



## DIGITIZATION PROBLEMS AND PERSPECTIVES IN SUPPLY CHAINS IN THE CONTEXT OF INDUSTRY 4.0 CHALLENGES

**Sudziuviene R.**

*Lecturer*

*Higher Education Institution Environment and Civil Engineering Department,  
Bijunu str. 10, Klaipeda, Lithuania*

**Sudziute I.**

*Mechanikos inžinierė*

*UAB „Lavango Group“, Pramonės str. 5, Klaipeda, Lithuania*

**Beniusiene G.**

*Lecturer*

*Higher Education Institution Environment and Civil Engineering Department,  
Bijunu str. 10, Klaipeda, Lithuania*

**Jukniene D.**

*Higher Education Institution Environment and Civil Engineering Department,  
Bijunu str. 10, Klaipeda, Lithuania*

**Abstract.** *The Fourth Industrial Revolution has been going on for a good 10-20 years and nobody can name the specific beginning. Industry 4.0 is a new economic development stage, featuring technologies such as big data, artificial intelligence, the Internet of things, robotics, 3D printing, and their physical, digital, and biological interactions. From the first three industrial revolutions the newest revolution differs, firstly, by its speed, and exponential development, secondly, by its variety which includes not only economic but business, society, and human paradigm changes, thirdly by systemic transformations that involve countries, companies, industrial sectors, and whole society sistematical revolutions. This industrial digitization certainly will provide sections of society with larger varieties, but the unprecedented speed of change will also significantly disrupt the economy and the labor market more broadly. Therefore it is important to understand that to successfully realize digitizations in companies, it is necessary to soften the threats by changing jobs with technologies, the polarization of the labor market, and increasing inequality, both at individual and regional levels. The purpose of the article is to suggest a model for supply chain improvement in manufacturing companies in the context of industrial digitization. To achieve the purpose of the article, various methods such as systematic data analysis, statistical data analysis, graphical data representation, and comparative analysis are applied.*

**Keywords:** *The industrial revolution, manufacturing, digitization, supply chains, COVID-19, technology implementation.*

### **Introduction.**

The Industry 4.0 revolution essentially means value and supply chain digitization and the smart factory is at the center of this process. In the smart factory, all items used in the production process (components, devices) are connected to a single network (Internet of Things), which is controlled by autonomously operating systems (robots, algorithms). This is where supply management changes fundamentally. By connecting all participants of the supply chain into one system, it becomes possible for the operating system to monitor in real-time which components or raw materials the company lacks and send a signal to the supplier without waiting for anything. Production and inventory itself can also be managed on a similar principle – goods are produced exactly as much as is needed to meet demand, which allows for a significant reduction in excess inventory. As part of this process, supply chains become crucial factors and are often considered the key to the success of Industry 4.0.



The digitization of industry becomes even more relevant in the current post-pandemic conditions, when there is an increased withdrawal of society from large cities to less populated areas, and as a result, remote work becomes more and more relevant. As digitization processes take place, it becomes more and more realistic to move work from offices to homes, without harming the production efficiency of companies in the manufacturing industry. The fourth industry revolution technologies, including digitals, provide a significant increase in production efficiency and allow companies to produce and sell consumer-friendly goods and products.

The topicality of the topic is justified by the radically changed conditions of economic activity. Changes are primarily associated with the development of information technologies and the importance of intangible resources. In the early and middle of the last century, most innovations were the result of accidental discoveries or the efforts of individual developers. In modern society, especially since the beginning of the 21st century, the creation of innovations has become a purposeful, planned, and strategically managed activity. Regarding the digitalization of industry, the European strategies of "The European Digital Strategy" and the Lithuanian national industrial digitalization platform "Industry 4.0" have already been prepared, most industrial companies have already defined their digitalization initiatives, but digitalization remains an undefined concept and the journey towards it seems long and winding. [1]. Therefore, this article focuses on the possibilities of improving supply chains in the context of the fourth industrial revolution. To achieve the aforementioned goal, the following tasks are set:

1. summarize the systematics of the production supply chain and the theoretical aspects of management models presented in the scientific literature;
2. to identify the main digitization issues that determine the efficiency of the supply chain in the context of Industry 4.0;
3. to propose a model for improving supply chains in manufacturing companies in the context of Industry 4.0 challenges.

