RESPONDING TO THE IMPACT OF THE COVID-19 ON FOOD VALUE CHAINS – CASE OF INDUSTRY PRACTICE

SLOBODAN ANTIĆ

University of Belgrade, Faculty of Organizational Sciences, Belgrade, Serbia.
E-mail: slobodan.antic@fon.bg.ac.rs

Abstract Supply chain operations in food value chains includes all logistics activities that enable the flow of agriculture inputs, outputs, and agriculture-related services, such as transportation, warehousing, procurement, packaging and inventory management. The efficacy of logistics is critical for the agri-food sector, in particular in times of crisis. Disruptions can cause adverse impacts on the quality of food, freshness, its safety, and can impede access to markets and affordability. The COVID-19 pandemic caused that the governments around the world implemented different measures, including a reduction in the transportation of goods (ground, ocean freight and air freight), as well as migration of labour domestically and internationally. In order to stop the transmission of the disease workers are less available in transportation systems because restrictions across borders. These issues induce disruptions in the logistics of the food supply chains. The contemporary business environment in COVID-19 pandemic environment imposes an increased need for the development of decision-support tools. The Shadow IT solution will be described on the example of the inventory control model for frozen fruit wholesale, implemented as a spreadsheet application.

1   Introduction

The period from 2019 to the present days is characterized by the COVID-19 pandemic, caused by the virus SARS-CoV-2, which affected almost all activities around the globe. COVID-19 or coronavirus disease caused global tragedy with high death rate. In order to prevent and retard the virus spreading in the population, governments of many countries have closed borders and have imposed quarantine and strict lockdowns. The world economy has been jeopardized through disruption of manufacturing operations, logistics and supply chain, and many other sectors (Singh et al., 2021; Hobbs, 2020; Remko, 2020). According to (Chamola et al., 2020) the pandemic strongly affected healthcare, food, tourism, automotive and aviation, oil and construction industries, and consequently majority of industrial and business sectors. The measures implemented against COVID-19 spreading have imposed reductions in the transportation of goods, services that rely on transport, as well as migration of labour domestically and internationally (FAO, 2020). Disturbances of transportation systems and movement restrictions (within and across borders) significantly influenced workers availability. All of these constraints have upset the balance of already fragile global food supply chain. Food supply chain (FSC) is based on a quite delicate balance between consumption, production and inventory (Song et al., 2021). As it is stated in (Sterman 2000), even a minor disruption of this chain can cause its instability due to the delays between decisions and the results, which in turn may introduce oscillation and amplification. Sustainability of FSC, already endangered by climate change, poverty and hunger (Workie et al.m 2020), has been additionally faced with logistics problems related to the shipment of food and agricultural inputs, which directly threated food security and nutrition. Realization of daily life and business activities have been difficult due to inability of planning based on historical data, but even more, uncertainty of workforce caused by employees' inability to work because of illness.

Food and agriculture are being affected in all countries as a result of measures against to COVID-19. The impacts of COVID-19 differ across farming systems and make some countries more exposed than others. Most agricultural activities are season-specific and weather-dependent; they follow a fine-tuned pattern of timing, pacing and sequencing of activities. A delay in one activity can have impacts throughout the production process, affecting yields and output. Capital-intensive farming could be most affected, particularly where production relies on a great variety and large

amounts of intermediate inputs, such as seeds, feeds, fertilizers, pesticides, lubes and diesel. But also, subsistence farmers can be affected. While they rely more on their own farm-based inputs, many have to purchase their inputs on local or regional markets, including their seeds, feeds or diesel. Their input supply chains are typically more fragile and more susceptible to disruptions. Importantly, they use more manual labour and, where the disease takes a direct toll on their health or their movement, this can impede not only their ability to produce for others, but also undermines their own food security. Weaknesses of the current global supply chain have been exposed resulted in revenue loss, demand, and supply unfulfillment in COVID-19.

Lockdown cannot be considered as a permanent solution for a long-run from an economic and social perspective. A lack or a delay of supply of these products affects people in the informal sector of urban areas who rely on produce from rural areas for their livelihood. The closure of restaurants, cafes, and street-food vendors, for instance, can also lead to significant reductions in otherwise reliable market outlets for many farmers, whose incomes will decline when products cannot be brought to markets. The International Labour Organization (ILO) reported an initial estimation that almost 25 million jobs could be lost worldwide due to COVID-19, and it may stretch to 40 million (ILO, 2020).

The contemporary business environment in COVID-19 pandemic environment imposes an increased need for the development of decision-support tools. Many of them are developed by people who are not professional programmers, but domain experts who need support in performing specific tasks and activities. These people are so-called end-user programmers. Shadow IT coexists with mandated information systems. Developed and applied by non-IT domain experts, it is as a rule, but not exclusively, used for resolving nonroutine issues, for which mandated IS does not have appropriate functions. Shadow IT solutions are not supported or controlled by IT departments (Rakovic et al., 2020). The Shadow IT solution will be described on the example of the inventory control model for frozen fruit wholesale, implemented as a spreadsheet application.

The company for which the spreadsheet application was developed operates within the food industry, in the sector of deep-frozen fruit and vegetables. The company cooperates with industrial and retail clients. The process of deep-frozen fruit wholesale on the German market will be described in this paper. The clients of the

company are the biggest retailers on the German market. They are ordering the goods every week in smaller quantities and from many different locations. To keep the status of a reliable supplier, the company has to deliver each order in the requested quantity and within the requested time. Considering the mentioned requests and dynamics of sales, an external warehouse and developed distribution network on the German market are necessary to deliver each order under requested conditions. The company has engaged a 3PL (third-party logistics) partner for this purpose (Jeremic et al., 2020).

2   Strategic measures, solutions, and opportunities for a more resilient post - COVID-19 in agricultural supply chain (ASC)

Agricultural supply chain (ASC) is essential for the economy and the society. This supply chain represents complex system, containing numerous participants, mutual dependencies and feedback (Ivanov, 2020a). Consequently COVID-19 pandemic affected ASC participants in multiple ways, directly and indirectly. Many papers tackled different topics in order to propose solutions to the crises caused by the coronavirus disease. COVID-19 supply chain risks and selected approaches to improving resilience could be described in Figure 1.

Figure 1: COVID-19 supply chain risks and selected approaches to improving resilience on COVID-19.

(Source: Remko, 2020)

2.1 Agriculture 4.0, Artificial intelligence and machine learning as a response to the COVID-19 impacts

Nayal et al. (2021) considers challenges of implementing artificial intelligence and machine learning (AI-ML) for moderating the impacts of COVID-19 on the ASC. Even before COVID-19 crises, ASC digitalization have been addressed in the context of risk and uncertainties mitigation and improvement of the supply chain resilience, agility and robustness (Antić, 2018; Ciruela-Lorenzo et al., 2020; Sharma et al. 2021). Digitalization includes various technologies such as AI (artificial intelligence), blockchain (BC), big data (BD), cloud computing (CC), Internet of things (IoT) and machine learning (ML) (Ciruela-Lorenzo et al., 2020; Wamba et al., 2018; Antić, 2018). According to (Nayal et al., 2021) AI represents technological driver for digitalization, while ML can be considered as application of AI. Digitalization of the ASC, defined by applying of AI-ML, aims to manage and optimize numerous challenges that the ASC faces during the COVID-19 period and beyond. AI-ML should contribute to the ASC risks reduction through more accurate forecasting, real-time information usage, transparency increment, traceability and predictability improvement (Nayal et al., 2021). Nevertheless, the application of AI-ML in the ASC is in its developmental stage and requires more focus from researchers and practitioners (Dhamija and Bag, 2020). Furthermore, many participants of ASC are far away from using any IT support for their activities, so AI-ML concept does not sound like a solution that can be applied in the near future.

