košarica »B« pomeni, da ima ta nekdo košarico »A« raje. Pogosto je pripravno, če mislimo o koristnosti kot o subjektivnem zadovoljstvu ali koristi, ki jo osebi prinese potrošnja neke dobrine ali storitve. Vsekakor pa se je treba upreti misli, da je koristnost psihološka funkcija ali občutek, ki ga je mogoče opazovati ali meriti. Namesto tega je koristnost znanstveni konstrukt, ki ga ekonomisti uporabljajo, da bolje razumejo, kako racionalni potrošniki razporedijo svoje omejene vire med dobrine, ki jim prinašajo*

zadovoljstvo. V teoriji povpraševanja pravimo, da ljudje maksimirajo svojo koristnost, kar pomeni, da izberejo tisto košarico potrošnih dobrin, ki jo imajo najraje (Jevons, 1886).

Teorija koristnosti pojasnjuje, kako posamezniki sprejemajo odločitve za maksimiranje zadovoljstva glede na stroške in alternative. Pri nakupu smučarske karte oseba ocenjuje koristnost smučanja, ki vključuje užitek, družbene vidike in kakovost storitev, v primerjavi s ceno ter proračunsko omejitvijo. Zmanjševanje mejne koristnosti lahko vpliva na izbiro večdnevni kart, saj je zadovoljstvo z dodatnimi dnevi pogosto manjše. Nakup je racionalen, če pričakovana koristnost presega stroške in alternative.

### **Teorija omejene racionalnosti**

Teorija omejene racionalnosti (Herbert Simon, 1957) pojasnjuje, da posamezniki pri odločanju ne maksimirajo vedno koristnosti, ampak sprejemajo »zadovoljive« odločitve zaradi omejitev, kot so pomanjkanje informacij, časovna omejitev in kognitivne sposobnosti. Tako teorija omejene racionalnosti (ang. »Bounded rationality«) predpostavlja, da potrošniki niso vedno popolnoma racionalni pri svojih nakupnih odločitvah (Simon, 2013). Pogosto se soočajo z omejenimi informacijami in časom, kar lahko vpliva na njihove odločitve. V takšnih primerih se lahko potrošniki odločijo za nakup blaga ali storitve, tudi če cena presega njihovo ceno odpovedi.

Teorija omejene racionalnosti pojasnjuje, da posamezniki pri nakupu smučarske karte sprejemajo zadovoljive odločitve zaradi pomanjkanja informacij, časovnih omejitev in kognitivnih zmognosti. Namesto iskanja optimalne možnosti se zanašajo na preprosta pravila ali čustva, na primer hitro izbiro znanega ponudnika. Omejeni vpogledi v cene, vremenske razmere ali alternative, vplivajo na to, da odločitve temeljijo na delnih podatkih ali intuiciji. Rezultat je izbira, ki je zadostna glede na okoliščine, a ne nujno idealna.



## **Teorija referenčne točke**

Teorija referenčne točke (ang. »Prospect Theory«) predpostavlja, da potrošniki svoje sodbe o ceni oblikujejo na podlagi referenčne točke, ki je lahko prejšnja cena, cena podobnih izdelkov ali storitev ali pa lastna pričakovanja (Kahneman & Tversky, 2013). Teorija referenčne točke je kognitivni okvir, ki opisuje, kako ljudje sprejemajo odločitve v pogojih negotovosti. To je lahko prejšnja cena, cena podobnih izdelkov ali storitev, ali pa lastna pričakovanja.

Pri nakupu smučarske vozovnice posameznik odloča glede na referenčno točko, ki jo oblikujejo pretekle izkušnje, promocije ali primerjave z drugimi. Če trenutna cena presega pričakovano vrednost, jo posameznik zazna kot izgubo, kar zmanjšuje verjetnost nakupa. Občutek dobička ali izgube ne izhaja iz absolutne cene, temveč iz razlike glede na referenčne norme. Smučišča pogosto vplivajo na referenčne točke z akcijami, popusti in prikazovanjem »privarčevanih« zneskov.

## **Teorija cene odpovedi**

Teorija Cena odpovedi (ang. »Theory of Reservation Price«) je ekonomski koncept, ki se uporablja za razlago vedenja potrošnikov pri nakupnih odločitvah. Cena odpovedi predstavlja največji znesek, ki ga je potrošnik pripravljen plačati za določeno blago ali storitev, preden se odloči za nakup (Myerson, 1981). Teorija predpostavlja, da ima vsak potrošnik individualno ceno odpovedi, ki je odvisna od njegovih preferenc, dohodka in cen drugih nadomestnih dobrin. Če je cena blaga ali storitve nižja od potrošnikove cene odpovedi, bo potrošnik blago kupil. Če pa je cena višja od cene odpovedi, se bo potrošnik odločil za nakup nadomestnega blaga ali storitve.

Cena odpovedi vpliva na odločitve o smučanju, saj ljudje pogosto vztrajajo pri uporabi že plačane vozovnice, tudi če okoliščine niso idealne. Nakup sezonskih ali predplačniških kart, velikokrat poveča pogostost smučanja zaradi psihološke želje po »opravičitvi« stroškov. Smučarji ne upoštevajo, da so že plačani stroški nepovratni in ne bi smeli vplivati na nadaljnje odločitve. Smučišča ta učinek spodbujajo z akcijami, ki izkoriščajo človeško težnjo po izogibanju občutka zapravljanja.

## 2.4 Gibanje cen smučarskih vozovnic

Različne tehnike oblikovanja cen in upravljanja prihodkov so bile v zadnjih desetletjih uspešno uporabljene na številnih področjih turizma in gostinstva. Glavni primeri vključujejo letalske družbe in hotele (tradicionalne industrije upravljanja prihodkov), križarjenja, golf klube in restavracije. Vendar so načela, ki stojijo za temi tehnikami, enako uporabna za druga podjetja v turističnem sektorju, če so izpolnjena številna merila. Ta merila so: (1) spremenljivo in predvidljivo povpraševanje, (2) razmeroma stalna zmogljivost, (3) nizki stroški obrobne prodaje in (4) omejene ali nobene možnosti skladiščenja (Berman, 2005).

Ključne ugotovitve glede cen smučarskih vozovnic na evropskih smučiščih so (Piva, 2023):

- Povprečna dnevna vozovnica za evropska smučišča je leta 2023 stala 66,46 EUR, kar je 24,7 % dražje kot pred pandemijo COVIDa-19 leta 2019.
- Na splošno so se stroški smučanja od leta 2015 do 2023 zvišali za 34,8 % nad inflacijo, pri čemer so prednjačila švicarska, avstrijska in italijanska letovišča.
- Švicarsko letovišče Zermatt je najdražje letovišče za smučarje v Evropi, dnevna vozovnica pa v povprečju stane 108 EUR.
- Italijanska smučišča so doživela največji porast cen od leta 2019, saj je letovišče Paganella dvignilo dnevne smučarske vozovnice za 51,1%.
- Srbsko letovišče Kopaonik je najcenejše, saj stane dnevna smučarska karta le 37 EUR na dan.
- Cene smučarskih središč v Bolgariji so se od leta 2015 najbolj zvišale, in sicer v povprečju za 34,8 %, kar je največ od vseh analiziranih evropskih držav.

### Podražitve v evropskih državah

Ko gre za najdražja smučišča v Evropi (Tabela 1), ni presenečenje, da na seznamu prevladujejo švicarska smučarska letovišča. Na splošno smučarske vozovnice v Švici v povprečju znašajo približno 78,92 EUR, pri čemer je smučišče Zermatt najdražje s 108 EUR (Piva, 2023).

Na drugi strani pa je najcenejše (Slovenija v tej raziskavi ni zajeta) smučišče v Srbiji. V ta rang se lahko vključi tudi večina slovenskih smučišč (Tabela 2). Zagotovo so odlična švicarska letovišča obvezen obisk za vse smučarske navdušence, obstaja veliko neverjetnih doživetij, ki jih lahko uživate po vsej Evropi za nižjo ceno. V slikovitem srbskem narodnem parku Kopaonik, se nahajajo najcenejša pobočja v Evropi, ki stanejo le 37 EUR na dan. V Alpah je francoski Espace Diamant po naši analizi najbolj dostopno letovišče v regiji. Nahaja se le nekaj kilometrov od Mont Blanca in v 90 minutah vožnje od Ženeve. V vrhuncu sezone 2023 so dnevne vozovnice znašale 47,50 EUR. To je manj kot polovica stroškov letovišč čez švicarsko mejo (Piva, 2023).

Tabela 1: Najdražja in najcenejša smučišča v Evropi

	Najdražja smučišča v sezoni 2023/2024	Država	Cena za odrasle (vrhunc sezona) v EUR 1 dan
1	Zermatt/Breuil-Cervinia/Valtournenche – Matterhorn	Švica	108,00
2	Andermatt/Oberalp/Sedrun	Švica	93,00
3	Arosa Lenzerheide	Švica	92,00
4	4 Vallées – Verbier/La Tzoumaz/Nendaz/Veysonnaz/Thyon	Švica	88,00
5	Corvatsch/Furtschellas	Švica	85,65
6	Parsenn (Davos Klosters)	Švica	84,00
7	Sveti Moritz – Corviglia	Švica	83,53
8	Jakobshorn (Davos Klosters)	Švica	80,00
9	Madonna di Campiglio/Pinzolo/Folgàrida/Marilleva	Italija	79,00
10	Kleine Scheidegg/Männlichen – Grindelwald/Wengen	Švica	78,00
	Najcenejše smučišče v sezoni 2023/2024	Država	Cena za odrasle (vrhunc sezona) v EUR 1 dan
9	Hafjell	Norveška	53,00
8	Saint-Lary-Soulan	Francija	52,00
7	Kühtai	Avstrija	52,00
6	Levi	Finska	51,50
5	Tauplitz – Bad Mitterndorf	Avstrija	48,00
4	Espace Diamant – Les Saisies/Notre-Dame-de-Bellecombe/Praz sur Arly/Flumet/Crest-Voland	Francija	47,50
3	Bansko	Bolgarija	46,00
2	Kläppen	Švedska	44,00
1	Kopaonik	Srbija	37,00

Vir: (Piva, 2023)

Smučanje je drag hobi, a z leti je postal pravi luksuz. Toda kako so se stroški smučanja sčasoma spremenili? Od leta 2005 je Piva izračunal povprečno ceno dnevne vozovnice v 100 najboljših letoviščih v Evropi. Na splošno se je smučanje po Evropi v tem obdobju podražilo za 92,6 %, kar pomeni, da smučarji izpred 18 leti plačujejo skoraj dvakrat višjo ceno za isto progo (Piva, 2023). Analizirali smo tudi povprečno zvišanje stroškov za izbrano državo (Tabela 2). Slovenija se je med navedenimi državami srednje podražila (27 %), vendar jo analiza Pive ne vključuje. Sicer pa je bilo največja podražitev v Bolgariji (34,8 %). Podobno povečanje je bilo opazno na smučiščih Avstrije (34,3 %) in Italije (33,1 %). Najmanj pa so se podražila skandinavska smučišča (Piva, 2023).

**Tabela 2: Podražitve povprečnih cen smučarskih vozovnic v nekaterih evropskih državah v letih 2015-2023**

Država	Podražitev smučarskih vozovnic (2015 - 2023)
Švedska	15,00%
Norveška	18,00%
Švica	21,40%
Finska	21,40%
Španija	22,40%
Francija	22,60%
Andora	25,00%
Srbija	27,00%
Slovenija	27,00%
Italija	33,10%
Avstrija	34,30%
Bolgarija	34,80%

Vir: (Piva, 2023), lastni izračuni

Smučarska industrija v Evropi se sooča s precejšnjimi izzivi zaradi podnebnih sprememb in gospodarske negotovosti. Upravljalci avstrijskih smučišč se zavedajo grožnje, ki jo predstavljajo podnebne spremembe in se zanašajo na tehnološke prilagoditve, kot je zasneževanje (Wolfsegger et al., 2008). Zato morajo veliko vlagati v infrastrukturo. Smučišča segajo vse višje in je zato potrebno zasneževanje, saj ni več gotovosti, da bodo lahko zagotovili naraven sneg. Ranljivost pirenejskih smučišč na podnebno povzročene spremembe snežne odeje dodatno obremenjuje okolje. Vsled tega je neizogibno, da se bodo stroški smučanja dvignili nad inflacijo. Čeprav so smučišča deležna nepovratnih sredstev, to ni dovolj za njihovo poslovanje. Trajnostne prakse, vključno z zmanjšanjem emisij ogljika in ohranjanjem naravnega okolja, so ključne za prihodnost industrije (Dragović & Pašić, 2020). Na odnos in vedenje smučarjev vplivajo tudi podnebne spremembe, ki poudarjajo potrebo po

okolju prijaznih storitvah (Ferrari, 2010). Ta zavezanost poudarja izzive industrije (Pons et al., 2015), da je potrebna okoljska ozaveščenost.

Na splošno so se cene smučarskih vozovnic od leta 2015 zvišale za 34,8 % nad inflacijo, če upoštevamo podatke MDS iz evropskih držav (Piva, 2023). Rekord je smučišče Steinplatte-Winklmoosalm, ki beleži 109,3% nad inflacijo.

## Gibanje cen v ZDA

Želite svojo družino peljati na zimske počitnice v Aspen na sproščujoče in razburljive počitnice? Že v letu 2020, ko je bila cena dnevne smučarske karte 209 USD, bi to znašalo vaj 25.000 USD (Blavatnik, 2021). V zimski sezoni 2023/2024, pa bi pri smučarski karti 299 USD bilo še mnogo več. Kako je to mogoče, ko pa bi se ista vozovnica za žičnico pred samo 62 leti prodajala že za 5 USD? Kateri dejavniki so v zadnjih letih privedli do tega, da je smučanje postalo tako nedostopno za povprečno ameriško družino? No, veliko dejavnikov (Blavatnik, 2021). Razčlenimo jih.

Spodnja tabela 3 prikazuje cene vozovnic za žičnico Vail skozi čas. Cene so se od odprtja letovišča leta 1962 neverjetno dvignile. Če bi cena ostala nespremenjena, bi vozovnica za 5 USD danes stala le okoli 52,42 USD. Vendar namesto tega stane šokantnih 299 USD. Očitno cena ni ostala niti približno nespremenjena, odkar je smučanje postalo med ameriško populacijo zelo iskano. Ta sprememba se je zgodila v devetdesetih letih prejšnjega stoletja, zaradi novega načina upravljanja vozovnic. Pred letom 1990 so bile cene relativno blizu tistim, ki bi jih prilagodili inflaciji. Od takrat si družine srednjega razreda zelo težko privoščijo smučarske vstopnice.

**Tabela 3: Inflacija smučarskih vozovnic v ZDA (1962-2023)**

Cena za odrasle (vrhunec sezone) v USD na dan					
1962	1979	1990	2006	2020	2023
5,00	10,00	35,00	85,00	229,00	299,00
Cena upoštevajoč inflacijo na bazno leto 1962 v USD dan					
1962	1979	1990	2006	2020	2023
5,00	12,26	22,08	34,05	43,72	52,42

Vir: (Blavatnik, 2021) (<https://www.usinflationcalculator.com>)

COVID-19 je omejil obratovanje in povzročil izgubo delovnih mest, kar je povprečnemu Američanu onemogočilo smučanje. Najbogatejši Američani so si medtem lahko privoščili smučanje, saj so delali od doma iz luksuznih vil ob smučarskih središčih. Povečano povpraševanje teh družin po nepremičninah v smučarskih središčih je dvignilo cene tako vilam, kot smučarskim vozovnicam. Strah pred letenjem je omejil potovanja povprečnih družin, medtem ko so bogati leteli z zasebnimi letali. Smučanje je postalo simbol elitnega statusa, saj so si ga lahko privoščili le premožni, kar je še poglobilo razliko med bogatimi in revnimi (Blavatnik, 2021).

## Slovenija

Žal so popolni podatki o cenah smučarskih vozovnic v Sloveniji nedostopni in jih ne zbira nobena statistika. Tako smo cene zbrali iz javno dostopno objavljenih cenikov. V spodnji tabeli je predstavljeno kako so se gibale cene smučarskih kart na slovenskih smučiščih (Tabela 4).

**Tabela 4: Gibanje cen dnevnih smučarskih kart v Sloveniji**

Smučišče	2006/ 2007	2011/ 2012	2015/ 2016	2020/ 2021	2021/ 2022	2022/ 2023	2023/ 2024	2024/ 2025	2024/ 2006	2024/ 2015
Kranjska Gora	28,0	29,0	31,5	35,5	37,0	40,0	45,0	47,0	1,68	1,49
Rogla	25,0	29,0	32,0	35,0	36,0	39,0	43,0	45,0	1,80	1,41
Vogel	22,0	26,0	29,0	33,0	35,0	40,0	42,0	43,0	1,95	1,48
Krvavec	25,0	29,0	32,0	35,0	37,0	39,0	41,0	43,0	1,72	1,34
Mariborsko Pohorje	28,0	29,5	31,0	33,0	33,0	39,0	39,0	45,0	1,61	1,45
Cerkno	27,0	28,0	29,0	32,0	33,0	36,3	39,0	42,0	1,56	1,45
Kope	26,0		29,0		33,0	34,0	37,0	37,0	1,42	1,28
Golte	22,0	27,0	29,0	31,0		39,0	33,0	39,0	1,77	1,34
Trije Kralji	22,0		24,0				28,0	28,0	1,27	1,17
Kanin	21,1	31,0	30,0	29,0		33,0	zaprt	zaprt		
Stari vrh	21,0	26,0	27,0	28,0	28,0	33,0	35,0	zaprt		
Kobla	20,0	22,0	zaprt	zaprt	zaprt	zaprt	zaprt	zaprt		
Soriška Planina	18,0	20,0	24,0			26,0	28,0	28,0	1,56	1,17
Celjska koča	18,0	16,0	20,0				25,0	25,0	1,39	1,25
<b>Povprečje</b>	<b>23,1</b>	<b>26,0</b>	<b>28,3</b>	<b>32,4</b>	<b>34,0</b>	<b>36,2</b>	<b>36,3</b>	<b>38,4</b>	<b>1,66</b>	<b>1,36</b>

Vir: Lastna raziskava

### 3 Raziskava

Našo populacijo predstavljajo polnoletni državljani Republike Slovenije. Vzorec po čiščenju podatkovne baze vsebuje 536 deležnikov. Raziskava je bila izvedena s pomočjo orodja 1ka (University of Ljubljana Faculty of Social Sciences Centre for Social Informatics, 2022), v času od 15.3.2024 do 16.5.2024. Gre za priložnostni vzorec, ki maksimalne naključnosti ne more zagotoviti. Izbira vzorca temelji na spletnem anketiranju, ki je v zadnjih desetletjih sprejeto kot dovolj zanesljivo orodje pri vprašanju zagotovitve vzorca. Bolj natančno strukturo vzorca prikazuje Tabela 5.

Tabela 5: Demografski podatki raziskave

		Število (536)	Delež
Tip naselja	Manj kot 2.000 prebivalcev (mestno)	48	9,94%
	Manj kot 2.000 prebivalcev (vaško)	42	8,70%
	2.000-10.000 prebivalcev	181	37,47%
	Več kot 10.000 prebivalcev	86	17,81%
	Maribor	18	3,73%
	Ljubljana	108	22,36%
	<b>Skupaj</b>	<b>483</b>	<b>100%</b>
Spol	Moški	163	33,47%
	Ženski	324	66,53%
	<b>Skupaj</b>	<b>487</b>	<b>100%</b>
Status	Dijak	6	1,23%
	Študent	72	14,72%
	Zaposlen v javnem sektorju (uprava, šolstvo, zdravstvo, sociala, kultura idr.)	126	25,77%
	Zaposlen v neprofitnem sektorju (društva, združenja idr.)	16	3,27%
	Zaposlen v podjetju	176	35,99%
	Samozaposlen	42	8,59%
	Upokojenec	41	8,38%
	Brezposeln	10	2,04%
	<b>Skupaj</b>	<b>489</b>	<b>100%</b>
Dohodek	Do 550 €	4	0,92%
	Od 551 do 800 €	23	5,26%
	Od 801 do 1000 €	28	6,41%
	Od 1001 do 1300 €	56	12,81%
	Od 1301 do 1600 €	44	10,07%
	Od 1601 do 1900 €	36	8,24%
	Od 1901 do 2200 €	36	8,24%
	Od 2201 do 2500 €	41	9,38%
	Od 2501 do 3100 €	49	11,21%
	Nad 3100 €	120	27,46%
	<b>Skupaj</b>	<b>437</b>	<b>100%</b>

Vir: Lasten

Glede na spol je anketo izpolnilo 33 % moških (163) in 67 % žensk (324). Najstarejši anketiranec se je rodil leta 1947, najmlajši pa leta 2005. V povprečju so se rodili leta 1982 oz. so bili stari dobrih 42 let s standardnim odklonom 13,4 let. V povprečju gospodinjstvo šteje 3,08 članov s standardnim odklonom 1,34. Iz rezultatov ankete lahko razberemo, da je bilo v anketo zajetih največ takih, ki so zaposleni v gospodarstvu (36 %), sledijo tisti ki so zaposleni v javnem sektorju (26 %) in nato sledijo študenti (14 %). Ostale skupine so prejele manj kot 10 % odgovorov. Četrtnina anketiranih živi v gospodinjstvu, kje je neto dohodek višji od 3.100 EUR. V povprečju živi v gospodinjstvu 3,1 oseba s standardnim odklonom 1,3 osebe. Povprečni neto dohodek gospodinjstva je več kot 2.100 EUR. Povprečna neto plača v občini je 1.433 EUR, medtem ko je povprečna neto plača v Sloveniji 1.445 EUR.

#### 4 Rezultati

V nadaljevanju najprej predstavljamo kakšna je cenovna elastičnost slovenskih smučarjev. Upoštevali smo zgolj tiste odgovore, kjer so anketiranci podali vse odgovore. Razdelili smo jo glede na domača smučišča in smučišča v tujini.

**Tabela 6: Cenovna elastičnost glede koriščenja smučarskih storitev**

	N	Min	Max	Povprečje	Standardni odklon	B/A
A-Koliko v povprečju namenite za ENODNEVNO smučarsko karto na SLOVENSKEM SMUČIŠČU	106	10,0	50,0	38,81	9,62	1,58
B- Kdaj bi prenehali obiskovati SLOVENSKA SMUČIŠČA	106	20,0	140,0	61,51	23,51	
A-Koliko v povprečju namenite za ENODNEVNA smučarsko karto na SMUČIŠČU V TUJINI z	106	20,0	100,0	54,38	17,83	1,49
B-Kdaj bi prenehali obiskovati SMUČIŠČA V TUJINI	106	25,0	200,0	81,13	32,33	

Vir: Lasten

Tabela prikazuje povzetek odgovorov anketirancev glede povprečnih izdatkov za enodnevne smučarske karte na slovenskih in tujih smučiščih ter cenovnih meja, pri katerih bi se odpovedali obiskovanju smučišč.



