Proceedings of the 11th International Scientific Conference Rural Development 2023
Edited by assoc. prof. dr. Judita Černiauskienė

ISSN 1822-3230 (Print)
ISSN 2345-0916 (Online)

Article DOI: http://doi.org/10.15544/RD.2023.050

SMART TECHNOLOGIES AND THEIR APPLICATION IN THE TRANSPORT SECTOR

Kristina KAROSEVIČIENĖ, Kolping University of Applied Sciences, address: Raguvos str. 7, Kaunas 44275, Lithuania, evc@kolpingokolegija.lt
Daiva ŠILEIKIENĖ, Kolping University of Applied Sciences, address: Raguvos str. 7, Kaunas 44275, Lithuania, daiva.sileikiene05@gmai.com *(corresponding author)*

This research suggested the potential for the use of smart technologies in Lithuanian transport logistics companies is high. Efficient work processes, faster and more accurate delivery of goods to consumers, increased business competitiveness and profitability, and optimised transport route planning are the most important positive aspects of smart technology development. GPS and GIS, artificial intelligence and smart transport infrastructure are the most appreciated smart technologies with the highest potential in the Lithuanian transport logistics sector. However, to effectively exploit these opportunities, it is necessary to invest in innovation, training of professionals, improvement of infrastructure and fostering cooperation between companies, universities and public institutions. Although the interviewees were mixed in their assessment of the Lithuanian government's support for the introduction of smart technologies in the transport logistics sector, they agreed that the most important initiatives that need to be taken are the promotion of innovation and investment, the provision of training, and the training of professionals in this area.

Keywords*: environmental pollution, transport, smart technologies, smart transport infrastructure*.

INTRODUCTION

The relevance of this topic is emphasized by the growing importance of technology in increasing the efficiency, sustainability and competitiveness of the logistics industry. The integration of smart technologies such as the Internet of Things (IoT), artificial intelligence (AI) and automation has transformed logistics operations. This enabled real-time monitoring, data-driven decision-making and optimization of supply chain processes (Harrison, Whittall, 2019). These technologies have reduced operating costs and improved customer service, contributing to the overall growth and success of the industry (Wang et al., 2016). In addition, the implementation of smart technologies in transport logistics plays an important role in promoting sustainable practices, such as reducing energy consumption and emissions (Li et al., 2018).

Research on smart technologies and their application in transport logistics is important because such technologies have a huge impact on this industry. There are several reasons why it is necessary to study the topic of smart technologies and their application in transport logistics. First, with globalization and increasing customer demands for faster, more reliable, and more cost-effective services, the logistics industry must adapt to compete at various stages of logistics. Smart technologies can help meet these demands by streamlining processes and increasing efficiency (Wang et al., 2016). Second, understanding the application of smart technologies can give companies a competitive advantage by using these technologies to optimize operations, reduce costs, and increase customer satisfaction (Evangelista et al., 2020). Finally, exploring smart technologies in transport logistics can lead to sustainable solutions that reduce the industry's environmental impact (Li et al., 2018). Smart technologies in transport logistics are various advanced tools, systems and solutions that use data, communications, automation and real-time insights to optimize and streamline various aspects of the logistics process (Tadić et al., 2022). These technologies are designed to increase operational efficiency, improve customer service, reduce costs and support better decision-making in the logistics industry (Korczak, Kijewska, 2019). Environmental issues are also an important reason. With growing environmental concerns, logistics companies are under pressure to adopt sustainable practices and reduce their carbon footprint. Smart technologies are valuable in solving these problems. For example, the UPS ORION system, an AI-driven route optimizer, successfully reduced the total distance travelled by delivery trucks, resulting in lower fuel consumption and CO2 emissions (Holland et al., 2017). Similarly, the world's largest shipping company, Maersk, has implemented a ship performance optimization solution that uses advanced analytics to reduce fuel consumption and emissions. This provides real-time data on the operational characteristics of

ships and creates conditions for more efficient sailing (Homayoun et al., 2016). For example, Tesla is developing electric and hydrogen-powered trucks, respectively, which are cleaner and more energy-efficient alternatives to traditional diesel-powered vehicles (Bhardwaj, Mostofi, 2022). By implementing these smart technologies in their operations, logistics organizations can contribute to global efforts to combat climate change.

