JAUNASIS
MOKSLININKAS

VYTAUTO DIDŽIOJO
UNIVERSITETO
ŽEMĖS ŪKIO
AKADEMIJA

IMPLEMENTATION OF SMART TECHNOLOGIES IN THE LOGISTICS BUSINESS

Mohamed CHAKHCHOUKH, Vytautas Magnus University Agriculture Academy, Faculty of Bioeconomy Development, email: mohamed.chakhchoukh@vdu.lt

Abstract

The significance of smart technology in logistics is increasing as companies place a higher priority on operational effectiveness, cost savings, and client satisfaction. This study looks at how automation, artificial intelligence (AI), and the Internet of Things (IoT) are driving digital transformation, which is transforming logistics operations by enabling data-driven decision-making, real-time tracking, and increased efficiency. In addition to addressing implementation issues, the research attempts to evaluate and suggest smart technologies that optimise logistical operations. Secondary data from scholarly sources is thematically examined using a qualitative technique to identify key problems, solutions, and developments in technology. The results show that high implementation costs, cybersecurity errors, system integration challenges, and workforce adaptability issues are some of the main adoption barriers. Strategies including scalable investments, worker training, cybersecurity improvements, and industry cooperation are suggested in order to optimise the advantages of digitalisation. The study comes to the conclusion that automation, blockchain, IoT-based tracking, and artificial intelligence (AI) are essential for revolutionising logistics, advancing sustainability, and boosting competitiveness in the rapidly changing global market.

Keywords: smart technology, smart technologies, logistics, business

Introduction

As enterprises concentrate on increasing customer satisfaction, reducing costs, and enhancing efficiency, the importance of smart technologies in the worldwide market is expanding (Ding et al., 2020). Businesses in a variety of industries, including logistics, are going through a digital transformation as a result of the rapid growth of technology. Supply chain operations are improved, real-time tracking is made possible, and data-driven decision-making is supported by the integration of smart technologies like automation, artificial intelligence, and the Internet of Things (Khan et al., 2022). This research is useful since it analyses the way digitization is changing logistics, boosting productivity, and boosting competitiveness. Businesses must learn how smart technologies are being adopted in logistics if they want to remain competitive in the ever-changing global market.

By examining the way advanced technologies are changing logistics operations and highlighting their role in enhancing productivity, sustainability, and real-time decision-making, this study presents a novel viewpoint. It focuses on innovations like blockchain-driven transparency, IoT-based tracking, and AI-powered automation, offering fresh perspectives on the quickly changing digital environment of the logistics industry.

Research aim: to analyse and propose the effective and profitable smart technologies in the logistics businesses.

The following **objectives** have been set to achieve the aim:
1. To find out the challenges of implementing smart technologies in the logistics business
2. To identify the possible strategies to enhance the use of smart technologies in the logistics business.
3. To suggest significant smart technologies in the logistics business.

Research object and methods

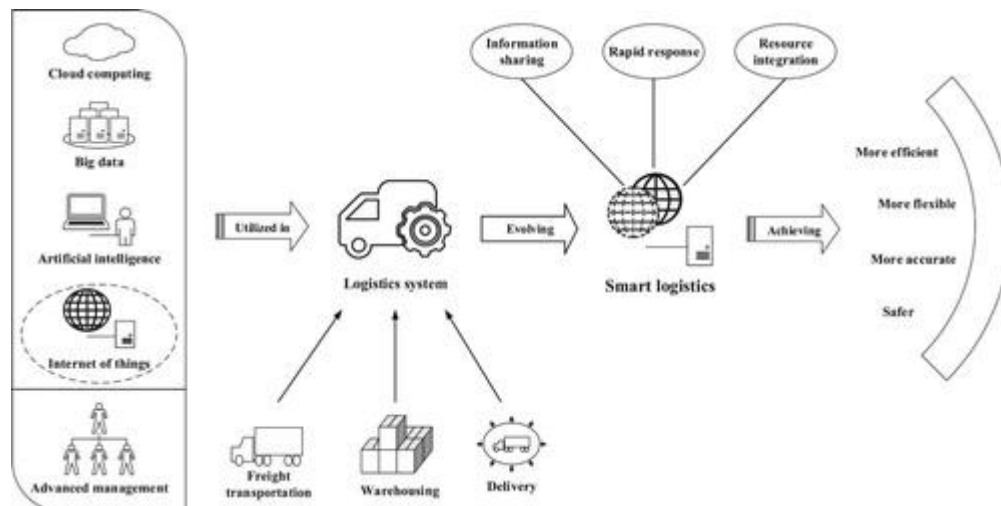Research object: smart technologies in logistics organisations