Anketiranci v povprečju plačajo več za karto na smučiščih v tujini (54 €) kot za karto na slovenskih smučiščih (39 €). Višji je tudi prag za prenehanje obiskovanja smučič v tujini (81 €) v primerjavi s slovenskimi (61 €).

Razlike v cenovnih ocenah in pragih kažejo na različne preference, kakovost storitev ali dojetje vrednosti med slovenskimi in tujimi smučiči. Standardni odkloni nakazujejo razpršenost odgovorov, kar pomeni, da se vrednotenja med anketiranci precej razlikujejo.

Tabela 7: T test glede na spol

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Indeks domača smučiča	Equal variances assumed	4,488	,037	1,490	100	,139	,154	,104	-,051	,360
	Equal variances not assumed			1,358	52,385	,180	,154	,114	-,074	,383
Indeks tuja smučiča	Equal variances assumed	2,045	,156	-1,013	100	,314	-,091	,090	-,270	,087
	Equal variances not assumed			-1,148	90,874	,254	-,091	,079	-,249	,067

Vir: Lasten

Odvisna spremenljivka modela je indeks cenovne elastičnosti koriščenja smučarskih storitev na domačih/tujih smučiščih (Tabela 6). Vrednost smo zajeli z vprašanjem, na katerega so anketiranci odgovorili tako, da so vnesli odgovor na vprašanje »Koliko v povprečju namenite za enodnevno smučarsko karto na SLOVENSKEM SMUČIŠČU/SMUČIŠČU V TUJINI?«, ter odgovor na vprašanje »Kdaj bi prenehali obiskovati SLOVENSKA SMUČIŠČA/SMUČIŠČA V TUJINI?«. Indeks pa smo izračunali tako da smo odgovor vprašanje »Kdaj bi prenehali obiskovati? ...« delili z odgovorom »Koliko v povprečju namenite?...«.

Naša neodvisna spremenljivka so dihotozne spremenljivke, in sicer spol (moški/ženski), starost in dohodek na družinskega člana.

Predpostavljamo da ni razlik v cenovni elastičnosti glede na demografske podatke.

Hipoteze

**H1: NE obstaja razlika v cenovni elastičnosti koriščenja smučarskih storitev glede na spol.**

Na podlagi analize (Tabela 7) lahko sklepamo, da ni statistično značilnih razlik v cenovni elastičnosti koriščenja smučarskih storitev glede na spol, ne za domača ne za tuja smučišča.

**Tabela 8: Linearna regresija glede koriščenja smučarskih storitev v Sloveniji glede na starost**

Model Summary						
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate		
1	,047 <sup>a</sup>	,002	-,008	,495		
a. Predictors: (Constant), Leta starosti						
ANOVA <sup>a</sup>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,056	1	,056	,229	,633 <sup>b</sup>
	Residual	25,008	102	,245		
	Total	25,064	103			
a. Dependent Variable: Indeks domača smučišča						
b. Predictors: (Constant), Leta starosti						
Coefficients <sup>a</sup>						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1,536	,171		8,963	,000
	Leta starosti	,002	,004	,047	,479	,633
a. Dependent Variable: Indeks domača smučišča						

Vir: Lasten

Hipotezo **H1** lahko potrdimo.

**H2: Starost NE vpliva na cenovno elastičnost smučarskih storitev.**

**H2<sub>1</sub>:** Starost NE vpliva na cenovno elastičnost smučarskih storitev v Sloveniji.

Da bi preverili to hipotezo smo izvedli linearno regresijo (Tabela 8).

Na podlagi podanih podatkov lahko potrdimo hipotezo **H2<sub>1</sub>**, da starost NE vpliva na cenovno elastičnost smučarskih storitev. Statistična analiza ne kaže pomembnega vpliva starosti na indeks za domača smučičša.

**H2<sub>2</sub>:** Starost NE vpliva na cenovno elastičnost smučarskih storitev v tujini.

Da bi preverili hipotezo smo izvedli linearno regresijo (Tabela 9).

**Tabela 9: Linearna regresija glede koriščenja smučarskih storitev v tujini glede na starost**

Model Summary						
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate		
1	,185 <sup>a</sup>	,034	,025	,420861		
a. Predictors: (Constant), Leta starosti						
ANOVA <sup>a</sup>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,640	1	,640	3,613	,060 <sup>b</sup>
	Residual	18,067	102	,177		
	Total	18,707	103			
a. Dependent Variable: Indeks tuja smučičša						
b. Predictors: (Constant), Leta starosti						
Coefficients <sup>a</sup>						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1,252	,146		8,599	,000
	Leta starosti	,006	,003	,185	1,901	,060
a. Dependent Variable: Indeks tuja smučičša						

Vir: Lasten

Na podlagi analize lahko potrdimo hipotezo H2<sub>2</sub>, da starost NE vpliva na cenovno elastičnost smučarskih storitev za tuja smučičša. Čeprav je vpliv starosti majhen (glede na B in R<sup>2</sup>), je statistično značilen. Starejši ljudje imajo rahlo višji indeks cenovne elastičnosti za tuja smučičša.

Hipotezo **H2**, lahko potrdimo.

**H3: Dohodek na družinskega člana NE vpliva na cenovno elastičnost pri koriščenju smučarskih storitev.**

**H3<sub>1</sub>:** Dohodek na družinskega člana NE vpliva na cenovno elastičnost pri koriščenju smučarskih storitev v Sloveniji.

Da bi preverili hipotezo smo izvedli linearno regresijo (Tabela 10).

**Tabela 10: Linearna regresija glede koriščenja smučarskih storitev v Sloveniji glede na dohodek**

Model Summary						
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate		
1	,075 <sup>a</sup>	,006	-,004	,497		
a. Predictors: (Constant), Prihodki družinski član						
ANOVA <sup>a</sup>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,139	1	,139	,566	,454 <sup>b</sup>
	Residual	24,654	100	,247		
	Total	24,793	101			
a. Dependent Variable: Indeks domača smučišča						
b. Predictors: (Constant), Prihodki družinski član						
Coefficients <sup>a</sup>						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1,697	,111		15,236	,000
	Prihodki družinski član	-9E-05	,000	-,075	-,752	,454
a. Dependent Variable: Indeks domača smučišča						

Vir: Lasten

Na podlagi analize potrjujemo hipotezo **H3<sub>1</sub>**, da dohodek na družinskega člana NE vpliva na cenovno elastičnost pri koriščenju smučarskih storitev v Sloveniji. Regresijski model ni statistično značilen, vpliv dohodka na indeks cenovne elastičnosti je zanemarljiv.

**H3<sub>2</sub>**: Dohodek na družinskega člana NE vpliva na cenovno elastičnost pri koriščenju smučarskih storitev v tujini.

Da bi preverili hipotezo, smo izvedli linearno regresijo (Tabela 11).

Tabela 11: Linearna regresija glede koriščenja smučarskih storitev v tujini glede na dohodek

Model Summary						
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate		
1	,004 <sup>a</sup>	,000	-,010	,426137		
a. Predictors: (Constant), Prihodki družinski član						
ANOVA <sup>a</sup>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,000	1	,000	,002	,966 <sup>b</sup>
	Residual	18,159	100	,182		
	Total	18,160	101			
a. Dependent Variable: Indeks tuja smučiča						
b. Predictors: (Constant), Prihodki družinski član						
Coefficients <sup>a</sup>						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1,532	,096		16,026	,000
	Prihodki družinski član	-4E-06	,000	-,004	-,042	,966
a. Dependent Variable: Indeks tuja smučiča						

Vir: Lasten

Na podlagi analize potrjujemo hipotezo **H3<sub>2</sub>**, da dohodek na družinskega člana vpliva na cenovno elastičnost pri koriščenju smučarskih storitev v tujini. Regresijski model ni statistično značilen, vpliv dohodka je zanemarljiv.

Hipotezo **H3**, lahko potrdimo.

## 5 Zaključek

Raziskali smo, kako so se v preteklosti gibale cene smučarskih vozovnic v Sloveniji in tujini. Ugotovili smo, da nobena referenčna skupina ne izkazuje statistično značilnih razlik v temu, da bi bila manj tolerantna za dvigovanje cen. Vsled tega lahko zaključimo, da obstaja prostor, da se cene lahko še dvigujejo in da bodo smučarji še

vedno posegali po tovrstnih storitvah. Teorija, cena odpovedi je ekonomski koncept, ki se uporablja za razlago vedenja potrošnikov pri nakupnih odločitvah. Cena odpovedi predstavlja največji znesek, ki ga je potrošnik pripravljen plačati za določeno blago ali storitev, preden se odloči za nakup (Myerson, 1981). Teorija predpostavlja, da ima vsak potrošnik individualno ceno odpovedi, ki je odvisna od njegovih preferenc, dohodka in cen drugih nadomestnih dobrin. Če je cena blaga ali storitve nižja od potrošnikove cene odpovedi, bo potrošnik blago kupil. Če pa je cena višja od cene odpovedi, se bo potrošnik odločil za nakup nadomestnega blaga ali storitve.

**Tabela 12: cena smučarske karte po tekočem kilometru smučarske proge**

Smučišče	Skupna dolžina prog (km)	Cena na km (€)
Dolomiti Superski	1.200 km	0,07 €/km
Nassfeld	110 km	0,60 €/km
Katschberg	80 km	0,80 €/km
Heiligenblut	55 km	0,80 €/km
Mariborsko Pohorje	35 km	1,20 €/km
Gerlitz	53 km	1,30 €/km
Krvavec	30 km	1,40 €/km
Turracher Hohe	38 km	1,70 €/km
Vogel	22 km	2,00 €/km
Kranjska Gora	20 km	2,35 €/km
Rogla	12 km	3,75 €/km

Vir: Lasten

Oblikovalci politik bodo morali razmisliti o tem, ali je potrebno sprejeti ukrepe za ublažitev vpliva visokih cen smučarskih vozovnic na dostopnost smučanja za ljudi z nižjimi dohodki. Tisti z višjimi dohodki, se namreč svojemu hobiju ne bodo odpovedali. Teorija koristnosti (ang. Theory of utility) predpostavlja, da potrošniki izbirajo blago in storitve na podlagi njihove koristnosti in cene (Jevons, 1886). Potrošnik bo izbral blago ali storitev, ki mu prinaša največjo koristnost glede na ceno. Če se cena blaga ali storitve poveča, se lahko zgodi, da bo potrošnik raje izbral cenejšo alternativo ali se povsem odpovedal nakupu. Iz raziskave izhaja, da smučarji še vedno povprašujejo po teh storitvah in se v primeru pomankanja smuke v Sloveniji odpravljajo v tujino. To še toliko bolj velja v kolikor primerjamo cene smučarskih kart glede na proge, ki jih ponujajo slovenska smučišča (Tabela 12).

Rezultati te raziskave bodo imeli pomembne posledice za smučarska središča in oblikovalce. Smučarska središča bodo morala skrbno pretehtati vpliv sprememb cen vozovnic na obiskanost in prihodke.

Smučanje je lahko drag šport, cene smučarskih vozovnic pa so v zadnjih letih znatno narasle. Ta raziskava bo preučila vpliv spremembe cen smučarskih vozovnic na obiskanost smučič. Pričakujemo, da bodo rezultati pokazali, da so cene smučarskih vozovnic pomemben dejavnik pri odločanju ljudi o tem, ali bodo šli smučat, ter da bodo ljudje z nižjimi dohodki bolj občutljivi na spremembe cen.

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# GIBANJE CEN KAVE SKOZI ČAS: ANALIZA TRŽNIH TRENDOV V SLOVENIJI (1990–2023)

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V prispevku smo raziskovali, ali se drobnoprodajne cene dvigujejo hitreje kot inflacija ter kolikšno povišanje cen so potrošniki še pripravljene sprejeti. Z uporabo zgodovinske metode smo analizirali podatke o svetovnih borznih cenah in maloprodajnih cenah kave v Sloveniji med leti 1990 in 2024. Poleg tega smo izvedli spletno anketo s 536 udeleženci. Ugotovili smo, da so se drobnoprodajne cene zvišale za 40 % več, kot je znašala inflacija. Analiza je pokazala, da ni statistično značilnih razlik v toleranci do višjih cen glede na občine, velikost naselja ali spol. Vendar so starejši potrošniki nekoliko bolj strpni do povišanja cen.

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# COFFEE PRICE TRENDS OVER TIME: AN ANALYSIS OF MARKET DYNAMICS IN SLOVENIA (1990– 2023)

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In this paper, we investigated whether retail prices are rising faster than inflation and how much price increases consumers are willing to accept. Using the historical method, we analyzed data on global stock market prices and retail coffee prices in Slovenia between 1990 and 2024. In addition, we conducted an online survey with 536 participants. We found that retail prices increased by 40% more than inflation. The analysis showed that there were no statistically significant differences in tolerance for higher prices by municipality, settlement size, or gender. However, older consumers are slightly more tolerant of price increases.



## 1 Uvod

Kava ima mnogo učinkov. Tako je bilo uživanje kave povezano s pozitivnimi in negativnimi učinki na zdravje. Pozitivno je, da je bilo povezano s povečano agilnostjo, stabilnostjo razpoloženja in zmanjšanim tveganjem za sladkorno bolezen tipa 2, srčno-žilne bolezni in nekatere vrste raka (Ijaz et al., 2021) (Szuster et al., 2020). Kava vsebuje tudi spojine z antioksidativnimi lastnostmi, ki prispevajo k obrambnemu sistemu telesa (Devasia et al., 2005). Vendar lahko prekomerno uživanje povzroči zgago, diurezo in zasvojenost (Ijaz et al., 2021) ter tudi nespečnost. Nosečnicam in ženskam po menopavzi svetujemo, naj omejijo njihov vnos (Ijaz et al., 2021). Kljub tem potencialnim pomanjkljivostim je bilo ugotovljeno, da ima zmerno uživanje kave preventivni učinek proti boleznim srca in ožilja (Bravo et al., 2019). Čeprav ima kava lahko pozitivne in negativne učinke, se zmerno uživanje na splošno šteje za varno in ima lahko celo koristi za zdravje. Vsled tega je ta napitek tako popularen.

Kot produkt, ki je široke potrošnje, je kava zanimiva za raziskovanje tudi z vidika gibanja proizvodnih, prodajnih in potrošniških cen. Raziskava o trendih cen kave je razkrila več ključnih ugotovitev. Ionescu (2022) in Vochozka (2023) poudarjata vpliv zunanjih dejavnikov, kot so naravne nesreče in inflacija, na cene kave. To je pomembno, saj kaže, da so ekonomske spremembe in dogodki v okolju lahko ključni dejavniki, ki vplivajo na cene surovin, kot je kava. Ghoshray (2021) in Carvalho (2018) nudita vpogled v dinamiko maloprodajnih mednarodnih cenovnih marž oziroma dolgoročne učinke podnebnih šokov na cene kave. To kaže, da so raziskovalci že preučevali, kako različni dejavniki, kot so podnebni šoki, vplivajo na cene kave na mednarodni ravni, ter kako se te spremembe odražajo v maloprodajnih maržah. Te raziskave so pomembne za razumevanje kompleksnih vzorcev cenovne dinamike na trgu kave. Daly (1958) in Bonnell (1990) se osredotočata na analizo trendov in napovedi cen kave in potrošniške potrošnje v Združenih državah, medtem ko Luitel (2022) preučuje trend najnižjih cen surove kave v Nepal. Te študije skupaj poudarjajo zapleteno medsebojno delovanje dejavnikov, ki vplivajo na cene kave, vključno s tržno koncentracijo, podnebnimi šoki in vedenjem potrošnikov.

Kava je ena izmed najpomembnejših kmetijskih pridelkov na svetu, zato je raziskovanje gibanja proizvodnje ključno za razumevanje globalnih trgovinskih tokov, vpliva podnebnih sprememb na pridelek ter socialnih in ekonomskih razmer v državah, ki so odvisne od proizvodnje kave. Analiza trgovinskih tokov kave lahko razkrije pomembne trende, kot so gibanje cen, regionalne preferenčne trge, vpliv političnih odločitev na trgovino in vlogo multinacionalnih korporacij v distribucijskih verigah. Raziskave o cenah kave lahko ponudijo vpogled v dejavnike, ki vplivajo na nihanje cen na svetovnih trgih, kot so ponudba in povpraševanje, vreme, politična nestabilnost, valutna nihanja in spremembe v potrošniških preferencah. Poleg tega lahko raziskave o kavi osvetlijo tudi družbene in okoljske vidike, kot so vpliv proizvodnje kave na okolje, delovne razmere na plantažah, vpliv certifikatov trajnosti na industrijo ter vloga kave v družbenem življenju in kulturi različnih skupnosti po svetu.

Študije o potrošniških navadah in preferencah lahko pomagajo razumeti, kako se spreminja povpraševanje po kavi, kakšne so regionalne razlike v potrošnji, trende v porabi kave (na primer rast priljubljenosti specialnih kav) ter vpliv marketinških strategij na potrošniške odločitve. Sami smo se lotevali prav tega izziva. Osvetlili smo cene po svetu. Poleg tega pa smo podrobno analizirali drobno prodajne cene v Sloveniji. Glavno raziskovano vprašanje je »Ali so se drobnoprodajne cene gibale hitreje kot inflacija in kolikšen dvig drobnoprodajnih cen so pripravljene še potrpeti potrošniki?«

## 2 Teoretično ozadje

### 2.1 Splošno o kavi

Raziskave o kavi niso nekaj novega, zato je težko napisati nekaj popolnoma izvirnega. Zajele so širok spekter tem, od agronomskih odzivov na gnojila (Pilaguano & Fabricio, 2017) do uporabe analitskih tehnik za preučevanje njene kemične sestave (dos Santos & Boffo, 2021). Poudarek je bil tudi na žlahtnjenju novih sort kave, pri čemer so se uporabljale metode, kot sta naravna in umetna hibridizacija (Jia-xiong & Guiping, 2008). Projekt Coffee Microarray je bil pomemben razvoj, katerega cilj je odkriti gene, povezane s kakovostnimi lastnostmi kave (Privat et al., 2008), da bi se te še izboljšale. Celovito je tudi raziskan vpliv pridelave kave na njeno kemično sestavo (Lee, 2019). Skozi različne raziskave je bila analizirana globalna dinamika

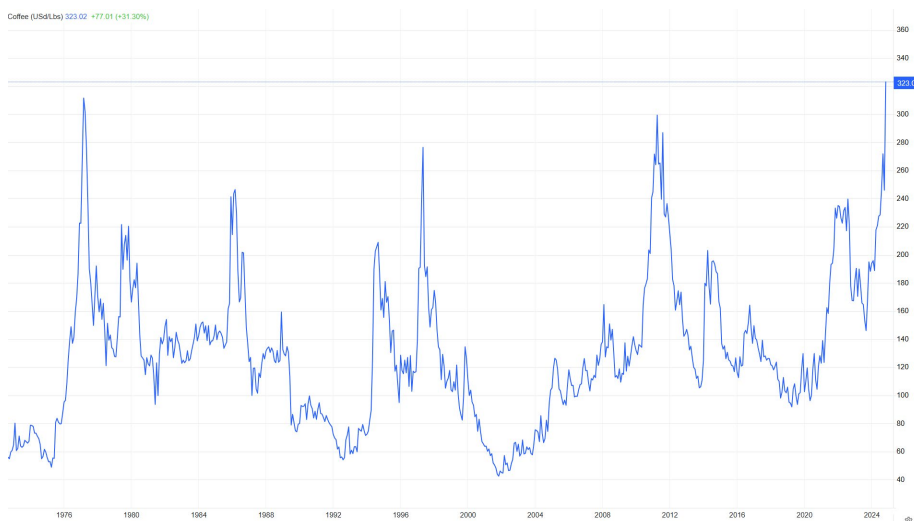
raziskav, z naraščajočim zanimanjem za tehnike obiranja in proizvodnjo kakovostnih kavnih napitkov (Rodríguez, 2018). Vse s ciljem, da se kava in kavni napitki še izboljšajo za potrošnika. Poudarjen je bil potencial stranskih proizvodov kave za različne uporabe (Durán et al., 2017), da bi se lahko vedli bolj trajnostno. Skratka v tem prvem pregledu raziskav gre za raziskave, ki se nanašajo na samo proizvodnjo, pridelavo in predelavo kavnih zrn do napitkov.

Kava Arabica je svetovno merilo za termenske pogodbe za kavo, ki trgujejo na medcelinski borzi (ICE). Arabica predstavlja 75 % svetovne proizvodnje in se večinoma goji v Braziliji (40 % celotne svetovne ponudbe) in Kolumbiji. Robusta predstavlja preostalih 25 % in se večinoma proizvaja v Vietnamu (15 % svetovne ponudbe) in Indoneziji. Drugi večji izvozniki so: Peru, Indija, Uganda, Etiopija, Mehika in Slonokoščena obala. Kava Robusta, sicer tradicionalno pridelana v Afriki in Aziji, postaja vse bolj priljubljena v Kolumbiji zaradi svojega gospodarskega potenciala in prilagodljivosti nižinskim območjem (Campuzano-Duque et al., 2021) pri njeni pridelavi. Vendar je pomembno upoštevati, da Robusta ni primerna za kavo espresso zaradi izrazitega okusa in višje vsebnosti kofeina (Campuzano-Duque 2021). To podpirajo raziskave, ki so uspešno razlikovale med arabico in robusto v kavnih mešanicah z uporabo različnih metod, vključno z analizo razmerja vrhov GC (Pacetti et al., 2012), infrardečo spektroskopijo s Fourierjevo transformacijo (Briandet et al., 1996) in  $^1\text{H}$  NMR spektroskopijo (Monakhova et al., 2015). Poleg tega je proizvodnja kave Robusta zelo občutljiva na temperaturo, z optimalnim razponom pod  $20,5\text{ }^\circ\text{C}$  (Kath et al., 2020). Kljub tem omejitvam obstajajo vrhunske sorte kave Robusta, ki so bile razvite, zlasti tiste, ki so prilagojene visokim nadmorskim višinam (Syafaruddin et al., 2020). Pridelovalci in predelovalci se trudijo, da bi pridelali čim več kakovostnih kavnih zrn in tako zadovoljili svetovno povpraševanje.

## 2.2 Gibanje borznih cen kave

Spodnja slika (Slika 1) prikazuje gibanje borznih cen kave od leta 1970 dalje. Najvišja cena je bila junija 1977, ko je dosegla 311 USD po funtu kave. Trenutno znaša 213,40 USD/Lbs. To pomeni, da je za 1 funt kave potrebno plačati 213,40 ameriških dolarjev (Trading economics, 2024). Graf prikazuje povprečno dnevno ceno arabice v ameriških dolarjih za funt od leta 1980 do leta 2024. Cena kave je v tem obdobju nihala, vendar je v splošnem trendu naraščanja. V osemdesetih letih so cene kave

močno narasle zaradi zmanjšanja ponudbe in povečanega povpraševanja. To je bilo delno posledica suše v Braziliji, ki je leta 1975 uničila velik del pridelka kave. Nakar se zgodi padec v devetdesetih letih, ko so cene kave padle zaradi povečanja ponudbe in zmanjšanja povpraševanja. To je bilo delno posledica vstopa Vietnam na trg kave kot pomembnega proizvajalca. V 2000-ih so cene kave spet narasle zaradi povečanega povpraševanja s strani rastočih srednjih razredov v državah, kot sta Kitajska in Indija. Naslednji vrh dosežejo cene v letu 2012. Cene so nihale zaradi različnih dejavnikov, kot so vremenski dogodki, spremembe vladnih politik in nihanja na svetovnih trgih z blagom. V zadnjem času cene kave ponovno dosegajo rekordno raven.