The implementation of smart technologies in the transport logistics sector is leading to significant advances in efficiency, cost reduction and overall productivity. These state-of-the-art solutions cover a wide range of applications, from real-time tracking and monitoring of goods using Internet of Things tools (Feng, 2016) to route optimization and demand forecasting using artificial intelligence (Woschank et al., 2020). Autonomous vehicles and robotics are becoming more and more practical, so they will change transport and warehousing activities (Monios, Bergqvist, 2020). In addition, advances in blockchain (Pournader et al., 2020), GPS and GIS technologies (Delmonteil, Rancourt, 2017), advanced analytics (Fosso Wamba et al., 2018), and cloud computing (Winkelhaus, Grosse, 2020) simplify communication and information management, promoting a more integrated and data-oriented logistics environment. The use of these smart technologies fundamentally changes the movement and management of goods, laying the foundations for a more efficient and green logistics future (Korczak, Kijewska, 2019). The implementation of smart technologies in transport logistics brings many benefits, but also faces certain challenges. To make the most of these new solutions, the industry needs to address issues such as integration, data security and regulations. Analyzing the challenges of implementing smart technologies in transport logistics is important for several reasons. Understanding the potential barriers helps companies make informed decisions about adopting new technologies, weighing the benefits and costs and risks. By identifying challenges, companies can develop strategic plans to overcome them, ensure a smoother implementation process and reduce the impact on ongoing operations (Jafari et al., 2022). In addition, companies that successfully address the challenges associated with smart technologies can better leverage their benefits and gain a competitive advantage (Winkelhaus, Grosse, 2020). Finally, addressing challenges at the level of the transport logistics industry encourages the development of best practices that support the wider adoption of smart technologies and drive progress in the transport logistics sector (Woschank et al., 2020).

The purpose of the study is to assess the possibilities of using smart technologies in transport logistics.

Research tasks: Reveal the reasons for the need for smart technologies in transport logistics; Analyze the diversity of smart technologies in transport logistics; To determine the potential of the use of smart technologies in Lithuanian transport logistics companies.

RESEARCH METHODS

In order to evaluate the possibilities of using smart technologies in transport logistics, a quantitative research method was chosen. Quantitative research allows for an objective assessment of the participants' opinions and attitudes towards smart technologies in the transport logistics sector. The results of the research can be summarized and presented with statistical data that help reveal essential trends (Kardelis, 2016).

Investigation method. A questionnaire survey was used to conduct the research, and descriptive statistics were used to analyze the research data. Questionnaires are a popular quantitative research strategy that allows for quick and efficient data collection from a large number of participants (Bryman, 2012). This provides an opportunity to receive various opinions and viewpoints on the implementation of smart technologies and the possibilities of their use in the transport logistics sector. Descriptive statistics, on the other hand, help to summarize and simplify the collected data by revealing the main parameters of the data set (Field, 2013). This method provides an opportunity to reveal the main trends, and also allows to reveal the areas where the use of smart technologies is most relevant and effective.

Both of these methods together help to conduct a detailed and structured study, which allows to assess the possibilities of using smart technologies in the transport logistics sector, and to identify the most important problems and challenges.

Research instrument. A questionnaire created by the author of the paper was used for the research. This questionnaire consisted of the following blocks of questions (see table 1).

Table 1. Research instrument and its objectives

Block of questions	Questions	Purpose
The need and implementation of smart technologies	1, 2	To determine whether there is a need for the implementation of smart technologies in the transport logistics sector and how Lithuanian companies implement these technologies.
Advantages and areas of application of smart technologies	3, 4	To find out what are the main reasons for the implementation of smart technologies and what technologies are most often implemented in the transport logistics sector.
Challenges and conditions for the implementation of smart technologies	5, 6	Identify the main challenges related to the implementation of smart technologies and determine what conditions must be created for the effective implementation of these technologies.
Positive effects and competitive challenges	1, 6	To identify the positive effects that the implementation of smart technologies can have on workers, businesses and consumers, and to find out whether respondents have faced competitive challenges in this area.