The secondary research method is employed in the article to analyze the implementation of smart technologies in the logistics business. The data collection and analysis process is held in an academic manner which ensures the academic integrity and relevance of the research. Secondary data is collected from secondary sources such as journals, articles, books, and reports. JSTOR, Science Direct, Google Scholar, Wiley Online Library, Taylor and Francis Online, ResearchGate and IEEE Xplore are some of the databases which help to collect the relevant data through keyword searching. The data published after 2019 is selected to analyze and achieve the research aim and objectives. In addition, thematic analysis is employed for this qualitative analysis. The themes are organized based on objectives and respective results of data collection.

Research results and discussion

The concept of smart technologies in logistics

Smart logistics is the use of the latest digital technologies to improve logistics operations' efficiency and optimisation. The Internet of Things (IoT), cloud computing, big data, and artificial intelligence (AI) are some of the technologies that are essential to optimising logistical operations (Ding et al., 2020). Their effective implementation in sectors such as distribution, storage, and freight transportation makes it easier to create intelligent logistics systems. As

mentioned in Fig. 1, ensuring smooth information flow, facilitating quick responses to operational difficulties, and optimising resource utilisation are all key components of smart logistics (Ding et al., 2020). Logistics companies may improve supply chain visibility by using AI and big data analytics to automate decision-making, optimise inventory management, and predict demand patterns (Kauf, 2019). Real-time shipment tracking is made possible by IoT-enabled sensors in goods transportation, which also improve security and reduce delays. Cloud computing, on the other hand, guarantees data accessibility for multiple stakeholders, promoting improved coordination between distribution networks, warehouses, and suppliers (Zhan et al., 2022). Across logistics operations, the integration of these technologies improves accuracy, safety, flexibility, and efficiency.

Source: According to Ding et al., 2020

Fig. 1. Concept of smart technologies in logistics

Additionally, by providing faster delivery, real-time tracking, and predictive insights into possible delays, smart logistics raises consumer satisfaction. By decreasing human error and speeding up order fulfilment, the use of automation and robots in warehousing further improves efficiency (Ding et al., 2020). Additionally, by maximising transportation routes and reducing fuel usage, smart logistics helps environmental initiatives by lowering carbon emissions (Zhan et al., 2022). The logistics sector benefits from increased productivity, lower costs, and better service quality as more and more logistics companies use these technologies.
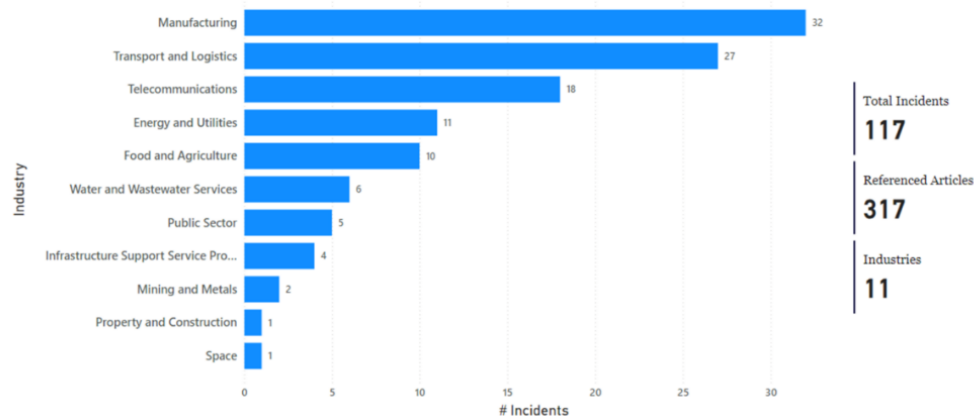
Challenges of implementing smart technologies in logistics