**Slika 1: Gibanje borznih cen kave**

Vir: (Trading economics, 2024)

Na ceno kave vpliva veliko dejavnikov, med drugim:

- Ponudba in povpraševanje: Če je povpraševanje po kavi veliko, cena borzne kave raste. Če je ponudba kave velika, cena kave pada.
- Vremenske razmere: Slabe vremenske razmere lahko vplivajo na pridelavo kave in s tem na njeno ceno.
- Politična nestabilnost: Politična nestabilnost v državah pridelovalkah kave lahko vpliva na ceno kave. Kupci se namreč usmerjajo v tiste države, kjer je dolgoročno stabilna politična sigurnost.



- Spekulativno trgovanje: Spekulativno trgovanje lahko vpliva na ceno kave, saj določeni kupci špekulativno pokupijo vse zaloge s ciljem da jih bodo dražje prodali naprej.

### 2.3 Cene kave v lokalih v posamezni državi

Kava je nedvomno ena izmed najbolj priljubljenih in konzumiranih pijač na svetu. Nadalje nas zanima koliko stane kava v različnih državah sveta in koliko kav si lahko v posamezni državi privoščijo s povprečno neto plačo. Vendar pa ima vsaka država na svetu drugačen odnos s to pijačo, zato se lahko stroški in poraba razlikujejo od države do države.

## Evropa

Tabela 1: Cene kave v Evropi

Država	Povpreč na cena kave USD	Cena espre so USD	Cena mlečne kave USD	Cena Cappuccino USD	Poraba kave na prebivalca (kg)	Cena kave v prestolnici USD	Povpreč na neto plača USD	Število kav v povprečni neto plači
Luksemburg	3,77	3,17	4,39	3,75	11,10	Luksemburg - 3,90	5.423,10	1.235,33
Švica	5,46	4,99	5,81	5,59	4,80	Bern - 5,65	6.568,18	1.130,50
Nizozemska	3,53	3,27	3,87	3,55	8,20	Amsterdam - 3,69	3.445,63	890,34
Severna Irsko	3,49	3,28	3,59	3,60	1,30	Belfast - 3,58	2.972,76	828,07
Anglija	3,60	3,39	3,71	3,71	1,30	London - 3,70	2.972,76	801,28
Škotska	3,57	3,17	3,78	3,78	1,30	Edinburg - 3,67	2.972,76	786,44
Valižanščina	3,71	3,53	3,81	3,81	1,30	Cardiff - 3,81	2.972,76	780,25
Irsko	3,88	3,66	4,01	3,98	1,20	Dublin - 4,02	3.086,40	769,68
Španija	2,66	2,48	2,46	3,03	3,00	Madrid - 2,75	1.886,70	766,95
Nemčija	3,54	2,96	4,02	3,65	5,40	Berlin - 3,67	3.023,70	752,16
Norveška	4,40	3,73	4,99	4,47	6,80	Oslo - 4,57	3.319,48	665,23
Italija	2,39	2,22	2,67	2,27	4,90	Rum - 2,47	1.706,13	639,00
Belgija	3,40	2,67	4,04	3,50	5,10	Bruselj - 3,52	2.552,12	631,71
Danska	5,36	4,49	5,86	5,73	7,40	Kopenhagen - 5,54	3.676,43	627,38
Švedska	4,25	3,76	4,67	4,32	7,70	Stockholm - 4,41	2.747,18	588,26
Avstrija	3,91	2,91	4,50	4,31	6,60	Dunaj - 4,04	2.573,91	571,98
Finska	4,33	3,41	4,97	4,62	8,20	Helsinki - 4,48	2.824,03	568,22

Država	Povpreč na cena kave USD	Cena espresso USD	Cena mlečne kave USD	Cena Cappuccino USD	Poraba kave na prebivalca (kg)	Cena kave v prestolnici USD	Povpreč na neto plača USD	Število kav v povprečni neto plači
Malta	2,35	1,93	2,83	2,29	3,10	Valletta - 2,43	1.537,91	543,43
Francija	4,66	3,38	4,88	5,71	3,50	Pariz - 4,82	2.502,67	512,84
Slovenija	2,41	1,82	3,24	2,18	4,10	Ljubljana - 2,50	1.593,70	491,88
Češka	3,01	2,65	3,30	3,08	1,30	Praga - 3,13	1.572,91	476,64
Hrvaška	2,25	1,70	2,65	2,40	4,30	Zagreb - 2,33	1.232,95	465,26
Portugalska	2,44	1,77	2,65	2,89	4,40	Lizbona - 2,52	1.147,43	432,99
Litva	2,45	2,10	2,67	2,58	4,20	Vilna - 2,54	1.153,22	431,92
Estonija	3,31	2,72	3,74	3,48	4,50	Talin - 3,43	1.597,33	427,09
Poljska	2,82	2,19	3,42	2,85	0,70	Varšava - 2,94	1.413,06	413,18
Albanija	1,17	0,73	1,43	1,35	1,70	Tirana - 1,21	588,16	411,30
Ciper	3,73	3,17	4,14	3,88	3,90	Nikozija - 3,86	1.615,38	390,19
Bolgarija	1,96	1,36	2,50	2,02	3,70	Sofija - 2,03	932,06	372,82
Latvija	3,19	2,53	3,65	3,41	2,90	Riga - 3,31	1.355,33	371,32
Srbija	1,75	1,50	1,91	1,83	2,70	Beograd - 1,81	699,80	366,39
Slovaška	2,93	2,51	3,34	2,96	4,30	Bratislava - 3,04	1.206,97	361,37
Madžarska	2,37	2,07	2,77	2,28	0,30	Budimpešta - 2,47	977,23	352,79
Severna Makedonija	1,54	1,15	1,77	1,69	0,50	Skopje - 1,59	567,30	320,51
Belorusija	1,53	1,25	1,81	1,53	1,30	Minsk - 1,55	518,30	286,35
Bosna in Hercegovina	2,02	1,46	2,49	2,10	4,80	Sarajevo - 2,08	676,00	271,49
Grčija	3,41	3,12	3,65	3,46	3,50	Atene - 3,53	984,45	269,71
Romunija	2,91	2,45	3,22	3,07	2,60	Bukarešta - 3,02	855,91	265,81
Armenija	2,20	1,65	2,50	2,46	2,70	Erevan - 2,10	659,58	263,83
Gruzija	1,80	1,55	2,06	1,80	2,50	Tbilisi - 1,74	507,30	246,26
Ukrajina	1,77	1,41	2,11	1,80	1,50	Kijev - 1,76	389,88	184,78
Rusija	2,69	2,08	3,10	2,88	0,90	Moskva - 2,68	550,45	177,56
Islandija	4,41	4,10	4,71	4,42	5,40	Reykjavik - 4,50		

Vir: (Trading economics, 2024) (Numeo, 2024)

V kolikor najprej pogledamo (tabela 1) Evropo izstopa Švica, ker tam plačate največ za skodelico kave, v povprečju 5,56 dolarja na skodelico. V vzhodni Evropi pa je kava nekoliko cenejša, saj v večini mest stane približno 2 dolarja na skodelico. Po drugi strani pa Albanija ponuja najcenejšo kavo na celini, ki stane le 1,17 USD za skodelico. Na drugi strani pa po dostopnih podatkih, si lahko največ kav v neto plači

privoščijo v Luksemburgu. Najmanj pa v Rusiji. Največja poraba po prebivalcu je v Luksemburgu (11,10 kg po prebivalcu), najmanjša pa na Madžarskem z 0,3 kg.

## Afrika

Na afriški celini (Tabela 2), znani kot rojstni kraj kave, je Bocvana država, kjer plačate največ za skodelico kave po 2,42 dolarja na skodelico. V Namibiji pa je kava najcenejša in znaša 1,83 dolarja na skodelico. So pa tu statistični podatki od vseh vključenih držav najbolj nepopolni in ne zajemajo vseh držav.

**Tabela 2: Cene kave v Afriki**

	Povprečna cena kave USD	Cena espresso USD	Cena mlečne kave USD	Cena Cappuccino USD	Poraba kave na prebivalca (kg)	Cena kave v prestolnici USD	Povprečna neto plača USD	Število kav v povprečni neto plači
Južna Afrika	2,20	1,96	2,40	2,26	0,30	Cape Town - 2,28	1.315,03	547,93
Maroko	2,17	1,90	2,03	2,57	0,80	Popust - 2,20	439,61	216,56
Kenija	2,26	1,86	2,48	2,44	0,10	Nairobi - 2,27	387,97	156,44
Egipt	2,33	2,31	2,38	2,30	0,30	Kairo - 2,34	133,54	56,11
Namibija	1,83	1,55	2,11	1,84	1,80	Windhoek - 1,89		
Uganda	2,27	2,02	2,39	2,39	0,40	Kampala - 2,27		
Zimbabve	2,20	1,90	2,50	2,20	0,10	Harare - 2,20		
Bocvana	2,42	2,28	2,59	2,38	0,70	Gaborone - 2,49		

Vir: (Trading economics, 2024) (Numeo, 2024)

## Azija in Oceanija

Na azijski celini (Tabela 3) izstopata Katar in Južna Koreja, ki imata najdražjo kavo na celini in po vsem svetu, in sicer 6,79 dolarja oziroma 7,71 dolarja. V nasprotju s tem imajo Iranci najnižjo ceno na svetu, in sicer le 0,45 dolarja na skodelico. Eden od dejavnikov, ki bi lahko pojasnil to nizko vrednost, je, da so iranski prebivalci bolj reprezentativni za čaj kot kavo in ga zato pogosteje uživajo. Prav tako ni nezamisljivo, da je Azija dom številnih muslimanskih kultur, kjer je kava simbol prijateljstva in gostoljubja. Po porabi na prebivalca prednjači Libanon s 7,6 kg. Kar nekaj držav pa je takih, kjer je poraba zanemarljiva in jo statistike na zajamejo.

Tabela 3: Cene v Aziji in Oceaniji

Država	Povpreč na cena kave USD	Cena espresso USD	Cena mlečne kave USD	Cena Cappucci no USD	Poraba kave na prebivalca (kg)	Cena kave v prestolnici USD	Povpreč na neto plača USD	Število kav v povprečni neto plači
Avstralija	2,99	2,99	2,99	2,99	2,10	Canberra - 3,10	3.780,83	1.264,49
Nova Zelandija	3,18	2,76	3,39	3,39	2,20	Wellington - 3,30	3.080,58	908,73
Singapur	4,79	4,19	5,09	5,09	1,70	Singapur - 4,87	4.503,42	884,76
Izrael	3,92	3,49	4,29	3,98	2,20	Jeruzalem - 3,95	2.570,94	599,29
Združeni arabski emirati	5,62	4,57	6,20	6,09	1,50	Abu Dabi - 5,63	3.528,94	569,18
Kuvajt	5,70	4,81	6,18	6,11	3,10	Kuvajt - 5,71	2.969,39	480,48
Iran	0,45	0,40	0,48	0,47	0,20	Teheran - 0,46	225,89	470,60
Turčija	1,41	1,27	1,52	1,44	0,20	Ankara - 1,45	676,17	444,85
Japonska	5,18	4,92	5,30	5,30	2,10	Tokio - 5,29	2.093,16	394,94
Saudska Arabija	5,04	3,78	5,70	5,65	1,30	Zadaj - 5,05	2.150,08	377,21
Malezija	2,45	2,06	2,64	2,64	0,50	Kuala Lumpur - 2,46	853,54	323,31
Tajvan	4,76	4,19	5,08	5,01	0,00	Taipei - 4,77	1.587,33	312,47
Južna Koreja	7,71	7,30	7,92	7,92	1,70	Seul - 7,77	2.394,64	302,35
Kazahstan	2,29	1,95	2,59	2,32	0,70	Astana - 2,30	617,89	238,57
Vietnam	1,97	1,77	2,07	2,07	1,40	Hanoi - 1,98	429,51	207,49
Kitajska	4,53	3,96	4,80	4,83	0,10	Peking - 4,57	923,29	192,35
Tajska	2,60	2,24	2,77	2,77	0,60	Bangkok - 2,66	529,00	190,97
Indija	3,25	3,07	3,33	3,37	0,00	Novo - Delhi 3,33	614,09	184,41
Jordanija	3,85	3,38	4,09	4,09	2,70	Zdaj - 3,86	629,92	154,01
Nepal	1,45	1,23	1,58	1,54	0,00	Katmandu - 1,49	214,96	136,05
Indonezija	2,19	1,84	2,40	2,34	0,60	Džakarta - 2,23	320,68	133,62
Azerbajdžan	2,99	2,45	3,55	2,98	0,20	Baku - 3,00	436,47	122,95
Filipini	2,97	2,54	3,20	3,16	1,30	Manila - 3,02	372,96	116,55
Bangladeš	2,64	2,45	2,76	2,72	0,30	Daka - 2,65	243,17	88,11
Šrilanka	2,52	2,16	2,79	2,62	0,20	Sri Jayawardeneपुरa Kotte - 2,53	200,94	72,02
Pakistan	2,54	2,16	2,83	2,62	0,00	Islamabad - 2,60	175,61	62,05
Bahrain	4,37	3,71	4,72	4,67	3,90	Manama - 4,37		
Kambodža	2,48	2,07	2,72	2,65	0,20	Phnom Penh 2,48		
Katar	6,79	5,76	7,36	7,25	5,20	Doha - 6,79		
Kirgizija	1,61	1,39	1,76	1,68	0,30	Biškek - 1,64		
Laos	1,83	1,64	1,93	1,93	0,80	Vientiane - 1,85		
Libanon	5,65	4,76	6,10	6,07	5,70	Bejrut - 5,71		
Oman	4,03	3,74	4,15	4,20	1,40	Muškat - 4,03		

Vir: (Trading economics, 2024) (Numeo, 2024)

## Amerike

V Ameriki (Tabela 4) so Bahami država z najdražjo kavo, skodelica pa stane kar 3,90 dolarja. Po drugi strani pa ima Honduras, znan po svoji raznolikosti mešanic kave, najcenejšo ceno v Severni Ameriki z 1,75 dolarja na skodelico. Kolumbija, ena

največjih izvoznih kave na svetu, ima najnižjo ceno v Južni Ameriki, in sicer 1,25 dolarja za skodelico. Največja poraba na prebivalca je v Kanadi (5,7 kg) in Braziliji (5,4 kg).

Tabela 4: Cene kave v Ameriki

Država	Povprečna cena kave USD	Cena espresso USD	Cena mlečne kave USD	Cena Cappuccino USD	Poraba kave na prebivalca (kg)	Cena kave v prestolnici USD	Povprečna neto plača USD	Število kav v povprečni neto plači
ZDA	3,77	3,20	4,12	4,00	3,70	Washington D.C. - 3,77	4.536,37	1.101,06
Kanada	3,02	2,49	3,34	3,22	5,80	Ottawa - 3,11	2.872,33	859,98
Urugvaj	3,03	2,54	3,16	3,39	1,10	Montevideo - 3,01	1.150,33	364,03
Mehika	2,16	1,75	2,40	2,32	0,50	Mexico City - 2,17	786,11	327,55
Kostarika	2,60	2,06	3,00	2,74	2,80	Sveti Jožef - 2,61	905,14	301,71
Kolumbija	1,25	0,98	1,35	1,41	1,50	Bogota - 1,00	386,44	286,25
Argentina	1,58	1,38	1,70	1,67	0,40	Buenos Aires - 1,61	433,62	255,07
Panama	2,94	2,36	3,28	3,20	2,10	Panama City - 2,95	792,59	241,64
Brazilija	2,03	1,68	2,16	2,24	5,40	Brazilija - 1,90	438,80	203,15
Ekvador	2,48	2,24	2,60	2,60	0,10	Quito - 2,48	499,75	192,21
Peru	1,95	1,61	2,16	2,08	0,70	Apno - 1,96	403,62	186,86
Čile	3,14	2,63	3,56	3,23	0,40	Santiago de Chile - 3,15	656,43	184,39
Bolivija	2,19	1,70	2,60	2,28	2,00	Mir - 2,20	383,74	147,59
Kuba	1,96	1,55	1,90	2,45	1,60	Havana - 1,97	34,06	17,93
Bahami	3,90	3,08	4,53	4,08	2,00	Nassau - 3,91		
Barbados	3,54	3,11	3,75	3,75	0,00	Bridgetown - 3,55		
Gvatemala	2,34	2,03	2,52	2,45	2,00	Gvatemala City - 2,35		
Honduras	1,75	1,55	1,82	1,90	2,50	Tegucigalpa - 1,75		
Nikaragva	2,26	1,85	2,49	2,44	0,10	Managua - 2,00		
Salvador	2,32	1,70	2,53	2,75	2,20	San Salvador - 2,33		

Vir: (Trading economics, 2024) (Numeo, 2024)

## 2.4 Povprečna cena kave skozi čas v Sloveniji

Tabela 5: Gibanje cen kave v lokalu

Leto	DIN* SIT	Skodelica kave Espresso v bifeju (EUR) - Po tekočih cenah	Skodelica kave Espresso v bifeju (EUR) - Po fiksnih cenah	Neto plača (EUR) - Po tekočih cenah v EUR	Neto plača (EUR) - Po fiksnih cenah	Število kav, ki si jih lahko kupil za plačo	Število kav, ki si jih lahko kupil za plačo
1990	7,00*	0,03	0,89	23,61	719,80	787,00	808,76
1991	18,06	0,08	0,42	43,07	242,34	571,43	571,43
1992	38,06	0,16	0,67	128,58	540,06	809,52	809,52
1993	64,70	0,27	0,94	195,40	678,34	723,70	723,70
1994	88,04	0,37	1,12	250,75	765,94	682,54	682,54
1995	109,53	0,46	1,27	297,44	827,01	650,79	650,79
1996	109,69	0,46	1,17	341,47	876,19	746,03	746,03
1997	119,70	0,50	1,19	380,57	904,93	761,90	761,90
1998	124,04	0,52	1,16	416,95	934,00	803,38	803,38
1999	126,84	0,53	1,09	456,01	937,93	859,24	859,24
2000	133,13	0,56	1,06	503,63	955,69	904,14	904,14
2001	141,25	0,59	1,04	562,74	993,45	952,18	952,18
2002	158,23	0,66	1,11	617,37	1.032,58	932,51	932,51
2003	170,56	0,71	1,15	663,80	1.071,76	934,93	934,93
2004	178,41	0,74	1,17	701,90	1.106,18	948,51	948,51
2005	183,57	0,77	1,18	735,73	1.131,65	955,49	955,49
2006	193,41	0,81	1,20	773,42	1.147,73	954,84	954,84
2007		0,93	1,31	834,50	1.171,93	897,31	897,31
2008		1,09	1,52	899,80	1.252,98	825,50	825,50
2009		1,14	1,56	930,00	1.272,14	815,79	815,79
2010		1,13	1,52	966,62	1.298,85	855,42	855,42
2011		1,16	1,52	987,39	1.293,14	851,20	851,20
2012		1,15	1,48	991,44	1.275,86	862,12	862,12
2013		1,16	1,49	997,01	1.280,46	859,49	859,49
2014		1,19	1,54	1.005,41	1.298,13	844,88	844,88
2015		1,20	1,55	1.013,23	1.309,01	844,36	844,36
2016		1,19	1,52	1.030,16	1.312,12	865,68	865,68
2017		1,20	1,50	1.062,00	1.329,54	885,00	885,00
2018		1,21	1,49	1.092,74	1.346,09	903,09	903,09
2019		1,26	1,55	1.133,50	1.397,00	899,60	899,60
2020		1,29	1,56	1.208,65	1.461,55	936,94	936,94
2021		1,33	1,48	1.270,30	1.411,86	955,11	955,11
2022		1,48	1,53	1.318,64	1.363,21	890,97	890,97
2023		1,63	1,63	1.445,12	1.445,12	886,58	886,58
<b>Povprečje</b>			<b>1,28</b>			<b>848,74</b>	<b>849,38</b>

Vir: (SURS, 2024a)(SURS, 2024b)

V nadaljevanju (Tabela 5) je predstavljena analiza gibanja cen kave v Sloveniji od leta 1990 dalje (SURŠ, 2024a). Pri tem smo podatke črpali iz statističnega letopisa (SURŠ, 2024a). Da bi lahko dobili podatke po fiksnih cenah pa smo uporabili kalkulator za preračun (SURŠ, 2024b).

Tabela prikazuje gibanje cen kave v Sloveniji od leta 1990 do leta 2023. Prikazani so podatki o cenah skodelice kave espresso v bifeju v tekočih in fiksnih cenah, neto plači v evrih ter o številu skodelic kave, ki jih je bilo mogoče kupiti za neto plačo.

Cena kave se je v omenjenem obdobju znatno povečala. V letu 1990 je bila cena skodelice kave espresso v bifeju 0,03 EUR, v letu 2023 pa 1,63 EUR. To pomeni, da se je cena kave v 33 letih povečala za kar 54-krat.

Cena kave se je povečevala hitreje od rasti plač. V letu 1990 je bilo mogoče za povprečno neto plačo kupiti 787 skodelic kave espresso, v letu 2023 pa le 886 skodelic. To pomeni, da so se ljudje v omenjenem obdobju relativno gledano morali več truditi, da bi si lahko privoščili skodelico kave.

Da bi izračunal ceno kave danes (leta 2024), ko je bila cena leta 1990 0,03 EUR, ob upoštevanju inflacije 3.648%, uporabimo naslednjo formulo za izračun:

$$\text{Cena danes} = \text{Cena leta 1990} \times \left(1 + \frac{\text{Inflacija}}{100}\right) \quad (1)$$

Kjer:

Cena leta 1990 je 0,03 EUR.

Inflacija je 3.648%.

$$\text{Cena danes} = 0,03 \times \left(1 + \frac{3648}{100}\right) = 0,03 \times (1 + 36,48) = 0,03 \times 37,48 \quad (2)$$

Cena kave, prilagojena za inflacijo 3.648 % (junij 1990-junij 2024), bi bila približno **1,12 EUR**.

V kolikor pogledamo kakšna je cena danes (1,63 EUR) ugotovimo, da se je ta za 40 % višja.

Cena kave se je v Sloveniji v zadnjih 33 letih znatno povečala. To je posledica več dejavnikov, med drugim rasti povpraševanja po kavi, višjih stroškov pridelave in prevoza ter inflacije. V prihodnosti je mogoče pričakovati, da se bodo cene kave še naprej zmerno povečevale.

Razlika med ceno skodelice kave v tekočih in fiksnih cenah se je v zadnjih letih pred COVID-19 zmanjšala. To je posledica upočasnitve inflacije. Po letu 2022 pa se je opazno podražila, saj se je zaradi sprostitve javnega življenja povpraševanje ponovno povečalo. Kava je namreč pomembna tudi za socializacijo.

