DOCTORAL CONSORTIUM

DECISION SUPPORT FOR RISK MANAGEMENT IN HEALTHCARE ORGANISATIONS

ROK DRNOVŠEK[1,2] & UROŠ RAJKOVIČ[1]

[1] University of, Maribor Faculty of Organizational Sciences, Kranj, Slovenia.
E-mail: uros.rajkovic@um.si, rok.drnovsek1@student.um.si
[2] University Medical Centre Ljubljana, Ljubljana, Slovenia.
E-mail: rok.drnovsek1@student.um.si

Abstract Poor quality of healthcare is a cause of needless mortality. Therefore, quality management in healthcare organisations is an important component of modern clinical practice. This paper focuses on risk management and, in response to flaws of the current approach, presents a novel strategy to improve risk level evaluation in healthcare organisations. A multi-attribute decision model for evaluating the level of risk in healthcare organisations was developed using the DEX method. The decision model addresses the shortcomings of the currently accepted and commonly used risk matrix approach. The developed model strives towards improved resolution and decreased bias of evaluators, to provide a transparent and objective method of evaluating the level of risk in healthcare organisations. It consists of eleven basic and seven aggregate attributes that are hierarchically structured and related with predetermined simple if-rules. The evaluated level of risk is derived from two main aggregated attributes based on the existing risk matrix - probability and severity of impact. The main advantage of the presented decision-making model is the consideration of various aspects of risks to promote a holistic, transparent and objective risk evaluation process.

Keywords: risk management, DEX method, risk matrix, quality management, healthcare.

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1 Introduction

Adverse events and medical mistakes are major causes of mortality in healthcare. American research ranks mortality due to medical mistakes as the third leading cause of mortality, estimating that a lethal medical mistake occurs in 0.71 % of hospitalizations (Makary & Daniel, 2016). Similarly, the World Health Organisation estimates that one in ten hospitalised patients are exposed to poor quality of health care and suffer related negative consequences (World Health Organisation [WHO], 2014). Since the poor quality of care is directly related to increased mortality (Kruk et al., 2018), maintaining the adequate and improved quality of care is an important goal of healthcare organisations and healthcare systems. Achieving adequate health care quality requires appropriately skilled healthcare professionals who strive to maximise efficiency and minimise patient risk while providing safe, patient-centred, timely, and equitable patient care (Seelbach & Brannan, 2021).

The most basic analysis of quality can be achieved by collecting data regarding the main quality indicators, which include mortality, disability, resolution or persistence of disease following treatment, discomfort and patient experience (Seelbach & Brannan, 2021; White, 1967). Similar approaches were taken in Slovenia when The Medical Chamber of Slovenia introduced the implementation of some basic quality indicators in 1998 (Lainščak et al., 2022). Development in the field of quality management continued more intensively in 2010 when the first national strategy for quality and safety of healthcare in Slovenia was developed (Simčič, 2010). Quality management is now an important part of modern healthcare practices. Within the strategic approach of total quality management, it strives toward continuous improvements, teamwork and customer focus (Dean & Bowen, 1994), while incorporating various approaches for quality improvement and monitoring, which include internal and external audits, accreditations, certifications, licensing, incident reporting and risk analysis (Lainščak et al., 2022). Our research will focus on risk management in healthcare organisations.

Risk is an effect of uncertainty on objectives, where this effect is a deviation from the expected. The effect can be positive, negative or both, and can address, create or result in opportunities and threats. Risk management is a set of coordinated activities to direct and control an organisation regarding risk (International Organization for Standardization [ISO], 2018). Approach to risk management can be either reactive (incident analysis) or proactive, meaning organisations identify risks in advance – before they recognize the effect of uncertainty in clinical practice (Preliminary Hazard Analysis, Root Cause Analysis, Failure Mode and Effect Analysis and similar methods) (Prijatelj, 2012; Simsekler, 2019). Risk management is especially present in high risks industries (Prijatelj, 2012) and includes three main phases: risk identification, risk analysis and risk evaluation (International Organization for Standardization [ISO], 2018). Our research will further focus on risk evaluation in healthcare organisations.

A common approach for risk evaluation in healthcare organisations is the use of the risk matrix. The approach is based on a graphical representation of the two main variables needed to determine the level of risk – probability and impact severity (Duijm, 2015). The risk matrix was first used in aviation where each risk was rated on a five-point scale for the probability of the event and a five-point scale for severity of impact (Garvey & Lansdowne, 1998). An example of a four-point scales risk matrix is presented in Figure 1. The calculated level of risk is presented in the body of the risk matrix and is calculated as *Level of risk* = *Probability* × *Severity*.