#### **Analysis of literature.**

Manufacturing is a global business that reached the peak of its development during the Industrial Revolution when the transformation of various ideas into real tools or processes began - the steam engine, electricity, and the steam locomotive laid the foundations for the formation of modern life, with modern factories and cities of millions. The main purpose of production, which remains to this day, is to satisfy large-scale production of products [11]. The main production challenge is to produce the largest possible quantities of products that consume less raw materials, energy, and human resources.

The manufacturing industry remains one of the main branches that create the basis of the economy both in Lithuania and in the world economy. It is an industry belonging to the second sector of the economy. The manufacturing industry refers to any business that uses machinery, tools, and labor to transform raw materials into marketable products.

Over the past five years, it is noticeable that the labor costs of manufacturing companies in Lithuania have risen by about 40 percent, while the productivity of the sector itself is only 14 percent. As the gap between wage costs and operational



productivity grows so rapidly, the competitiveness of the Lithuanian manufacturing sector is at risk. Recognizing such threats not only in the Lithuanian industry, but also in many other developed countries, businesses and the state itself have been investing heavily in recent years to increase productivity and, at the same time, competitiveness. One of the tools is digitization. Digitization of the industry enables a significant increase in productivity, and a reduction in the use of resources at all stages of the value chain and helps to remain competitive in the international market. The implementation of business processes and other digital solutions led to the creation of new business models, the introduction of new services or products to the market, and the creation of new, highly added value-creating specialists, jobs, etc. Digitization is becoming one of the strategic guidelines of companies in order to remain competitive and innovative. [7].

However, no technology will be important if we forget supply chains, because supply chain management is vital and nowadays most often an irreplaceable helper in production, trade organizations in their activities, focused on meeting customer expectations, successful business and society development [6]. It is very important for the end user how efficiently the supply chain provides them with the most necessary resources, products, and services, but certainly, not every user thinks about it: for example, when the user goes to the gas station to fill up with fuel, goes to the store to buy fresh food products, or when there is a hospital the ward is equipped with the most necessary rescue equipment. Most of the time, people think simply that products and services are easily available and they know where and who provides them with high quality, without thinking about how much people's own quality and comfortable life depends on production factors and efficient supply chains [10].

### **Concept of supply chains.**

In today's world, in the process of digitization and globalization, supply chains are global, complex networks, the purpose of which is to supply products in the right quantity, at the right time, at the right place in unpredictable markets [9]. Instability in global markets causes disruptions in supply chains, which also brings chaos to the operations of manufacturing companies. Today's supply chains operate in a dynamic environment where an adverse event that poses no risk today may be a serious risk tomorrow.

The supply chain can usually be divided into five main parts: raw material supplier, retailer, wholesaler, manufacturer, and customer. However, supply chain management also includes production planning, resource allocation, transportation of raw materials and finished products, and management of commodity flows, stocks, and warehouses [5]. And also transportation, defect fixing, and maintenance of production facilities. Each part of the supply chain includes all the functions related to it, from new product development, marketing, production, finance, customer service, and the goal is to satisfy the customer's needs while making a profit for themselves [14]. It must also be understood that supply chain disruption poses technical or behavioral problems for manufacturers in manufacturing companies. Technical problems include equipment failures, system failures, and financial difficulties; and unemployment, strikes, and human fraud are behavioral problems. Effective supply chain management is therefore essential. Supply chain management can be defined as the coordination of business



functions in the company's divisions, as well as in other parts of the supply chain, in order to supply and improve products and information flows from suppliers to final customers, thus strengthening the efficiency of the supply chain, and satisfying customer needs, wishes and requests [1].