Agriculture 4.0 is the 4th agriculture revolution that involves digitalizing the entire agricultural production process (through smart / precision farming) and its supply chain. Digital agriculture involves remotely gathering and saving, reviewing, and exchanging data for optimum activities across the entire food supply chain using software and resources in order to reduce the impact of the COVID-19 on food value chains. In agriculture 4.0, decisions are made at three distinct stages (pre-farming, on-farm, and supply value chain – after-farming) based on available data to improve food production, processing, storage, distribution, and consumption. The application of agriculture 4.0 to modern agriculture is summarized in Figure 2.
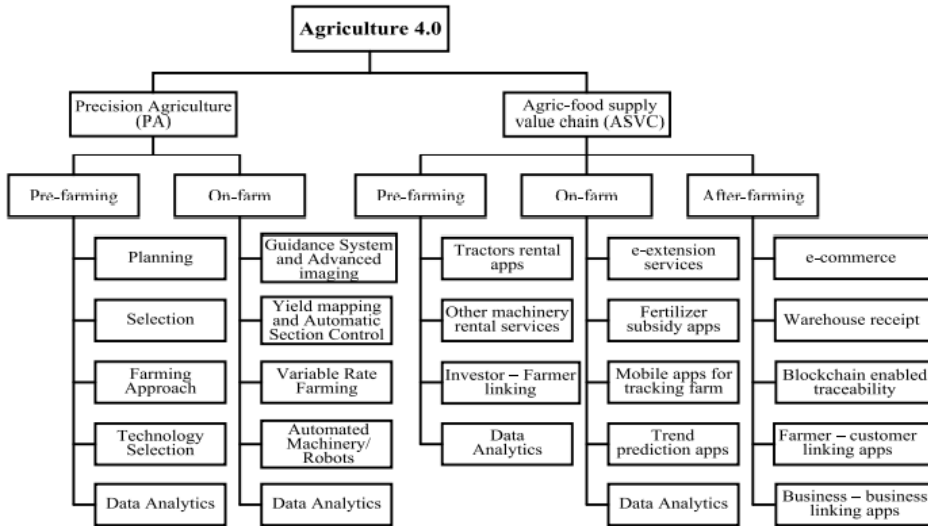
Figure 2: Structure of Agriculture 4.0
(Source: Oruma et al., 2021)

Farmers should realize that agriculture 4.0 is the future of farming. A good understanding of digital farming technology is necessary to ensure a profitable business model especially in pandemic COVID-19. They should invest in modern smart machinery and avoid the importation of obsolete machinery and influence of disturbance in agricultural supply chain (ASC) caused by pandemic COVID-19. In the Agricultural supply chain (ASC), the emphasis is on decision support systems (DSS) through mobile phones, software, and apps, including activities, technologies, and processes that add value or optimize any or all the blocks in the agri-food supply chain. The ASC covers operations before the actual farming like services or mobile apps that link farmers with tractors, other machinery (drones), investors, and aggrotech that handles data analytics. During the main farming operation, stakeholders can also provide value addition through e-extension service apps, fertilizer subsidy apps, mobile apps for farm tracking/monitoring, trends prediction apps, and aggrotech service providers for various aspects of data analytics (Lezoche et al., 2020).

Precision agriculture (PA) is using digital technology to manage and control all aspects of food production, processing, and storage to improve production sustainability (Shafi et al., 2019). As it shown at Figure 3., PA uses digital technologies of IoT, GPS guidance, GPS-based soil sampling, control systems, drones, robotics, autonomous vehicles, variable rate technology, automated hardware, telematics, and software.
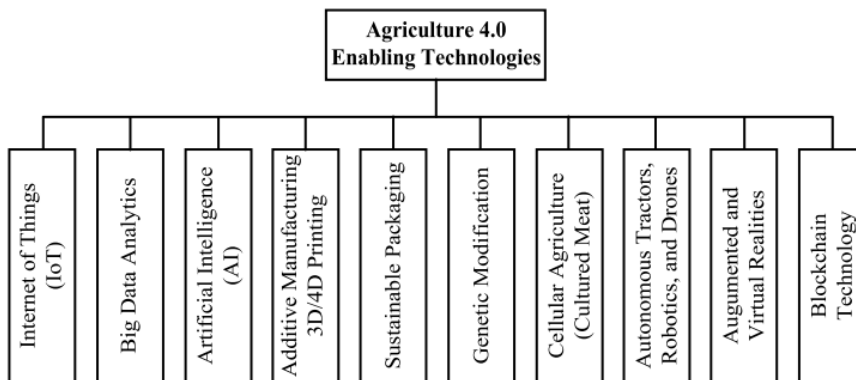

Figure 3: Technologies for Agriculture 4.0
(Source: Oruma et al., 2021)

Farmers can apply PA before and during farming through a decision support system. The pre-farming stage helps farmers to plan, select seedlings or agricultural inputs, choose a farming approach, and apply the appropriate technology based on the available data. During farming, PA enables farmers to use the proper amount of farm inputs, fertilizer, and other resources to improve farming output sustainability by adopting appropriate digital technologies. Farmers can do farming in a whole new way with PA through approaches like desert farming using drip irrigation, hydroponics, urban farming, etc., which are now possible. PA assumes that growth, stability, and performance are affected by a farm's topology, environmental factors, and morphology (Shafi et al., 2019). Farm monitoring/forecasting platforms are integrated with the most precision farming and smart mechanization services to manage and optimize the food production process. Farm monitoring is achieved through the data obtained from IoT, drone technology, satellite aerial imaging, etc., and customized to meet specific farm requirements. Farmers can use the results from farming monitoring for a variable-rate farming application of inputs to

different farm sectors. Forecasting/prediction of farm yield is possible with additional data from weather/metrological centers. Yield prediction and what-if analysis are also performed from these data to improve output at minimum inputs in a sustainable farming approach. Farm monitoring platforms also provide early warning systems to farmers to mitigate the risk of low yields due to unfavorable environmental conditions like bad weather, pest, and disease invasion (Abayomi-Alli et al., 2021).

Big data is a computer science field concerned with the analytics of big (large and complex) data to draw useful information. On their own, the individual data may not make much sense, but when analyzed on a large scale using artificial intelligence, helpful information, trends, and patterns can be drawn from big data analytics. Big data uses statistical analysis, optimization, inductive statistics, and principles from nonlinear statistics to derive laws (regression, nonlinear interactions, and causal effects) from large data sets with low information density to discover relationships and dependencies or perform forecast outcomes behaviors (Corallo et al., 2020). Five Vs characterize big data; volume, velocity, variety, veracity, and value (Ishwarappa et al., 2015). Big data requires high computation, storage, and processing resources, which the IoT network cannot handle in isolation.

Blockchain technology enables recording information digitally that is very difficult to change, hack, or alter. It consists of an increasing list of records (blocks), with each block containing a cryptographic hash of the previous record. It is a digitally distributed ledger system with seven distinct properties: programmable, secure, immutable, unanimous, distributed, anonymous, and time stamped. Blockchain technology is secured because all its records are individually encrypted; it is immutable because any validated record in Blockchain cannot be reversed or changed. The approach is unanimous because all participants must agree to the validity of each entry. All network participant has a copy of the transaction records for transparency. It is anonymous because the identity of all participants is either anonymous or pseudonymous. Finally, all its records are time-stamped blocks. Blockchain technology enables traceability, information security, and efficient use of resources within the agriculture 4.0 context. Some benefits of blockchain technology adoption in agriculture 4.0 include reduction in food wastage by detecting bottlenecks in the agri-food supply chain; combating food fraud such as fraudulent labeling of food, thereby increasing food safety (De Clerq et al., 2018).

Artificial intelligence involves the intelligence demonstrated by machines or computers. It is the study of intelligent agents. AI describes machines that mimic human cognitive functions like learning and problem-solving. AI makes machines more capable of understanding human speech, competing with professionals at the highest levels of strategic games, autonomously operating vehicles, intelligent routing and content delivery networks, and military simulations. Modern AI approaches include deep neural networks (computational intelligence), statistical methods, and traditional symbolic AI. The tools commonly used for AI applications include search and mathematical optimization, neural networks, and strategies based on probability and economics. AI applications include machine learning, natural language processing, expert systems, computer vision, robotics, etc. (Brzeski et al., 2019).

Robots are used in agriculture to automate simple, dirty, dehumanizing, repetitive, or dangerous tasks (like weed control, planting, harvesting, sorting, packing, or pest control), thereby enabling farmers to focus on more critical tasks. Smart machinery and drone technology are other enabling technology for Agriculture 4.0. Smart mechanization involves using autonomous tractors/drones for planning, automation, monitoring, optimization, and management of farm operations in providing more food sustainably from our limited land resources and changing climatic conditions for our teeming population. Smart mechanization uses IoT sensors, software, autonomous solutions, and artificial intelligence for soil preparation, planting, crop treatment, farm monitoring, harvesting, and processing using data from the farm. Autonomous tractors can eliminate operator fatigue by ensuring more daily working hours (Erfani et al., 2019).