Vsled tega nas zanima, kdaj bi potrošniki prekinili z navado pitja kave, v kolikor bi bil tak trend. Na to bomo poskušali odgovoriti v raziskavi, ki je predstavljena v nadaljevanju.

### 3 Raziskava

Našo populacijo predstavljajo polnoletni državljani R Slovenije. Vzorec po čiščenju podatkovne baze vsebuje 536 deležnikov. Raziskava je bila izvedena s pomočjo orodja Ika (University of Ljubljana Faculty of Social Sciences Centre for Social Informatics, 2022) v času od 15.3.2024 do 16.5.2024. Gre za priložnostni vzorec, ki maksimalne naključnosti ne more zagotoviti. Izbira vzorca temelji na spletnem anketiranju, ki je v zadnjih desetletjih sprejeto kot dovolj zanesljivo orodje pri vprašanju zagotovitve vzorca. Bolj natančno strukturo vzorca prikazuje Tabela 6. Glede na spol je anketo izpolnilo 33 % moških (163) in 67 % žensk (324). Najstarejši anketiranec se je rodil leta 1947, najmlajši pa leta 2005. V povprečju so se rodili leta 1982 oz. so bili stari dobrih 42 let s standardnim odklonom 13,4 let. V povprečju gospodinjstvo šteje 3,08 članov s standardnim odklonom 1,34. Iz rezultatov ankete lahko razberemo, da je v bilo v anketo zajetih največ takih, ki so zaposleni v gospodarstvu (36 %), sledijo tisti ki so zaposleni v javnem sektorju (26 %), študenti (14 %). Ostale skupine so prejele manj kot 10 % odgovorov. Četrtnina anketiranih živi v gospodinjstvu, kje je neto dohodek višji od 3.100 EUR. Vzorec pokriva 61 od 212 občin ali 29 %. V povprečju živi v gospodinjstvu 3,1 oseba s standardnim odklonom 1,3 osebe. Povprečni neto dohodek gospodinjstva je več kot 2.100 EUR.



Povprečna neto plača v občini je 1.433 EUR, medtem ko je povprečna neto plača v Sloveniji 1.445 EUR.

Tabela 6: Demografski podatki raziskave

		Število (536)	Delež
Tip naselja	Manj kot 2.000 prebivalcev (mestno)	48	9,94%
	Manj kot 2.000 prebivalcev (vaško)	42	8,70%
	2.000-10.000 prebivalcev	181	37,47%
	Več kot 10.000 prebivalcev	86	17,81%
	Maribor	18	3,73%
	Ljubljana	108	22,36%
	<b>Skupaj</b>	<b>483</b>	<b>100%</b>
Spol	Moški	163	33,47%
	Ženski	324	66,53%
	<b>Skupaj</b>	<b>487</b>	<b>100%</b>
Status	Dijak	6	1,23%
	Študent	72	14,72%
	Zaposlen v javnem sektorju (uprava, šolstvo, zdravstvo, sociala, kultura idr.)	126	25,77%
	Zaposlen v neprofitnem sektorju (društva, združenja idr.)	16	3,27%
	Zaposlen v podjetju	176	35,99%
	Samozaposlen	42	8,59%
	Upokojenec	41	8,38%
	Brezposeln	10	2,04%
<b>Skupaj</b>	<b>489</b>	<b>100%</b>	
Dohodek	Do 550 €	4	0,92%
	Od 551 do 800 €	23	5,26%
	Od 801 do 1000 €	28	6,41%
	Od 1001 do 1300 €	56	12,81%
	Od 1301 do 1600 €	44	10,07%
	Od 1601 do 1900 €	36	8,24%
	Od 1901 do 2200 €	36	8,24%
	Od 2201 do 2500 €	41	9,38%
	Od 2501 do 3100 €	49	11,21%
	Nad 3100 €	120	27,46%
<b>Skupaj</b>	<b>437</b>	<b>100%</b>	

Vir: Lasten

## 4 Rezultati

Kava (Tabela 7) v slovenskih krajih znaša med 1,00 in 5,50 EUR (v povprečju je 1,603 EUR, s standardnim odklonom 0,48 EUR). Potrošniki pa bi bili pripravljeni max. plačati 10,00 EUR (v povprečju 3,209 EUR s standardnim odklonom 1,609 EUR).

To v praksi pomeni, da bi bili potrošniki pripravljeni na 50 % dvig cen kave, preden bi se popolnoma odpovedali tej pijači. Seveda pa to ne velja za vse. Nekateri bi se bili pripravljeni odpovedati že mnogo prej – pri 1,20 EUR.

**Tabela 7: Cenovna elastičnost glede pitja kave**

	N	Min	Max	Povprečje	Standardni odklon	B/A
Koliko v povprečju v vašem kraju znaša cena KAVE	477	1,00	5,50	1,603	0,477	2,00
Kdaj bi prenehali s pitjem KAVE v vašem kraju?	413	1,20	10,00	3,209	1,609	

Vir: Lasten

Odvisna spremenljivka modela je indeks cenovne elastičnosti pitja kave (Tabela 7). Vrednost smo zajeli s vprašanjem, na katero so anketiranci odgovorili tako, da so obkrožili odgovor »Koliko v povprečju v vašem kraju znaša cena KAVE«, ter odgovor »Kdaj bi prenehali s pitjem KAVE v vašem kraju?«. Izračunali pa smo jo zato, da smo dobili odgovor na »kdaj bi prenehali ...«, delili z odgovorom »Koliko v povprečju v vašem kraju ...«.

Naša neodvisna spremenljivka so dihonomične spremenljivke, in sicer občina, tip naselja, starost in spol (moški/ženski).

### **H 1: »Občina in tip naselja skupaj vplivata na indeks dviga cene kave«.**

V kolikor podrobneje pogledamo (Tabela 8) stanje po slovenskih občinah je zelo različno in zaradi nepopolnih podatkov v določenih občinah tudi ni reprezentativno. Vendar pa se povprečje v celoti približa povprečju, kot ga navaja SURS v tabeli 6 (SURS, 2024a).

Ko pa pogledamo statistične razlike (Tabela 9) vidimo, da ni statističnih razlik glede na občine.

Tabela 8: Kava v slovenskih občinah

Občina	N	Koliko v povprečju v vašem kraju znaša cena KAVE		Kdaj bi prenehali s pitjem KAVE v vašem kraju?		Razlika	
		Povprečje (EUR)	Standardni odklon (EUR)	Povprečje (EUR)	Standardni odklon (EUR)	Dvig v EUR	Indeks dviga
Pivka	2	1,20	,00	1,20	0,00	0,00	1,00
Šempeter - Vrtojba	2	1,20	,00	1,20	0,00	0,00	1,00
Renče - Vogrsko	2	1,10	,00	1,20	0,00	0,10	1,09
Šenčur	2	1,20	,00	1,50	0,00	0,30	1,25
Komenda	2	1,30	,00	1,70	0,00	0,40	1,31
Škofljica	4	1,90	,58	2,50	0,58	0,60	1,32
Brežice	2	1,50	,00	2,00	0,00	0,50	1,33
Slovenj Gradec	2	1,50	,00	2,00	0,00	0,50	1,33
Krško	4	1,43	,16	1,90	0,12	0,48	1,33
Dobrova - Polhov Gradec	2	1,80	,00	2,50	0,00	0,70	1,39
Žirovnica	2	1,80	,00	2,50	0,00	0,70	1,39
Brezovica	2	1,40	,00	2,00	0,00	0,60	1,43
Kranjska Gora	2	1,40	,00	2,00	0,00	0,60	1,43
Tržič	4	1,40	,23	2,00	0,00	0,60	1,43
Kamnik	4	1,47	,05	2,15	0,17	0,68	1,47
Murska Sobota	2	1,35	,17	2,00	0,00	0,65	1,48
Zagorje ob Savi	2	1,35	,06	2,00	0,00	0,65	1,48
Ribnica	2	1,60	,00	2,40	0,00	0,80	1,50
Sevnica	4	1,50	,00	2,25	0,29	0,75	1,50
Novo mesto	4	1,55	,31	2,50	0,58	0,95	1,61
Koper	6	1,75	,66	2,83	0,26	1,08	1,62
Črnomelj	2	1,20	,00	2,00	0,00	0,80	1,67
Kobarid	2	1,20	,00	2,00	0,00	0,80	1,67
Trbovlje	2	1,50	,00	2,50	0,00	1,00	1,67
Izola	6	1,38	,13	2,33	0,52	0,95	1,69
Kranj	6	2,42	1,00	4,27	2,33	1,84	1,76
Komen	4	1,35	,17	2,50	1,15	1,15	1,85
Maribor	16	1,63	,34	3,06	1,22	1,43	1,88
Sežana	2	1,30	,00	2,50	0,00	1,20	1,92
Zreče	2	1,30	,00	2,50	0,00	1,20	1,92
Radovljica	6	1,60	,09	3,17	1,44	1,57	1,98
Grosuplje	6	1,60	,20	3,17	0,93	1,57	1,98
<b>Skupaj</b>	<b>339</b>	<b>1,61</b>	<b>,50</b>	<b>3,21</b>	<b>1,63</b>	<b>1,60</b>	<b>1,99</b>
Dol pri Ljubljani	2	1,50	,00	3,00	0,00	1,50	2,00
Kočevje	2	1,50	,00	3,00	0,00	1,50	2,00
Medvode	2	1,50	,00	3,00	0,00	1,50	2,00
Rače - Fram	2	2,00	,00	4,00	0,00	2,00	2,00
Ajdovščina	19	1,48	,42	2,95	1,14	1,48	2,00
Nova Gorica	60	1,60	,82	3,20	1,61	1,60	2,00
Piran	6	1,50	,27	3,17	1,44	1,67	2,11
Ljubljana	82	1,86	,34	3,96	2,24	2,10	2,13
Brda	4	1,40	,15	3,00	1,15	1,60	2,14
Postojna	2	1,40	,00	3,00	0,00	1,60	2,14
Celje	14	1,60	,30	3,59	1,20	1,99	2,24
Žiri	2	1,10	,00	2,50	0,00	1,40	2,27
Domžale	6	1,50	,27	3,43	0,88	1,93	2,29
Škofja Loka	4	1,57	,23	3,75	0,29	2,18	2,39
Kuzma	2	1,20	,00	3,00	0,00	1,80	2,50
Tolmin	6	1,33	,09	3,43	2,01	2,11	2,59
Vodice	2	1,50	,00	4,00	0,00	2,50	2,67
Ljutomer	2	1,70	,00	5,00	0,00	3,30	2,94
Miren - Kostanjevica	2	1,00	,00	3,00	0,00	2,00	3,00
Ptuj	2	1,50	,00	5,00	0,00	3,50	3,33
Slovenska Bistrica	2	1,40	,23	5,00	0,00	3,60	3,57
Rogaška Slatina	2	1,20	,00	5,00	0,00	3,80	4,17

Vir: Lasten

**Tabela 9: ANOVA: Indeks dviga cen kave in občine**

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	10,949	31	,353	1,467	,085
Within Groups	20,700	86	,241		
Total	31,649	117			

Vir: Lasten

Boj reprezentativen je vzorec v kolikor pogledamo stanje glede na tip naselja (Tabela 10). V povprečju so potrošniki pripravljene sprejeti dvig cene kave na drobno za 100 %. Najmanj v mestnih okoljih z manj kot 2000 prebivalci (70 %), največ pa v Ljubljani in mestnem okolju z več kot 10.000 prebivalci (140 %).

**Tabela 10: Kava glede na tip naselja**

	N	Koliko v povprečju v vašem kraju znaša cena KAVE		Kdaj bi prenehali s pitjem KAVE v vašem kraju?		Razlika	
		Povprečje (EUR)	Standardni odklon (EUR)	Povprečje (EUR)	Standardni odklon (EUR)	Dvig v EUR	Indeks dviga
Manj kot 2.000 prebivalcev (mestno)	38	1,78	0,97	3,03	1,63	1,25	1,70
2.000-10.000 prebivalcev	140	1,47	0,31	2,68	0,99	1,21	1,83
Maribor	16	1,63	0,34	3,06	1,22	1,43	1,88
<b>Skupaj</b>	<b>371</b>	<b>1,61</b>	<b>0,49</b>	<b>3,25</b>	<b>1,66</b>	<b>1,64</b>	<b>2,02</b>
Manj kot 2.000 prebivalcev (vaško)	26	1,52	0,53	3,07	1,39	1,55	2,03
Ljubljana	86	1,86	0,34	4,17	2,33	2,31	2,24
Več kot 10.000 prebivalcev	65	1,55	0,38	3,48	1,42	1,93	2,25

Vir: Lasten

V tem primeru (Tabela 11) obstajajo statistične razlike. Med posamezniki skupinami in sicer manj kot 2.000 prebivalcev (vaško) v primerjavi z 2.000–10.000 prebivalcev.

Tabela 11: ANOVA: Indeks dviga cen kave in tip naselja

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3,057	5	,611	2,554	,031
Within Groups	29,202	122	,239		
Total	32,259	127			

Vir: Lasten

Hipoteze H 1: Občina in tip naselja skupaj vplivata na indeks dviga cene kave, ne moremo potrditi.

## H 2: »Starost vpliva na toleranco do dviga cene kave«.

Da bi preverili to hipotezo smo opravili linearno regresijo (Tabela 12). Pri tem je bila odvisna spremenljivka indeks dviga cene kave. Neodvisna spremenljivka pa dopolnjena leta starosti. Iz tabele izhaja, da ima starost statistično značilen pozitiven vpliv na toleranco do dviga cene kave. Z vsako dodatno starostno leto se pričakovani indeks tolerance do dviga cene poveča za 0,460 enot. Model razloži 15,3 % variabilnosti v indeksu, kar pomeni, da obstajajo tudi drugi dejavniki, ki vplivajo na toleranco.

Tabela 12: Linearna regresija – starost

Model Summary						
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate		
1	,391 <sup>a</sup>	,153	,145	,48351		
a. Predictors: (Constant), Leta starosti						
ANOVA <sup>a</sup>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4,312	1	4,312	18,443	,000 <sup>b</sup>
	Residual	23,845	102	,234		
	Total	28,157	103			
a. Dependent Variable: Indeks kava						
b. Predictors: (Constant), Leta starosti						
Coefficients <sup>a</sup>						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,823	,183		4,498	,000
	Leta starosti	,460	,107	,391	4,295	,000
a. Dependent Variable: Indeks kava						

Vir: Lasten

Hipotezo H2: »Starost vpliva na toleranco do dviga cene kave, lahko POTRDIAMO.

H 3: »Spol vpliva na toleranco do dviga cen kave«.

Za preveritev te hipoteze smo uporabil t-test (Tabela 13). Glede na rezultate t-testa ni dovolj dokazov za trditev, da spol statistično značilno vpliva na toleranco do dviga cene kave ( $p=0,072$ ). Čeprav je razlika v povprečju med spoloma prisotna (moški imajo nižji indeks), razlika ni dovolj velika, da bi bila pomembna na 5-odstotni ravni značilnosti.

**Tabela 13: T test – spol**

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	14,373	,005	-1,01	8	,341	-,458	,452	-1,500	,585
Equal variances not assumed			-2,12	7,00	,072	-,458	,216	-,969	,054

Vir: Lasten

Hipoteze H 3: »Spol vpliva na toleranco do dviga cen kave«, ne moremo potrditi.

## 5 Zaključki

Smo v času, ko smo po obdobju pandemije COVID-19 ponovno soočeni z visokimi inflacijskimi pritiski, ki so preseglj stopnje, ki so bile prisotne od uvedbe evra. Starejše generacije se spominjajo časov, ko je Slovenija doživela hiperinflacijo, kar še vedno vpliva na njihov pogled na gospodarstvo in cene. V okviru tega smo se odločili preučiti gibanje cen kave, tako na debelo kot na drobno, od leta 1990 do danes. Poleg tega smo izvedli raziskavo med slovenskimi potrošniki, da bi ugotovili, kako oni vidijo naraščanje cen kave in kakšna je njihova pripravljenost ter tolerantnost do morebitnih prihodnjih dvigov maloprodajnih cen. Glavno vprašanje raziskave je bilo: »Ali so se cene na drobno zvišale hitreje kot inflacija, in kolikšen dvig cene kave so potrošniki pripravljeni še sprejeti?«

Naša glavna ugotovitev je, da so se cene kave bistveno hitreje dvigale kot inflacija v istem obdobju. Kava je tako postala bolj dostopna le tistim, ki so se pripravljene prilagoditi temu naraščanju cen. Potrošniki so sicer pripravljene tolerirati nadaljnje zvišanje cene, vendar se zdi, da obstaja določen prag tolerance. Kar zadeva demografske razlike, niso bile ugotovljene statistično značilne razlike v pripravljenosti na višje cene glede na občine, velikost naselja ali spol. Vendar pa so nekoliko bolj tolerantni do dviga cene starejši potrošniki, ki imajo izkušnje z inflacijo, še posebej s hiperinflacijo, kar jih je verjetno naučilo večje prilagodljivosti v težkih gospodarskih razmerah.

Zaključimo lahko, da so potrošniki sicer pripravljene sprejeti višje cene, vendar je pomembno, da ponudniki kave upoštevajo meje tolerance, saj bi pretiran dvig cen lahko vodil v zmanjšano povpraševanje. Poleg tega je treba razmisliti o vplivu dolgoročnih inflacijskih pritiskov na nakupne navade potrošnikov, še posebej tistih, ki niso navajeni na takšne nihanje cen. V prihodnje bi lahko spremembe v potrošniških navadah še dodatno vplivale na način, kako se bodo oblikovale cene in kako bo potrošniški trg reagiral na nadaljnje gospodarske izzive.

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na primer MODI, MLAB, Implementacija modela (LACORE), Evropsko teritorialno sodelovanje s pomočjo tehnologije in znanosti ipd. Bibliografija: COBISS izpis obsega 645 enot.

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# PRIDOBIVANJE LITIJA V EVROPI IN MOŽNE POSLEDICE ZA OKOLJE

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Litij je ena izmed ključnih snovi za proizvodnjo baterij za električne avtomobile in tudi za mnoge druge naprave, kot so prenosni računalniki in ure. Trenutno je v svetovni proizvodnji litija delež Evrope minimalen, velika večina litija je pridobljena v Južni Ameriki, v Avstraliji in na Kitajskem. Med prvo deseterico proizvajalcev litija je edina evropska država Portugalska, a še ta s precej majhnim deležem. Vendar pa ocene kažejo, da ima poleg Portugalske še kar nekaj evropskih držav omembe vredne zaloge litija. Glede na pričakovano veliko povečanje povpraševanja po litiju zaradi proizvodnje električnih avtomobilov načrtujejo pričeti s pridobivanjem litija tudi v nekaterih evropskih državah. To bi po eni strani prispevalo k zmanjšanju energetske odvisnosti Evrope od uvoza, po drugi strani pa bi lahko povzročilo precejšnje vplive na okolje. Pojavlja se vprašanje, ali so tako imenovane zelene energije res tako prijazne do okolja. Prispevek tudi izpostavlja vprašanje okoljske pravičnosti.

**Ključne besede:**  
litij,  
električni avtomobili,  
proizvodnja baterij,  
vplivi na okolje,  
okoljska pravičnost

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# LITHIUM MINING PROSPECTS IN EUROPE AND POSSIBLE ENVIRONMENTAL CONSEQUENCES

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**Keywords:**

lithium,  
electric cars,  
battery production,  
environmental impact,  
environmental justice

Lithium is one of the crucial materials for the production of batteries for electric cars as well as for many other devices as are laptops and watches. At present, the share of Europe in the world production of lithium is very small. The majority of lithium is mined in South America, Australia and China. Portugal is the only European country among the world's top ten lithium producers and its share is also very small. However, the stock assessment shows that, in addition to Portugal, some other European countries have significant lithium reserves. In view of the expected growing demand for lithium for the production of electric cars, plans are underway to start lithium production in some of these European countries. This will reduce Europe's energy dependence on imports and, on the other hand, have a major impact on the environment. The present article will try also to address the problem of environmental justice.



## 1 Uvod

Človeštvo se danes sooča s številnimi problemi in konflikti: naraščanjem prebivalstva<sup>1</sup> in njegovih potreb (Worldometer, 2024), prevladujočo potrošniško mentaliteto pogojeno s paradigmo rasti in ponekod že pomanjkanjem virov zaradi fizične, prehranske in energetske omejenosti planeta. Problemi pa vodijo v konflikte med ljudmi in človekom in naravo. Posledice trenj v prostoru, pa v dilemo obstoja živih bitij na planetu.

Razvoj je v stoletju tako imenovane industrijske družbe, povzročil številne premike in pretrse. Skozi družbeni in ekonomski napredek, je vplival tudi na mnoge negativne posledice v naravi, okolju in družbi. Če je bila do sedaj gonila sila razvoja raba fosilnih virov, se zaradi negativnih okoljskih in družbeno socialnih posledic njihove intenzivne rabe, okoljistični svet sooča z vprašanjem, kako na omejenem planetu preživeti. Temeljno vprašanje, ki se pojavlja je, kako in na kakšen način ter s katerimi viri, zadovoljiti potrebe človeštva ter zmanjšati konflikte v okolju in prostoru. Kriza z energenti zaradi konfliktov v svetu, je ob usmerjenosti k potrošniški mentaliteti in ekstremni porabi virov<sup>2</sup> (primer Kitajska<sup>3</sup> in ZDA) (EIA, 2024) od leta 1950 naprej (Ritchie in sod, 2024), postala glavni vzrok številnih okoljskih in družbeno socialnih konfliktov. Če so bila ekološka in okoljska vprašanja v preteklosti (in pogosto tudi še danes) glede na ekonomska, ne glede na različne politično-gospodarske sisteme, v podrejenem položaju ali zanemarjena, postajajo danes pomemben dejavnik opozarjanja, da je za ohranitev narave potreben premik k drugačnim, v okolje usmerjenim konceptom (Žnidarič, 2024).

## 2 Energetska odvisnost in revščina skozi koncept različnih oblik enakosti in pravičnosti

Izkoriščanje politično ekonomskega vpliva bogatih držav na oblikovanje svetovne politike, ob vse večji okoljski in družbeni nepravičnosti in ekonomsko socialni neenakosti, ovira iskanje ustreznih in zavezujočih globalnih energetskih politik, ki bi

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<sup>1</sup> Po Worldometru (2024) je bilo 18.12.2024 na svetu že 8,194 milijarde ljudi, dvakrat večje od umrljivosti, je tudi rojstev. Samo v letu 2024 (isti datum) se je populacija človeštva povečala za več kot 67,6 milijona prebivalcev.

<sup>2</sup> Največje porabnice energije so; Islandija, Norveška, Kanada, ZDA in bogate države Bližnjega vzhoda, Oman, Savdska Arabija in Katar. Največje porabnice energije na prebivalca, porabijo sto krat več energije kot najrevnejše države.