It should be emphasized that the specifics of supply chains, precisely in the context of the achievements of the fourth industrial revolution, create prerequisites for each entity to apply sufficiently innovative and, in each specific case, very effective mechanisms. In this case, it must be taken into account that only effective and rational identification and use of appropriate measures can ensure the successful and sustainable functioning of the entire sector and a specific economic entity [11].

In cases where the elements of the supply chain are determined without taking into account how the elements of a particular sector (in this case - the manufacturing industry) function, there is a real risk that this way will not create opportunities for the sustainable functioning and growth of the whole sector.

However, it is very important to evaluate and define supply chain models in manufacturing companies. According to Mentzer, there are three levels of supply chain complexity [11]:

1. a direct supply chain that consists of a central organization, a supplier, and a consumer involved in the internal or external movement of products, services, finance, or information. In addition to all this, the central organization sets the structure of the supply chain and the management structure, the rules of cooperation. With such a chain, the movement cycle is short and usually ensures minimal time costs, this supply model usually operates within the country and is less common for international markets [13].

2. extended supply chain, which additionally consists of a second-tier supplier. Such a chain is more complex than a direct supply chain because raw materials do not go directly to the manufacturer, but go through several supply channels or individual suppliers. In such a supply chain scheme, there are greater opportunities for the participation of retailers and wholesalers [13]. In such a chain, the need for transportation increases, which can affect the cost price and selling price of the product, and the time of production and delivery to the consumer increases [8].

3. the composite supply chain includes the extended supply chain and additional participants - service providers: financial sponsors, market research specialists, and carriers of all levels.

Supply chain management is vitally important and nowadays most often an irreplaceable assistant for production and trade organizations in their activities focused on meeting customer expectations, and successful business and society development [4]. In order to have a strategic supply chain and manage it effectively, a very important aspect is the dissemination of information. It is very important that at the right time, appropriate and specific information reaches each member of the supply chain, here the linear sequence is especially important - from the order submission, the design, the production process takes place, then it is transferred to the distributor, then to the retailer and only finally to the main customer. It is a long process of creating a product and obtaining information, which not only requires time but also reduces the efficiency of the production process. Each relationship between parts of the supply chain



(supplier, manufacturer, distributor, retailer, customer) has processes required for each process cycle (sales order cycle, material replenishment cycle, production cycle, purchasing cycle). Such a view of cycles is useful for the digitalization of supply chains, such as the development of information systems to support supply chain operations in the consideration of operational decisions, as it defines the role and responsibility of each participant and predicts the results of each process [14].

#### **Industry 4.0 and digitization of industry.**

The fourth industrial revolution is taking place on the foundations of the third digital revolution. The latter flooded the world with computers and automated data hoarding. However, the new wave of changes differs from previous ones in several important aspects. Firstly, innovations are created and can spread at a speed that we could not even imagine before. Secondly, decreasing marginal production costs and the emergence of platforms that concentrate business activities in many sectors increase the connection between profit and scale. Thirdly, this revolution will affect all countries, and people will feel the changes in all areas as they contribute to its development.

Summarizing various authors' ideas on this topic, Industry 4.0 is focused on digitization and replacing older technologies. However, it's important not to forget and strive to integrate cyber-physical systems that ensure information security and improve the organization of production systems [16]. For manufacturing companies aiming to remain successful in today's business world, it's no longer enough to produce high-quality products or be at the forefront of technological or innovative levels. In developed economies, services have become the main tool for economic growth and productivity. For this reason, to promote operational efficiency, manufacturing companies often choose to engage in a new additional activity - providing services, which in the long run creates an advantage and distinctiveness over competitors operating in the market. Offering a wider range of services alongside product manufacturing provides greater value to the consumer. The search for new solutions, the application of high technologies, smart utilization of organizational resources, capacities, capabilities, and market utilization create opportunities for manufacturing companies to smoothly integrate services into the production system.

