VILNIUS TECH
Vilnius Gediminas Technical University

25-osios Lietuvos jaunųjų mokslininkų konferencijos „Mokslas – Lietuvos ateitis“ teminė konferencija
Proceedings of the 25th Conference for Junior Researchers “Science – Future of Lithuania”

EKONOMIKA IR VADYBA / ECONOMICS AND MANAGEMENT

2022 m. spalio 13 d., Vilnius, Lietuva
13 October 2022, Vilnius, Lithuania

eISSN 2029-7149
eISBN 978-609-476-311-3
Article Number: vvf.2022.032

Šiuolaikinio verslo aktualijos / Actualities of Modern Business

http://jmk.vvf.vilniustech.lt

OVERVIEW OF RISK ASSESSMENT MODELS IN MEDICAL SUPPLY CHAINS

Alma ČERKAUSKIENĖ*, Ieva MEIDUTĖ-KAVALIAUSKIENĖ

Department of Business Technologies and Entrepreneurship, Business Managenment Faculty, Vilnius Gediminas Technical University, Saulėtekio al. 11, 10223 Vilnius, Lithuania
**E-mail: alma.cerkauskiene@vilniustech.lt*

Received 5 March 2022; accepted 29 June 2022

Abstract. Supply chain risks are a widely studied topic, but there is a lack of research in the healthcare sector. The aim of this paper is to review the research that has been carried out on risk assessment models and methods. As supply chain risks increase the vulnerability of the supply chain, it is important to analyse existing research. In this context, new risk assessment models can be developed to prevent potential problems. The literature analysis shows that evaluation models can be categorised into: a) methods for evaluating supply chain processes across the sector; b) models for evaluating internal hospital processes. The methods are chosen taking into account the highest risks and the longest lasting risks. Multi-criteria evaluation approaches are the most studied in the literature.

Keywords: supply chain, risk assessment models, healthcare sector.

Introduction

The supply chain in healthcare is not only about the procurement and logistics of medicines and medical supplies. It is also about the people, processes, information, resources, and maintenance of a healthcare facility to provide healthcare services. The aim is to improve treatment outcomes, patient/customer experience and optimise financial cost efficiency. It must also be taken into account that the healthcare supply chain is dependent on the collaboration of stakeholders (Beldek et al., 2019).

Researchers recognise that the acceleration of globalisation and digitalisation has made supply chains more complex, less transparent and thus more vulnerable to various threats. This means that any company with weak supply chain process management controls may be exposed to threats (Vidrova, 2020).

The topic of supply chain risk management is becoming an increasingly important research area. There may be various reasons for increasing supply chain vulnerability. As a consequence, both private companies and public companies have started to look for ways to implement a proper risk management programme (Gurtu & Johny, 2021). Although efforts are being made to standardise supply chain risk assessment, targeted methodologies are still lacking (Choudhary et al., 2022).

The aim of this paper is to analyse the literature on supply chain risk management models and approaches. The focus of this paper is on the analysis of the proposed models and approaches in order to identify the most useful models. It also aims to find out what is most lacking in supply chain risk assessment.

The topic of risk assessment is not widely addressed in the supply chain. There is a paucity of research on risk assessment models in the healthcare sector. The uncertainty and ambiguity of the supply chain is increasing due to increasing globalisation and complexity. Risks to the supply chain thus increase the vulnerability of the supply chain. This means that the supply chain is increasingly weakened by risk, and risk threatens the sustainability of the chain. As the causes of risks in the supply chain are diverse, so too are the consequences of risks in the supply chain.

Articles from WoS and Scopus databases were selected for analysis. A total of 50 articles were selected for analysis. The keyword method was used to select the articles. The selected articles were divided into two groups. In writing the

review, one part deals with articles on supply chain risk management models in general. The next part of the review looks at risk assessment models in the healthcare sector.

The analysis of the selected studies divided the risk assessment models into models for internal risk assessment and external supply chain risk assessment.

1. Models of supply chain risk assessment

As we know, supply chain risks can be internal and external. The models considered in the literature can also be divided into: a) supply chain internal risk assessment; b) supply chain external risk assessment.

Table 1 provides a breakdown of risk assessment models by internal and external risk.