Study sample and selection methods. The study included 195 subjects who were the most accessible to the researcher, i.e. i.e. a "convenience sample" selection method was applied. The most commonly recommended minimum sample size is 30, and the ideal sample size is at least 100 or more to ensure a sufficiently accurate result (Kim, Seo, 2013). The selection of such a number and sampling method is based on several considerations. First, with the participation of 95 respondents, it is possible to obtain sufficient information about the opinions and trends in the transport logistics sector related to the implementation of smart technologies. Secondly, this method of selection allows to reduce research costs and time consumption.

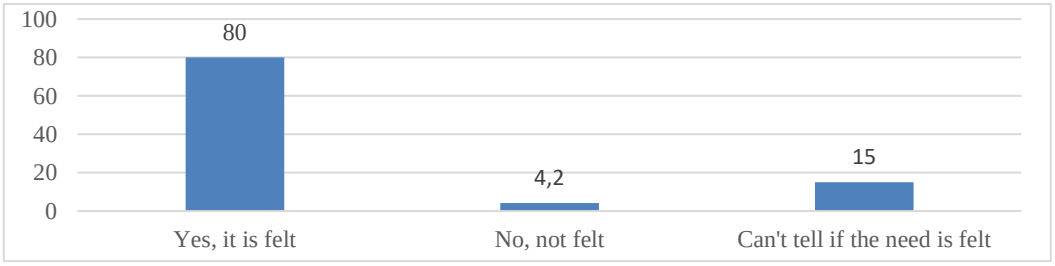
Research stages. The created questionnaire was placed on the website www.apklausa.lt. Subjects could fill out the questionnaire from 2023 April 19 to 2023 May 12. The collected data were presented graphically (tables and graphs) and discussed based on scientific literature.

Research ethics. Before starting the study, the participants were informed about the aims, methodology and possible results of the study. Study participants participated in the study voluntarily and could withdraw from the study at any time. Participation in the study was anonymous (the subjects' personal data are not provided) and confidential (the study data are available only to the researcher and his supervisor).

Limitations of the study. The results of the research depend on the honesty of the subjects and the ability to objectively assess their situation. Some subjects may be inclined to give socially acceptable answers or may not consider the questions carefully enough. Survey research may limit the ability of subjects to express their opinions and experiences. Answer choices can be overly simplistic, and the absence of open-ended questions can reduce the opportunity for deeper insights. Also, the research is done at a specific time and can only reflect the trends and opinions prevailing at that time. The results may differ if the study were conducted in a different time period. While quantitative research can provide a general impression of current trends and attitudes, it may lack deeper insights into respondents' experiences, motivations and decision-making processes. Therefore, it is believed that a mixed-methods study that includes quantitative and qualitative research methods with a larger sample would be appropriate in the future.

RESEARCH RESULTS AND DISCUSSION

During the questionnaire survey, the respondents discussed the perceived need for the implementation of smart technologies in the transport logistics market (see picture3.1). As can be seen from the presented picture, most of the respondents believed that there is a need for the implementation of smart technologies in the transport logistics market (80%). Only 4.2 percent the subjects were of the opinion that this need is not felt. However, even 15 percent respondents could not say whether there is a felt need for the implementation of smart technologies in the transport logistics market.



Source: compiled by the author of the paper based on research data

Figure 1. In the transport logistics market, there is a need for the implementation of smart technologies

Thus, the results of the study showed that most of the respondents are aware of the benefits of smart technologies in the transport logistics sector. Rodriguez et al. According to (2021), smart technologies and devices help increase the efficiency of transport logistics activities, as well as reduce costs and negative environmental impact. In addition, (Eom et al., 2020) observe that smart technologies are changing the operations of the transport logistics sector.