Additive manufacture (3D and 4D printing) is computer controlled three-dimensional manufacturing by depositing materials in layers. It uses binder jetting, directed energy deposition, powder bed fusion, sheet lamination, vat polymerization, and material extrusion in creating new three-dimensional objects. Three additive manufacturing technologies are sintering (melting materials without liquefaction to create complex, high-resolution products), melting (electron beam), and stereolithography (photopolymerization whereby an ultraviolet laser is fired into a vat of photopolymer resin to create torque-resistant ceramics parts able to endure extreme temperature (Javaid et al., 2019).

Augmented reality (AR) uses digital technology to superimpose generated text, graphics, images, etc., on the real physical view of objects, thereby providing an enhanced user experience. AR user interface includes a screen, monitor, helmets, facemask, glasses, goggles, head-mounted display, window, windshield, etc. This technology blurs the boundary between the physical and digital worlds. For an AR user, the real and virtual worlds coexist. The user can obtain helpful information about an object or location while interacting with virtual content in the real world (Jung et al., 2018).

Other disruptive technologies include bioplastics for sustainable packaging (e.g., starch-based bioplastics) that will result in entirely biodegradable waste on its stated lifespan. This is intended to solve the plastics problem that takes several years to decompose and constitutes a severe threat to aquatic life (Gadhave et al., 2018).

Genetic modification (genomics) enables new breeds with improved yields and resistance to harsh environmental conditions. It can also develop crops with particular vitamins and minerals for healthy living (Raman, 2017).

Cellular agriculture produces food (agricultural produce) from cell cultures using different applicable technologies such as biotechnology, molecular biology, synthetic biology, and tissue engineering. Culturing food is another technology that can produce meat and grow plants in the lab (of commercial quantity) to ensure food security in the future. Cellular agriculture has a lot of potential and positive environmental effects for the future of farming. It will enable space astronauts to culture meats on spaceships in the future while eliminating animal cruelty in slaughterhouses. Cellular agriculture has applications in meat, dairy, eggs, gelatin, coffee, horseshoe crab blood, fish, fragrances, and silk (Stephens et al., 2000).

2.2   Urban agriculture perspectives

Urban agriculture in developed countries should be fostered with emerging growing practices and edible green infrastructures, such as vertical farming, hydroponics, aeroponic, aquaponic, and rooftop greenhouses. Notwithstanding the limitations of traditional urban farming activities, innovative and disruptive solutions and short food supply chains of fresh agricultural products might play a positive role in lessening uncertainties from global systemic risks. of urban production. Findings

from field-scale studies and reviews suggest that various forms of smart and innovative urban agriculture, such as vertical indoor farming, greenhouses, aquaponics, soil-less hydroponics, and aeroponics, result in high yields of horticultural products up to 140 kg/m2 /year (Armanda et al., 2019).

Innovative urban farms with climate control systems encompass high levels of technology, such as precision automation for nutrient dosing, light-emitting diode (LED) technology, artificial intelligence and blockchain, to optimize the growing process minimizing maintenance and costs (O'Sullivan et al., 2019). In addition to production capacities, advanced indoor urban farms are less subject to natural disasters and weather-related problems, and may revitalize abandoned buildings, brownfield sites, and vacant spaces (O'Sullivan et al., 2020).

Pulighe and Lupia (2020) presents the idea of urban agriculture based on eatable green infrastructures, such as vertical farming, hydroponics, aeroponic, aquaponic, and rooftop greenhouses. This idea is response of the authors, Pulighe and Lupia (2020), to the fragility of large cities to unexpected multifaceted global risks introduced by COVID-19. Urban agriculture involves the cultivation, processing, and distribution of food in or around heavily populated towns, cities, or metropolitans on a commercial scale. It includes animal husbandry, aquaculture, apiculture (beekeeping), horticulture, etc. Due to the high land cost in urban areas, it is usually practiced at the perimeters of cities. Urban farming includes creating fresher foods, using unutilized spaces, increasing food security, and reducing food waste due to proximity to food load centers. Urban farming can be in the form of vertical farming, hydroponics, aeroponics, aquaponics, microgreens farms, shipping container farms, and rooftops farming, mushrooms farming, etc. In our proposed framework for adopting agriculture 4.0, we shall focus on peri-urban farm locations for an efficient realization of commercial-scale urban farms (Shamshiri et al., 2018).

Vertical farms are indoor farms that use soilless technologies such as hydroponics or aeroponics to grow crops. Vertical farming technologies ensure the optimal use of land by stacking the level of yields on each other. It uses artificial lighting in a highly controlled crop growing condition to ensure all year-round growing and harvesting irrespective of the farm location's environmental conditions. The crops cultivated in a vertical farm are characterized by high edible mass percentage, low plant height, fast-growing plant species, and short shelf life. The idea of vertical

farming is to reclaim land from agriculture to forestry, save clean freshwater, reduce CO_2 emissions resulting from long transportation of food, increased variety (biodiversity) of food, and freshness of food. Despommier (2010) first used the term vertical farm.

Hydroponics technology is the soilless cultivation of plants, in which nutrients are supplied to the crops through the water. The nutrients can be from organic sources or inorganic/artificial sources. The nutrients solution can be static or continuous flow in design. The nutrient solution will cause eventual loss of its nutrient after prolonged usage, and the answer is usually drained out and replaced with a new solution. The drained solution can mix with ocean water leading to water pollution. One major limitation of hydroponics is the limited air holding capacity of water, as one kilogram of water can only hold 8 milligrams of air, even if aerators are used. This means that inadequate aeration may result; hence, the continuous water flow is crucial for successful operation (Jones, 2016).

Aeroponics is the cultivation of crops with no substrate. It involves growing crops in an environment that is saturated with nutrient-rich water droplets. This farming approach provides excellent aeration and water saving. Aeroponics requires 65 % less water than hydroponics and one-quarter of nutrients under the same farming conditions. Mist is generally easier to handle than water in a zero-gravity environment; hence, aeroponics is of particular interest to NASA's space research. Aquaponics combines aquaculture (usually fish farming) and hydroponics. The aquatic effluents resulting from fish waste and uneaten feeds accumulate in the water and increase its toxicity. This nutrient-rich water is filtered and pumped to the hydroponics section for crop cultivation. Aquaponics has five basic units: rearing tank, settling basin, biofilter, hydroponics subsystem, and sump. It has the water-saving capacity of hydroponics coupled with an added advantage of eliminating environmental pollution from wastewater (Diver et al., 2000).

Aquaculture is the farming of aquatic plants and animals such as fish, algae, crustaceans, aquatic plants, etc. It involves both the cultivation of fresh water and saltwater plants and animals under controlled conditions. Marine culture is the cultivation of aquatic organisms for food in a marine environment. The four commonly used mariculture structures are: floating cage, net enclosures, earth ponds, and a constant water circulation system (Gentry et al., 2017).

2.3 Fragility of the regional food supply chains RFSC at the COVID-19 crisis

The COVID-19 pandemic has illuminated the fragility of the prevailing food supply system. Prior to the pandemic, the amount of food consumed at home and away from home in the U.S. was roughly equal (USDA, 2020). At the height of the COVID-19 emergency, however, wholesale markets rapidly diminished when restaurants, hotels, and schools closed (Yaffe-Bellany, 2020). Consequently, grocery retail demand increased significantly, with consumer panic-buying and more meals prepared at home (Hall et al., 2020; Morgan, 2020; Venuto, 2020). Conventional food supply chains, with package sizes and infrastructure intended for wholesale buyers, struggled to adapt for retail sales, and large concentrated meat and dairy processors and longhaul transportation networks were disrupted by labor shortages as workers became ill (Hobbs, 2020). As a result, many consumers experienced increased food prices and shortages at the grocery store.

The long-term sustainability, viability, and resilience of RFSCs can be significantly improved by selectively employing some transportation, warehousing, and inventory management best practices that make conventional food supply chains efficient and effective (Rogoff, 2014). Faced with the COVID-19 crisis, the regional food producers and distributors need to adopt logistics best practices. These best practices are extracted from the comprehensive literature review on logistics for regional food systems conducted by Mittal et al. (2018) and Marusak et al. (2020):

– Determining the optimum number and facility locations of warehouses is critical for logistics efficiency, with implications for labor, transportation, inventory, and indirect costs; proximity to suppliers and/or customers is another important consideration. Urban distribution centers for agriculture farmers – direct relation with urban cities customers. Identify collection centers closer to producers, for example develop storage facilities like warehouse receipt system platforms where farmers can deliver their produce without the need to go to markets. Take an inventory of public and private storage facilities, including available cooling infrastructure, and map out and assess cold chains that can be used for emergency storage. Ensure that the stockpiles of food meet the nutritional needs of the population when combined into food baskets for distribution. Provide sufficient

physical spaces to farmers' organizations that allow workers to maintain physical distancing rules and to manage the home delivery logistics, for example spaces for product aggregation and preparation of boxes.