<sup>3</sup> Kitajska je v letu 2023 skupno porabila 47,428 TWh energij, medtem ko so ZDA 26,189 TWh. Medtem ko je za primerjavo Slovenija porabila le 72 TWh.

vodile v okoljsko in družbeno sprejemljivejšo družbo prihodnosti in s tem večjo okoljsko in politično pravičnost. Energetska odvisnost pa vodi države v vse večjo politično in ekonomsko odvisnost. Potrebno je zagotoviti večjo prehransko in energetska samooskrbo ter rabo zelenih energetskih sistemov in obnovljivih energij. Vendar se tudi tukaj pojavlja vprašanje; kako definirati zelene energije in na kakšen tehničen način, s čim manj posegi v okolje, doseči njeno zadovoljivo produkcijo. Smernice EU držav, so jasno zapisane v Načrtu okrevanja za Evropo (2021 do 2027) v katerega naj bi EU vložila kar 806,9 milijarde evrov (Evropska komisija, 2024). Vendar je realizacija programov zaradi različnih vzrokov časovno vprašljiva (2030)<sup>4</sup>. Uspešnost implementacije zelenih programov pa odvisna tudi od ekonomskega statusa družbe in posameznika. Status posameznika (tako po Ingelhartu kot Maslowu), igra odločilno vlogo pri prehodu na zelene in učinkovitejše sisteme, ki omogočajo manjšo energetska odvisnost (Žnidarič, 2021).

Primer iz Zasavja kaže, da so ljudje iz obrobja družbe, predvsem tisti, ki so socialno ogroženi, kljub dobri nameri države po večji subvenciji sistemov za URE in OVE, zaradi omejenega finančnega in socialnega statusa, zaradi pogoja lastne soudeležbe, niso vključevali na razpise, ki so omogočali pridobitev varčnejših sistemov ogrevanja. Okrnjen finančni status igra pomembno, omejitveno vlogo pri večji okoljski angažiranosti. Čeprav sam finančni status posameznika ni nujno povezan z večjo okoljsko angažiranostjo, kot je to v primeru kazalcev BDP-ja za ZDA<sup>5</sup>, predstavlja ekonomski nivo pomemben in nezanemarljiv dejavnik pri uvedbi tehničnih rešitev za URE v v Zasavju (Žnidarič, 2021), kjer se energetska revščina povečuje. Njej so najbolj izpostavljeni starejši in tisti z nizkimi dohodki, oziroma prebivalci na podeželju in ruralnih mestnih območjih (RRA, 2024).

### **3      **Produkcija zelene energije ali preizpraševanje o tem ali je zelena energija resnično zelena (okoljsko politološki vidik)****

Pri produkciji nekaterih zelenih energij in produktov, kot sta hidroenergija ali električna mobilnost, se zaradi do sedaj znanih vplivov na okolje in družbo, postavlja vprašanje ali sta proizvedena energija iz hidroelektrarn oziroma produkcija baterij za

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<sup>4</sup> Cilji EU za leto 2030 so, zmanjšanje emisij toplogrednih plinov za 55 %, v primerjavi z letom 1990, zmanjšanje porabe vsaj za 11,7 %. Povečanje produkcije energij iz OVE na minimalno 42,5 % celotne produkcije, prej 32 % glede na leto 2018.

<sup>5</sup> V ZDA je je povprečni BDP na prebivalca visok (predvsem na račun bogatih), vendar je okoljska anagažiranost nizka, poraba virov pa kljub vse večji krizi z energeti, velika.

električne avtomobile, resnično zelena? Oziroma v kolikšni meri lahko v klasifikaciji vplivov na okolje zaradi njihove produkcije, sploh govorimo o zelenih energijah in konceptih. Dvom v zelenenje energij povzroča predvsem začetna, primarna faza produkcije energij. Skozi časovnico vplivov na okolje in družbo, pa lahko govorimo o dolgotrajnih in segmentnih vplivih postopkov in procesov produkcije. Med prve lahko prištevamo negativne vplive, ki jih povzročajo zamejitve vodnih teles, oziroma izgradnje hidroelektrarn<sup>6</sup>. Druge, pa lahko klasificiramo skozi proizvodnjo kovin za baterije, kjer je obremenjevanje največje pri sami produkciji kovin v njihovi začetni fazi pridobivanja (litij, kobalt,...). Pri produkciji kovin za baterije, so nekateri postopki bolj obremenjujoči za okolje kot produkcija klasičnih agregatov ali pa osnovna produkcija kovin zahteva enormne količine energije (Žnidarič in sod., 2018). Zato je pomembno, da pri vrednotenju in klasifikaciji pojma zelena energija, analiziramo vse segmente vplivov na okolje, skozi postopke distribucije, produkcije ali porabljene energije, ki pri transformaciji nastopijo. Šele ob vseh relevantnih informacijah, lahko dobimo realno sliko o resnično »zelenih«, okoljsko sprejemljivih rešitvah.

Ob sami produkciji kovin in virov za baterije, pa moramo za realno sliko o vplivih na okolje upoštevati tudi družbeno socialni dejavnik. Vprašati se je potrebno, kdo in na kakšen način kovine v primarni fazi pridobiva. Vprašanje se nanaša predvsem na segmente otroškega dela, varovanja zdravja, rabe zaščitnih sredstev pri produkciji surovin ali poštenega plačila za opravljeno delo, nenazadnje pa tudi okoljskih vplivih. Pridobivanje litija iz slanice ali neposredno iz rude, je namreč okoljsko obremenjujoče in v fazi pridobivanja kovin za baterije, povzroča veliko večji ogljični odtis kot proizvodnja klasičnih avtomobilskih agregatov.

Poleg tega je pomembno, koliko energije je potrebno za zeleno transformacijo in iz katerih virov<sup>7</sup> je energija za transformacijo v kovine pridobljena. Podatki o potrošnji kumulativne energije (CED) pri proizvodnji električnih baterij kažejo, da je potrošnja pri e-baterijah skoraj štirikrat večja kot pri klasičnih generičnih baterijah (Kim, 2022).

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<sup>6</sup> Gradnja jezov za hidroelektrarne ima dolgotrajne negativne vplive na okolje, prostor in ljudi. Jezovi namreč omejujejo naravni tok rek, spremenijo biotsko raznovrstnost prej prostotekočih rek, spremeni se flora in favna, poleg dviga temperature, pa je poglobitveno zmanjšanje vertikalnega toka reke, ki napaja podzemne rezervoarje pitne vode, hkrati pa se zmanjšajo samočistilne sposobnosti vodnih teles (Toman, 2022; Žnidarič, 2024).

<sup>7</sup> Elektroenergetski sistemi večinoma še vedno proizvajajo električno energijo iz fosilnih goriv, jedrske energije (kjer imajo elektrarne), le manjši delež je iz OVE. Pa še ta je odvisen od ekonomske moči posameznih držav. V primeru, da se električni avtomobili napajajo z elektriko proizvedeno iz omenjenih fosilnih virov, ne moremo govoriti o zelenih ukrepih. Lahko govorimo zgolj o delno *segmentiranem zelenenju*.

Pri tem je pomembno poudariti dejstvo, da je stopnja emisij pri proizvedenih baterijah za e avtomobile v končni fazi bistveno nižja, kot pri avtomobilih na fosilna goriva, kar predstavlja pozitiven primer pri vrednotenju vplivov na okolje.

#### **4      **Produkcija zelene energije (hidro in e-mobilnosti) skozi konstruktivno kritičen okoljistični pogled****

V primeru hidroenergije in e-avtomobilnosti, se zaradi načina proizvodnje pojavlja dvom, ali takšno energijo lahko še vedno obravnavamo kot zeleno. Primer produkcija energije iz vode, je poleg produkcije kovin za baterije, zaradi zaježitve virov vodnih tokov, okoljsko vprašljiva. Negativne okoljske in družbene posledice omejitve voda, ki so evidentne pri obstoječih pregradah, podajajo dvom o zeleni produkciji tako pridobljene energije. Spremembe na flori in favni, omejitve samočistilnih sposobnosti voda ob zaježitvi, dvig temperature vode, porast kontaminacije ter vplivi na izvire pitne vode<sup>8</sup> (Toman, 2022; Žnidarič, 2023), predstavljajo tveganja za okolje in družbo. Ekonomski učinki proizvedene energije, pa so v primerjavi z daljnosežnimi, negativnimi okoljskimi in intrizičnimi omejitvami, zaradi posledic izgradnje pregrad, zanemarljivi.

Tudi produkcija litija za baterije v električnih baterijah je zaradi negativnih okoljskih in družbenih posledic z okoljskega vidika problematična. Vprašljiva ni samo produkcija litija temveč tudi odlaganje baterij po uporabi. Avstralska študija o baterijah je pokazala, da kar 98,3 % odsluženih baterij končna nereciklirano, na deponijah. Tako odložene baterije pa zaradi vsebovanih surovin, predstavljajo grožnjo požarne nevarnosti. Samo med leti 2017 do 2020 je bilo na odlagališču Pacific Northwest zaznano 124 požarov (Kim, 2022). Požari, ki zaradi odsluženih baterij nastanejo pa so vse pogostejši.

#### **5      **Izkoriščanje mineralov in vpliv produkcije litija v družbi****

Izkoriščanje mineralnih virov, ima zaradi negativnih okoljskih in posredno družbeno socialnih posledic, pomembno vlogo in velik okoljsko-družbeni vpliv. Rudarske in energetske družbe selijo umazane tehnologije v sredine izven matičnih držav

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<sup>8</sup> Ob zaježitvah rek se pojavljajo težave z nivojem podtalnice in podzemnim tokom voda, ki se ob posegih na reki spreminjajo. Na Dravskem polju, se je podtalnica znižala med tremi in sedmimi metri, večina vodnjakov pa ob zaježitvi Drave presahnila (Slameršek, 2024).



korporacij, kjer delujejo po principu NIMBY. V večini držav z nizko ali omejeno okoljsko skrbjo, pa so delovanja korporacij povezana s koruptivnimi tveganji in dvigom politične nepravčnosti. Rudarjenju izpostavljena območja in ljudje, pa podvrženi političnim manipulacijam (primer Jadar v Srbiji). Vpliv rudarskih korporacij in politično vplivnih struktur, se kaže tudi skozi pritiske na politike posameznih držav, ki pomembne vire posedujejo. Delovanje korporacij in kapitala, se v težnjah po pridobivanju surovin, kaže skozi omejevanje ali potvarjanje informacij o negativnih vplivih na okolje, oziroma minimiziranju okoljskih tveganj. Primere neokoljskih in nedružbenih praks s strani korporacij (tudi pri produkciji litija), je slikovito opisal filozof Kirn (2012), ki je delovanje kapitala opisal z besedami, da kapital deluje na način; *da se socializirajo izgube ter privatizirajo dobički*. Kjer se dobički stekajo v žepe lastnikov korporacij in kapitala, z okoljskimi in socialnimi problemi neokoljskih praks, pa se soočajo prebivalci degradiranih okolij. Primer Jadar v Srbiji, kaže na neenak in nepravičen boj prebivalcev pri zaščiti osnovnih človekovih pravic, po življenju v zdravem in čistem okolju in omejevanju temeljnih načel okoljske pravičnosti.

Področji, ki se s ukvarjata s problemi neenakega položaja prebivalcev rudarsko industrijskih okolij v primerjavi z drugimi neindustrijskimi, s strani institucij in sistemov vladanja, sta okoljska in politična pravičnost. Okoljska povzema neokoljske prakse, kot so obremenjevanje zraka, voda in zemljin, oziroma se ukvarja s posledicami neokoljskih praks in njihovimi vplivi na ljudi. Področje politične pravičnosti, pa se nanaša na delovanje političnih sistemov, organov vladanja in njihovih podsistemov, katerih delovanja se v praksi odmikajo od temeljnih nalog države, to je delovanju v korist družbe.

## 5.1 **Produkcija litija in vpliv na okoljsko in politično pravičnost**

Produkcija mineralov, zaradi posegov v in na okolju, predstavlja potencialno veliko tveganje za rast okoljske nepravčnosti. Industrijsko rudarska okolja, so zaradi vztrajanj zgolj na dveh segmentih, energiji in ekonomiji, podvržena okoljski in družbeni neenakosti in nepravčnosti. Namesto vlaganj v ekološko sprejemljive tehnološke procese in ukrepe, se na račun dobičkov, nadaljuje okoljska in družbena stagnacija. Zaradi delovanj korporacij in držav po principu NIMBY, pa se povečuje okoljska in politična nepravčnost, izrazito v nerazvitih ali v manj vplivnih državah.

Če okoljsko pravičnost poenostavljeno opredelimo kot zagotovitev ustreznih življenjskih pogojev in virov posameznikom, ne glede na družbeno, socialno, kulturno ali kakršnokoli drugo raznolikost, lahko opazamo, da so nekatere skupine in območja v neenakopravnem položaju do drugih, industrijsko manj izpostavljenih območij. Pogled skozi zgodovino kaže, da se industrijska in post industrijska okolja, zaradi specifičnih in okoljsko spornih delovanj v prostoru, soočajo s številnimi problemi. Okoljskimi degradacijami, PTE<sup>9</sup> ji v zemljinah zaradi izpustov obremenil v zraku, zdravstvenimi problemi, zaradi obremenjevanj okolij, ter nenazadnje z ekonomsko socialnimi problemi zaradi podcenjenosti nepremičnin in razvojne negotovosti (Žnidarič, 2023). Vse našteje anomalije, pa vplivajo na nivo okoljske pravičnosti. Kljub temu, da smo danes seznanjeni s posledicami preteklih obremenjevanj in neekološkega delovanja industrij, so nekatera območja še vedno izpostavljajo okoljskim tveganjem. Države tretjega sveta, nerazviti, manj vplivne države EU in pristopne članice, so podvržene interesom vplivnih držav in kapitala, ki delujejo po principu NIMBY. Primeri sežiganja odpadkov (tudi nevarnih) v Zasavju in Anhovem ali danes težnji po izkopavanju litija v severovzhodni Bosni in Zahodni Srbiji, kažejo na neokoljske prakse in nadaljevanj politike 2 E, kjer dobički in težnje po čim več energije, še vedno prevladajo nad interesi družbe in okolja. Ob manjši okoljski, so državljani izpostavljeni še politični nepravilnosti. Dogaja se, da so prebivalci namesto zaščite in ohranitve zdravega in čistega okolja, s strani državnih organov žrtvovani, zaradi politično gospodarskih interesov posameznikov in elit.

## 5.2 Politična pravičnost

V okoljskih zadevah, je politična pravičnost pomembna, saj naj bi skozi sistemske in institucionalne ukrepe države, vsem državljanom zagotavljala enakopravnost in enakost v vseh pomembnih zadevah. Nekateri ukrepi, ki naj bi vodili do večje pravičnosti so: transparentnost delovanja sodnih in izvrševalnih vej oblasti, enakopravna obravnava vseh ljudi pred zakonom, dopustitev vseh zainteresiranih akterjev v enakopraven proces odločanja o vseh za ljudi pomembnih zadevah. Kljub dejstvu, da so ukrepi v zakonih navedeni, je njihova realizacija v praksi največkrat na ravni teoretičnih razglabljanj. Neupoštevanje argumentov nevladnih organizacij in okoljistov, proti dokazano negativnim posegom na okolje, naletijo na

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<sup>9</sup> PTE je okrajšava za Potencialno Toksične Elemente, oziroma v preteklosti težke kovine, ki so za okolja, naravo in ljudi v prekomernih količinah škodljive.

neodobravanje, nespoštovanje ali odkrito nasprotovanje politike. Primeri iz Zasavja (EKO Krog vs Lafarge) in trenutno »Jadar« v Srbiji kažejo, da s(m)o nekateri državljani zaradi dobičkov in povezav politike in kapitala, drugorazredni prebivalci, katerih interes po zdravem okolju se podreja interesu kapitala (največkrat tujega) in dobičkom.

### 5.3 Litijeve ionske baterije in proizvodnja litija

V zadnjih letih je zaradi proizvodnje električnih avtomobilov močno naraslo povpraševanje po litijevih ionskih baterijah. Litijeve-ionske baterije so se uveljavile zaradi velike energijske gostote, ki je pri električnih avtomobilih bistvena za povečanje dosega vožnje. Različne vrste litijevih ionskih baterij se med seboj razlikujejo po sestavi katode. Ta je sicer vedno sestavljena iz litijevih spojin, prisotne pa so tudi druge kovine. Anoda pa je vedno iz grafitu, z izjemo (LTO) baterije, kjer je anoda iz litijevega titanata. (Bhutada in sod., 2024; Dragonfly Energy, 2022). Litij je v obliki spojin je v majhnih količinah prisoten tako v vodah slanih jezer in mineralnih virov kot tudi v magmatskih kamninah. V kamninah je prisoten v obliki različnih mineralov, izmed katerih je najpomembnejši spodumen (Di Maria in sod.; 2022; Sharp, 1990; Royal Society of Chemistry, 2023).

Čeprav litij tudi prej ni bil tehnološko nepomemben element, pa sta se povpraševanje in posledično proizvodnja litija precej povečala z razvojem litijevih ionskih baterij. Tako je letna svetovna proizvodnja leta 2014 znašala 37.000 ton, v letu 2022 pa že 137.000 ton (Climate MIT in White-Nockleby, 2024; Sharp, 1990; Royal Society of Chemistry, 2023; U.S. Geological Survey; 2021). V letu 2021 je bilo več kot 70 % litija porabljen za izdelavo baterij (U.S. Geological Survey; 2021). Kljub temu, da se litij največ povezuje z avtomobilsko industrijo in e-avtomobilnostjo, najdemo katode iz litijevih in kobaltovih oksidov tudi v prenosnih računalnikih, mobilnih telefonih in digitalnih kamerah (Miao in sod., 2019).

Količina mineralnih snovi, ki jih potrebujemo za izdelavo baterije v e-avtomobilih, je odvisna od vrste in kapacitete baterije. Tako je za baterijo s kapaciteto 60 kWh kapacitete potrebnih 185 kg mineralnih materialov<sup>10</sup> (Chevy Bolt model

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<sup>10</sup> Od skupno 185 kg mineralov, odpade na anodo in porabljen grafit 52 kg, za katodo, ohišje in tokovne kolektorje, porabimo 35 kg aluminija, 29 kg niklja za katode, 20 kg bakra za tokovne kolektorje, 20 kg jekla za ohišja, 10 kg mangana za katode, 8 kg kobalta za katode, 6 kg litija prav tako pri katodah in 5 kg železa prav tako za katode.

avtomobilov). Čeprav je delež litija pri celotni teži baterij zelo majhen (3,2 % od 185 kg ali 6 kg), pa ima litij v baterijah bistveno vlogo. Njegove elektrokemične lastnosti omogočajo učinkovito shranjevanje in sproščanje energije (Lithium Harvest, 2024). Poleg litija, je za izdelavo baterij potrebna še vrsta drugih snovi mineralnega izvora, kot so aluminij, nikelj, baker, mangan, kobalt, železo oz. jeklo in grafit (Our World in Data, 2023; Žnidarič, 2023).

V svetovni proizvodnji litija prevladujejo Avstralija, Čile, Kitajska in Argentina. Težnje po zmanjšanju vplivov na okolje, ter proizvodnji »čiste« energije, pa so spodbudile potrebe po litiju tudi drugod po svetu. Svetovne rezerve litija se nahajajo v različnih državah. Med državami z največ rezervami najdemo poleg Čila (9.3 milijona ton) in Avstralije (6.2 milijona ton) tudi Argentino (3,6 milijona ton). Nasploh velja za največje nahajališče litija na svetu območje, imenovano tudi litijev trikotnik, ki sega na ozemlje treh južnoameriških držav: Čila, Argentine in Bolivije (Pistilli, 2024). Med tem ko Čile in Argentina ob Avstraliji in Kitajski sodita tudi med največje svetovne proizvajalke litija, pa so nahajališča v Boliviji zaenkrat praktično povsem neizkoriščena (Fawthrop, 2020). Medtem ko v litij v južnoameriških državah pridobivajo iz slanice, v Avstraliji iz rude, pa Kitajska izkorišča oba vira (Pistilli, 2024).

Zaradi velikega porasta povpraševanja se je izpostavil tudi interes za pridobivanje litija v Evropi. Med proizvajalkami litija je od evropskih držav do sedaj prisotna le Portugalska, pa še ta z zelo majhno proizvodnjo v primerjavi z vodilnimi proizvajalkami. Vendar zdaj tudi nekatere druge evropske države načrtujejo pridobivanje litija. Ocenjene rezerve kapacitet litija do leta 2030 v evropskih državah so prikazane v Tabeli 1 (Statista, 2024).

**Tabela 1: Ocenjene rezerve kapacitet litija za obdobje do leta 2030 v evropskih državah**

Država	Količina ocenjenih zalog (tone)
Francija	14.000
Španija	12.000
Srbija	11.000
Nemčija	9.000
Portugalska	9.000
Velika Britanija	7.000
Češka	5.000
Avstrija	2.000
Finska	2.000

Vir: Statista, 2024

Proizvodnja kovin za baterije (večinoma v uporabi za avtomobilsko industrijo) je v začetni fazi produkcije nekaterih kovin kot sta kobalt in litij, vprašljiva tako z ekološkega kot družbeno socialnega pogleda. Z ekološkega, zaradi porabljene energije in obremenjevanja okolja, iz družbeno socialnega pa zaradi izkoriščanja otrok in socialno ogroženih skupin pri produkciji nekaterih kovin (npr. pridobivanje kobalta v DR Kongu)<sup>11</sup>. Ob vse večjih vremenskih vplivih in pomanjkanju nekaterih virov kot je voda, je kritična tudi poraba sladke vode pri izkoriščanju litija iz slanice. Primer produkcije litija iz slanice v Južni Ameriki se za tono litija, porabi 2,2 milijona litrov sladke vode (Kalale, 2024).

Študija iz leta 2021 je pokazala, da se v primeru proizvodnje litija, tako iz slanice kot same rudnine, sproščajo večje količine ogljikovega dioksida. Na tono litija pridobljenega iz slanice se sprosti 11 ton ogljikovega dioksida, pri proizvodnji iz rude pa kumulativno kar 37 ton. Upoštevati je potrebno tudi neposredne vplive izpustov uporabljenih voda iz produkcije litija na okolje. Žveplove kisline in natrijev hidroksid, ki se uporabljata pri pridobivanju, lahko prodreta v zemljo in vodo, kjer zastrupljata ekosisteme, za živa bitja pa predstavljata neposredno grožnjo preživetja. Ogroženi so vodni viri podtalnice, uničijo se površine za rudarjenje, sama produkcija litija, pa po študiji The Wall Street Journala (2019 v Mining Technologies, 2024), povzroči 40 % celotnega podnebne vpliva, proizvodnje litij-ionskih baterij.

## 6 Zaključki in predlogi rešitev

Rešitve v smeri resnično zelenih tehnologij in ukrepov bodo morale biti v prihodnosti usmerjene v zagotovitev samooskrbnih sistemov in sprememb življenjskih navad, kar zahteva tehnološke, systemske in politične rešitve. Realizacije ukrepov pa uresničene ne samo na lokalnih področjih ampak tudi na globalnem nivoju. Brez ustrezne, skupne globalne politike, ki bo zagotavljala politično in ekološko pravičnost, ne moremo pričakovati izboljšanja razmer na Zemlji. Čeprav imamo v Evropi države, ki so kot Skandinavske trudijo vpeljati zelene koncepte v lastne ekonomije in družbo, so države še vedno izpostavljene posledicam obremenjevanj od zunaj. Primer izpostavljenosti Skandinavskih držav žveplovemu dioksidu (SO<sub>2</sub>) in posledično kislemu dežju, kot posledici izpustov SO<sub>2</sub> iz Velike

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<sup>11</sup> V Kongu se pri produkciji kobalta uporablja tudi otroška delovna sila, izkoriščajo slabo plačani delavci, ki v rudnikih delajo brez ustreznih zaščitnih sredstev.