		Severity			
		1 - negligible	2 - low	3 - severe	4 - catastrophic
Probability	1 - improbable	1	2	3	4
	2- remote	2	4	6	8
	3 - likely	3	6	9	12
	4 - frequent	4	8	12	16

Figure 1: Risk matrix

Following modifications of the risk scale allowed this approach to be applied to diverse fields. In addition to scales changes, the variables of the risk matrix were adapted to better describe the evaluated risk. An example of this is a risk matrix combining the features of plants and different herbicides to describe the level of herbicide resistance development risk (Moss et al., 2019). Similarly in healthcare, the risk matrix was modified so it could be used to evaluate the risk of contracting the Covid 19 infection. In this case, the matrix derived the final estimate of risk based on the nature and duration of interpersonal contact (Williams et al., 2021).

The risk matrix is widely applicable and easy to use. The approach is also used in healthcare, where the use of probability and severity of impact variables can be used to evaluate diverse risks associated with healthcare organisation management and patient care. Evaluation of such risk is important since it ensures the framework for comparison of detected risks and is the basis for management of risk, planning and establishing priorities in corrective measures implementation (Pascarella et al., 2021). Nevertheless, the approach is not without faults. Cox (2008) points out that the main faults of the risk matrix are poor resolution, the ambiguity of inputs and outputs and proneness to error. The approach does not ensure the minimization of bias by the person evaluating the probability and severity of impact (Smith et al., 2009). Furthermore, the risk matrix is not transparent. In-depth interpretation of results or comparison of evaluated risks is not plausible without explanation, which is rarely provided in practice and not quarantined by the approach (Cox, 2008).

Subjective bias in risk evaluation is an important weakness in risk management, especially if risks are not evaluated by the same person. This is often the case in healthcare organisations as risks are evaluated by different evaluators from diverse clinics or working environments within the institution. Second, transparency of the decision process is vital for further investigation of the evaluated risk, since reasoning for the evaluated level of risk is crucial to consider when choosing appropriate correction measures. That is why in our research we aim to decrease the evaluator bias in evaluating risks to promote more accurate risk comparison and support appropriate organisational response. Furthermore, the existing risk matrix is categorised as a qualitative risk evaluation method (Bower-White, 2013), however, its design more accurately provides a rough discrete approximation to an underlying quantitative relation, which can be inaccurate (Cox, 2008). We wish to design an improved model for evaluating risks that are based solely on qualitative evaluation and ordinal categorisation of risks to achieve the most accurate, adaptable and easy to understand approach to evaluating risks, suited for use in diverse modern healthcare organisations.

2 Methods

DEX method was used for the development of our decision model. This method was chosen based on our familiarity with the approach and its previous application for similar decision problems support in healthcare and other fields (Boshkoska et al., 2020; Erdogan & Refsdal, 2018).

DEX (Decision Expert) is a method for multi-criteria decision modelling that dates from the year 1980. It represents a fusion of multi-criteria decision-making and artificial intelligence (Bohanec, 2022). DEX method belongs to the multi-attribute utility theory, where the attributes are defined with qualitative value domains consequently classifying the alternatives. Attributes are arranged hierarchically. Values of hierarchically lower attributes are used to determine the values of hierarchically higher attributes. Evaluated options are described in hierarchically lowest basic attributes. The values of hierarchically higher aggregated attributes are calculated according to their predetermined utility functions, which are presented as a set of simple if-then rules. Weights of attributes are not pre-fixed but may depend on the values of attributes as each rule can be independently altered. For example, a very negative value may be more important than positive values of the same attribute. This is a benefit of this approach in comparison to the usual weighting sum models. This methodology is included in a Microsoft Windows-based software titled DEXi, that was used for model development (Bohanec, 2021; Bohanec et al., 2013).

A preliminary review of the literature was undertaken to identify the most crucial studies and guidelines related to risk management practices in healthcare organisations. Using clinical knowledge, information gained was synthesized into a multi-attribute decision model using DEXi software. The selection of two main aggregated attributes was based on the risk matrix, which is a common contemporary approach for risk evaluation. Additional attributes were enlisted based on the preliminary literature review and clinical experience regarding risk evaluation.