Table 1. The risk assessment models by internal and external risk

Internal risks	External risks
Decision-making processes in supply chain	Supply chain resilience
Collaborative and communication in supply chain	Supply chain agility
	Supply chain visibility

Addressing the most complex and longest-lasting risks aims to make the supply chain as stable and resilient as possible. Based on the literature analysis, it is evident that researchers have made considerable efforts to find the most appropriate model for building supply chain resilience.

Supply chain risks are increasing or supply chains are completely stuck without taking into account regional differences and changes. The literature proposes a text mining-based framework for global supply chain risk management. This model is based on the literature analysed and on the application of statistical analysis techniques. Based on the results obtained, a risk categorisation covering a total of seven types of global supply chain risks and the main risk factors was developed, together with a sentiment analysis to identify the pattern of risk variation. The results of the risk hierarchy and sentiment analysis can contribute to a better understanding of regional global supply chain risks (Chu et al., 2020).

Supply chain resilience is a set of measures to prepare in advance for unforeseen events and to minimise negative impacts. It also enables rapid recovery of disrupted operations. A study was carried out to investigate the link between supply chain risk management and supply chain collaboration. The study showed that there is a link between these actors. The authors conclude that it is important to prioritise risk assessment in order to build a resilient supply chain (Syahchari et al., 2022). Another factor that has prompted research on supply chain resilience is major natural and pandemic disasters. Researchers are developing resilience frameworks that can keep supply chains up and running (Piprani et al., 2022). A mediation model can also be used to increase supply chain resilience. This model combines the risk information processing capabilities of the supply chain with the financial side of the supply chain. The study shows that risk information processing has a positive impact on both the financial and resilience aspects of the supply chain (Yaqin & Li, 2021).

Cooperation is another important factor in the functioning of the supply chain. Disruptions to cooperation can be a risk to supply chain performance. Collaborative planning practices are more useful in architecture or construction. However, according to the findings of the study, this practice can be applied in all areas. Ineffective communication, lack of coordination, failure to meet schedules disrupt the supply chain in all areas (Elsayegh & El-adaway, 2022). Against the backdrop of increasing globalisation, the companies involved in the supply chain have become fragmented. A negative consequence of this phenomenon is that supply chain disruptions spread rapidly and affect other parts of the chain. As a result, the interdependence of the firms involved in the supply chain must be modelled (Blos & Miyagi, 2015).

An examination of the research carried out by the researchers shows that it is possible to analyse the model in terms of the relationship between supply chain integration, supply chain risk and supply chain performance (Chienwattanasook & Jermsittiparsert, 2018).

In the context of examining supply chain process risk, the researchers present a study that examines the impact of horizontal inter-organisational agreements on inventory costs in hospitals and the uncertainty in clinical demand faced by the hospital. The model is based on comprehensive data from hospitals in the State of California. The results of the study suggest that these arrangements may influence managers' confidence in their supply chains, which in

turn influences stockpiling. The results also show that joining the system can increase operational efficiency (Zepeda et al., 2016).

Dr. Meike Schröder, examines and proposes a supply chain maturity model. There is a shortage of models that can quickly assess supply chain risks. The results of the study showed that companies lack the skills and capabilities to assess supply chain risks (2017).

Another part of the models studied by researchers is the assessment of supply chain agility. The supply chain consists of production, logistics and transport operations. These processes aim to best meet the needs of the end-user, maximise the company's revenue and reduce costs and inventories. Unfortunately, supply chain processes can be disrupted by various unforeseen changes. S. Boubaker with team proposes a model for assessing supply chain agility (Boubaker et al., 2022).

In addition, supply chain agility can be examined from a different perspective. It is possible to assess the impact of supply chain flexibility on supply chain agility. The relationship can be assessed using the framework developed by Jamal et al. The study shows that there is a link between supply chain flexibility, collaboration and agility. Moreover, supply chain agility can be identified as an externally oriented capability. It can also have a competitive advantage (Jamal et al., 2019).

Another large and important group of risk assessment models are those that assess the impact of information technology and digital supply chain risk assessment. The digitalisation process has brought a number of benefits to businesses and supply chain processes. However, these processes have also brought new threats to supply chains. Risk management should be a major focus in order to avoid losses in the digital supply chain. The results of the study show that the internal risks facing digital supply chains include technological and cyber security risks, as well as systemic risks involving digital systems. In addition, digital supply chain risks can be analysed on a technological basis (Özkanlısoy & Akkartal, 2020).