Britanije<sup>12</sup>, je v preteklosti pokazal, da je potrebno reševati probleme na začetku pipe, torej pri izvoru in ob politični volji odločevalcev. Danes se še vedno prepogosto dogaja, da se politika udinja kapitalu, hkrati pa pozablja na temeljno pravico, da naj bi imel po Aarhuški konvenciji vsak državljan pravico do življenja v zdravem okolju.

Podobna zgodba kot se je dogajala glede problematike kislega dežja, se danes dogaja zaradi litija in e-mobilnosti. Obremenjevanja okolja, izkoriščanje delovne sile, prekomerna izraba virov pitne vode (pri proizvodnji litija iz slane) ali dodatna proizvodnja toplogrednih plinov, postavljajo pod vprašaj zeleno mobilnost. Električna mobilnost: proizvodnja litija in drugih kovin, ki jih potrebujemo za preskrbo v električnih avtomobilih za proizvodnjo baterij, bi za resnično zeleno mobilnost zahtevala tudi proizvodnjo energije za polnilne sisteme iz zelenih (OVE) virov. Šele ob sistemskih in tehnoloških rešitvah, ki bi zmanjšale porabo energije in neokoljske tehnološke procese v začetni fazi proizvodnje kovin za baterije, bi lahko govorili o zeleni energiji. Enak pomislek velja tudi za proizvodnjo hidroenergije, katere proizvodnja in negativni vplivi na okolje, naravo in ljudi, ni proizvodnja zelene energije.

## 6.1 Ukrepi za večjo okoljsko in politično pravičnost

Pomoč pri odločanju o ukrepih povezanih z rudarjenjem nam danes olajša sodobna informacijska tehnologija in dostop do informacij. Zato neokoljska in nedružbena ravnanja, ki so usmerjena proti ljudem in skupnostim, ne morejo dolgo ostati skrita. Prav informiranje o negativnih platih »razvoja«, je pomemben dejavnik v procesih umeščanja potencialno rizičnih objektov v prostor. Dopuščanje in sodelovanje tudi kritične javne sfere pri procesih odločanja, predstavlja pomemben dejavnik pri implementaciji morebitnih posegov v prostor. Nasprotno, pa omejevanje javnosti in zavajanje s pozicij moči, povzroča odpor med prebivalci potencialno izpostavljenih območij.

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<sup>12</sup> Primer iz VB in izpustov obremenjevanj iz njihovih termoelektrarn je pokazal, da so se omejitve izpustov realizirale šele ob pritiskih sosednjih držav in kritične znanstvene sfere. Dolgoletno dokazovanje posledic in omalovaževanje kritične znanstvene in civilne sfere, se tako kot v VB, dogaja še danes v primeru proizvodnje litija ali vpeljave umazanih tehnologij.

Glede na okoljsko in družbeno socialno stanje v globalnem in lokalnem okolju, kjer se neenakosti in nepravilnosti povečujejo, bi bilo potrebno ustaviti nebrzdano potrošništvo, zmanjšati porabo virov, ter se posvetiti lokalni prehranski in energetski samooskrbi. Za zmanjšanje neenakosti pa bo potrebno spremeniti družbene odnose iz prevladujoče neoliberalne paradigme v skupnostne projekte. Če se osredotočimo na produkcijo litija in postopkov za produkcijo in recikliranje po izrabi baterij, lahko glede na rezultate vplivov na okolje trdimo, da je proizvodnja le pogojno zelena. Zelena je le v vmesni fazi rabe baterij, medtem, ko sta začetna-produkcija kovin in končna, reciliranje odluženih baterij, neokoljska, neekološka in netrajnostna.

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# MIKROPLASTIKA IN BOLEZNI SRCA IN OŽILJA

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Plastični materiali se uporabljajo praktično na vseh področjih. Poleg mnogih koristi ima to dejstvo tudi vrsto negativnih posledic. Vzroki so pogosto v neustreznem ravnanju s plastičnimi odpadki, ki se kopičijo v naravi in pri tem tudi mehansko razpadajo na manjše delce. Glede na dimenzije delcev plastične odpadke delimo na makroplastiko, mezoplastiko in mikroplastiko. Mikroplastika je še posebno problematična, saj poleg okolja neposredno ogroža tudi človeško zdravje. Mikroplastika ne izvira samo iz plastičnih odpadkov, ampak so delci mikroplastike lahko namerno dodani nekaterim izdelkom, kot so kozmetični proizvodi, ali pa se delci mikroplastike sproščajo v okolje pri uporabi plastičnih predmetov, kot so posode, cevi ali embalaža živil. Delci mikroplastike lahko vstopijo v človeški organizem preko kože, dihal ali prebavnega trakta in se nato akumulirajo v različnih tkivih, tudi v krvi in obtočilih. Pričujoči prispevek obravnava probleme, ki so povezani z množično uporabo plastike, s poudarkom na vplivih mikroplastike na bolezni srca in ožilja.

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# MICROPLASTICS AND CARDIOVASCULAR DISEASE

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Plastic materials are used in almost every field today. This fact brings with it a number of problems in addition to its many advantages. The causes often lie in the improper management of plastic waste, which accumulates in nature and mechanically breaks down into smaller particles. Depending on the size of the particles, plastic waste is divided into macroplastics, mesoplastics and microplastics. Microplastics are particularly problematic as they are not only harmful to the environment but also to human health. Microplastics not only come from plastic waste, but microplastics are often deliberately added to certain products, such as cosmetics. Pieces of microplastics can also be released into the environment during the use of plastic products such as containers, pipes or food packaging. Microplastic fragments can enter the human body through the skin, respiratory tract or digestive tract and accumulate in various tissues, including blood and blood vessels. The topic of this paper is the problems associated with the mass use of plastics, with a particular focus on the impact of microplastics on cardiovascular diseases.



## 1 Uvod

Razvoj družbe, novih znanj, tehnologij in produktov, predvsem pa vztrajanje na potrošniški družbi, je imelo skozi različna časovna obdobja različne okoljske in družbeno socialne učinke. Na eni strani pozitivne, ki so se odražali skozi izboljšano zdravstveno oskrbo, omejitvami fizičnega in nevarnega dela, ter nad drugi strani številne negativne vplive. Med negativnimi vplivi na okolje in živa bitja ima pomembno vlogo iznajdba plastike.

Pod izrazom plastika ali plastični materiali pojmujeemo sintetične ali polsintetične polimere, ki so najpogosteje proizvedeni iz nafte. Plastični materiali vedno vsebujejo ogljik in vodik, lahko pa tudi atome drugih elementov (npr. klor). Poleg osnovnega polimera plastični materiali pogosto vsebujejo še razne dodatke (barvila, stabilizatorji, polnila itd.) (Helmenstine, 2020).

Plastične materiale glede na termične lastnosti delimo na termoplaste in duroplaste. Nekateri termoplasti imajo amorfno, drugi pa kristalinično strukturo. Za vse termoplaste pa je značilno, da se pri segrevanju stalijo, po ohladitvi pa se ponovno strdijo. Ta lastnost se tudi izkorišča pri oblikovanju izdelkov (Helmenstine, 2020). Duroplasti pa so amorfne snovi, pri segrevanju se ne stalijo in jih zato tudi ni mogoče preoblikovati s segrevanjem (Stecker Express, b.d.).

Plastične materiale delimo tudi glede na potek reakcije polimerizacije v dve skupini, na adicijske in kondenzacijske polimere. Med adicijske polimere sodijo polimeri alkenov ali njihovih derivatov (npr. polietilen, polipropilen, polivinilklorid), med kondenzacijske polimere pa poliestri ali poliamidi (Bettelheim in March, 1998).

### 1.1 Vloga plastike v vsakdanjem življenju

Lahek in multi uporaben produkt, ki ga danes najdemo vsepovsod, nam kroji vsakdanje življenje. Tako kot razvoj, pa zaradi neustreznega ravnanja po uporabi povzroča različne negativne učinke. Kljub temu, da je produkcija plastike enostavnejša kot na primer proizvodnja železa, hkrati pa ima plastika nizko težo in večjo uporabnost, igra pri njeni produkciji pomembno vlogo tudi cena. Ta po podatkih za leto 2024 znaša 1 euro za kilogram (Milliery, 2024), vendar je realna cena produkcije nedvomno precej višja. Zaradi njene cene in tehničnih lastnosti, je

plastika v uporabi široko razširjena in jo lahko najdemo v skoraj vseh napravah. Njena produkcija po podatkih združenih narodov vsako leto raste in znaša že več kot 400 milijonov ton (413, 8 milijona metričnih ton), pri čemer naj bi bilo recikliranih le okrog 10 % vse plastike, v sežigalnicah pa uničeno le okrog 12 % (UN, 2021 in Statista, 2024). Če primerjamo produkcijo v letu 1950, ko je ta znašala »le« 1,5 milijona ton in produkcijo v letih kasneje, lahko opazimo, da je produkcija skokovito rasla od leta 2002 in še vedno narašča. Uporabnost in cena sta pri širjenju plastike igrala pomembno vlogo, saj je plastika prisotna skoraj v vseh produktih, kjer so lahko s plastiko zamenjali kovinske dele. Pomembno je prisotna tudi v vsakdanjem življenju. Gospodinjski aparati, embalaža, medicinski pripomočki, avtomobilska industrija itd., so samo nekateri produkti in panoge v katerih je plastika prisotna.

## 2 Vplivi plastike na okolje in naravo

Multifunkcionalnost in dostopnost plastike ter (z ekonomskega pogleda) nizka cena v primerjavi z drugimi snovmi, povzročajo, da si danes brez uporabe plastike težko zamišljamo vsakdanje življenje. Toda njena uporaba, predvsem pa neustrezno tretiranje po koncu uporabnosti, povzroča številne negativne učinke v okolju in prostoru. Pravzaprav so določene lastnosti plastike, ki so pozitivne, dokler so plastični izdelki v uporabi, povzročajo težave, ko plastični izdelki odslužijo in postanejo odpadki. Tako je odpornost proti vlagi in mikroorganizmom, dokler je proizvod v funkciji, zaželena lastnost, saj prispeva k večji uporabnosti plastičnih izdelkov, a ravno ta lastnost postane zelo problematična, ko plastika postane odpadki.

V vodnem okolju prisotno plastiko pogosto delimo glede na velikost delcev. Večje kose plastike imenujemo makroplastika, majhne delce pa mikroplastika. Vendar pa je točna razmejitev nekoliko nejasna in se v različnih virih pogosto razlikuje. Prvotno so opredelili kot makroplastiko delce z dimenzijami nad 5 mm, manjše delce pa kot mikroplastiko (Betts, 2008; Fendall in Sewell, 2008). Vendar pa sta Gregory in Andrady predlagala nekoliko bolj podrobno klasifikacijo, saj kot gornjo mejo za mikroplastiko postavljata mejo 500  $\mu\text{m}$  (0,5 mm), medtem ko za nekoliko večje delce predlagata izraz mezoplastika (Gregory in Andrady, 2003, v Andrady, 2011). Med mikroplastiko sodi tudi nanoplastika, kjer gre za delce z dimenzijami med 1 nm in 1 000 nm oz. 1  $\mu\text{m}$  (Qin, 2024).

Pojavnost mikroplastike glede na mesto izvora obremenjevanja, lahko opredelimo kot primarni, oziroma sekundarni vir. Kot primarni vir lahko obravnavamo mikroplastiko, ki jo danes najdemo v produktih, ki vsebujejo mikrokroglice. Le te najdemo v zobnih pastah, pilingih, uporabljajo jih v kozmetiki (Andrady, 2017 v Kumar in sod., 2023). Drug, primarni vir predstavlja tako imenovani industrijski vpliv. Plastika se v tem primeru v okolje sprošča zaradi industrijskih procesov s prašnimi delci kot nosilci obremenil. V to skupino spadajo tudi obremenjevanja zaradi uporabe sintetičnih oblačil (Napper in Thompson, 2016). Za razliko od primarnih virov, predstavljajo sekundarni vir fragmentacije večjih oblik plastik, ki jih sonce, voda, mehansko valovanje ali UV žarki spreminjajo v manjše delce (Wright in sod., 2020). Najizrazitejši primer obremenitev predstavlja vodno okolje, saj se v oceanih, rekah in jezerih razgrajujejo enormne<sup>1</sup> količine odvržene plastike. Po podatkih Evropske komisije (2024) samo v Sredozemlju konča dnevno 730 ton odpadkov. Vsako minuto pa v oceanih konča 1 milijon plastičnih vrečk (Brittany Ferries & Condor Ferries, 2024).

Analize obremenjenosti voda, so pokazale da je plastika prisotna tudi v najglobljih predelih oceanov. V oceanih po podatkih Eriksena in sodelavcev (2013) zaradi pomanjkanja ustreznega ravnanja z odpadki plava več kot 250.000 ton kosov plastike. Samo obalne države, so v letu 2010 v oceane izpusile do 12,7 milijona metričnih ton plastike (Jambeck in sod. 2015). Med desetimi največjimi obremenitvami v morjih, predstavlja plastika za enkratno uporabo največjo obremenitev s kar 86 %, oziroma 43 % vseh odpadkov v morju (Evropski parlament, 2024). Za morske živali in druge manjše organizme, predstavlja plastika neposredno težavo kadar jo zamenjajo za hrano. Zaužitje plastike pa pogosto tudi zaradi mehanskih in fizičnih vplivov na žive organizme, vodi v njihovo umiranje. Pomemben, posredni vpliv ima kontaminacija s plastiko prek prebavnega trakta, na živali vključno s človekom, ki se s kontaminiranimi organizmi iz vode prehranjujejo (Evropski parlament, 2024). Na trofičnih ravneh<sup>2</sup> so plastiko in mikroplastiko odkrili v različnih organizmih, od planktona in nevretenčarjev, do rib in sesalcev (Derraik, 2002; Rochman et al., 2013).

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<sup>1</sup> 5,25 trilijona delcev makro in mikro plastik se nahaja v oceanih. Na vsakem kvadratnem kilometru oceanov, se nahaja 46.000 kosov ali skupno 269.000 ton (Brittany Ferries, 2024).

<sup>2</sup> Trofična raven, je pojem, ki ponazarja prehranjevalno strukturo v ekosistemu in je povezana z dvema poglavitnima načinoma prehranjevanja organizmov. Elemente trofične strukture delimo na tri skupine organizmov; producente, konzumente in razkrojvalce.

Plastiko v različnih oblikah in velikostih, zaradi neustreznih ravnanj po uporabi, ne najdemo samo v morjih in morskih organizmih, temveč tudi v zemljinah, zraku ter hrani. Raziskave (v zadnjem obdobju), so pokazale njeno prisotnost (mikro delci), tudi v virih pitne vode. V raziskavah vzorcev pitne vode iz pip so ugotovili, da 81 % le teh vsebuje 5,45 mikroplastičnih delcev na liter vode. Še kritičnejši je podatek o mikroplastiki iz ustekleničene vode, saj se je na 19 lokacijah po vsem svetu, pri 11 vodilnih blagovnih znamkah distributerjev vode, v 93 % pokazalo, da vode vsebujejo povprečno 10,4 plastične delce na liter vode (Kumar in sod., 2023). Prisotnost delcev mikroplastike so ugotovili v morski hrani, medu, mleku, pivu in kuhinjski soli (Prattichizzo in sod., 2024).

Za razliko od večjih kosov plastike, ki povzročajo predvsem mehanske poškodbe morskih živali (zapletanja, ureznine, zadušitve), pa imajo delci mikroplastike podobne dimenzije kot plankton in vstopajo v prehransko verigo. Tako se mikroplastika prenaša od nižjega do višjih členov prehranjevalne verige in končno tudi do človeka. Toksične snovi v mikroplastiki so (Andrady, 2011):

- Rezidualni monomeri, ki preostanejo od izdelave, ali pa toksični aditivi
- Toksični produkti, ki nastanejo zaradi delne razgradnje polimerov
- Obstojni organski onesnaževalci (pogosto označeni s kratico POP, ki izvira iz angleškega izraza *persistant organic pollutants*). To so toksične organske snovi, ki so običajno v morski vodi zaradi slabe topnosti prisotne v nizkih koncentracijah, ker pa so v organskih snoveh mnogo bolje topijo, se zato intenzivno akumulirajo v delcih mikroplastike.

V zraku pa jo lahko pripišemo virom, kot je obraba plastičnih izdelkov. Kritična je obremenitev prahu, ki vsebuje delce mikroplastike, saj se zaradi atmosferskega transporta lahko ti delci prenašajo tudi na večje razdalje. (Dris et al., 2016; Zhang et al., 2019).

### 3 Škodljivi vplivi plastike na človeški organizem

Človek je tako kot pri drugih obremenjevanjih, vplivu plastike izpostavljen na več načinov. Delci mikroplastike lahko vstopajo v organizem skozi kožo, preko dihalnih poti ali skozi prebavni trakt s hrano ali pijačo. Čeprav so vplivi plastike na žive organizme trenutno v zdravstvu še vedno premalo izpostavljeni, lahko skozi študije

iz tujine zatrdimo, da ima plastika, predvsem mikro in nano velikosti, velik vpliv na žive organizme in s tem tudi na človeka. Glede na mesto prisotnosti v živih organizmih in agregatno stanje, delci plastike ob dolgoročni izpostavljenosti pri človeku škodljivo vplivajo na različne organe, hkrati pa predstavljajo pomemben dejavnik zdravstvenih tveganj. Izpostavljenost plastiki ima pri človeku vpliv na težave prebavnega trakta, dihal; vpliv se kaže tudi skozi poudarjene dermatološke pojave in nenazadnje tudi težave v krvožilnem sistemu, ki mu je v pričujočem prispevku posvečeno največ pozornosti.

Posamezni matematični modelni izračuni dajo sicer nekoliko različne ocene glede vnosa trdnih delcev v organizem, npr. en model med 74.000 in 121.000 delcev na osebo letno, drugi model pa med 39.000 in 52.000 delcev na osebo letno. Glede posameznih živil oziroma pijač pa je ocena prispevkov npr. za morsko sol do 1000 delcev, za vodo iz pipe 4000 delcev in za školjke 11.000 delcev (Prattichizzo in sod., 2024).

V človeškem tkivu so ugotovili več kot deset različnih vrst sintetičnih polimerov, med najpogostejše pa sodijo polietilen, polivinilklorid, polietilentereftalat, polipropilen in polistiren, ki so tudi sicer najpogosteje uporabljani plastični materiali. Iz teh materialov je zelo pogosto izdelana embalaža hrane, pijače in kozmetičnih izdelkov pa tudi vodovodne cevi (Prattichizzo in sod., 2024).

Prisotnost plastičnih delcev so zaznali praktično v vseh tkivih človeškega organizma, vendar pa so do sedaj ugotovljene povezave med prisotnostjo plastičnih delcev in obolenji skoraj izključno omejene na srce in ožilje. Edini doslej znani izjemi so jetra in črevesje (Prattichizzo in sod., 2024).

Tako so prisotnost delcev mikro in nanoplastike našli v jetrih pacientov s cirozo, ne pa tudi v jetrih zdravih ljudi (Horvatits in sod., 2022). Prisotnost plastičnih delcev v izločkih bolnikov z vnetnimi obolenji črevesja je bila višja kot pa pri zdravih ljudeh (Yan in sod., 2022).

### **3.1 Mikroplastika in srčno-žilne bolezni**

Rezultati raziskav potrjujejo, da delci mikro- in nanoplastike lahko vstopajo v celice človeškega organizma in povzročajo vrsto procesov, povezanih z boleznimi srca in ožilja. Tovrstni procesi so (Prattichizzo in sod., 2024):

- Oksidativni stres
- Celično staranje
- Zlepjanje krvnih ploščic (trombocitov) in
- Nizka stopnja vnetnih procesov.

Precejšnje število raziskav je bilo doslej opravljeno v laboratoriju (in vitro) ali pa na živalih. Pri teh raziskavah je bil kot polimer večinoma uporabljen polistiren. Pri raziskavah na živalih je bil polistiren dodan z zaužitjem v relativno visokih odmerkih, zato se pojavlja vprašanje, v kolikšni meri je mogoče zaključke teh raziskav neposredno prenesti tudi na ljudi (Prattichizzo in sod., 2024).

Srce in ožilje sta izpostavljena vsem snovem, ki so prisotne v krvnem obtoku. Več raziskav je potrdilo tudi prisotnost delcev mikro in nanoplastike v ex-vivo vzorcih iz človeškega srčno-žilnega sistema.

Epidemiološka študija iz leta 2024 (Duk-Hee, 2024) je pokazala, da so osebe pri katerih je bila v plakih ugotovljena prisotnost mikroplastike, za 4,5 krat bolj izpostavljene tveganju za miokardni infarkt, možgansko kap ali umrljivost kot tisti, ki plastiki niso bili izpostavljeni.

Marfella in sod. (2024) so opravili raziskavo o povezavi med prisotnostjo mikroplastike v plakih (ateroskleroznih oblogah na stenah arterij) iz karotidnih arterij in srčno-žilnih zapletih (srčni infarkt, možganska kap). Vzorce tkiva iz plakov so odvzeli pri pacientih z asimptomatično stenozo karotidnih arterij s postopkom endarterektomije (kirurške odstranitve ateromatoznega tkiva t.j. tkiva obloge na žilni steni). V vzorcih tkiva so nato preverjali prisotnost plastičnih delcev z uporabo vrste različnih metod: elektronske mikroskopije, pirolize, plinske kromatografije, masne spektrometrije in analize stabilnih izotopov. Po odvzemu vzorcev tkiva so nato v obdobju  $33,7 \pm 6,9$  meseca spremljali zdravstveno stanje pacientov (Marfella in sod., 2024).

Izmed 257 oseb, ki so sodelovale v raziskavi, pri 107 osebah (41,6 %) v vzorcih tkiva niso ugotovili prisotnosti delcev mikro- ali nanoplastike, pri 150 osebah (58,4 %) so ugotovili prisotnost polietilena v povprečni vrednosti  $21,7 \pm 24,5$   $\mu\text{g}/\text{mg}$  tkiva plaka, ter pri 31 osebah (12,1 %) prisotnost polivinilklorida v povprečni vrednosti  $5,2 \pm 2,4$   $\mu\text{g}/\text{mg}$  tkiva. Elektronska mikroskopija je pokazala, da se med penastimi celicami



makrofagov in amorfnim materialom plaka nahajajo delci z nazobčanimi robovi. Pri teh delcih gre očitno za tujke, ki niso biološkega izvora, najverjetneje za plastične delce. V nekaterih izmed teh delcev so ugotovili tudi prisotnost klora. V primeru prisotnosti plastičnih delcev v plaku so opazili tudi povečane vsebnosti vnetnih faktorjev interlevkina-6, interlevkina-18, interlevkina-1 $\beta$  in tumorskega nekroznega faktorja (TNF  $\alpha$ ) (Marfella in sod., 2024).