Digitization fundamentally changes all segments of society and the economy, affecting not only the activities of manufacturing companies but also the macroeconomics of a country and societal employment (Table 1).

In general, the main goal of Industry 4.0 is the emergence of digital manufacturing, which means the creation of intelligent networks, mobility, flexibility, the interaction of industrial operations, integration, and adoption of innovative business models [2].

Digitization is the process of taking physical formats of information and converting them into digital formats. For example, letters sent by mail are now sent via email, manual spreadsheets are transformed into Excel, and typewriters are replaced by Google documents. The most important aspect is that processes and systems remain the same when digitized. Industrial digitization allows for the creation of products simultaneously in multiple countries, even without meeting face-to-face, thereby eliminating distance, and transportation problems can be addressed through



digitization. For example, if a signature is needed on a constructed model, there's no need to travel to the location; the document can be electronically signed in a CAD file. However, it's important not to confuse digitization with digitalization. Interestingly, the term "digitalization" was first mentioned in a paper by Robert Machal in 1971. According to the literature, the most important characteristics of digitalization are not data usage or technological application, but the speed of changes and degree of connection [6]. Therefore, digitalization shapes a world that immediately experiences its actions and consequences: volatility, uncertainty, complexity, and ambiguity, collectively known by the managerial acronym VUCA [3].

**Table 1 - The Impact of Industrial Digitization on Macroeconomics and Society by Various Authors.**

Macroeconomics	Macroeconomics	In the 2013 Global Information Technology Report, it was stated that a 10 percent increase in a country's digitization results in a 0.75 percent increase in GDP per person. As an economic accelerator, digitization is 4.7 times more powerful than the average impact of broadband deployment.	(Sabbagh ir kt., 2013)
		The European Parliament's Research Service forecasts that around 390,000 new jobs will be created in Germany alone. The digitization of European production will not only impact productivity growth but also all manufacturing processes and business models.	(Davies, EPRS, 2015)
		A new type of work is emerging - the on-demand goods and services economy. Digital technologies and global communication infrastructure are changing the traditional understanding of work and wages, leading to the emergence of more and more new types of jobs characterized by flexibility and short-term nature.	(Grossman & Helpman, 2015)
	Society	Productivity is the most important factor determining long-term growth and <i>rising living standards</i> .	(Jurgelionienė, 2017)
		Technology enables work to be done more easily, quickly, and efficiently. However, technology creates not only opportunities but also potential risks. There is a <i>growing polarization</i> in the world, characterized by some embracing changes while others resist them.	(Degryse, 2016)

Authoring Indre Sudziute

However, in any area we examine, positive and negative aspects can be identified. Specialists highlight four areas that will have the greatest impact from digitalization technologies: productivity, income growth, employment, and investments [14]. The



development of the Fourth Industrial Revolution, artificial intelligence, the Internet of Things (IoT), blockchain technology, cloud computing, virtual reality, 3D printers, virtual assistants, big data streams, and nanotechnology further accelerated the digitization processes. However, according to various authors, it's important to also address the four main challenges prevailing in the manufacturing sector's digitalization:

1. Technical/technological barriers – related to financial constraints, and limited availability of technical resources capable of easily enhancing and implementing digital technologies.

2. Organizational barriers – associated with people's resistance to change and the need to change the management of key business operations, products, processes, and organizational structure innovations, requiring new competencies, resources, and collaboration.

3. Human resource-oriented barriers – related to a shortage of skilled workers and a lack of digital competencies.

4. Customer-related barriers – including customers' fears of losing control of information, such as privacy breaches, security issues, and the security of access to production and company systems.

**Research results and their analysis.** The experimental study was carried out in 2022. For this study, the criteria determining the efficiency of production supply chains were selected based on the sources of scientific literature, and they were grouped into four categories: cooperation with the environment, human capital, use of technology, and implementation of innovations (Table 2). Seven production supply chain experts in manufacturing companies participated in the study. The importance weights of the criteria were evaluated with the help of the Analytical Hierarchy process method, which is done by the Super Decisions program.