Table 2 provides the distribution of risk assessment models by risk and author.

Table 2. The distribution of risk assessment models by risk and author

Author	Risk assessment model
Rehman and Ali (2022); Syahchari et al. (2022); Piprani et al. (2022); Yaqin et al. (2022); Wilding (2021); Warmbier and Kinra (2022); Zahid et al. (2020); Marmolejo and Hartmann-Gonzalez (2021)	Supply chain resilience
Lancharoen et al. (2020); Lo et al. (2021)	Analytic network process method for decision-making
Alzahrani et al. (2022); Chavez et al. (2020)	Assessment of the blockchain technology and digitalisation
Elsayegh and El-adaway (2022); Jamal et al. (2019); Göleç and Karadeniz (2020)	Assessment of implementing collaborative planning practises
Shashi and Gossett (2022); Gomez and Espana (2020)	Supply chain network for pharmaceutical products
Messina et al. (2022); Taghizadeh et al. (2021)	Supply chain visibility assessment
Boubaker et al. (2022); Shashi and Gossett (2022)	Supply chain agility assessment
Curbelo et al. (2019)	Dependency in supply chain risk assessment

2. Models of supply chain risk assessment in healthcare

The analysis of the efficiency of supply chain management in healthcare facilities has become crucial in recent years as healthcare systems have started to struggle to improve operational efficiency and reduce costs. A study was therefore carried out to assess healthcare supply chain management through a competency-based performance assessment. For this purpose, a fuzzy model was developed to assess the performance of healthcare supply chain management through competency-based operational assessment. Healthcare services are provided by many interrelated business processes in the supply chain. The process should add value to the service by eliminating waste and unnecessary costs. Processes should also add value to customers throughout the supply chain. A process perspective is essential and provides a basis for understanding the detailed organisation of operations and the services provided by healthcare systems. The supply chain constructs the link between processes and performance, consisting of the company's internal and external customers and suppliers (Göleç & Karadeniz, 2020).

One of the models being explored by researchers is supply chain resilience. Strategies are developed to find the most important factors that have a significant impact on supply chain resilience. Rehman and Ali (2022) identified multi-criteria assessment methods in their study.

Spanish researchers (Flores et al., 2016) carried out an evaluation of three risk adjustment systems. This was in the form of an assessment of predictors of consumption of medicines and medical supplies in polyclinics. The use of medicines and medical supplies is an important part of healthcare expenditure and is closely linked to the quality of care and the efficient allocation of resources.

Researchers at a hospital in Thailand (Lancharoen et al., 2020) conducted a large study assessing the readiness to integrate information in a hospital using an analytic network process approach to decision-making in a health-care network. Three capability factors were found to have a significant impact on information integration and hospital performance. The model analysis suggests that the identified capability factors (organisational, group and individual) should be refined in the context of information integration used to assess performance in healthcare, and that this risk assessment may be useful in other relevant industries.

The pharmaceutical sector is an important part of the healthcare supply chain. It goes beyond the manufacture and supply of medicinal products. Ahlaqqach et al. (2020), proposed a new model to develop a sustainable closed-loop network of location-based supply chain routes, taking the pharmaceutical product life cycle as a model. This model aims to generate economic benefits, increase corporate social responsibility through job creation and reduce the risks arising from the transport of end-of-life products (medical waste generated after the expiry of pharmaceutical products and their use in health care centres). Disruptions affect the pharmaceutical supply chain. Researchers Shashi and Gossett conducted a study to investigate how digitalisation can help reduce supply chain disruption. Digitalisation systems have a positive impact on supply chain agility and flexibility, making the supply chain resilient to unexpected events (Shashi & Gossett, 2022). In the pharmaceutical part of the supply chain, it is important to pay attention to the shelf life of products. For this purpose, a new multi-objective model was proposed to develop a coherent closed-loop network of location-based supply chain routes, tailored to the shelf life of pharmaceutical products. It is considered that this model could be useful to achieve cost-effectiveness and increased social responsibility (Ahlaqqach et al. 2020). Many supply chain disruptions in healthcare are caused by product recalls. In the absence of reliable tracking of deliveries, it is difficult to recall or safely dispose of products. In this context, practitioners are looking for ways and developing models to ensure safe and timely product recalls. In addition, the right models and strategies would benefit communication and proper supply chain operations (Jayaraman et al., 2019). Risks in the medicines supply chain can affect not only an organisation's bottom line but also people's lives. This is a very important reason to manage risks in the supply chain. There are many approaches to supply chain risk management that focus on operational risks. These approaches aim to reduce or eliminate the most important risks in order to achieve the results expected from the chain. In their study, researchers Gomez and Espana present a methodological approach to eliminate or mitigate key risks through the application of ontologies and the implementation of fuzzy quality functions (FQFD) (Gomez & Espana, 2020).