V nadaljnji fazi raziskave so preverjali povezavo med prisotnostjo plastičnih delcev v plakih in srčno-žilnimi zapleti (srčni infarkt brez smrtnega izida, možganska kap brez smrtnega izida, naravna smrt zaradi kateregakoli vzroka) v obdobju 33, 7  $\pm$  6,9 meseca. Pri 107 osebah brez zaznane prisotnosti plastičnih delcev v plakih so v obdobju opazovanja zabeležili 8 zapletov (7,5 % ali 2,2 dogodka na 100 pacientov-let). Pri 150 osebah z zaznano prisotnostjo plastike v plakih pa je v obdobju opazovanja prišlo do 30 zapletov (20 % ali 6,1 dogodka na 100 pacientov-let). Iz navedenega je mogoče sklepati, da imajo pacienti s prisotnostjo delcev plastike v plakih večje tveganje za pojav srčno-žilnega zapleta in tudi za smrt kot pa tisti brez prisotnosti plastike (Marfella in sod., 2024).

Liu in sod. (2024) so analizirali prisotnost plastike v vzorcih iz plakov, odvzetih iz karotidnih in koronarnih arterij ter vzorcih tkiva iz aorte. V vzorcih iz plakov je bila vsebnost plastičnih delcev bistveno višja kot pa v tkivu iz aorte, kjer ni bilo prisotnih plakov. To nakazuje na dejstvo, da se plastični delci prednostno nabirajo v ateroskleroznih oblogah (Liu in sod., 2024).

Prisotnost devetih različnih sintetičnih polimerov so ugotovili tudi v različnih delih srca (moikardij, epikardij, perikardij, perikardijsko adipozno tkivo, levi atrijski privesek)(Yang in sod. (2023), medtem ko so v tkivu iz safenozne vene zaznali prisotnost petih različnih polimerov (Rotchell in sod., 2023).

Prisotnost plastičnih delcev so ugotovili tudi v možganih, odvzetih po avtopsijah. Koncentracije delcev plastike v možganih so bile višje kot pa v vzorcih iz ledvic in jeter (Campen in sod., 2024).

Plastične delce so našli tudi v krvnih strdkih pri arterijski disekciji (Wu in sod., 2023) ali pa v strdkih odvzetih po srčnem infarktu, možganski kapi in trombozi globokih ven (Wang in sod., 2024). Ugotavljajo tudi povezavo med koncentracijo plastičnih delcev in resnostjo obolenj.

Opažena je bila tudi povezava med prisotnostjo plastičnih delcev v črevesju in obolenji ožilja, saj so pri pacientih s kalcifikacijo torakalne aorte ugotovili višje koncentracije plastičnih delcev v blatu kot pa pri zdravih ljudeh (Yan, 2023).

Rezultati vseh navedenih študij kažejo na to, da vnos delcev mikroplastike in nanoplastike v organizem igra vlogo pri razvoju ateroskleroznih obolenj, a je za potrjevanje vzročnih povezav potrebno opraviti še vrsto nadaljnih raziskav (Prattichizzo in sod., 2024).

#### 4 Rešitve za odpravo posledic rabe plastike v vsakdanjem življenju

Zaradi vsesplošne uporabe plastike v vsakdanjem življenju, nizkih cen, industrije in delovnih mest, so rešitve za vplive plastike v okolju in vsakdanjem življenju, kompleksne. Rešitve, ki bi zadovoljile tako industrijo, zaposlene, uporabnike in omejile vplive na naravo in okolje, bi morale zajeti koncept reflektivne ekološke modernizacije. Ta sloni na spremembi tehnoloških procesov, spodbujanju industrij v okoljsko in ekološko sprejemljivejše postopke ob vključitvi vseh akterjev v prostoru k oblikovanju ustreznih in za vse vpletene, konsenzualno sprejetih rešitev. Rešitve bi morale zajeti;

- spremembe polisi
- tehnološke izboljšave v smeri več uporabnosti produktov
- spremembe potrošniških navad
- ustrezno ravnanje z odpadki
- prehod na druge materiale

Plastika je zaradi količine obremenitev v oceanih, vodah, zemljinah, globalni problem. Zato bi morale polisi držav strmeti k njeni manjši produkciji in rabi v vsakdanjem življenju. Materiali obstajajo, vendar so v primerjavi s ceno plastike občutno dražji, kar omejuje njihovo splošno rabo. Zaradi usmerjenosti industrij v

maksimiranje dobičkov, bi moral biti prehod iz plastike na druge vire subvencioniran. Delno s strani države, delno bi morale strošek prehoda kriti neposredni proizvajalci- industrija, zaradi njihovih posrednih in neposrednih vplivov na negativne okoljske in družbene posledice. Za lažji prehod v okoljsko sprejemljivejše tehnologije in postopke, bi morala biti skrb za okolje in družbo, s strani države in pristojnih služb, predstavljena kot nova poslovna priložnost. Prehod na čistejše produkte, pa korak k večji konkurenčnosti, saj se vse več ljudi odloča za nakup ekoloških ali okoljsko prijaznih produktov.

Za prehod in zmanjšanje vplivov plastike v prostoru, bi morale na globalni ravni politiki držav, sprejeti ukrepe za prehod iz plastike na druge, za okolje, naravo in ljudi manj obremenjujoče materiale, ki bi jih v začetnem obdobju subvencionirale. Države bi morale poskrbeti za delavce in transformacijo njihovih delovnih mest ter socialni in ekonomski status na način, kot se je to ustrezno reševalo na področju rudarstva (samozaposlitve, prekvalifikacije, odpravnine).

Strategija podjetij bi morala biti usmerjena v izdelavo produktov, ki bi bili trajnostno naravnani, večkratno uporabni in se lahko v končni fazi večkratno reciklirajo. V prehodnem obdobju, do prehoda na izdelavo produktov iz naravnih materialov, bi morali biti tehnološki sistemi prirejeni na način izdelave plastike, ki bi imela s pogleda obremenjevanj, okoljsko čim manjše vplive zaradi morebitne razgradnje.

Rešitve, bi morale zajeti tudi spremembe miselnih vzorcev potrošnikov. Zaradi nizkih cen predvsem splošno uporabnih produktov, kot so nosilne vrečke, plastični lončki itd., se je v preteklosti v odpadkih, tudi nerekiclriranih, nabralo na milijone ton odpadnih izdelkov. Potrošniki bi v kontekstu rabe plastičnih materialov, morali narediti korak nazaj. V preteklosti se je namesto plastike uporabljalo steklo, les. Tudi materiali niso bili vezani na število klikov ali časovno obdobje. Z večjo kvaliteto materialov bi se podaljšal rok uporabnosti osnovnih produktov, ki bi po eni strani zmanjšal izdelavo novih in s tem potencialno negativnih vplivov na okolje in živo ter neživo naravo.

Sežiganje, sicer druga najslabša možnost ravnanja z odpadki takoj za odmetavanjem v prostor, je vprašljiva, saj producira dodatne obremenitve, če tehnološki sistemi v pečeh niso ustrezno konstruirani in izpusti v prostor urejeni z ustreznimi filtrirnimi sistemi. Rešitev problema plastičnih odpadkov, mora zato vsebovati koncept *na*

začetku pipe in ne na koncu. Ob manjši uporabi, bi bilo potrebno tudi sankcioniranje neokoljskih praks, še prej pa saniranje obstoječih posledic.

## 5 Zaključek

Najlažje je uporabo plastike prepovedati. Ta rešitev bi bila najhitrejša in najučinkovitejša, vendar bi na drugi strani pomenila izgubo delovnih mest. Samo v Evropi industrija zaposluje 1,6 milijona ljudi v 60.000 podjetjih (Plastics Europe, 2021). Globalno pa se ocenjuje, da je v panogi zaposlenih več deset milijonov ljudi. Nekaj milijonov neposredno, v podjetjih za reciklažo, pa je samo v Indiji zaposleno več kot 1,5 milijona ljudi. Kljub dobičkom in zaposlitvam, so problemi zaradi rabe plastike, predvsem pa neustreznih ravnanj po uporabi v okolju, prostoru, naravi in posledično na ljudeh tako veliki in kompleksni, da zahtevajo ukrepanje. Zamenjavo plastike z drugimi manj okoljsko spornimi materiali, je kompleksen problem, vendar zaradi vseh negativnih posledic v prostoru, nujen in potreben.

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# DINAMIČNI MEDSEBOJNI VPLIV TEHNOLOŠKIH INOVACIJ NA TRAJNOSTNO PROIZVODNJO IN EKOLOŠKE SLEDI

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Obravnavamo vpliv tehnoloških inovacij pri oblikovanju trajnostne proizvodnje in vrednotenju ekoloških sledi v Sloveniji, ob prepoznavanju potrebe po bolj kritičnem vrednotenju vpliva trajnostne proizvodnje na vrednotenje ekoloških sledi (vplivov na okolje). Povečana raba naravnih virov in gospodarska rast povečujeta ekološke sledi, tehnološke inovacije pa prispevajo k zmanjševanju negativnih vplivov na okolja. Slovenija na področju inovativnosti dosega inovacijski indeks 84,9% (2020) in želi doseči do leta 2030 vrednost 110% glede na povprečje EU. Kazalec ekoloških sledi Slovenije leta 2020 je 4,78 gha kar je 102,7% povprečja EU in po letu 2008 upada in šibko nakazuje potrditev hipoteze okoljske Kuznetsove krivulje. Ocenjujemo, da raziskave tega področja ne dajejo točnih rezultatov (manjka preučevanje socialnega okolja), ob upoštevanju dejstva, da vsaka aktivnost usmerjena v rabo virov in tehnološke inovacije lahko bistveno spremeni ekološke sledi. Naše ključne ugotovitve vodijo k zavedanju pomena inovacij za doseganje trajnostne proizvodnje in posledično k zmanjševanju ekoloških sledi.

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# DYNAMIC INTERACTIONS OF TECHNOLOGICAL INNOVATIONS ON SUSTAINABLE PRODUCTION AND EF

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We discuss the impact of technological innovations in shaping sustainable production and assessing ecological footprints in Slovenia, recognizing the need for a more critical assessment of the impact of sustainable production on the assessment of ecological footprints (impacts on the environment). Increased use of natural resources and economic growth increase ecological footprints, while technological innovations contribute to reducing negative environmental impacts. Slovenia achieves an innovation index of 84.9% (2020) in the field of innovation and aims to achieve a value of 110% by 2030 compared to the EU average. Slovenia's ecological footprint indicator in 2020 is 4.78 gha, which is 102.7% of the EU average and has been declining since 2008, weakly indicating confirmation of the hypothesis of the environmental Kuznetsov curve. We estimate that research in this area does not provide accurate results (the study of the social environment is missing), taking into account the fact that any activity aimed at resource use and technological innovation can significantly change ecological footprints. Our key findings lead to an awareness of the importance of innovation for achieving sustainable production and, consequently, reducing ecological footprints.





## 1 Uvod

Inovacije so gonilna sila za omogočanje trajnostne proizvodnje. Intenzivna proizvodnja v predelovalnem sektorju je vir velikih pritiskov na okolje, zato je potrebno takšen pristop spremeniti in sprejeti omejitve virov in okolja ter pri razvoju upoštevati tudi socialne koristi.

Razvoj tehnoloških inovacij in vpliv podnebnih sprememb, skupaj z novim gospodarskim, političnim in družbenim kontekstom, kažejo na potrebo po prožnih proizvodnih sistemih, ki olajšajo in pospešijo razvoj trajnostnih pobud, ki so lahko posledica upoštevanja načel trajnostne proizvodnje (Dwivedi, 2021).

Določitev jasnih ciljev pri določanju definicije trajnosti moti odločevalce v podjetjih, ki so tradicionalno osredotočeni na merjenje ekonomskih rezultatov (Henao, 2022). Rast novih tehnologij, povezanih z znanostjo o podatkih, bi lahko vodila k uporabi merilnih tehnologij in določiti obvladljiv nabor kazalnikov.

## 2 Kazalci trajnostne proizvodnje

Kazalci trajnostne proizvodnje razdelimo v tri nivoje (tabela 1). Vsi, razen emisije odpadne vode, izpustov v zrak in odlaganje odpadkov, so pozitivni. Vrednost podatke za večje statistično obdelane opazovane sisteme lahko črpamo iz statističnih podatkov SURSa, na manjših opazovalnih skalah pa iz letnih poročil podjetij.

Glede na stopnjo inovativnosti in razvoja proizvodnje na državnem nivoju lahko kazalce trajnostne proizvodnje razvrstimo po šestih področjih (Quan, 2021). Prikazujemo jih v tabeli 1.

- Inovacije so gonilna sila pri trajnostni proizvodnji, spremljamo investicije v inovacije in njihove rezultate.
- Intenzivnost rabe virov je primarni kazalec trajnostne proizvodnje, upoštevamo omejitve rabe virov in učinkovitost rabe virov ter tudi učinkovitost investicij, dela in energije.
- Posodabljanje proizvodnje povezujemo s preходом na trajnostno proizvodnjo z vključitvijo trajnostnih izdelkov in storitev.

- Spremljanje in optimizacija koristi v ekonomskem, socialnem in ekološkem okolju.
- Spremljanje vplivov v okolju, kot so emisije odpadne vode, izpustov v zrak in odlaganje odpadkov.
- Prosta trgovina, spremljanje celotne oskrbovalne verige s pogleda proste trgovine in tujih naložb.

**Tabela 1: Kazalci trajnostne proizvodnje**

	1. nivo	2. nivo	3. nivo	Izračun kazalca
1	Inovacije	Vlaganje v inovacije	Investicijska intenzivnost raziskav in razvoja	Število zaposlenih v industrijskih raziskavah in razvoju
			Talenti	Število zaposlenih v proizvodnji
			Investicijska intenzivnost raziskav in razvoja	Izdatki za industrijske raziskave in razvoj / BDP
		Rezultati vlaganj v inovacije	Število patentov / Zaposlenega	Število patentov / Število apliciranih patentov
			Število novih izdelkov / Zaposlenega	Prihodek od novih industrijskih izdelkov / Celoten prihodek
		Učinkovitost kapitala	Produktivnost kapitala	Dodana vrednost / Skupna naložba v proizvodnjo – osnovna sredstva
2	Intenzivnost rabe virov	Učinkovitost dela	Produktivnost dela	Dodana vrednost / Zaposlenega
		Učinkovita raba energije	Energetska produktivnost	Dodana vrednost / Porabo energije
		Učinkovita raba površine	Pozidana površina	Dodana vrednost / Pozidano površino
		Posodabljen izdelkov	Število posodobitev izdelka	Število posodobljenih izdelkov
3	Posodabljanje je proizvodnje	Posodabljen podjetja	Uvajanje novih tehnologij	Vlaganje v nove tehnologije / Celoten prihodek
			Vlaganje v raziskave v podjetju	Vlaganje v raziskave in razvoj / Celoten prihodek
		Ekonomске koristi	Dobiček	Dobiček / Zaposlenega
4	Spremljanje in optimizacija koristi	Socialne koristi	Vlaganje v lokalno skupnost – Plačilo davkov	Vlaganje v lokalno skupnost / Zaposlenega
		Okoljske koristi	Z4t življenjski krog izdelka	Delež recikliranih surovin
		Emisije v vode		Emisije/ dodano vrednost
5	Spremljanje vplivov v okolju	Emisije v zrak		Emisije/ dodano vrednost
		Odlaganje odpadkov		Vrednost tujih naložb / vrednost lastnih naložb
6	Prosta trgovina	Tuje naložbe	Odvisnost od tujih naložb	Vrednost tujih naložb / Vrednost lastnih naložb
			Odvisnost od uvoza	Vrednost uvoza / Vrednost proizvodnje
			Odvisnost od izvoza	Vrednost izvoza / Vrednost proizvodnje

Vir: Quan, 2021

### 3 Inovacije

Inovacije pomembno prispevajo k reševanju ključnih družbenih izzivov, kar je tudi opredeljeno v devetem cilju trajnostnega razvoja (SDG9, United Nation, 2025). Razvoj novih tehnologij, skrajševanje življenjskega cikla izdelkov in naraščajoča globalna konkurenca povečujejo pomen inovacij, ne le za prihodnjo rast podjetij, temveč tudi za dvig konkurenčnosti podjetij in njihovo uspešno rast na dolgi rok ter zmanjšanju pritiskov na okolje.

V obdobju 2018–2020 je bilo inovacijsko aktivnih 55 % podjetij, registriranih v Sloveniji (tabela 2). V primerjavi s prejšnjim obdobjem so bila podjetja bolj inovacijsko aktivna, uvedla so več inovacij poslovnega procesa in manj inovacij proizvodov (Inovacijska dejavnost v industriji in izbranih storitvenih dejavnostih, 2018–2020).

**Tabela 2: Inovacijsko aktivna in inovativna podjetja, 2018–2020** Vir: SURS

	Skupaj	Mala in srednje velika podjetja	Velika podjetja
Inovacijsko aktivna podjetja	2715	2547	168
Podjetja, ki so razvila inovacijo proizvoda	1788	1648	140
Podjetja, ki so razvila inovacijo poslovnega procesa	2114	1970	143

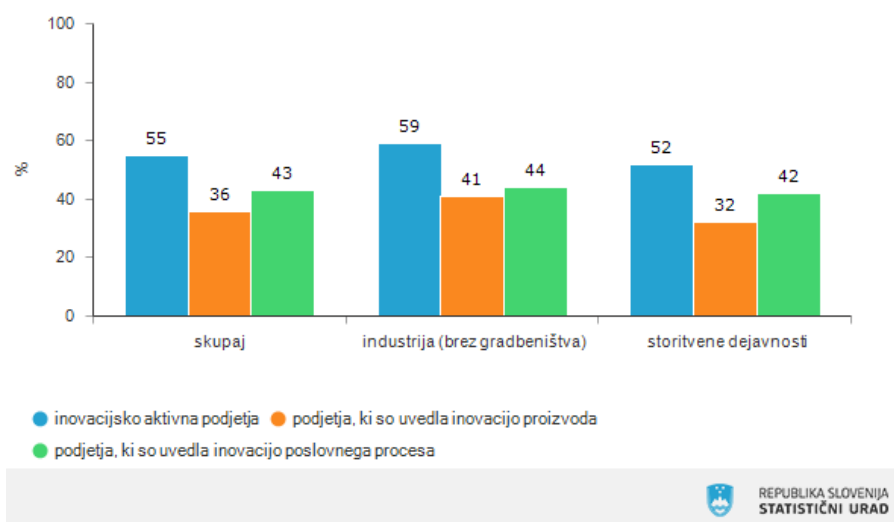
Vir: SURS

V primerjavi z obdobjem 2016–2018 so podjetja uvedla za 0,2 % manj inovacij proizvodov in za 16 % več inovacij poslovnega procesa. Velika podjetja so vpeljala za 4 % manj inovacij in za 4 % več inovacij poslovnega procesa, 17 % več inovacij poslovnega procesa so uvedla tudi mala in srednje velika podjetja.

Velika podjetja pri raziskovalno-razvojni dejavnosti (RRD) in drugih inovacijskih dejavnostih bolj sodelujejo z drugimi kot mala in srednje velika, 15 % inovacijsko aktivnih podjetij je pri RRD in drugih inovacijskih dejavnostih sodelovalo z drugimi podjetji ali organizacijami. Med velikimi podjetji je bilo takih 59 %, med malimi in srednje velikimi podjetji pa 13 %. V primerjavi s prejšnjim obdobjem so velika podjetja na tem področju za 4 % manj sodelovala z drugimi, mala in srednje velika

pa za 5 % več (Inovacijska dejavnost v industriji in izbranih storitvenih dejavnostih, 2018–2020).

Delež inovativnih in inovacijsko aktivnih podjetij je bil tudi v tem opazovanem obdobju nekoliko večji med podjetji, registriranimi za predelovalne dejavnosti, kot pa med podjetji v izbranih storitvenih dejavnostih. Inovacijsko aktivnih je bilo 59 % podjetij, registriranih za predelovalne dejavnosti; inovacijo proizvoda jih je uvedlo 41 % in inovacijo poslovnega procesa 44 %. Med podjetji, registriranimi v izbranih storitvenih dejavnostih, je bilo 52 % inovacijsko aktivnih, 32 % jih je uvedlo inovacijo proizvoda in 42 % inovacijo poslovnega procesa (slika 1).



Slika 1: Inovacijsko aktivna podjetja po dejavnosti podjetja, 2018–2020

Vir: SURS

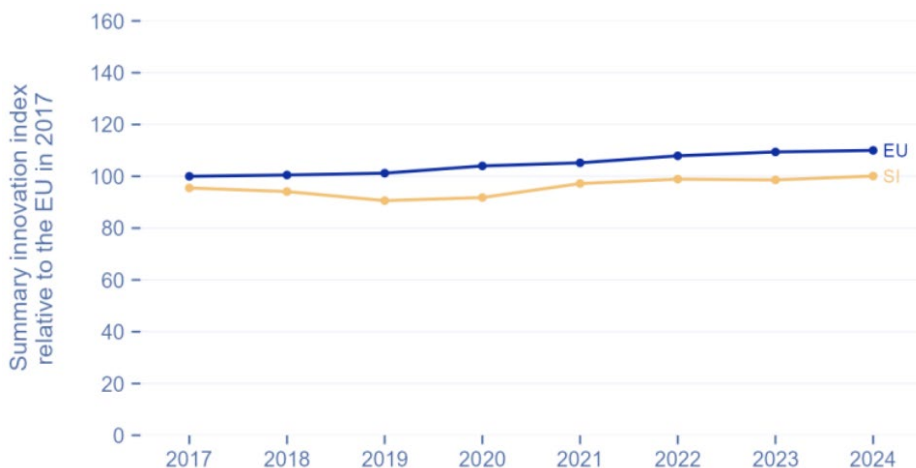
Za področje ustvarjalnega razvoja je kot ključni kazalnik izbran inovacijski indeks, ki vključuje različne vidike ustvarjalnosti in inovativnosti vrednosti kazalnika v primerjavi z EU prikazujemo v tabeli 3.

Slovenija je zmerna inovatorica z uspešnostjo 91 % povprečja EU leta 2024 (slika 2). Uspešnost je nad povprečjem zmernih inovatorjev (84,8 %). Uspešnost se povečuje manj kot v EU (+10 %) (European Innovation Scoreboard 2024 Country profile Slovenia).