From the first group of criteria, cooperation with the environment, experts singled out as the most important criteria for cooperation with educational institutions of the region, which would help not only to ensure the required number of specialists, since it would be easier for educational institutions to organize learning and study programs, but in educational institutions it is possible to try various methods that can later be applied also in production processes.

In the second group of criteria, the greatest significance is played by training for raising the competence of employees. Smart technologies, digitization, and automation of production processes transform processes into more manageable and performable ones, but these processes require the involvement of competent employees.

From the group of criteria for the use of technology, experts single out integration with suppliers and customers as the most significant criteria for improving production supply chains. Knowing the situation and managing it in real time ensures an efficient production strategy, as well as ensuring an efficient production supply chain process.

Based on the obtained weights of significance of the criteria of the fourth group, we can distinguish the criterion of new or improved methods of manufacturing products. It is important for managers of manufacturing companies to take the initiative and make decisions, to apply new or improved methods in the development of products, for example, by introducing or improving the technological process of production.



**Table 2 - The criteria influencing the improvement of production supply chains in manufacturing companies are evaluated in scientific literature.**

<b>1. Criterion of collaboration with the environment</b>
1.1 Collaboration with non-affiliated business entities
1.2 Collaboration with research institutions
1.3 Collaboration with regional educational institutions
1.4. Dissemination of best practices with foreign companies
<b>2. Criterion of human capital</b>
2.1 Good conditions for effective staff work
2.2 Training for improving the competence of employees
2.3 Ensuring the capacity of human resources
2.4 Recruitment of highly qualified personnel
2.5 Employee motivation
2.6 Employee experiences in the new conditions of digitalization
<b>3. Criterion for the use of technology</b>
3.1 Automatization
3.2 Robotics
3.3 Additive manufacturing (3D printing)
3.4 Artificial intelligence
3.5 Cybersecurity
3.6 Managing production processes using cloud computing
3.7 Enterprise operational process management systems
3.8. Integration with suppliers/customers
<b>4. Innovation criterion (otherwise organizational and strategic criterion)</b>
4.1 New methods of information processing and communication
4.2 New decision-making methods
4.3 New or improved methods of manufacturing products
4.4 New practice in organizing external communications
4.5 Implementing the principles of the circular economy
4.6 Innovative methods in the storage of raw materials
4.7 New methods of organizing human resource management

*Authoring Indre Sudziute*

We must not forget that one of the most important factors in the supply chains of the manufacturing industry is the lack of materials. The increase in prices due to the lack of materials, and delays, leads to buyer behavior, and with it the entire activity of the supply chain. Manufacturing companies must aim to ensure that production lines provide real-time information on raw materials through supplier systems to make it possible to see stocks and replenish them as soon as possible, and to look for new suppliers in the event of an increase in raw material prices. However, it is also very important for industrial enterprises to see the real situation in retailers' enterprises, stocks in stores, and warehouses, changing customer expectations and moods, external factors such as weather forecasts, outbreaks of infectious diseases, geopolitical tensions, and other data that help to predict in advance possible disruptions in supply





or demand and prepare for it. In order for all actors in the supply chain to work in unison and for information between the links to move smoothly, companies need to not look back and implement digital business management systems that help integrate and optimize the basic processes of supply, production, warehouse, inventory, purchase, and sale. [15]