– Implementing warehouse inventory management systems, using inventory tracking systems, and matching supply with demand through demand forecasting can reduce logistics costs and improve service levels.

– Increase the power of public procurement on essential agricultural supplies and ensure that market channels and logistics are still available for farmers. Make rapid reforms to procurement procedures and rules, including rapid payment and cash-on-delivery, for small farmers and processors, while maintaining high food quality and safety standards. Transform restaurants, cafes, and street-food vendors into local food suppliers using their urban facility location for online delivery services. Strengthen home delivery or "near" to home delivery to ensure consumers access to fresh and local products. Retain agri-dealers and livestock supplies shops as essential services with call and collect or delivery services only. Procurement of supplies to the urban cities should be organized directly from agriculture farmers

– Improved supplier reliability and reducing supply uncertainty can help organizations to match supply and demand, thereby increasing inventory availability and supply chain responsiveness.

– Increasing vehicle utilization load rates via optimized routing and scheduling and consolidating delivery routes can help organization to increase its logistics efficiency and reduce transportation costs. Vehicle selection presents selecting appropriate vehicle types and sizes to meet supply chain objectives is critical for transportation efficiency; large and refrigerated vehicles can improve product freshness and facilitate longer delivery routes, but they also tend to have low fuel efficiency. Adopt measures like "green channels/green lanes/green corridors" for critical agricultural products and production materials such as fruits and vegetables to minimize hurdles in transport.

– Use innovative logistics and transport methods for direct deliveries to semi- or urban populations, including delivery trucks, pick-ups or bicycles. Ensure on-time and frequent deliveries. Buyers with busy schedules tend to highly value on-time deliveries; they also typically prefer more frequent deliveries,

which reduce the amount of inventory that they must carry while increasing product availability and freshness.

- Hiring outsourced transportation services of third-party logistics providers can reduce overall transportation costs and for making home deliveries through e-commerce. The railways play a major role in making both the supply and demand end meet. However, it is necessary for the railways to utilize this opportunity to make its freight operations more efficient so as to increase the volume of freight transportation.
- Organizations in different supply chains can work at horizontal collaboration together to cluster their logistics activities and assets (e.g., through shared transportation and processing facilities) for greater efficiency and reduced logistics costs.
- Understand the demand and make plans with forecasting and simulations, how demand may evolve and how production, processing and distribution can be adapted.
- Technologies such as RFID and blockchain can accelerate information sharing and improve visibility into inventory positions and logistics flows.
- Allow movement of seasonal workers and transport operators (e.g. truck drivers) across domestic and international borders. Adequate health screening, testing, and safety protection measures should be taken. Special flights/trains/coaches can be organized to help seasonal workers to get to their workplace.
- Train local labor force in agricultural activities. Many agricultural activities, such as planting, harvesting and storage are tightly integrated into seasonal timetables. When and where seasonal workers are not available, options to mobilize unemployed or underemployed workers or reallocate workers from other areas with temporary labor surpluses (restaurants) should be considered. This would afford unemployed individuals with additional income, and open options to retrain the workforce, in addition to contributing to keep the food value chain alive. It could also be a new variation of the public work programs.
- Inform and promote the use of existing apps that have been developed to reduce food waste in urban areas.
- The government authorities collaboration with the ground level authorities is essential to maintain law and order and communication. Involve

government and local authorities in order to ensure fast deliveries. It is observed that trucks are stranded for several hours at the national highways. This can be solved by utilizing FAST tags for identification of vehicles. The process can be augmented through online based permissions from a government portal checked through bar code or similar.

3   Shadow IT – Reasons for Occurrence

Shadow IT coexists with mandated information systems. Developed and applied by non-IT domain experts, it is as a rule, but not exclusively, used for resolving nonroutine issues, for which mandated IS does not have appropriate functions. Shadow IT solutions are not supported or controlled by IT departments. The reasons for the emergence of shadow IT are numerous, but there is always a need for end users to complete their job. Despite an ERP (Enterprise Resource Planning) system implemented to increase standardization and control, end users create workarounds in the form of shadow IT due to Unreliability, Inflexibility, Not Easy to Use, and Lack of coordination (Alojairi, 2017). Dissatisfaction of employees with the existing ERP system (Tajul et al., 2016) or dissatisfaction during its implementation, according to Kerr, Houghton and Burgess (2007), provides a fertile ground for the development of shadow (feral) IT.

Authors generally agree that Shadow IT, Feral Systems, IT workarounds are opposite of IT systems, but their definitions are in some respects different.

Shadow IT describes the supplement of "official" IT by several, autonomous developed IT systems, processes and organizational units, which are located in the business departments. These systems are generally not known, supported and accepted by the official IT department (Rentrop et al., 2019). Shadow system is defined by usage as individual user's voluntary deployment of one or more systems besides or instead of the mandatory system to perform a task (Haag et al., 2015). Shadow Information Technology (IT) occurs when users develop systems outside of the central information technology department (Chua et al., 2014). Feral systems are argued to be those mechanisms which circumvent regular systemic procedures to the extent that they create alternative means of accessing data (Kerr et al., 2007). Feral Information Systems (FIS) is any technological artefact (e.g. spreadsheets) that end users employ instead of the mandated Enterprise System (ES) (Spierings et al.,

2014). Feral systems have largely been regarded as the users' response to discrepancies between official IT software systems and actual business processes (Tambo et al., 2016). A workaround is a strategy of using a computer system in a manner that it was not designed to be used for or using alternative methods to accomplish a work task (Alojairi, 2017). Computer workarounds are a form of anomalous system use which refers to a variety of sociometrical actions around IT artefacts. These actions may not be consistent with the designed uses and official rules but nevertheless constitute a form of IT enactment in practice (Azad et al., 2012). Where a mismatch occurs between the expectations of technology and actual working practice, employees may implement a 'workaround' by deviating from set procedures (Ferneley et al., 2006).
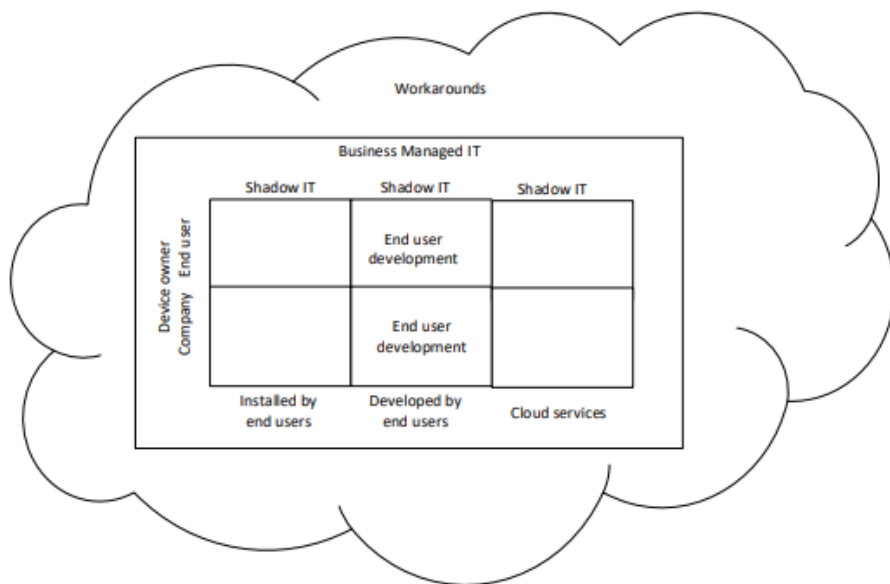

Figure 4: Shadow IT, End user development and Workaround
(Source: Rakovic et al,. 2020)

The reasons for the emergence of shadow IT are numerous, but there is always a need for end users to complete their job. Despite an ERP (Enterprise Resource Planning) system implemented to increase standardization and control, end users create workarounds in the form of shadow IT due to Unreliability, Inflexibility, Not Easy to Use, and Lack of coordination (Alojairi, 2017). Dissatisfaction of employees

with the existing ERP system (Tajul et al., 2016) or dissatisfaction during its implementation according to Kerr, Houghton and Burgess (2007) provides a fertile ground for the development of shadow (feral) IT. Although companies consume huge resources for the ERP system implementation that does not guarantee accurate data in the centralized database. As shadow IT often complements or replaces certain ERP system functions, "real data" can be different from the data found in the ERP system (Kerr et al., 2010). The very systems that should reduce and remove shadow IT become their spawning ground (King et al., 2014). It is useful to know that even distrust in the ERP system can be the reason for end users to start developing shadow IT (Kerr et al., 2007). As the reasons for shadow IT, users often mention a long response time (fulfilment of user requests) by IT department (Györy et al., 2012), and low initial (perceived) costs of shadow IT (Zimmermann et al., 2014). The growing number of mergers and acquisitions of organizations indicates that the "problem" of shadow IT will continue to occur in the future (Kerr et al., 2007). However, shadow IT should not only be observed from a negative point of view, and it is also necessary to consider the adaptability and innovative potential of shadow IT (Zimmermann et al., 2014).