By analyzing the literature related to smart technologies, it has to be highlighted that the logistics industry has significant challenges even if the logistics companies have begun to implement smart technologies in their operations. Researchers highlighted the high cost of implementing smart technology into practice as a significant barrier (Korczak and Kijewska, 2019). Logistics firms must spend heavily on infrastructure, including cloud computing, automation tools, IoT devices, and analytics driven by AI. There is a digital adoption gap between major organizations and smaller businesses since smaller and mid-sized logistics companies sometimes cannot afford these advanced technologies (Abdul-Yekeen et al., 2024). Protecting privacy and guaranteeing data security is another significant challenge. Cloud computing and IoT networks, which continuously collect and exchange sensitive data, are essential to smart logistics. However, there are significant risks to logistics organizations and their clients from cybersecurity threats including ransomware attacks, data breaches, and hacking (Abbas et al., 2020). A logistics system cyberattack may result in financial losses, reputational harm, and operational delays (Abbas et al., 2020). The 2017 hack on Maersk, which caused significant disruptions to international shipping operations and resulted in losses exceeding 300 million dollars, is a notable case ("Ship Operations," 2020). Moreover, a report by James and James (2024) points out that the transportation and logistics industry along with the manufacturing industry faces more cyber incidents than other industries.

The adoption of smart technology is also limited by system integration challenges. Several organizations are involved in logistics operations, including suppliers, warehouses, transportation companies, and retailers. It can be difficult and time-consuming to connect different digital systems across these businesses, especially when older technologies are being used (Chung, 2021). Many businesses struggle to ensure seamless communication between their current software and new digital solutions, which frequently leads to delays and inefficiencies. The capacity of the workforce to adjust to new technology is an important challenge. Workers used to traditional logistical techniques can find it difficult to adapt to data-driven management, automated workflows, and AI-driven decision-making (Korczak and Kijewska, 2019). It takes a lot of time and money to train and upskill employees, and resistance to change can slow down the digital transformation process even more. Sustaining technical dependability is a constant challenge. IoT devices, AI algorithms, and cloud-based platforms are all essential to smart logistics, and they all need regular maintenance and monitoring (Abdul-Yekeen et al., 2024). Operations might be interrupted and significant expenses can arise from software bugs, system breakdowns, or network issues (Tan and Sidhu, 2022). System dependability requires regular upgrades and

committed IT support. Logistics businesses must overcome these obstacles if they want to make full use of smart technology and maintain their competitiveness in a sector that is becoming more and more digitalised.

Publicly reported cyber incidents by industry - 1 July 2023 - 30 June 2024

Industry	# Incidents
Manufacturing	32
Transport and Logistics	27
Telecommunications	18
Energy and Utilities	11
Food and Agriculture	10
Water and Wastewater Services	6
Public Sector	5
Infrastructure Support Service Pro...	4
Mining and Metals	2
Property and Construction	1
Space	1

Total Incidents
117

Referenced Articles
317

Industries
11

Source: According to James and James, 2024

Fig. 2. Cyber incidents in industries, especially in the transport and logistics sectors