The subjects revealed whether Lithuanian companies implement smart technologies in transport logistics (see picture 3.2). The results of the survey show that Lithuanian companies are actively implementing smart technologies in transport logistics. The vast majority of respondents (71.6%) said that companies are implementing these technologies, and 15.8%. respondents indicated that companies are indeed implementing smart technologies. However, 9.5 percent of the respondents indicated that companies neither implement nor implement smart technologies, while 2.1 percent respondents said that companies do not implement these technologies. Only 1.1 percent respondents said that Lithuanian companies do not really implement smart technologies.

These results show that it is possible that Lithuanian companies are already using smart technologies in transport logistics, which is in line with global trends. This shows that companies in this sector strive for efficiency, competitiveness and sustainability, as smart technologies help to optimize processes, save costs and reduce the negative impact on the environment.

However, it is important to take into account the fact that 9.5 percent respondents said that companies neither implement nor implement smart technologies. This may mean that some companies are not yet able to adopt these technologies for some reason. These reasons can be financial constraints, technological gap or lack of understanding about the application of smart technologies in their activities (Cimini et al., 2020).

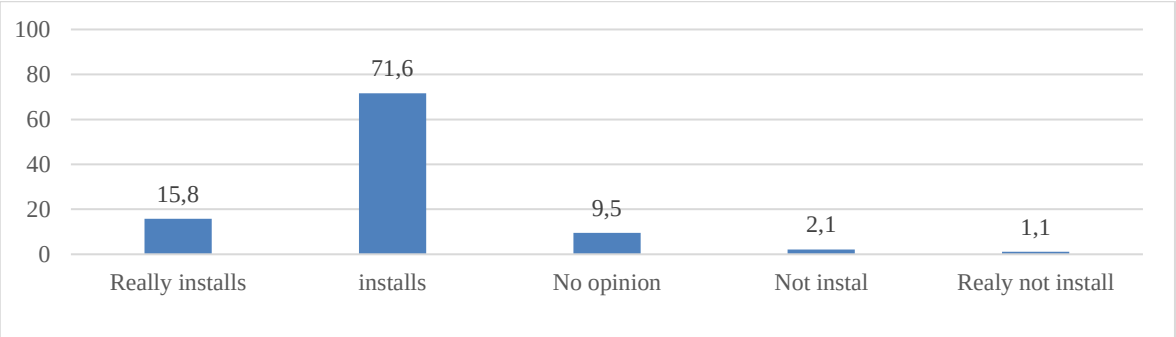


Figure 2. Implementation of smart technologies in transport logistics in Lithuanian companies.

During the research, the reasons for the implementation of smart technologies in transport logistics were revealed (see picture 3.3). The main reason given by the subjects is increasing efficiency (25.6%). This is understandable because smart technologies help to better manage logistics processes and make decisions faster and more efficiently (Rodrigue et al., 2021).