Managing shadow IT is necessary because many shadow ITs support key business processes. Although these systems are mostly developed without the knowledge and support of IT departments, and bring many risks, Haag et al. (2015) emphasize that organizations should be careful with sanctioning the shadow IT system development as these systems can be very useful both for the organization and for the performance of individuals in doing their job. Behrens (2009) provides advice for a successful organizational use on the basis of a case study conducted: recognize shadow IT, learn from shadow IT, eliminate bias towards shadow IT, do not try to control shadow IT, and encourage good shadow systems. In the same manner, Haag et al. (2015) state that it is necessary to recognize and support the development of shadow IT. Managing shadow IT should start with researching the motivation of shadow IT occurrence (Tambo et al., 2016), then analyzing users' abilities to develop shadow IT (Spierings et al., 2014) and once each individual shadow IT instance is identified in individual business processes, it is necessary to evaluate each shadow IT instance and control the shadow IT instances (Zimmermann et al., 2014).

4   Spreadsheet application for inventory control of frozen fruit

According to Jeremic, Djordjevic and Antic (2020), in order to improve material flow management, decision-makers should have the appropriate form of support in the process of decision-making. For these purposes, decision-making models are widely used. These models should include all relevant information from the environment and represent significant support to the decision-maker in choosing the available alternatives. Nowadays there are a lot of BI (business intelligence) tools and software solutions that provide necessary support in the process of decision-making. However, spreadsheets are still one of the most used tools for decision-support because of their functionalities, ease of use, and flexibility.

Since the company supplies one main distribution centre, for the 3PL partner is required to have a developed logistics network and to be able to deliver each order to the customer on time. Therefore, it is necessary to apply the logistic concept of cross-docking delivery. Cross-docking implies the existence of one large, main distribution centre from which smaller distribution centres are supplied (Vogt, 2010). Smaller distribution centres' locations provide the ability to cover all regions and delivery locations in Germany. The essence of this concept is that full truck (Full Truck Load - FTL) departs from the main distribution centre loaded with the goods that have to be delivered to the multiple unloading points. The trucks arrive to smaller distribution centres and each of them serves several unloading points. Depending on which unloading point the goods have to be delivered, transhipment is performed in a smaller distribution centre. Then, the goods are loaded into smaller vehicles which transport them to the final place of delivery. This concept of delivery proves to be efficient when it is necessary to deliver smaller quantities of 33-euro pallets, as is the standard for FTL, to more locations. The described concept enables savings in terms of time and costs.

The process of delivery is initiated with a sales order. Upon receiving the sales order logistics planner records it in the existing spreadsheet tool and checks the inventory level of ordered SKUs (Stock Keeping Unit). If there are enough inventories on stock, a planner proceeds to creation of sales order in ERP (Enterprise Resource Planning) system and creates a delivery note which is referred to the previously created sales order. If there are not enough inventories on stock, the replenishment order has to be created. The replenishment order should be created as soon as the

stock level reaches a defined safety stock level. Safety stocks are often called reserve stocks. They should satisfy the demand, during unforeseen, sudden events, which were not foreseen in previous periods (machine failure in the production line, unrealized deliveries, etc.) (Antic, 2014). For the inventory control problem, considered in this paper, the safety stock was defined as an average daily sale for the current month multiplied by Lead Time. Lead Time is defined as the time between placing the replenishment order and delivering the goods to the customer. However, given the lack of an adequate procurement plan and the lack of tools to support the decision-maker in defining inventory replenishment points, this process represents a significant challenge for the planner controlling the process. The planner takes control actions based on his experience and his predictions of customer demand.

After order processing, a transport order with instructions for deliveries is created and forwarded to the logistics provider in Germany. The logistics provider should confirm deliveries within the required deadlines. According to the distance of the retail distribution centre, one or two days before the required delivery date, the goods are collected and sorted, depending on the place of unloading, and transported to the appropriate distribution centre. On the delivery day, the goods are delivered to the final place of unloading, and after the completion of deliveries in the current day, the logistics provider sends information about the status of all deliveries. After confirmation of deliveries, invoices are sent to the customer thus completing the order delivery process.

The success of this process is depended upon successfulness of the inventory control process. The inventory control process is a key factor in the success of the delivery and ultimately customer satisfaction. To improve the process of inventory control, it is necessary to identify material flows and their subjects in the process of wholesale delivery. When material flows are defined, accumulation places of the flow's subject should be identified and implemented in the decision-support tool. In this way, a decision-maker has available information about the state of the flow's subject all the time. Based on this information, the planner takes control actions that will affect the state of the flows' subjects, and thus the entire delivery process. Appropriate decision-support tool, for the logistics planner, should enable insight into data relevant for the process (inventory levels, forecasted demand, history sales data, etc.) and generate suggestions of control actions for the decision-making.

4.1 Specification and design of outputs

This stage is oriented toward end-user of the solution being developed i.e. model interpreter. The end-user in this case is the person who uses the output of the model/application for a specific purpose i.e. decision-making. The methodology based on the structured design requires the outputs to be presented on separate worksheets. Since the solutions' main goal is the improvement of the material flows control, users require three types of reports: active sales orders report, replenishment realization report and delivery realization report.

Active sales orders report enables insight into all orders that will be delivered in the upcoming period or that are already in the process of delivery. This report has multiple benefits to the user of the application because it enables insight into deliveries of ordered SKUs in the current and upcoming period, and decision-making upon these deliveries (creating delivery routes, negotiating additional quantities, etc.). The replenishment realization report provides an overview of planned and realized inventory replenishments. The user has available different statuses, which he can use for replenishment orders filtering (by processing, in preparation, transit, realized and unrealized orders) and upon which he can perform various analyses. Delivery realization report provides an insight into realization of deliveries in the previous period. Based on these data the user performs analyses such as: dynamics of deliveries by SKUs, delivery locations, time period of the year, service level, etc.

4.2 Conceptual design of the workings section

Conceptual design of the workings section shows the hierarchical relationship of the model elements and their interconnections. It is created according to the importance of functions and elements in the process itself. The first step is defining of root elements, i.e. elements/functions of the highest level which do not have dependents. On the top of the hierarchy are located the elements of the highest importance, which represent the purpose of the process and below them are added the elements that are their direct predecessors. The main goal of this stage is to visualize instances of multiple dependants of a particular element of the model.