3 Results

The designed multi-attribute risk assessment model consists of two main aggregated attributes – Probability and Impact severity. Hierarchically highest aggregated attribute- Risk level is representing the evaluated level of risk and is the final result of the decision process. Hierarchically lower aggregated and basic attributes of the decision model can be visualized as a tree of attributes, which is presented in Figure2.

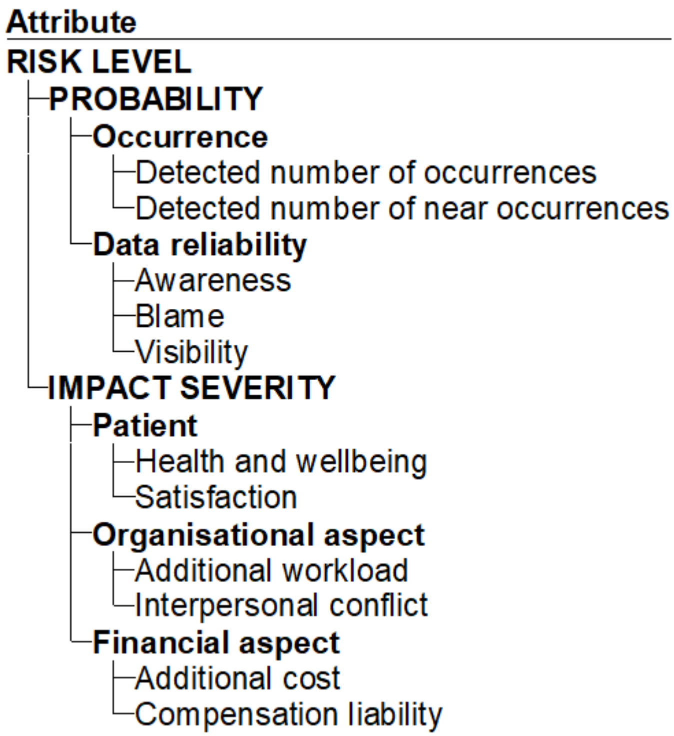

Figure 2: Tree of attributes

The model differs from the risk matrix approach in the way that it expands both main attributes relevant to evaluating risk levels. Each option is described with all basic attributes guiding the evaluator to perform a more thorough evaluation of risk.

As an example, we present a hypothetical evaluation of aggregated criteria Impact severity for a risk of a patient developing a severe pressure ulcer. As presented in Figure 3. The model evaluated the impact severity of a severe pressure ulcer as moderate, considering not only the impact on the patient's health and well-being but also the organisational and financial aspects of the event.

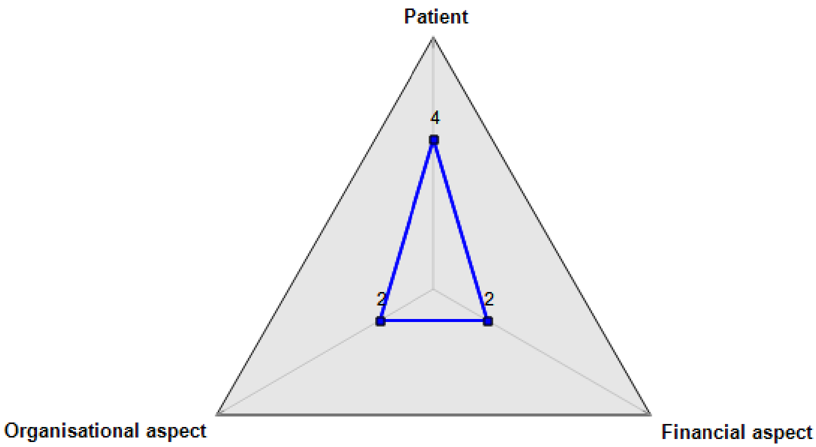

Figure 3: Example of graphical representation of values for a selected option for three chosen criteria

Relations between basic and aggregated attributes are established with utility functions as not all attributes contribute to the estimated level of risk equally. Utility function distribution is presented in Figure 4.