Tabela 3: Inovacijski indeks (glede na razvitost EU)

	Zadnji znani podatek	2030, cilj
<b>Inovacijski indeks (glede na razvitost EU)</b>	<b>84,9 % (2020)</b>	<b>110,00%</b>
Število veljavnih nacionalnih znamk	24.599 (julij 2020)	26.000
Število raziskovalcev v poslovnem sektorju	8.285 (2018)	12.000
Delež inovacijsko aktivnih podjetij	48,6 % (2016–2018)	55,00%
Vključenost v podjetništvo (% od populacije)*	7,8 % (2019)	10,00%
Zaznavanje poslovnih priložnosti (% odraslega prebivalstva v starosti od 18 do 64 let)*	3,6 % (2019)	4,00%
Zaznavanje poslovnih priložnosti (% odraslega prebivalstva v starosti od 18 do 64 let)*	47,6 % (2019)	55,00%
Število hitro rastočih podjetij v zadnjih petih letih	5.347 (2014–2018)	7.000 (2026-2030)
Delež zaposlenih v kreativni ekonomiji (glede na vse zaposlene)	7 % (2017)	10%
Bruto dodana vrednost na zaposlenega v KKS (BDV)	45.527 EUR (2017)	5 % nad povprečjem v RS

Opomba: GEM (kazalniki, označeni z \*, se nanašajo na metodologijo GEM), European Innovation Scoreboard 2019, Ajpes, Statistična analiza stanja KKS v Sloveniji 2008–2017, Tm View, napovedi: Analitika GZS, URSIL, Vir: Slovenska industrijska strategija 2021–2030



Slika 2: Sumarni indeks inovativnosti

Vir: European Innovation Scoreboard 2024 Country profile Slovenia

## 4 Ekološke sledi

Izračun ekoloških sledi temelji na naslednjih predpostavkah:

- da je mogoče slediti snovnim in energijskim tokovom v nekem sistemu, vključno s količinami odpadkov, ki pri porabi in pretvorbah nastajajo,
- za večino surovin in odpadkov, ki pri njihovi uporabi nastanejo lahko njihove količine z upoštevanjem tehnologij črpanja, uporabe in odlaganja izrazimo s površino prostora, ki je potrebna, da so ti tokovi stalni,
- surovine za katere ne moremo določiti toka porabe in odpadkov ne vključujemo v izračun ekoloških sledi,
- da v primeru dvomov izberemo najbolj previdno oceno ekoloških sledi, to je tisto, ki nam da največjo vrednost,
- da pri izračunu ekoloških sledi ne upoštevamo aktivnosti ljudi, za katere trenutno ni zadovoljivih podatkov,
- pri analizah ne upoštevamo aktivnosti, ki nepopravljivo uničujejo okolje (izsuševanje vodonosnikov, golosek,...) ali raba snovi, ki se v okolju ne razgradijo (plutonij, PCB, CFC in druge).

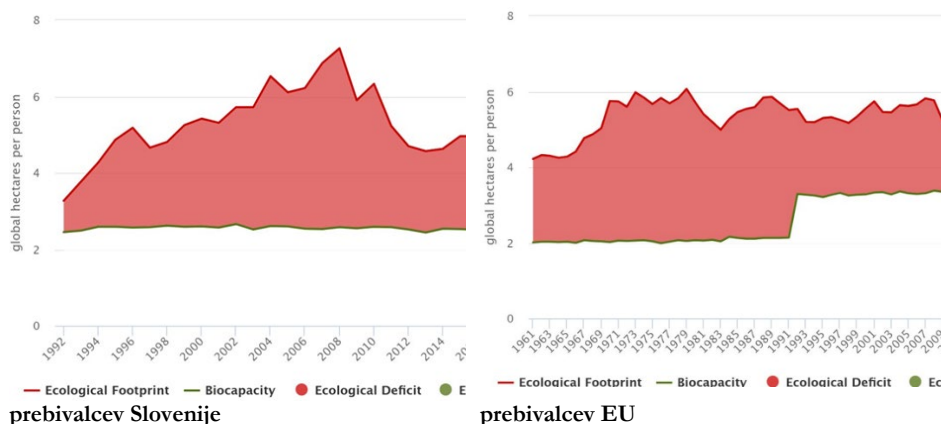
Ekološke sledi, ki so posledica rabe energije pri integralni metodi določimo z izrazom:

$$ES_E = \sum_{m=1}^n \sum_{j=1}^6 (k_{j,m} u_m + k_{j,m} v_m - k_{j,m} e_m) \quad (1)$$

kjer je:

- $ES_E$  energijske ekološke sledi (gha/ leto)
- $m$ , vrsta energenta (1),
- $j$ , vrsta bioproduktivne površine (1),
- $u_m$  količina primarne energije, ki jo v sistem uvozimo z energentom  $m$  (GWh/leto)
- $v_m$  notranji vir primarne energije energenta  $m$  (GWh/leto)

- $e_m$  količina primarne energije, ki jo iz sistema izvozimo z energentom  $m$  (GWh/leto)
- $k_{j,m}$  utežni faktor za  $j$  vrsto bioproduktivne površine in energent  $m$  (gha/GWh)



Slika 3: Ekološke sledi in biokapaciteta prebivalcev Slovenije (gha/preb)

Vir: Global Footprint Network

Ekološke sledi, ki so posledica rabe snovi pri integralni metodi določimo z izrazom:

$$ES_S = \sum_{i=1}^n \sum_{j=1}^5 (k_{j,i} p_i + k_{j,i} u_i - k_{j,i} e_i) + \sum_{i=1}^n (k_{6,i} u_i - k_{6,i} e_i) + \sum_{i=1}^n (k_{6,h,i} s_{h_i} u_i - k_{6,h,i} s_{h_i} e_i) \quad (2)$$

kjer je:

- $ES_S$ , ekološke sledi, ki so posledica rabe snovi (gha/leto),
- $i$ , vrsta snovi (1)
- $j$ , vrsta bioproduktivne površine (1),
- $h$ , sredstvo transporta,
- $u_i$ , količina uvožene snovi  $i$  (t/leto),
- $e_i$ , količina izvožene snovi  $i$  (t/leto),
- $p_i$ , količina proizvedene snovi  $i$  (t/leto)
- $j$ , 6 tipov bioproduktivne površine: pozidana površina, morja, pašniki, gozdovi, kmetijske površine, energijske površine

- $k_i$ , pretvorbeni faktor za snov  $i$  (gha/t leto),
- $k_h$ , pretvorbeni faktor za vrsto prevoza  $h$  (gha/kmt leto),
- $s$ , prevožena razdalja snovi, ki jih uvozimo ali izvozimo, med mestom proizvodnje in mejo sistema (km)

Ekološke sledi porabe vode določimo na osnovi porabljene energije za črpanje in oskrbo. Zato jih pri integralni metodi ne upoštevamo, pri komponentni metodi pa zgolj kot energijsko površino.

**Tabela 4: Ekološke sledi in biokapaciteta prebivalcev Slovenije (gha/preb)**

leto		pozidane površine	energijske površine	kmetijske površine	vodne površine	gozd	pašniki	skupaj
		gha/preb						
2006	ES/preb	0,11	3,74	0,74	0,69	0,75	0,2	6,22
2006	Biocap/preb	0,11	0	0,28	0,01	2,1	0,13	2,54
2008	ES/preb	0,08	3,96	0,8	1,57	0,59	0,26	7,26
2008	Biocap/preb	0,08	0	0,34	0,01	1,99	0,17	2,58
2014	ES/preb	0,07	2,66	0,76	0,05	0,87	0,22	4,63
2014	Biocap/preb	0,07	0	0,38	0,01	1,92	0,16	2,54
2020	ES/preb	0,08	2,48	0,71	0,06	1,31	0,23	4,87
2020	Biocap/preb	0,08	0	0,39	0,01	1,85	0,16	2,49
2022	ES/preb	0,08	2,39	0,71	0,06	1,31	0,23	4,78
2022	Biocap/preb	0,08	0	0,39	0,01	1,85	0,16	2,49

Vir: Global Footprint Network

Ekološke sledi populacije v opazovanem sistemu so lahko večje ali manjše od bioproductivne površine tega sistema. V prvem primeru govorimo o ekološkem primanjkljaju in razvoj sistema temelji na izkoriščanju potencialov drugih sistemov. V nasprotnem primeru govorimo o ekološkem presežku. Za tak sistem velja, da je njegov razvoj uravnotežen, presežek ekoloških sledi pa je lahko ekonomska veličina.



Glede na to ali primerjamo ekološke sledi sistema z lastno bioproduktivno površino ali pa z bioproduktivno površino celotnega planeta, lahko opredelimo lokalno ali globalno uravnoveženost ekoloških sledi (slika 3, tabela 4 in 5). Mnenja raziskovalcev o potrebni površini za ohranjanje biotske raznolikosti so različna – od 3.5 do 50%. Najpogosteje, v literaturi uporabljajo vrednost 12% (Wackernagel, 1996, Chambers, 2014). Ta površina zmanjšuje površino prostora, ki jo za svoje potrebe lahko izkoriščajo ljudje.

**Tabela 5: Ekološke sledi in biokapaciteta prebivalcev Evrope (gha/preb)**

leto		pozidane površine	energijske površine	kmetijske površine	vodne površine	gozd	pašniki	skupaj
		gha/preb						
2006	Biocap/preb	0,11	0	0,89	0,45	1,66	0,18	3,29
2006	ES/preb	0,11	3,43	1,8	0,21	0,57	0,25	5,66
2008	Biocap/preb	0,12	0	0,99	0,45	1,65	0,17	3,38
2008	ES/preb	0,12	3,49	1,18	0,2	0,54	0,24	5,77
2014	Biocap/preb	0,13	0	0,98	0,44	1,61	0,17	3,33
2014	ES/preb	0,13	2,86	1,7	0,19	0,57	0,22	5,4
2020	Biocap/preb	0,11	0	1	0,45	1,59	0,17	3,31
2020	ES/preb	0,11	2,41	1,1	0,18	0,59	0,2	4,49
2022	Biocap/preb	0,11	0	1	0,45	1,58	0,17	3,31
2022	ES/preb	0,11	2,57	1,1	0,18	0,59	0,2	4,65

Vir: Global Footprint Network

## 5 Zaključek in razprava

Namen raziskave je bil večplasten. Na teoretičnem nivoju želimo ugotoviti omejitve in izbrati najprimernejšo metodo določitve trajnostne proizvodnje. Na aplikativnem nivoju pa želimo ovrednotiti vpliv inovacij na ekološke sledi izbranega opazovanega sistema – Slovenije.

Ekološke sledi prebivalcev Slovenije (4,78 gha/preb) bistveno presegajo globalno razpoložljivo bioproduktivno (1.51 gha/preb); primerjava z EU (ES = 4,78 gha/preb BC = 3,314,78 gha/preb) pokaže, da so ekološke sledi naše države nad povprečjem, biokapaciteta pa pod povprečjem EU,

Slovenski raziskovalci so zelo dejavni pri skupnem raziskovanju s tujimi raziskovalnimi partnerji, na kar kaže visok delež mednarodnih znanstvenih objav, ki presega povprečje EU, in sicer 152,0 %. Kljub raziskovalnemu sodelovanju z drugimi državami so slovenske znanstvene objave v 10 % najbolj citiranih pod povprečjem EU (76,4 % povprečja EU). Slovenski visokošolski zavodi vsako leto pritegnejo več študentov iz tujine, predvsem tujih doktorskih študentov, katerih udeležba se je v primerjavi s povprečjem EU med letoma 2017 in 2024 povečala za 84,5 % točk. Vendar to ni povzročilo povečanja števila novih doktoratov s področja STEM (science, technology, engineering, and mathematics), ki je enako povprečju EU in je v zadnjih letih zelo nestanovitno. Na splošno je prebivalstvo s terciarno izobrazbo 40,7 %, kar predstavlja 86,9 % povprečja EU leta 2024. (Slovenska industrijska strategija).

Poraba javnega sektorja za RR (raziskovanje in razvoj) v Sloveniji je nizka in znaša 0,6 % BDP (78,7 % povprečja EU), vendar je med letoma 2017 in 2024 zabeležila pozitivno rast (+13,1 %-točke). Po drugi strani so izdatki za RR v poslovni sektor je znašal 1,5 % BDP, kar je enako povprečju EU, in je od leta 2017 doživel močan padec. (-14,3 %-točke) (Slovenska industrijska strategija).

Inovacijska dejavnost v Sloveniji je dobro razvita in nad povprečjem EU, razen pri ustvarjanju intelektualnih sredstev, kjer Slovenija zaostaja, predvsem PCT (Patent Cooperation Treaty) patentnih prijav in modelov, ki predstavljajo 74,6 % oziroma 76,0 %. Po drugi strani pa je Slovenija boljše kot v EU pri prijavah blagovnih znamk (118,5 % povprečja EU). (Slovenska industrijska strategija).

Vplivi na okoljsko trajnost so vidni, zlasti na produktivnost virov in emisije finih delcev, ki so se v zadnjih letih vztrajno izboljševale (+28,3 %-točke oziroma +14,6 %-točke) in so tik pod povprečjem EU. Vendar pa Slovenija zaostaja pri proizvodnji okoljskih tehnologij (54,1 % povprečja EU), kar ob skupni omejeni proizvodnji patentov kaže na zelo nizko generacijo znanja na tem področju.

Slovenski BDP na prebivalca je pod povprečjem EU (90,3 % povprečnega BDP EU) in raste z 2,0 % letno. Slovenija ima močan proizvodni sektor, ki predstavlja 22,2 % zaposlenosti, kar je precej več od povprečja EU, kjer prevladujejo strojogradnja, kovinska, električna in kemična proizvodnja. Storitveni sektor je manjši od povprečja EU in predstavlja 37 % zaposlenosti, vendar je glede na EU bolj usmerjen v storitve, ki temeljijo na znanju. Nekoliko nad povprečjem EU je tudi delež zaposlenosti v visoki in srednji visoki tehnologiji.

Okoljski okvir v Sloveniji je zmeren. Učinkovitost rabe virov in energije nekoliko zaostajata za EU, zlasti glede izpustov toplogrednih plinov, intenzivnosti porabe energije in stopnje krožne porabe materiala. Pod povprečjem EU je Slovenija tudi na indeksu ekološke inovativnosti.

Pri oceni primernosti metode ekoloških sledi pa je najbolj pomembno, da ugotovimo ali te enakovredno vrednotijo vse tri sfere trajnostnega razvoja – ekonomsko, socialno in okoljsko in tudi možnost vrednotenja trajnostne proizvodnje.

Odgovor je lahko pritrdilen, sej v opazovanih sistemih Slovenija presega povprečja ekoloških sledi, pri vrednotenju inovacij pa ne dosega povprečja primerljivih opazovanih sistemov.

Primerjava vrednosti ES in gospodarske rasti kažejo pozitiven vpliv gospodarske rasti na ES, kar je potrjeno tudi v literaturi Uddin, 2019, Destek, 2020. Ugotovitve kažejo, da se v zgodnjih fazah gospodarska rast pospešuje in povečuje ES, po dosegu določene točke pa začne krivulja kazati padajoči trend kar potrjuje prisotnost Kuznetsove teorije (Danish, 2020).

Negativna povezava med tehnološkimi inovacijami in ES je potrjena, tehnološke inovacije so pomemben dejavnik, ki ga je treba upoštevati in vključiti v trajnostni razvoj gospodarstva. Poleg tega tehnološke inovacije vplivajo na zmanjšanje emisij toplogrednih plinov in doseganju energetske učinkovitosti. Pozitivni učinki tehnoloških inovacij so potrjeni tudi v literaturi (Cho, 2018). Tehnološke inovacije veljajo za enega od načinov, ki jih je mogoče sprejeti za zmanjšanje naraščajočega ES. Empirični podatki kažejo, da so ES, tehnološke inovacije in gospodarska rast med seboj stabilno in povezani. Raba virov povečuje ES, medtem ko imajo

tehnološke inovacije negativno povezavo z ES, zato vse aktivnosti usmerjene v učinkovito rabo virov, tehnološke inovacije in gospodarsko rast, pomembno vplivajo na ES in obratno.

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# ZAKAJ JE POMEMBO ZNATI PISATI TUDI V DOBI UMETNE INTELIGENCE?

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S pisanjem izražamo svoje misli, ki se nanašajo na ideje, informacije, občutke ali zgodbe. Pri tem uporabljamo simbolični sistem, ki sloni na pisnih znakih, kot so črke, številke ali drugi simboli. Prispevek obravnava pomen pisanja v času, ko umetna inteligenca (UI) postaja vse bolj razširjena in dostopna. Generativna UI, kot je npr. Chat GPT, omogoča hitro ustvarjanje, včasih presenetljivo kakovostnih besedil in lahko se vprašamo: »Kaj še ostane človeku?«. Kljub napredku UI ostaja človeku sposobnost artikuliranega pisanja, ki je ključna za razvijanje osebne in profesionalne identitete. Človek lahko ustvarja povsem nove koncepte, preoblikuje tradicije in povezuje na videz nepovezane teme, kar lahko presega možnosti UI, ki temelji na že obstoječih podatkih. Sposobni smo kompleksne analize informacij in oblikovanja argumentov na podlagi lastnega razmisleka. Človeške zgodbe pogosto vsebujejo elemente, ki jih UI ne more replicirati, kot je humor, ironija in paradoks. Ne smemo pa prezreti mesta in vloge UI kot pomočnika v različnih fazah ročnega pisanja. V pripravljalni fazi UI lahko predlaga teme, ideje in ključne točke. Pridobi podatke o naši temi iz obstoječih virov. V fazi pisanja lahko razširi ideje in pomaga prilagoditi slog in ton glede na občinstvo in namen. V fazi urejanja besedila nas lahko opozori na nejasnosti in predlaga izboljšave. Ne smemo pa pozabiti, da je UI še vedno omejena pri ustvarjanju popolnoma unikatnih zamisli in da avtor lahko vnese osebni ton in čustveni pečat. Iz povedanega lahko sklenemo, da je danes učenje pisanja še vedno zelo pomembno, vendar je drugačno. Učiti se je treba pisati z uporabo orodij UI kot pripomočka. Pri tem avtor ohranja nadzor nad vsebino in zagotavlja, da je besedilo kakovostno in pristno.

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# WHY IS IT IMPORTANT TO KNOW HOW TO WRITE EVEN IN THE AGE OF ARTIFICIAL INTELLIGENCE?

VLADISLAV RAJKOVIČ

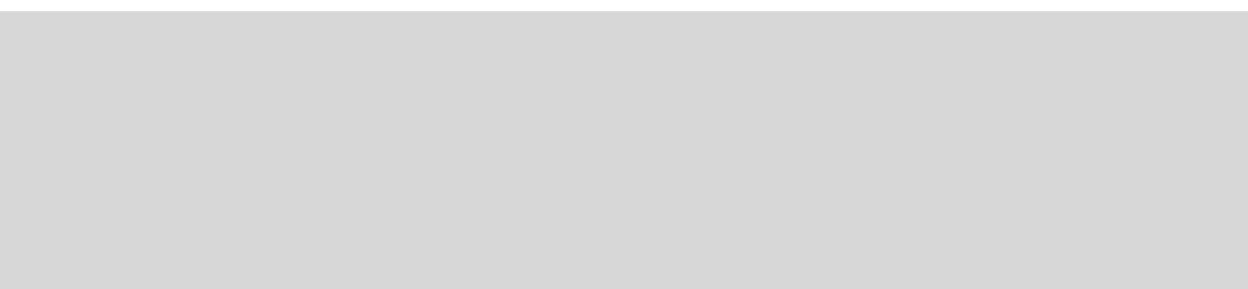
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Through writing we express our thoughts relating to ideas, information, feelings or stories. We use a symbolic system based on written characters such as letters, numbers or other symbols. The paper discusses the importance of writing at a time when artificial intelligence (AI) is becoming more widespread and accessible. Generative AI, such as Chat GPT, enables the rapid creation of sometimes surprisingly good texts, leading us to ask: "What remains for humans?". Despite the progress of AI, the ability to write articulately remains the key to developing personal and professional identity. One can create entirely new concepts, transform traditions, and connect seemingly unrelated topics, which can exceed the capabilities of AI based on pre-existing data. We are capable of complex information analysis and formulating arguments based on our own thinking. Human stories often contain elements that cannot be replicated by AI, such as humor, irony, and paradox. However, we should not ignore the place and role of AI as an assistant in the various stages of handwriting. In the preparatory phase, AI can propose topics, ideas and key points, as well as gather information from extensive materials. In the writing phase, it can expand our ideas and help us adjust our style and tone according to audience and purpose. During editing, AI can alert us to ambiguities and suggest improvements. However, AI remains limited in generating truly unique ideas, and only the author can introduce a personal tone and emotional imprint. From what has been said, we can conclude that today learning to write is still very important, but it is different. Writing should be learned with AI as a tool. In doing so, the author maintains control over the content and ensures that the text is of high quality and authenticity.



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# 44<sup>TH</sup> INTERNATIONAL CONFERENCE ON ORGANIZATIONAL SCIENCE DEVELOPMENT: HUMAN BEING, ARTIFICIAL INTELLIGENCE AND ORGANIZATION

POLONA ŠPRAJC ET AL. (ED.)

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The 44<sup>th</sup> International Scientific Conference on the Development of Organisational Science was focused on developing and advancing knowledge in the organisational sciences, with a focus on the contemporary challenges and opportunities of our time. On the one hand, it is humans who have woven the knowledge of organisations and will continue to enrich the knowledge of organisations in the future. On the other hand, we need to take into account the situational factors and the wider environment that are intrinsic to understanding organisations. The title of this year's conference is: Human being, Artificial Intelligence and Organization. The society we live in today is going through a period of great change in various areas of our lives. Although our pace sometimes stops, the forces of the environment do not. The pace of change often no longer surprises us. But the pillars of our action, the achievements of human society, are something of which we can be justly proud. Artificial intelligence is one of the forces that has entered our everyday lives in many places in recent times. Where are the opportunities and where are the dangers of artificial intelligence, where is human intelligence still a significant step ahead of artificial intelligence?

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organizacijski razvoj

# 44. MEDNARODNA KONFERENCA O RAZVOJU ORGANIZACIJSKIH ZNANOSTI: ČLOVEK, UMETNA INTELIGENCA IN ORGANIZACIJA

POLONA ŠPRAJC ET AL. (UR.)

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44. mednarodno znanstveno konferenco o razvoju organizacijskih znanosti smo usmerili v razvoj in poglobljanje znanja o organizacijskih vedah pri čemer smo se osredotočili na sodobne izzive in priložnosti, ki jih današnji čas prinaša. Na eni strani je človek tisti, ki je tkal spoznanja o organizaciji in bo tudi v prihodnje bogatil vedenje o organizacijah. Po drugi strani pa moramo upoštevati situacijske dejavnike in širše okolje, ki so neločljivo povezani z razumevanjem organizacij. Naslov letošnje konference je: Človek, umetna inteligenca in organizacija. Družba, v kateri živimo danes, je v obdobju velikih sprememb, ki se odvijajo na različnih področjih našega življenja. Čeprav se naš korak včasih ustavi, pa se silnice okolja ne ustavijo. Hitrost sprememb nas pogosto niti ne preseneti več. So pa stebri našega delovanja, dosežki človeške družbe nekaj, na kar smo lahko upravičeno ponosni. Umetna inteligenca je v zadnjem obdobju ena izmed silnic, ki marsikje vstopa v naš vsakdan. Kje so priložnosti in kje nevarnosti umetne inteligence, kje je človeška inteligenca še vedno pomemben korak pred umetno inteligenco?







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