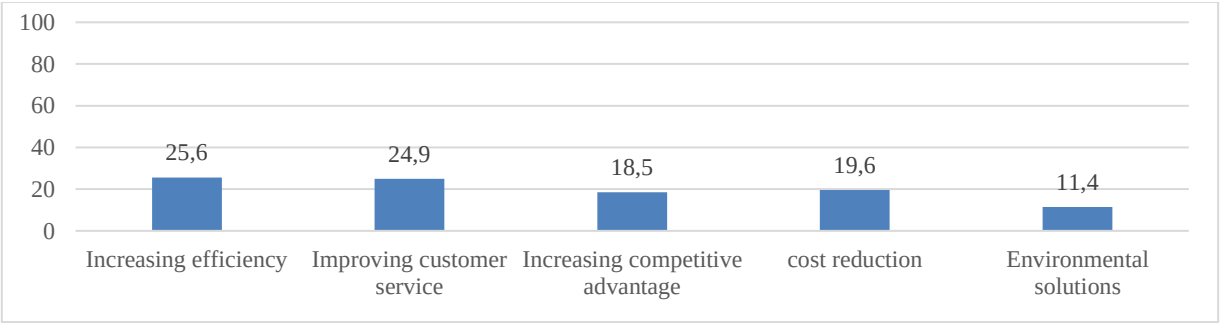


Figure 3. Reasons for implementing smart technologies in transport logistics

Another important reason is improving customer service (24.9%). The implementation of smart technologies allows transport logistics companies to improve communication with customers, respond faster to their needs and ensure a higher level of service quality (Sudbury, Hutchinson, 2016). Also, the respondents named increasing the competitive advantage as a significant reason (18.5%). Smart technologies are said to help companies stand out in the market and ensure long-term business growth (Gu et al., 2021). Cost reduction (19.6%) was named as an important reason by almost a fifth of the respondents. The use of smart technologies can help companies use resources more efficiently, optimize transport routes and reduce unnecessary costs (Korczak, Kijewska, 2019). Finally, only 11.4 percent of respondents cited environmental protection goals as a reason for implementing smart technologies. For this reason, companies can seek to reduce negative environmental impacts by reducing emissions and using less energy during logistics processes (Holland et al., 2017). Thus, the results of the study show that the subjects appreciate the benefits of smart technologies in transport logistics and understand their importance in various aspects.

The respondents named the most commonly implemented smart technologies in transport logistics (see figure.4)

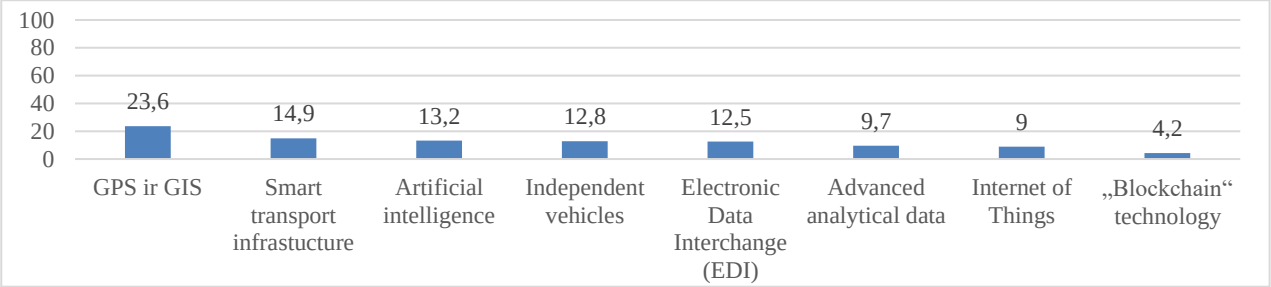


Figure 4. Most often, smart technologies are implemented in transport, %

The results of the survey showed that the respondents named various smart technologies that are most commonly implemented in transport logistics. The main ones are GPS and GIS (23.6%), artificial intelligence (13.2%), smart transport infrastructure (14.9%), autonomous vehicles (12.8%), electronic data exchange (EDI) (12.5 percent). Advanced analytics (9.7 percent), Internet of Things (9 percent), and Blockchain technology (4.2 percent) were cited as less commonly implemented smart technologies. A similar opinion is presented by other authors. For example, Rodrigue et al. (2021) and Eom et al. (2020) also discuss the impact of these technologies on the transport logistics sector. According to them, the Internet of Things, artificial intelligence, GPS and GIS, and autonomous vehicles are important factors that are changing the operations of the transport logistics sector (Eom et al., 2020; Rodrigue et al., 2021).

Thus, many smart technologies are being implemented in the Lithuanian transport logistics sector, which are also relevant on a global scale. However, more attention should be paid to the less frequently implemented Blockchain technology, as this technology can help ensure transparency and reliability in logistics processes (Kamble et al., 2019).

The study also revealed the main challenges related to the implementation of smart technologies in the transport logistics sector in Lithuania (see figure 5).