A study on the circulation of products in the supply chain and their recall if necessary was carried out by Jayaraman and team (2019). Product recalls in the healthcare industry cause major supply chain disruptions. In the absence of reliable product tracking, communicating recall information and recovering or safely disposing of the product is very challenging. Healthcare product recalls are usually classified according to the severity of the impact on the patient's life, a classification that often does not help the supply chain community to assess the impact of recalls and to develop alternative supply strategies. Therefore, it is essential to assess and review health-care product recalls with a focus on the supply chain and logistics (Jayaraman et al., 2019).

There is a lack of comprehensive studies and models in the literature to assess the ability of healthcare organisations to work with blockchain technology. A literature review of academic papers shows that a number of models have been applied in the healthcare supply chain to assess the application of blockchain technologies (Alzahrani et al., 2022).

One of the studies carried out was on how the blockchain ensures transparency and governance in the organ supply chain. The blockchain seems to be suitable for organ supply chain management. However, given some of the challenges (such as data security and ethical requirements), there is a need to develop models that ensure transparency of the supply chain (Chavez et al., 2020). The healthcare sector generates a huge amount of data. However, there is a lack of capacity to manage and analyse the data properly and filter out irrelevant information. In addition, understanding trends based on data-driven insights helps pharmaceutical companies and hospitals to develop automation systems to improve the relationship with their customers/patients and to improve their competitive advantage, as well as strategic supply chain planning (Salau, 2022). Blockchain technology has the potential to increase security and reliability, and is transparent and private. As a result, this technology is becoming valued

in all areas. In healthcare, blockchain technology is very complex. The abundance of records and the circulation of confidential data creates a risk of privacy breaches (Aguiar et al., 2021). Researchers Balasubramanian and his team looked at how the healthcare system will prepare to adopt blockchain systems. The study found that large organisations are more willing to adopt and take advantage of blockchain technologies. It should be noted that an appropriate regulatory framework and privacy issues need to be put in place to accelerate the uptake of the technology (Balasubramanian et al., 2021).

When it comes to assessing the use of technology in the healthcare sector, researchers highlight the IoT security risk management model. IoT technologies have made medical devices a point of breach. The healthcare environment is at risk. Therefore, researchers propose an IoT security risk management model that could ensure safe operation in healthcare (Zakaria et al., 2019).

3. Methods in supply chain risk assessment

The methods are chosen taking into account the highest risks and the longest lasting risks.

When developing risk assessment models, it is always important to clarify the factors, causes and elements needed to make the model relevant and functional.

To do this, evaluation methods are used. Multi-criteria evaluation methods shall be used in situations where a supplier selection problem needs to be addressed. The Analytical Hierarchy Process (AHP) method is used to evaluate the criteria, and the list of suppliers is compiled using the Rank Order Preference by Similarity to Ideal Solution (TOPSIS), Simple Added Weight (SAW) method. As the processes become more complex, hybrid methods are also being developed which provide a uniform ranking of the best supplier selection (Akcan & Güldeş, 2019).

Supplier selection and transport planning are among the most important tasks in supply chain management. The selection of the right supplier is important for transport planning. There are few studies in the literature that simultaneously address the issues of supplier selection and transport planning. The researchers' study proposes a two-stage multi-criteria decision-making approach for sustainable supplier evaluation and transport planning in complex supply chains. The results of the study show that this approach can effectively assess the sustainable performance of suppliers and optimise transport planning in complex supply chains (Lo et al., 2021)

Health system technologies are used extensively and require a wide range of medical equipment. The challenge for equipment manufacturers here is how to ensure smooth cooperation with both raw material suppliers and product delivery. Decision-making methodology is again used to ensure this process. It is based on the Delphi approach and the Dematel approach (Bhalaji et al., 2021).