The purpose of developed spreadsheet application is an overview of all data relevant to the specific SKU, which are necessary for decision-making and control of SKUs material flow. Considering that, it is necessary to have available data regarding planned inputs, state of inventory levels and planned outputs for each SKU. Figure 5. shows conceptual design of the workings section.
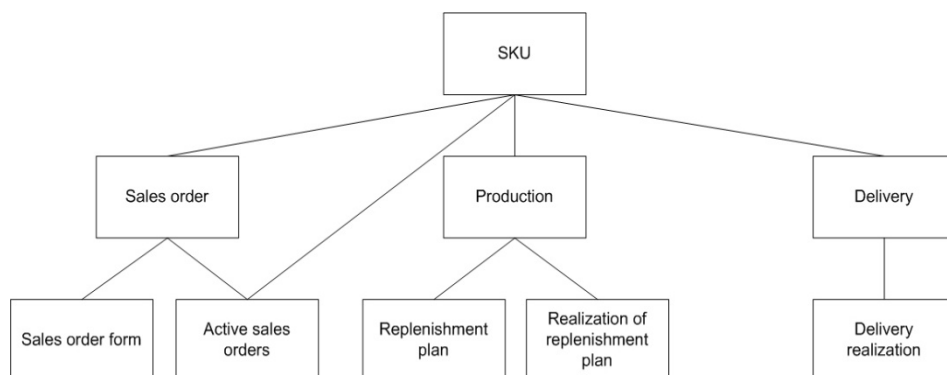

Figure 5: Conceptual design of workings section
(Source: Jeremic et al., 2020)

4.3   Logical design of the workings section

In this stage it is necessary to describe the structure defined in the previous stage in more detail. Given that for complex spreadsheet models, a complex form of a graph can occur when defining a conceptual design, in this step, it is necessary to transform it into a tree form. Thereby, the two rules can be applied (Rajalingham et al., 2008). The first rule introduces duplicating of the elements with more than one dependant, whereby predecessors of these elements are not shown in the model at this stage. The second rule implies that predecessors of duplicated elements should be presented as a separate module in the tree form. Logical design of workings sections of developed spreadsheet application, in accordance with previously described, is shown in Figure 6. In this case, database of active sales orders represents predecessor of two elements – sales order and SKU. Since this element does not have predecessors, there was no need for presenting additional module.
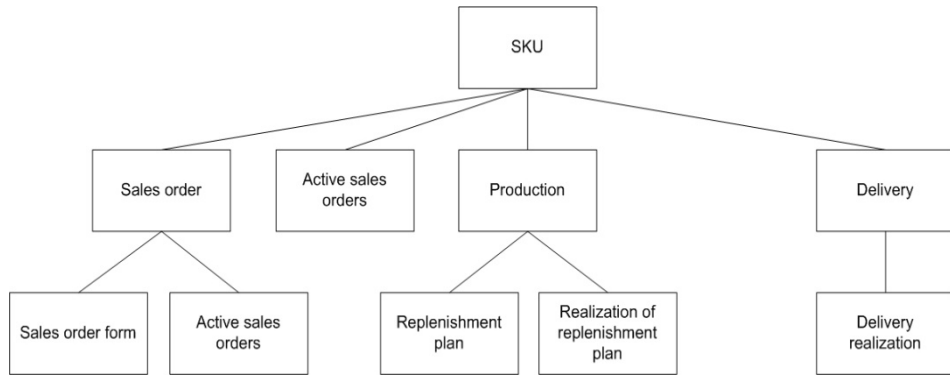
Figure 6: Logical design of workings section
(Source: Jeremic et al., 2020)

4.4   Construction of the workings section structure

Construction of the workings section structure defines how the previously described structure and logic of the model are implemented in the spreadsheet. This stage is based on the indentation principle which is applied to the row labels and its corresponding values. Each value is indented by the assignment of a virtual spreadsheet column for each indentation level. The elements of the same hierarchical level are represented in the same column, whereby each row contains only one function. Since the developed spreadsheet application doesn't have functions that interconnect its elements, Figure 7. represents a modified workings section structure according to the applied structured methodology (Rajalingham et. al., 2008). Since one of the main deficiencies of the existing spreadsheet tool was data overprocessing and the need for a lot of manual work, the new spreadsheet application is implemented with a significant level of work automation through the procedures developed in Visual Basic for Applications.

26

XV. INTERNATIONAL CONFERENCE ON LOGISTICS IN AGRICULTURE 2021
CONFERENCE PROCEEDINGS.

SKU	Procedure		
Sales order		Procedure	
Sales order form			Procedure
Active sales orders			Procedure
Production		Procedure	
Replenishment plan			Procedure
Realization of replenishment plan			Procedure
Delivery		Procedure	
Delivery realization			Procedure
Active sales orders		Procedure	

Figure 7: Construction of the workings section structure
(Source: Jeremic et al., 2020)

Workings section is accessed through the main menu of the application or through the navigation menu which is implemented for each worksheet. By filling the sales order form users activate macro which transfers the data to the workings section. The sales order element considers sales order management. If there are enough inventories of ordered SKU, the user proceeds to the sales order processing. There are three different sales order statuses: pending, ordered, and delivered. Pending status means that the order is recorded but not processed. Ordered status considers that the sales order is processed and that the delivery order is forwarded to the logistics provider. Delivered status is active when the goods are delivered, and its sales order can be archived in the database of realized deliveries. The user manages the sales order status depending on its realization, which is coordinated with the logistics provider.

If there is not enough of ordered goods on stock or its inventory level is below defined safety stock, the user has to place the replenishment order. The replenishment order form is the output of the inventory control model, which is implemented through the spreadsheet application, and it is a part of the production element. Each generated replenishment order has its status: ordered, in preparation, transit, delivered, unrealized. Ordered status means that the replenishment order is recorded, and it is pending for approval from the production department. In preparation status defines that the order is confirmed, and it is in the process of production. Transit status identifies that the order is on its way to the main distribution centre. Unrealized status considers that the order is either rejected from the production unit or it is decided to cancel its realization. All replenishment orders

are presented in two reports, active and archived orders. Active orders report consists of orders which have status pending, in preparation or transit. In the report of archived orders there are the orders with status delivered or unrealized. Depending on the realization of these orders, the user manages their statuses. When the status changes the user has to update the reports, which is done by activating the macro which transfers the data to the appropriate report.

In case when there are enough inventories on stock, the user processes the order through the ERP system, sends delivery order to 3PL partner and changes its status to ordered. After delivery realization, order status should be changed to delivered. By activating the macro from active orders report all delivered orders are archived to delivery realization report.

4.5   Construction of the input section

During this stage, it is important to separate the cells intended for the input of the data, for two reasons. The first one refers to the importance of obtaining accurate input data. The second reason is that data entry cells are often referenced in more than one formula. In this manner possibility of formulae overwriting is reduced, as well as accidental interference of users to the application functioning.

The input section of the developed application consists of two input forms: sales order form and replenishment order form. The sales order form implies following input data: sales order number, requested delivery date, delivery destination, ordered SKUs, the quantity of ordered SKUs. This order form is created considering the clarity and ease of use, but the data arrangement is different than for the working and output section. Therefore, a transition table is implemented in order to prepare the data in the form and formats of destination database. The replenishment order form is the output of the inventory control model that is implemented through this spreadsheet application. This form consists of the following data: ordered SKUs, the quantity of ordered SKUs and the requested loading date.

28

XV. INTERNATIONAL CONFERENCE ON LOGISTICS IN AGRICULTURE 2021
CONFERENCE PROCEEDINGS.

Figure 8: Input interface developed in Visual Basic for Application
(Source: Jeremic et al., 2020)

4.6 Implementation of functions and relationships

This step represents interdependences of model/application elements implemented through calculations and formulas. In this step formulas and calculations needed for the workings section are created. In contrast to the structure of conceptual and logical design of the workings section, in which the top-down approach is applied, this step is based on the bottom-up approach. The bottom-up approach implies moving from the lowest hierarchical levels to the highest during formula creation.

The spreadsheet application, described in this paper, except for the control model, does not have implemented calculations in the form of functions/formulas that interconnect the elements of the application. Simple calculations are used at the level of the working section, while interconnection of application elements is achieved by the implementation of procedures developed in Visual Basic for Application. The procedures fill the workings section and provide the appropriate output based on the given inputs.

SKU	SKUOverview ()		
Sales order		OrdersUpdate ()	
Sales order form			OrderEvidence ()
Active sales orders			OrdersReport ()
Production		RealizedReplenishmentsUpdate ()	
Replenishment plan			ReplenishmentEvidence ()
Realization of replenishment plan			ActiveReplenishmentsUpdate ()
Delivery		DeliveriesUpdate ()	
Realization of delivery			DeliveryEvidence ()
Active sales orders		OrdersReport ()	

Figure 9: Implementation of functions and relationships
(Source: Jeremic et al., 2020)

4.7   Completion of the output section

Completion of the output section is the final stage of the application development and implies definition of the output, based on the previously shown input values and calculations. The output section of the described spreadsheet application consists of several reports which represent records of certain material flows. These reports are related to the elements of the structure diagram: sales order, production and delivery.

The sales order element contains active orders report which gives insight to all active sales orders in one place. This overview can be really useful in determination of trend dynamics according to different criteria. The element production generates two reports related to the realization of the replenishment orders, active orders and archived orders. The active orders represent evidence of the orders that are pending, or they are in the process of realization. This report is divided into three parts related to ordered, in preparation and orders in transit. The archived orders are orders realized or rejected due to various circumstances. The delivery element results in a report of realized deliveries. Based on the data from the report the user can perform a various set of analysis, which can give him valuable information for the process of decision-making.