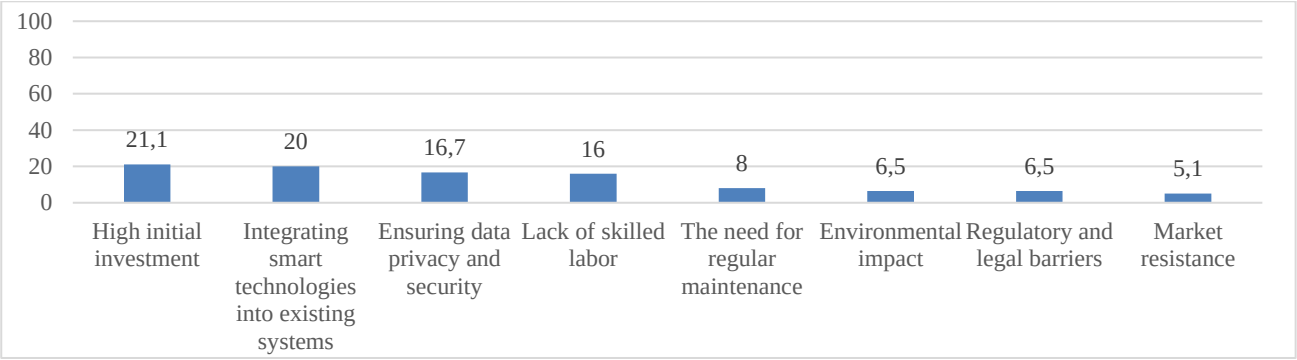


Figure 5. The main challenges related to the implementation of smart technologies in the transport logistics sector, %

The results of the survey revealed the main challenges related to the implementation of smart technologies in the transport logistics sector in Lithuania. The most frequently cited challenges were high initial investments (21.1 percent) and integration of smart technologies into existing systems (20 percent). This shows that the respondents believe that the financial aspect and technology compatibility are the most important factors that can hinder the implementation of these technologies. The least frequently cited challenges were environmental impact (6.5 percent), regulatory and legal barriers (6.5 percent), and market resistance (5.1 percent). Although these factors are also important, the subjects considered them to be less significant compared to other challenges. Chong et al. (2017) highlights the challenges of implementing smart technologies in terms of ensuring data privacy and security, lack of skilled labour and overcoming regulatory and legal hurdles. These challenges correspond to the results of the Lithuanian survey.

Thus, the results of the survey showed that there are a number of challenges in the transport logistics sector in Lithuania related to the implementation of smart technologies. The most commonly cited challenges are the high initial investment and the integration of smart technologies into existing systems. This opinion is consistent with the findings of other authors, who emphasize that these challenges are important factors that can hinder the implementation of smart technologies.

The respondents were asked whether there are currently enough investments and resources for the implementation of smart technologies in the transport logistics sector in Lithuania (see figure 6).

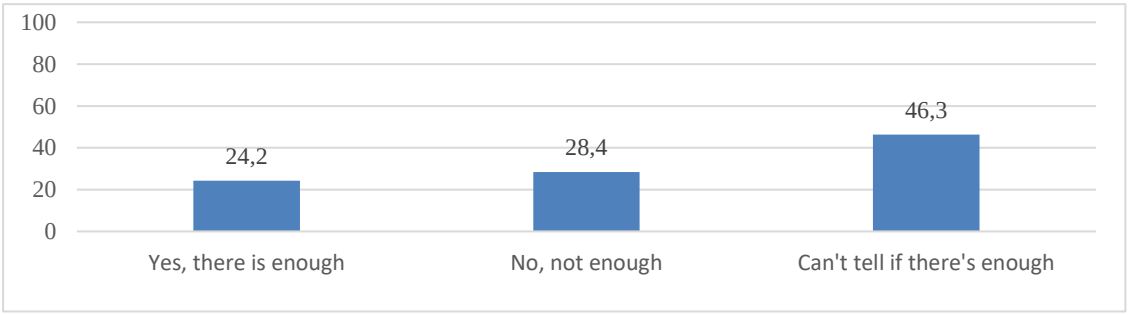


Figure 6. Sufficiency of investments and resources for the implementation of smart technologies in the transport logistics sector in Lithuania.