Conclusions

The literature reviewed shows that supply chain risk assessment is a topic of interest, but the search for appropriate assessment models is still ongoing. In the past, as interest in this topic has grown, the factors of cooperation and communication that influence the supply chain have been examined. Recent research shows that there is now a shift towards technology assessment for supply chain risk management. The aim is also to assess supply chain resilience and visibility. These factors are difficult to assess and therefore represent a niche for researchers to explore.

An analysis of the literature has revealed that there are few studies examining supply chain risk management in the healthcare sector. The research and publications found show that the topic of supply-side management resilience is the most addressed. Looking for to ensure cooperation in the selection of suppliers. Also, there is a growing body of research on the impact of technology, digitization processes on the emergence of risks in the supply chain. In addition, a significant amount of research has been conducted to assess the risks of the pharmaceutical supply chain. The researchers singled out several models. Emphasis is placed on timely product delivery, raw material and production assurance.

It can also be unequivocally stated that supply chain risk assessment uses multi-criteria assessment methods.

It should be noted that the supply chain is fraught with challenges, with many organisations interacting, making it difficult to ensure an efficient and functional supply chain.

There is a lack of studies and models in the academic literature to analyse and assess the impact of risks. Not only is there a lack of research in the healthcare sector, but the topic in general has received little research attention.

References

Aguiar, E. J., Faical, B. S., Krishnamachari, B., & Ueyama, J. (2021). A survey of blockchain-based strategies for healthcare. *ACM Computing Surveys*, *53*(2), 1–27. https://doi.org/10.1145/3376915

Ahlaqqach, M., Benhra, J., Mouatassim, S., & Lamrani, S. (2020). Closed loop location routing supply chain network design in the end of life pharmaceutical products. *Supply Chain Forum: An International Journal, 21*(2), 79–92. https://doi.org/10.1080/16258312.2020.1752112

Akcan, S., & Güldeş, M. (2019). Integrated multicriteria decision-making methods to solve supplier selection. *Journal of Healthcare Engineering, 2019*. https://doi.org/10.1155/2019/5614892

Alzahrani, S., Daim, T., & Choo, K. K. R. (2022). Assessment of the Blockchain technology adoption for the management of the electronic health record systems. *IEEE Transactions on Engineering Management*. https://doi.org/10.1109/TEM.2022.3158185

Balasubramanian, S., Shukla, V., Sethi, J. S., Islam, N., & Saloum, R. (2021). A readiness assessment framework for blockchain adoption: a healthcare case study. *Technological Forecasting and Social Change*, *165,* 120536. https://doi.org/10.1016/j.techfore.2020.120536

Beldek, T., Konyalioglu, A. K., & Akdag, H. C. (2019). Supply chain management in Healthcare: A literature review. In *Lecture Notes in Mechanical Engineering* (pp. 570–579). Springer. https://doi.org/10.1007/978-3-030-31343-2_50

Bhalaji, R. K. A., Sankaranarayanan, B., Alam, S. H., Hossain, N. U. I., Ali, S. M., & Karuppiah, K. (2021). A decision support model for evaluating risks in a collaborative supply chain of the medical equipment manufacturing industry. *Supply Chain Forum: An International Journal, 23*(3), 227–251. https://doi.org/10.1080/16258312.2021.1989268

Blos, M. F., & Miyagi, P. E. (2015). Modeling the supply chain disruptions: A study based on the supply chain interdependencies. *IFAC-Papers OnLine, 48*(3), 2053–2058. https://doi.org/10.1016/j.ifacol.2015.06.391

Boubaker, S., Jemai, Z., Sahin, E., & Dallery, Y. (2022). A supply chain flow model to assess agility in supply chains. *International Journal of Production Research.* https://doi.org/10.1080/00207543.2021.2010143

Chavez, N., Kendzierskyj, S., Jahankhadi, H., & Hosseinian, A. (2020). Securing transparency and governance of organ supply chain through blockchain. In *Advanced Sciences and Technologies for Security Applications* (pp. 97–118). Springer.

Chienwattanasook, K., & Jermsittiparsert, K. (2018). Supply chain integration, supply chain risk practices and supply chain performance: A contingent view. *Logistic & Supply Chain Management, 34*(86), 2160–2177.