Strategies to enhance the use of smart technologies in logistics

The articles analyzed highlighted that a comprehensive strategy is required to effectively increase the use of smart technology in logistics. It has to focus on workforce training, cybersecurity, investment, integration, and cooperation. Implementing cost-effective digital solutions is especially important for small and medium-sized logistics companies that must deal with massive installation expenses (Abdul-Yekeen et al., 2024). Before progressively implementing innovative AI-driven automation and robots, businesses should start with scalable technologies like cloud-based logistics management systems and Internet of Things-enabled tracking devices (Jefroy et al., 2022). The cost of putting smart logistics solutions into practice can also be lessened with the support of government incentives. Ensuring efficient system integration across the supply chain is an essential strategy. The inability of many logistics firms to integrate smart technology with outdated systems frequently leads to inefficiencies (Gupta et al., 2022). Businesses may solve this by concentrating on implementing adaptable and compatible software solutions that promote connection across digital platforms and allow for effective communication between transportation providers, warehouses, and suppliers (Enrique et al., 2022). Additionally, standardised data-sharing protocols can increase supply chain visibility and operational coordination. Initiatives for digital literacy and employee training are essential to the effective use of smart logistics. Employees must acquire the abilities needed to manage automated warehouse systems, IoT-based tracking, and AI-driven analytics (Devi et al., 2023). Businesses should spend money on continuous learning initiatives, and practical training to help employees adjust to new technology while reducing resistance to change. Improving data security and cybersecurity is essential for maximising smart technology in logistics. Because of the increased dependence on cloud computing and IoT networks, businesses need to implement robust security measures like multi-factor authentication, encryption, and real-time monitoring to reduce cyber risks (Das and Mukherjee, 2024). To further improve confidence and secure essential logistical data, regular security audits and data protection requirements should be followed. Cooperation with industry stakeholders and technology suppliers may accelerate the adoption of smart logistics. Logistics organizations may obtain tailored solutions that increase operational efficiency by collaborating with companies that specialise in AI, IoT, and big data analytics (Zong and Guan, 2024). Furthermore, regulatory frameworks and industry-wide initiatives can promote standardisation and the wider use of smart logistics solutions. Logistics firms may completely utilise smart technology to improve supply chain performance, reduce expenses, and increase efficiency by adopting these strategies. Moreover, logistics companies have to identify the suitable technologies which will uplift their operations without any issues.

Significant smart technologies in logistics

The use of smart technology has brought about an important transformation in the logistics industry by increasing supply chain operations' accuracy, efficiency, and flexibility. The Internet of Things (IoT), blockchain, cloud computing, big data analytics, autonomous vehicles and robotics, and artificial intelligence (AI) are some of the major improvements (Song et al., 2020). These developments result in more intelligent and efficient logistics operations by improving several processes, including real-time tracking, inventory management, warehousing, and transportation. AI is essential for contemporary logistics because it improves supply chain efficiency and streamlines decision-making. Algorithms powered by AI examine past data to predict changes in demand, plan the best routes for deliveries, and enhance inventory control (Chen et al., 2024). Logistics businesses can predict possible delays and propose proactive solutions with the use of machine learning algorithms. Furthermore, chatbots and virtual assistants driven by AI improve customer service by providing real-time shipment tracking and quick replies (Abdul-Yekeen et al., 2024). Real-time tracking and monitoring of cargo, automobiles, and warehouse conditions are made possible with IoT technology. Logistics firms may improve