The results of the study showed that the respondents do not have a unanimous opinion regarding the sufficiency of investments and resources for the implementation of smart technologies in the transport logistics sector in Lithuania. 28.4 percent respondents believed that currently there are insufficient investments and resources, while a similar number of respondents (24.2%) said that they are sufficient. However, even 46.3 percent the subjects could not say whether the investments and resources are sufficient. This shows that many of the subjects did not have a clear view on this problem.

Compared to other authors, Lee et al. (2018) also discuss the importance of investment and resources for the adoption of smart technologies. The authors emphasize that funding, partnerships, technology and a skilled workforce are essential factors driving the adoption of these technologies.

CONCLUSIONS

1. The need for smart technologies in transport logistics is determined by aspects such as increasing customer expectations, intense competition, environmental issues, regulatory acts and data-based decision-making. Smart technology is critical to meeting these challenges and ensuring the success of a transportation logistics organization.
2. The diversity of smart technologies in transport logistics includes the Internet of Things (IoT) for real-time data collection and monitoring; artificial intelligence that plans routes and optimizes demand forecasting; autonomous

vehicles for safer and more efficient transport; smart transport infrastructure for better traffic management; blockchain for secure and transparent supply chain transactions; GPS and GIS for precise tracking and route optimization; advanced analytics for data-driven insights and decision-making; electronic data interchange (EDI) for smooth exchange of information; and cloud computing that allow economical and efficient storage and processing of data. These technologies allow logistics organizations to adapt to dynamic market conditions and provide the highest quality customer service. During this study, it was established that more efficient work processes, faster and more accurate delivery of goods to consumers, increased business competitiveness and profitability, and optimized planning of transport routes are the most important positive aspects of the implementation of smart technologies. GPS and GIS, artificial intelligence and smart transport infrastructure are the most valued smart technologies with the greatest potential in the Lithuanian transport logistics sector.

REFERENCES

1. Bhardwaj, S., & Mostofi, H. (2022). Technical and Business Aspects of Battery Electric Trucks—A Systematic Review. *Future Transportation*, 2(2), 382-401. Bryman, A. (2012). Social Research Methods. Oxford University Press. https://doi.org/10.3390/futuretransp2020021
2. Chong, A. Y. L., Ma, X., & Li, B. 2020. Predictive analytics for real-time data in supply chain management. *Industrial Management & Data Systems*, 120 (7), 1323-1343.
3. Cimini, C., Lagorio, A., Romero, D., Cavalieri, S., & Stahre, J. 2020. Smart logistics and the logistics operator 4.0. *IFAC-PapersOnLine*, 53(2), 10615-10620. https://doi.org/10.1016/j.ifacol.2020.12.2818
4. Delmonteil, F. X., & Rancourt, M. È. 2017. The role of satellite technologies in relief logistics. *Journal of Humanitarian Logistics and Supply Chain Management*, 7(1), 57-78. https://doi.org/10.1108/JHLSCM-07-2016-0031
5. Eom, S., Lee, J., & Kim, J. 2020. The impact of information and communication technology and the Internet of Things on the logistics service industry. *Technological Forecasting and Social Change*, 150, 119792. https://doi.org/10.1016/j.techfore.2019.119792
6. Evangelista, P., Sweeney, E., & Rodrigues, V. S. 2020. The role of logistics innovation in fostering sustainability. International *Journal of Operations & Production Management*, 40(6), 951-976.
7. Feng, L. 2016. Intelligent logistics and distribution system based on Internet of Things. 2016 *IEEE Advanced Information Management, Communicates, Electronic and Automation Control Conferenc*e (IMCEC), p. 228-231. https://doi.org/10.1109/IMCEC.2016.7867206
8. Field, A. 2013. Discovering Statistics using IBM SPSS Statistics. SAGE Publications Ltd.
9. Fosso Wamba, S., Gunasekaran, A., Papadopoulos, T., & Ngai, E. 2018. Big data analytics in logistics and supply chain management. *The International Journal of Logistics Management*, 29(2), 478-484. https://doi.org/10.1108/IJLM-02-2018-0026
10. Gu, Y., Goez, J. C., Guajardo, M., & Wallace, S. W. 2021. Autonomous vessels: state of the art and potential opportunities in logistics. *International Transactions in Operational Research*, 28(4), 1706-1739. https://doi.org/10.1111/itor.12785
11. Harrison, A., & Whittall, D. 2019. Digital technology and the future of the logistics industry. Accessed on: https://www.itfglobal.org/en/reports-publications/digital-technology-and-future-logistics-industry
12. Holland, C., Levis, J., Nuggehalli, R., Santilli, B., & Winters, J. 2017. UPS optimizes delivery routes. *Interfaces*, 47(1), 8-23. https://doi.org/10.1287/inte.2016.0875
13. Homayoun, S., Al-Thani, F. F., & Homayoun, S. 2016. A sustainability accounting: Case study on exploration, production and midstream activities at Maersk oil. *International Journal of Energy Economics and Policy*, 6(1), 20-27.
14. Jafari, N., Azarian, M., & Yu, H.202). Moving from Industry 4.0 to Industry 5.0: what are the implications for smart logistics?. *Logistics*, 6(2), 26. https://doi.org/ 10.3390/logistics6020026
15. Kamble, S. S., Gunasekaran, A., & Arha, H. 2019. Understanding the blockchain technology adoption in supply chains-Indian context. International *Journal of Production Research*, 57(7), 2009-2033. https://doi.org/10.1080/00207543.2018.1518610
16. Kardelis, K. 2016. Mokslinių tyrimų metodologija ir metodai. Vilnius: Mokslo ir enciklopedijų leidybos centras [n Lihuanian].
17. Kim, J., & Seo, B. S. 2013. How to calculate sample size and why. *Clinics in orthopedic surgery*, 5(3), 235-242. https://doi.org/10.4055/cios.2013.5.3.235
18. Korczak, J., & Kijewska, K. 2019. Smart Logistics in the development of Smart Cities. *Transportation Research Procedia*, 39, 201-211. https://doi.org/10.1016/j.trpro.2019.06.022
19. Lee, I., & Lee, K. 2018. The Internet of Things (IoT): Applications, investments, and challenges for enterprises. *Business Horizons*, 61(4), 485-497.