Choudhary, N. A., Singh, S., Schoenherr, T., & Ramkumar, M. (2022). Risk assessment in supply chains: A state-of-the-art review of methodologies and their applications. *Annals of Operations Research*, *2022*. https://doi.org/10.1007/s10479-022-04700-9

Chu, C. Y., Park, K., & Kremer, G. E. (2020). A global supply chain risk management framework: An application of text-mining to identify region-specific supply chain risks. *Advanced Engineering Informatics*, *45*, 101053. https://doi.org/10.1016/j.aei.2020.101053

Curbelo, A. D., Municio, A. M. G., & Delgado, F. M. (2019). Dependency perpective in supply chain risk assessment. In *13th International Conference on Industrial Engineering and Industrial Management.* ResearchGate.

Elsayegh, A., & El-adaway, I. H. (2022). Quantitative holistic assessment of implementing collaborative planning practices. *Journal of Management in Engineering, 38*(3). https://doi.org/10.1061/(ASCE)ME.1943-5479.0001032

Flores, A. M. M., Bonifaz, S. del Busto, & Bernal, J. L. (2016). Assessment of three risk adjustment systems as predictors of the consumption of medicines and medical supplies at polyvalent hospitalization units. *Revista Española de Salud Públic, 90*, e1–e10.

Göleç, A., & Karadeniz, G. (2020). Performance analysis of healthcare supply chain management with competency-based operation evaluation. *Computers & Industrial Engineering*, *146*, 106546. https://doi.org/10.1016/j.cie.2020.106546

Gomez, J. C. O., & Espana, K. T. (2020). Operational risk management in the pharmaceutical supply chain using ontologies and fuzzy QFD. *Procedia Manufacturing*, *51*, 1673–1679. https://doi.org/10.1016/j.promfg.2020.10.233

Gurtu, A., & Johny, J. (2021). Supply chain risk management: literature review. *Risks*, *9*(1), 16. https://doi.org/10.3390/risks9010016

Jamal, N. M., Yi, W. S., Chin, T. I., & Idris, N. (2019). Effects of supply chain flexibility towards supply chain collaboration and supply chain agility. *International Journal of Supply Chain Management*, *8*(1), 2051–3771.

Jayaraman, R., Alhammadi, F., & Simsekler, M. C. E. (2019). Managing product recalls in healthcare supply chain. In *IEEE International Conference on Industrial Engineering and Engineering Management* (pp. 293–297). IEEE. https://doi.org/10.1109/IEEM.2018.8607403

Lancharoen, S., Suksawang, P., & Naenna, T. (2020). Readiness assessment of information integration in a hospital using an analytic network process method for decision-making in a healthcare network. *International Journal of Engineering Business Management*, *12*. https://doi.org/10.1177/1847979019899318

Lo, H. W., Liaw, C. F., Gul, M., & Lin, K. Y. (2021). Sustainable supplier evaluation and transportation planning in multi-level supply chain networks using multi-attribute and multi-objective decision making. *Computers & Industrial Engineering, 162*, 107756. https://doi.org/10.1016/j.cie.2021.107756

Marmolejo, J. A., & Hartmann-Gonzalez, M. S. (2021). Resilience in healthcare supply chains. In *Intelligent Computing and Optimization, Proceedings of the 3rd International Conference on Intelligent Computing and Optimization 2020 (ICO 2020)*. Springer. https://doi.org/10.1007/978-3-030-68154-8_45

Messina, D., Soares A. L., Barros A. C., & Zimmermann, R. (2022). How visible is your supply chain? A model for supply chain visibility assessment. *Supply Chain Forum: An International Journal*. https://doi.org/10.1080/16258312.2022.2079955

Özkanlısoy, O., & Akkartal, E. (2020). Risk assessment in digital supply chains. *Journal of Economics and Social Research*, *7*(14).

Piprani, A. Z., Jaafar, N. I., Ali, S. M., & Shahbaz, M. (2022). Multi-dimensional supply chain flexibility and supply chain resilience:the role of supply chain risks exposure. *Operation Management Research, 15*, 307–325. https://doi.org/10.1007/s12063-021-00232-w

Rehman, O. U., & Ali, Y. (2022). Enhancing healthcare supply chain resilience: Decision-making in a fuzzy environment. *International Journal of Logistics Management*, *33*(2), 520–546. https://doi.org/10.1108/IJLM-01-2021-0004

Salau, A. (2022). Data analytics in healthcare supply chain. *In Data Analytics in Supply Chain Management.* ResearchGate.