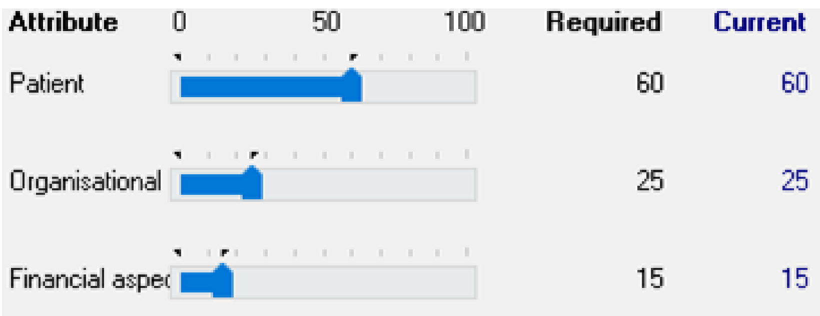

Figure 4: Defining weights of subcriteria in DEXi

Utility functions for individual attributes were assigned according to literature, clinical experience and institutional goals. In our distribution, consequences related to patient's health and satisfaction contribute most, the organisational impact of consequences less and the financial aspect the least.

4 Discussion

The presented model improves the comprehensiveness of the risk evaluation process and reduces evaluator bias in comparison to the contemporary used risk matrix. The model accounts for multiple attributes when evaluating the level of risk, enabling a more systematic and complete determination of impact severity and probability. Evaluator bias is decreased with an expansion of the evaluated attributes. The specific design of basic attributes and their domain values promote a more accurate and consistent description of risk characteristics. The benefits of using multi-attribute decision support are evident in the representation of impact severity evaluation of the presented model. The aggregated attribute Impact severity consists of three hierarchically lower aggregated attributes and six basic attributes. This leads the evaluator to consider a different aspect of an event that can contribute to the impact factor severity of the evaluated risk, besides its impact on the patient's health and well-being to promote holistic evaluation of impact severity and decrease evaluator bias.

The organisational aspect attribute consists of two basic attributes – Additional workload and Interpersonal conflicts. Additional workload is an important problem facing modern healthcare. Besides staff shortages, inadequately designed work processes and poor work organisation can contribute to a workload increase (Robida, 2009). Adverse events can further increase workload because they often require repeated clinical interventions or the performance of even more complex interventions to mitigate the consequences of the event. Quality management strategies should focus on decreasing the unnecessary workload as work overload can lead to the more frequent occurrence of adverse events (Farid et al., 2020) or even exacerbate staff shortages as an overwhelming workload can lead to termination of occupation (Holland et al., 2019). Good interpersonal relationships and communications also importantly contribute to overall staff satisfaction. That is why an aggregated attribute Interpersonal conflict is added as an influence to risk impact facto evaluation. Research in this field shows that a significant share of reported incidents in healthcare are related to work-related communication and relationships (Jerng et al., 2017) and is therefore important to consider when evaluating the level of risk.

Although all previously defined contributors to the criterion Impact severity have direct or indirect financial consequences, the financial aspect of risk was included independently in our decision model. The reason for this is that some risks have an exclusively financial impact and do not manifest themselves as negative effects on patients' health and well-being or organisational consequences. An example of this type of risk is inadequate management of medical and pharmaceutical waste (Agrawal et al., 2017; Vaccari et al., 2018). Similarly, the attribute Compensation liability could be adequately represented in the attributes described above in examples like surgical errors, misdiagnosis, negligence etc. Nevertheless, a higher liability for compensation greatly increases the overall impact and should be considered in the evaluation. Furthermore, in the example of personal belongings misplacement, no patient-related or organisational aspect related harms occur. In this case, the included basic attributed can be utilized to adequately define the impact severity. To better represent the benefits of including these attributes in the decision process we presented an evaluation of a hypothetical risk in the results section. The impact of a pressure ulcer is not limited to patients' health, but also leads to some additional costs and organisational disturbances (pressure ulcer dressings, additional workload, and prolonged hospitalization). Using all three aggregated attributes, the presented model can adequately consider these factors in the final level of risk evaluation.

An important limitation of our research is the lack of empirical evidence to support the validity of the decision model. Future validation of the model should be focused on obtaining empirical data that can provide a rational basis for formulating appropriate decision rules. Empirical research could also reveal attributes that should be additionally included in our decision model or eliminate those that are not appropriate or useful. This could alter the structure of the proposed model to ensure results that are more valid. The benefit of using the DEX method is its adaptability as individual decision rules and the resulting relationships with included attributes can easily be modified and adapted to best describe future empirical findings.

3 Conclusion

The presented decision model can improve the objectivity, completeness and transparency of the risk evaluation process in healthcare organisations. Future empirical research should take place to analyse the validity of the proposed model and incorporate necessary modifications into the decision model.

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