Based on the literature analysis carried out and an examination of the importance of the manufacturing sector and an expert study of the criteria determining the improvement of supply chains in the manufacturing industry, an expert study of the criteria determining the improvement of supply chains in the manufacturing industry has been carried out, a model for improving supply chains has been developed, which aims to develop and improve the performance of the supply chain with a single goal – to increase the competitiveness of the company. The most important thing is that every stage of the supply chain is very important and it is not possible to single out who is more important than what. First of all, the first actors in the supply chain – suppliers – should analyze critical raw materials and think about their storage. It is also very important to provide alternative suppliers who, in the event of a critical shortage of raw materials, can ensure that the supply of raw materials does not stop. It is very important for manufacturers to assess in advance the available capacity for resources and equipment. Therefore, by integrating Industry 4.0's advanced technologies – warehouse management automation tools or cloud computing – the dissemination of information among the members of the first supply chain would be faster and smoother. We need to understand and assess that cloud computing allows all actors in the supply chain to access a common information system from anywhere in the world, and warehouse management automation tools make it possible to ensure that only the necessary goods are always supplied. The integration of 3D printing technologies into production processes allows companies to create prototypes of products that are already common in the world and also allows companies to avoid large investments in new production purchases or installation of machines. However, the minuses also need to be considered, since 3D printers are not capable of creating products in large quantities since their labor productivity is significantly slower than that of traditional production methods. Also, materials for 3D printers can be significantly more expensive than traditional materials and it is important to predict whether these innovations are profitable for the company. It must also have to be in mind that the automation of production, which we most often understand as the use of robotic or conveyor systems in production. Automation of production can help reduce production costs, increase the quality of products, reduce the likelihood of production errors, and increase production efficiency [15]. In addition to all the innovations, one should not forget about the close cooperation of enterprises with educational institutions, which would ensure the required number of specialists, but in educational institutions that have the most modern hardware, more than one production unit can be tested. Industrial IoT technology can be successfully integrated into the rest of the supply chain, as it is most capable of reducing the mistakes made by people and by that improving the performance of all parts of the supply chain. Cloud computing enables different parts of the supply chain to connect their physical infrastructure on a cloud-based basis, which enables employees to work remotely and communicate in real-time. But how



advanced all technological innovations would be there are also problematic moments because in this way the vulnerability of information systems increases. This causes huge security problems: hacks, identity theft, impersonations, etc. It is very important that, when implementing all these innovations, companies take stock of risk factors and carry out preventive measures.

### **Conclusions.**

The analysis of the processes of digitization of the manufacturing industry changes the perception of intellectual activity, thinking, creativity, and cooperation, which allows us to make changes not only in the consumption of technology and innovation but also in economic life. After all, with the development of society, we strive not only for technological efficiency but for social social society, which develops the way for economic efficiency.

Based on the conducted analysis of the scientific literature and analyzing the criteria that determine the possibilities of improving the supply chain at manufacturing enterprises in the context of Industry 4.0, we can draw the following conclusions:

1. after analyzing the theoretical material, it can be said that the concept of the supply chain is primarily focused on the quickness of operations and their improvement, as well as cooperation with suppliers, but there is no talk of processes for raising human resource competencies, which would also allow to effectively improve the production supply chain;

2. based on the analyzed literature, supply chains can be of three degrees of complexity, which are reviewed in the article. Supply models must be directly oriented towards ensuring, as far as possible, the conformity of supply with market trends. Ensuring the exchange of information is precisely the biggest challenge in modern supply chains;

3. Together with the fourth industrial revolution, the processes of digitization, automation, and robotization are fundamentally changing the nature of the work of manufacturing companies. In order to integrate Industry 4.0 processes into supply chains, company managers face significant challenges: lack of human resources skills and competencies, technological barriers, organizational and strategic barriers, and a lack of cooperation between companies and the environment.

4. A study of the analytical method of the hierarchy process showed that the introduction of innovations has the greatest impact on the improvement of supply chains and helps to maintain the functioning of an efficient production supply chain in the context of the manufacturing industry. The innovations introduced provide an opportunity to increase production capacity, vary in human resources, as well as to better manage all production planning, as well as to improve the communication function between the different parts of the supply chain.

5. The proposed model for improving supply chains is to periodically conduct studies by various associations of manufacturing companies to assess the impact of Industry 4.0 measures on supply chains and to identify trends regarding the impact of future progressive technologies in the manufacturing industry. It is also essential to include in manufacturing and engineering training programs that examine the applicability of the technologies of the fourth industrial revolution in improving supply chains.