Schröder, M. (2017). How mature is your supply chain risk management? A self assessment model for supply chain risk management maturity. In *Conference: NOFOMA 2017*. Lund University, Sweden.

Shashi, M., & Gossett, K. D. (2022). Agile supply chain for mitigating disruption in pharmaceutical supply chains. *International Journal of Research and Analytical Reviews*, *9*(2).

Syahchari, D. H., Sudrajat, D., Lasmy, L., Herlina, M. G., Estefania, F., & Zanten, E. V. (2022, January). Achieving supply chain resilience through supply chain risk management and supply chain partnership. In *ICCMB 2022 5th International Conference on Computers in Management and Business* (pp. 209–212). ACM Digital Library. https://doi.org/10.1145/3512676.3512712

Taghizadeh, E., Venkatachalam, S., & Chinnam, R. B. (2021). Impact of deep-tier visibility on effective resilience assessment of supply networks. *International Journal of Production Economics*, *241*, 108254. https://doi.org/10.1016/j.ijpe.2021.108254

Vidrova, Z. (2020). Supply chain management in the aspect of globalization. *SHS Web of Conferences, 74*, 04031. https://doi.org/10.1051/shsconf/20207404031

Warmbier, P., & Kinra, A. (2022). Disruption risks, supply chain resilience and the future of global supply chain operations. In *Mittelstandsausschuss of Handelskammer Bremen Conference*. ResearchGate.

Wilding, R. (2021). Supply chain risk management: Creating the resilient supply chain. *International Encyclopedia of Transportation*, *2021*, 41–46. https://doi.org/10.1016/B978-0-08-102671-7.10216-7

Yaqin, Y., & Li, W. (2022). The effects of supply chain risk information processing capability and supply chain finance on supply chain resilience: A moderated and mediated model. *Journal of Enterprise Information Management*. https://doi.org/10.1108/JEIM-09-2021-0383

Zahid, A., Piprani A. Z., Mohezar, S., & Ismawati N. (2020). Supply chain integration and supply chain performance: The mediating role of supply chain resilience. *International Journal of Supply Chain Management*, *9*(3).

Zakaria, H., Bakar, N. A. A., Hassan, N. H, & Yaacob, S. (2019). IoT security risk management model for secured practice in healthcare environment. *Procedia Computer Science*, *161*, 1241–1248. https://doi.org/10.1016/j.procs.2019.11.238

Zepeda, E. D., Nyaga, G. N., & Young, G. J. (2016). Supply chain risk management and hospital inventory: Effects of system affiliation. *Journal of Operations Management*, *44*(1). https://doi.org/10.1016/j.jom.2016.04.002

TIEKIMO GRANDINIŲ RIZIKOS VERTINIMO MODELIŲ APŽVALGA MEDICINOJE

Alma ČERKAUSKIENĖ, Ieva MEIDUTĖ-KAVALIAUSKIENĖ

Santrauka. Tiekimo grandinės rizika yra plačiai nagrinėjama tema, tačiau sveikatos priežiūros sektoriuje tyrimų šia tema trūksta. Šio straipsnio tikslas – apžvelgti atliktus rizikos vertinimo modelių ir metodų tyrimus. Kadangi tiekimo grandinės rizika didina tiekimo grandinės pažeidžiamumą, svarbu išanalizuoti esamus tyrimus. Vadovaujantis gautais rezultatais, būtų galima sukurti naujus rizikos vertinimo modelius, kurie padėtų užkirsti kelią galimoms tiekimo grandinės problemoms. Literatūros analizė rodo, kad vertinimo modelius galima suskirstyti į: a) viso sektoriaus tiekimo grandinės procesų vertinimo metodus; b) ligoninės vidaus procesų vertinimo modelius. Rizikos vertinimo metodai parenkami atsižvelgiant į didžiausią riziką ir ilgiausiai trunkančią riziką. Daugiakriterinio vertinimo metodai literatūroje nagrinėjami dažniausiai.

Reikšminiai žodžiai: tiekimo grandinė, rizikos vertinimo modeliai, sveikatos priežiūros sektorius.