The newly developed application represents improvement of the existing spreadsheet solution by increased automation, upgraded structure and various reports upon which the user can perform different analyses. One of the greatest benefits is shifting users' focus from manual work to managing the process of frozen fruit delivery, and allowing him to think about the further improvement of both, process and application itself.

References

Abayomi-Alli, A., Arogundade, O., Misra, S., Akala, M., Ikotun, A., Ojokoh, B. (2021). An ontology-based information extraction system for organic farming, Int. J. Semantic Web Inf. Syst., vol. 17, no. 2, pp. 79–99, Apr. 2021, doi: 10.4018/IJSWIS.2021040105.

Alojairi, A. (2017). The Dynamics of IT Workaround Practices - A Theoretical Concept and an Empirical Assessment. International Journal of Advanced Computer Science and Applications, 2017, 8(7), 527-534.https://doi. org/10.14569/IJACSA.2017.08077.

Antic, S. (2014). Models and methods of inventory control based on metaheuristics, (in Serbian: Modeli i metode upravljanja zalihama zasnovani na metaheuristikama). Doctoral dissertation, Belgrade: Faculty of Organizational Sciences.

Antic, S. (2018). Digitalization in Agriculture: Digital Revolution in Agriculture – Industry 4.0, XII. In *Conference Proceedings of the International Conference on Logistics in Agriculture 2018*, University Press, University of Maribor, Faculty of Logistics, pp. 53-68, ISBN 978-961-286-213-8 (pdf) doi: 10.18690/978-961-286-213-8.

Armanda, D.T.; Guinée, J.B.; Tukker, A. (2019). The second green revolution: Innovative urban agriculture's contribution to food security and sustainability. A review. Glob. Food Sec. 2019, 22, 13–24.

Azad, B., King, N. (2012). Institutionalized Computer Workaround Practices in a Mediterranean Country: an Examination of Two Organizations. European Journal of Information Systems, 2012, 21(4), 358-372.https://doi. org/10.1057/ejis.2011.48.

Behrens, S. (2009). Shadow Systems: The Good, the Bad and the Ugly. Communications of the ACM, 52(2), 124- 129. https://doi.org/10.1145/1461928.1461960.

Brzeski, A., Grinholc, K., Nowodworski, K., Przybyłek, A. (2019). Evaluating performance and accuracy improvements for attention. Computer Information Systems and Industrial Management, Switzerland: Springer, 2019, pp. 3–11.

Ciruela-Lorenzo, A. M., Del-Aguila-Obra, A. R., Padilla-Meléndez, A., & Plaza-Angulo, J. J. (2020). Digitalization of agri-cooperatives in the smart agriculture context. proposal of a digital diagnosis tool. Sustainability, 12(4), 1325. doi: 10.3390/su12041325.

Corallo, A., Latino, M., Menegoli, M. (2020). Agriculture 4.0: How use traceability data to tell food product to the consumers, in Proc. 9th Int. Conf. Ind. Technol. Manage. (ICITM), pp. 197–201, doi: 10.1109/ICITM48982.2020.9080349.

Chamola, V., Hassija, V., Gupta, V., & Guizani, M. (2020). A comprehensive review of the COVID-19 pandemic and the role of IoT, drones, AI, blockchain, and 5G in managing its impact. *IEEE Access, 8*, 90225-90265. doi:10.1109/ACCESS.2020.2992341.

Chua, C. E. H., Storey, V. C., Chen, L. (2014). Central IT or Shadow IT? Factors Shaping Users' Decision to Go Rogue With IT. Proceedings of the 35th International Conference on Information Systems, 2014, 1-14. Atlanta: The Association for Information Systems.

Despommier, D. (2010). The Vertical Farm: Feeding World 21St Century. New York, NY, USA: Macmillan.

De Clercq, M., Vats, A., Biel, A. (2018). Agriculture 4.0: The future of farming technology. Proc. World Government Summit, Dubai, (UAE), Feb. 2018, pp. 11–13.

Dhamija, P., & Bag, S. (2020). Role of artificial intelligence in operations environment: a review and bibliometric analysis. The Total Quality Management Journal, Emerald Publishing, 32(4), 869-896. doi:10.1108/TQM-10-2019-0243.

Diver, S., Rinehart, L. (2000). Aquaponics - Integration Hydroponics With Aquaculture. Gurgaon, India: Attra.

Erfani, S., Jafari, A., Hajiahmad, A. (2019). Comparison of two data fusion methods for localization of wheeled mobile robot in farm conditions. Artif. Intell. Agricult., vol. 1, pp. 48–55, Mar. 2019, doi: 10.1016/ j.aiia.2019.05.002.

Ferneley, E. H., Sobreperez, P. (2006). Resist, Comply or Workaround An Examination of Different Facets of User Engagement with Information Systems. European Journal of Information Systems, 2006, 15(4), 345-356. https://doi.org/10.1057/palgrave.ejis.3000629.

FAO (2020). Responding to the impact of the COVID-19 outbreak on food value chains through efficient logistics. Rome. https://doi.org/10.4060/ca8466en.

Gadhave, R., Das, A., Mahanwar, A., Gadekar, P. (2018). Starch based bio-plastics: The future of sustainable packaging, Open J. Polym. Chem., vol. 8, no. 2, pp. 21–33, 2018, doi: 10.4236/ojpchem.2018.82003.

Gentry, R., Froehlich, H., Grimm, D., Kareiva, P., Parke, M., Rust, M., Gaines, S., Halpern, B. (2017). Mapping the global potential for marine aquaculture, Nature Ecol. Evol., vol. 1, no. 9, pp. 1317–1324, 2017, doi: 10.1038/s41559-.017-0257-9.

Györy, A. A. B., Cleven, A., Uebernickel, F., Brenner, W. (2012). Exploring The Shadows: IT Governance Approaches To User-Driven Innovation. European Conference of Information Systems. Association for Information Systems.

Haag, S., Eckhardt, A., Bozoyan, C. (2015). Are Shadow System Users the Better IS Users - Insights of a Lab Experiment. 36th International Conference on Information Systems, 1-20.

Hall, M.C., Prayag, G., Fieger, P., Dyason, D. (2020). Beyond panic buying consumption displacement and COVID-19. J. Serv. Manag. https://doi.org/10.1108/JOSM-05- 2020-0151.

Hobbs, J. E. (2020). Food supply chains during the COVID-19 pandemic. Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie, 68(2), 171-176. doi:10.1111/cjag.12237.

ILO. 2020. COVID-19 and World of Work: Impacts and Policy Responses. International Labour Organisation. March 18. https://www.ilo.org/wcmsp5/groups/public/dgreports/ dcomm/documents/briefingnote/wcms_738753.pdf.

Ishwarappa I., Anuradha, J. (2015). A brief introduction on big data 5 Vs characteristics and Hadoop technology. Procedia Comput. Sci., vol. 48, pp. 319–324, Jan. 2015, doi: 10.1016/j.procs.2015.04.188.

Ivanov, D. (2020). A blessing in disguise'or 'as if it wasn't hard enough already': reciprocal and aggravate vulnerabilities in the supply chain. International Journal of Production Research, 58(11), 3252-3262. doi: 10.1080/00207543.2019.1634850.

Javaid, M., Haleem, A. (2019). Using additive manufacturing applications for design and development of food and agricultural equipments. Int. J. Mater. Product Technol., vol. 58, nos. 2–3, pp. 225–238, 2019, doi: 10.1504/IJMPT.2019.097662.

Jeremic, U, Djordjevic Milutinovic, L., Antic, S., (2020). Spreadsheet model for inventory control of frozen fruit. Symorg 2020.

Jones, B. (2016). Hydroponics: A Practical Guide for Soilless Grower. Boca Raton, FL, USA: CRC Press.

Jung, T., Dieck, M. (2018). Augmented reality and virtual reality, Empowering Human, Place Business. Cham, Switzerland: Springer.

Kerr, D. V., Houghton, L., Burgess, K. (2007). Power Relationships That Lead To the Development of Feral Systems. Australasian Journal of Information Systems,14(2),141-152.https://doi.org/10.3127/ajis.v14i2.473.