20. Monios, J., & Bergqvist, R. 2020. Logistics and the networked society: A conceptual framework for smart network business models using electric autonomous vehicles (EAVs). *Technological Forecasting and Social Change*, 151, 119824. https://doi.org/10.1016/j.techfore.2019.119824

21. Pournader, M., Shi, Y., Seuring, S., & Koh, S. L. 2020. Blockchain applications in supply chains, transport and logistics: a systematic review of the literature. *International Journal of Production Research*, 58(7), 2063-2081. https://doi.org/10.1080/00207543.2019.1650976

22. Rodrigue, J. P., Comtois, C., & Slack, B. 2021. The Geography of Transport Systems (5th ed.). Routledge.

23. Sudbury, A. W., & Hutchinson, E. B. (2016). A cost analysis of amazon prime air (drone delivery). Journal for Economic Educators, 16(1), 1-12.

24. Tadić, S., Krstić, M., Kovač, M., &Brnjac, N. 2022. Evaluation of Smart City Logistics Solutions. *Promet-Traffic&Transportation*, 34(5), 725-738. https://doi.org/10.7307/ptt.v34i5.4122

25. Wang, X., Gunasekaran, A., Ngai, E. W., & Papadopoulos, T. 2016. Big data analytics in logistics and supply chain management: Certain investigations for research and applications. *International Journal of Production Economics*, 176, 98-110. https://doi.org/10.1016/j.ijpe.2016.03.014

26. Winkelhaus, S., & Grosse, E. H. 2020. Logistics 4.0: a systematic review towards a new logistics system. *International Journal of Production Research*, 58(1), 18-43. https://doi.org/10.1080/00207543.2019.1612964

27. Woschank, M., Rauch, E., & Zsifkovits, H. 2020. A review of further directions for artificial intelligence, machine learning, and deep learning in smart logistics. *Sustainability*, 12(9), 3760. https://doi.org/10.3390/su12093760