**References:**

1. Al-Shboul, M. A., Vikas, K., & Garzza-Reyes, J. A. (2017). The Effect of Supply Chain Management Practices on Supply Chain and Manufacturing Firms' Performance, pp. 22. *Journal of Manufacturing Technology Management*.
2. Barreto, L., Amaral, A., & Pereira, T. (2017). Industry 4.0 implications in logistics: an overview. *Procedia Manufacturing* 13, pp. 1245–1252. <https://doi.org/10.1016/j.promfg.2017.09.045>
3. Bennett, N., & Lemoine, G. J. (2014). What a difference a word makes: Understanding threats to performance in a VUCA world. *Business Horizons*, 57(3), pp. 311–317. <https://doi.org/10.1016/j.bushor.2014.01.001>
4. Brian J. Gibson, Joe B. Hanna, C. Clifford Defee, Haozhe C. (2013), *The definitive guide to integrated supply chain management*.
5. Gelzinytė, G. (2017). Working capital management of milk processing company. „Verslas, Technologijos, Biomedicina: Inovacijų Įžvalgos 2018“, 1(8).
6. Gimpel, H., Hosseini, S., Huber, R., Probst, L., Röglinger, M., & Faisst, U. (2018). Structuring Digital Transformation: A Framework of Action Fields and its Application at ZEISS. *Journal of Information Technology Theory and Application*, 19(1), pp. 31–54. <https://doi.org/10.1111/j.1467-8276.2007.00999.x>
7. <https://litek.lt/informaciniai/skaitmeninimas-raktas-i-sekme/>
8. Hugos M. (2003), *Essentials of supply chain Management*, pp. 254.
9. Kochan, C. G., & Nowicki, D. R. (2018). Supply chain resilience: a systematic literature review and typological framework. *International Journal of Physical Distribution and Logistics Management*, 48(8), pp. 842–865. <https://doi.org/10.1108/IJPDLM-02-2017-0099>
10. Lynn A. Fish (2011). *Supply Chain Quality Management, Supply Chain Management - Pathways for Research and Practice*, Prof. Dilek Onkal (Ed.), ISBN: 978-953-307-294-4, InTech, Available from: <http://www.intechopen.com/books/supply-chain-managementpathways-for-research-and-practice/supplychain-quality-management>
11. Mohamed, N. M. Z. N. (2020). The Development of a Hybrid Knowledge-Based System for Designing a Low Volume Automotive Manufacturing Environment . The Development of A Hybrid Knowledge-Based ( KB )/ Gauging Absences of Pre-Requisites ( GAP )/ Analytic Hierarchy Process ( AHP ) System, pp. 0–11.
12. Peillon S. and Dubruc N., Barriers to digital servitization in French manufacturing SMEs, “*Procedia CIRP 2019*”, no. 83, pp. 146-150.
13. Rakickas, A. (2010). Model for evaluation of supply chain processes management, pp. 293.
14. Ramirez-Peña, M., Mayuet, P. F., Vazquez-Martinez, J. M., & Batista, M. (2020). Sustainability in the aerospace, naval, and automotive supply chain 4.0: Descriptive review. *Materials*, pp. 1–23. <https://doi.org/10.3390/ma13245625>
15. Sudziute, I. (2021). Improving the supply chain in manufacturing companies in the context of the challenges of industry 4.0, pp. 39-40.
16. Tran, D. K., Edista, K., & Kandoi, S. ( 2006). Supply chain management in the manufacturing industry. 10210856, pp. 27. <http://hosteddocs.ittoolbox.com/Supplychainmanagement.pdf>



17. Zsidisin, G. A., & Henke, M. (2019). Springer Series in Supply Chain Management Revisiting Supply Chain Risk. <http://www.springer.com/series/13081>

Article sent: 11.03.2024

© Sudziuviene R., Sudziute I., Beniusiene G., Jukniene D.