Kerr, D., Houghton, L. (2010). Just in Time or Just in Case: A Case Study on the Impact of Context in ERP Implementations. Australasian Journal of Information Systems, 16(2), 5-16. https://doi.org/10.3127/ajis.v16i2.549.

King, N., Azad, B. (2014). Feral Systems as Institutional Phenomena: A Framework for Analyzing Persistent Computer Workarounds. In Kerr, D. V., Burgess, K., Houghton, L. (Eds.), Feral Information Systems Development: Managerial Implications, 2014, 43-67.https://doi. org/10.4018/978-1-4666-5027-5.ch003.

Lezoche, M., Hernandez, J., Alemany Díaz, M., Panetto, H., and Kacprzyk, J. (2020). Agri-food 4.0: A survey of the supply chains and technologies for the future agriculture, Comput. Ind., vol. 117, May 2020, Art. no. 103187, doi: 10.1016/j.compind.2020. 103187.

Marusak, A., Sadeghiamirshahidi, N., Krejci, C., Mittal A., Beckwith, S., Cantu, J., Morris, M., Grimm J. (2021). Resilient regional food supply chains and rethinking the way forward: Key takeaways from the COVID-19 pandemic. Agricultural Systems, https://doi.org/10.1016/j.agsy.2021.103101.

Morgan, T. (2020). Some Growers Plow Under Fields As Fruit, Vegetable Demand Disappears - AgWeb. Retrieved from: [WWW document]. URL. https://www.agweb. com/article/some-growers-plow-under-fields-fruit-vegetable-demand-disappears.

Mittal, A., Krejci, C.C., Craven, T.J. (2018). Logistics best practices for regional food systems: a review. Sustain. https://doi.org/10.3390/su10010168.

Nayal, K., Raut, R. D., Queiroz, M. M., Yadav, V. S., & Narkhede, B. E. (2021). Are artificial intelligence and machine learning suitable to tackle the COVID-19 impacts? An agriculture supply chain perspective. The International Journal of Logistics Management. doi: 10.1108/IJLM-01-2021-0002.

Oruma S., Sanjay, M., Luis, F., S. (2021). Agriculture 4.0: An Implementation Framework for Food Security Attainment in Nigeria's Post-Covid-19 Era, IEEE Acces, Volume 9.

O'Sullivan, C.A., Bonnett, G.D., McIntyre, C.L., Hochman, Z., Wasson, A.P. (2019). Strategies to improve the productivity, product diversity and profitability of urban agriculture. Agric. Syst. 174, 133–144.

O'Sullivan, C.A., McIntyre, C.L., Dry, I.B., Hani, S.M., Hochman, Z., Bonnett, G.D. (2020). Vertical farms bear fruit. Nat. Biotechnol. 38, 160–162.

Pulighe, G., & Lupia, F. (2020). Food first: COVID-19 outbreak and cities lockdown a booster for a wider vision on urban agriculture. *Sustainability*, 12(12), 5012. doi:10.3390/su12125012.

Raman, R. (2017). The impact of genetically modified (GM) crops in modern agriculture: A review. GM Crops Food, vol. 8, no. 4, pp. 195–208, Oct. 2017, doi: 10.1080/21645698.2017.1413522.

Remko, V. H. (2020). Research opportunities for a more resilient post-COVID-19 supply chain– closing the gap between research findings and industry practice. International Journal of Operations & Production Management, 40(4), 341-355.

Rajalingham, K., Chadwick, D., & Knight, B. (2008). An Evaluation of a Structured Spreadsheet Development Methodology. arXiv preprint arXiv:0801.1516.

Raković, L., Sakal, M., Matković, P., Marić, M. (2020). Shadow IT – A Systematic Literature Review. Information Technology and Control, 49(1), 144-160. https://doi.org//10.5755/j01.itc.49.1.23801

Rentrop, C., Zimmermann, S. (2019). Shadow IT Evaluation Model. Federated Conference on Computer Science Information Technology and Control 2020/1/49 159 and Information Systems (FedCSIS), 2012b, 1023-1027.

Rogoff, J. (2014). Improving Systems of Distribution and Logistics for Regional Food Hubs:The Central Appalachian Network. The Department of Urban Studies and Planning, Massachusetts Institute of Technology: Cambridge, MA, USA, Abingdon, VA, USA.

Shamshiri, R., Kalantari, F., Ting, K., Thorp, K., Hameed, I., Weltzien, C, Ahmad, D., Shad, Z. (2018). Advances in greenhouse automation and controlled environment agriculture: A transition to plant factories and urban agriculture," Int. J. Agricult. Sci. Biol. Eng., vol. 11, no. 1, pp. 1–22.

Singh, S., Kumar, R., Panchal, R., & Tiwari, M. K. (2021). Impact of COVID-19 on logistics systems and disruptions in food supply chain. International Journal of Production Research, 59(7), 1993-2008. doi:10.1080/00207543.2020.1792000.

Song, S., Goh, J. C., & Tan, H. T. (2021). Is food security an illusion for cities? A system dynamics approach to assess disturbance in the urban food supply chain during pandemics. Agricultural Systems, 189, 103045. doi:10.1016/j.agsy.2020.103045.

Spierings, A., Kerr, D., Houghton, L. (2014). What Drives the End User to Build a Feral Information System. In Feral Information Systems Development: Managerial Implications, 161-188. https://doi.org/10.4018/978-1- 4666-5027-5.ch008.

Sterman, J. (2000). Business dynamics: Systems Thinking and Modeling for a Complex World. McGraw-Hill, Inc.

Stephens, N., Di Silvio, L., Dunsford, I., Ellis, M., Glencross, A., Sexton, A. (2018). Bringing cultured meat to market: Technical, socio-political, and regulatory challenges in cellular agriculture,' Trends Food Sci. Technol., vol. 78, pp. 155–166, Aug. 2018, doi: 10.1016/j.tifs.2018.04.010.

Shafi, U., Mumtaz, R., García-Nieto, J., Hassan, S., Zaidi, R., Iqbal, N. (2019). Precision agriculture techniques and practices: From considerations to applications, Sensors, vol. 19, no. 17, p. 3796, Sep. 2019, doi: 10.3390/s19173796.

Sharma, R., Parhi, S., & Shishodia, A. (2021). Industry 4.0 applications in agriculture: cyber-physical agricultural systems (CPASs). In Advances in Mechanical Engineering (pp. 807-813). Springer, Singapore. doi:10.1007/978-981-15-3639-7_97.

Tajul, S., Molla, A. (2016). The Exploratory Study of ERP Systems Usage Problem and its Coping Mechanism: The Deployment of Feral System. Qualitative Research Conference (QRC).

Tambo, T., Olsen, M., Bækgaard, L. (2016). Motives for Feral Systems in Denmark. In Kerr, D. V., Burgess, K., Houghton, L. (Eds.), Web Design and Development: Concepts, Methodologies, Tools, and Applications, 193-222. https://doi.org/10.4018/978-1-4666-8619-9.ch010.

USDA, (2020). Open Ag Transport Data [WWW Document]. URL. https://agtransport.us da.gov/d/acar-e3r8/visualization.

Yaffe-Bellany, D., Corkery, M., (2020). Dumped milk, smashed eggs, plowed vegetables: food waste of the pandemic. The New York Times. Retrieved from: [WWW document]. URL. https://www.nytimes.com/2020/04/11/business/coronavirus-d estroying-food.html.

Venuto, D. (2020). Covid-19 Coronavirus Lockdown: Your Panic Buying is Putting Other Kiwis at Risk. Retrieved from: https://www.nzherald.co.nz/business/news/article.

Vogt, J. J. (2010). The successful cross‐dock based supply chain. Journal of Business Logistics, 31(1), 99-119.

Wamba, S. F., Gunasekaran, A., Papadopoulos, T., & Ngai, E. (2018). Big data analytics in logistics and supply chain management. The International Journal of Logistics Management. Emerald Publishing, 29(2), 478-484. doi:10.1108/IJLM-02-2018-0026.

Workie, E., Mackolil, J., Nyika, J., & Ramadas, S. (2020). Deciphering the impact of COVID-19 pandemic on food security, agriculture, and livelihoods: A review of the evidence from developing countries. Current Research in Environmental Sustainability, 100014. doi:10.1016/j.crsust.2020.100014.

Zimmermann, S., Rentrop, C., Felden, C. (2014). Managing Shadow IT Instances - A Method to Control Autonomous IT Solutions in the Business Departments. Americas Conference of Informantion Systems, 1-12.