136

asset management, reduce fuel consumption, and improve route planning by using IoT-enabled sensors and GPS devices to collect and send data (Chung, 2021). IoT sensors in warehousing monitor inventory levels, temperature, and humidity to provide the most effective possible storage conditions for delicate goods like medications and perishable foods (Kauf, 2019). For example, to maintain an eye on cargo conditions and preserve product quality, Maersk, a well-known international shipping business, uses Internet of Things sensors in its refrigerated containers ("Ship Operations," 2020). Big Data is essential to logistics because it provides insightful information on the performance of the supply chain. Logistics firms may improve demand forecasting, enhance risk management, and optimise shipping routes by evaluating vast amounts of organised and unstructured data (Jefroy et al., 2022). Big Data analytics also supports more informed decision-making, reduces operating expenses, and finds inefficiencies. Cloud computing provides a scalable and adaptable digital infrastructure, which increases logistical efficiency. Cloud-based logistics management solutions allow transportation companies, warehouses, and suppliers to work together in real time (Ding et al., 2020). Businesses can store and retrieve important information remotely due to this technology, which improves supply chain visibility and reduces the cost of IT equipment (Ding et al., 2020). Cloud solutions also provide automated inventory control and electronic documentation, which lowers mistakes and boosts productivity. Blockchain technology offers safe and unbreakable record-keeping, which improves logistics' transparency, security, and efficiency. It reduces fraud, copying, and inefficient paperwork while protecting the integrity of supply chain data (Abbas et al., 2020). Blockchain-powered smart contracts automate transactions, reducing paperwork and administrative costs. For instance, Walmart uses blockchain technology to track and confirm the reliability of food products, improve transparency, and adhere to safety regulations (Xu et al., 2020). Logistics is being transformed by automation through robotics and autonomous vehicles, which reduces the need for manual labour and boosts operational effectiveness. Autonomous vehicles provide quicker and more economical delivery, while robotic systems maximize warehouse efficiency (Ding et al., 2020). Robotic arms and automated guided vehicles (AGVs) sort, pack, and move items precisely, increasing warehouse productivity (Chen et al., 2024).

Smaller businesses must concentrate on scalable and affordable solutions, whereas larger logistics firms may invest in innovative technologies (Abdul-Yekeen et al., 2024). Because of their low cost and simplicity of use, cloud computing, IoT, and big data analytics are perfect for developing logistics companies. Without needing large investments in IT infrastructure, cloud-based logistics management systems give SMEs digital capabilities for inventory control, real-time tracking, and communication (Abdul-Yekeen et al., 2024). While big data analytics helps optimize supply chain operations with little expense, IoT-enabled tracking devices provide real-time shipment visibility at a reduced cost. Small firms may increase productivity, reduce expenses, and maintain their competitiveness in the dynamic logistics sector by implementing these technologies.

Conclusions

1. Smart technologies in the logistics businesses are analysed in the article. Article identified that digitalisation enhances productivity, reduces mistakes, and makes real-time tracking easier, as a result, it is essential to the transformation of logistics operations. Innovative technologies like automation, IoT, and AI improve procedures, leading to lower operating costs and faster delivery. However, effective integration and a large infrastructure investment are necessary for an efficient implementation.

2. High initial expenses, cybersecurity risks, opposition to technical change, and system integration challenges are some of the main obstacles to digital adoption. Effective planning, training for employees, and cooperation with technology suppliers are necessary for addressing these challenges and ensure an effortless transition.

3. Employers should use cloud-based solutions, engage in employee skill development, improve cybersecurity procedures, and take an organised approach to digitalisation. Businesses may achieve sustainable development, increase customer satisfaction, and significantly improve supply chain efficiency by using these strategies.

References

1. Abbas, A. W., Marwat, S. N. K., Ahmed, S., Hafeez, A., Ullah, K., & Khan, I. U. (2020). Proposing Model for Security of IoT devices in Smart Logistics: A review. *2020 3rd International Conference on Computing, Mathematics and Engineering Technologies (iCoMET)*. https://doi.org/10.1109/icomet48670.2020.9073916

2. Abdul-Yekeen, A. M., Rasaq, O., Ayinla, M. A., Sikiru, A., Kujore, V., & Agboola, T. O. (2024). Utilizing the internet of things (IoT), artificial intelligence, machine learning, and vehicle telematics for sustainable growth in small and medium firms (SMEs). *Deleted Journal*, *5*(1), 237–374. https://doi.org/10.60087/jaigs.v5i1.197

3. Chen, W., Men, Y., Fuster, N., Osorio, C., & Juan, A. A. (2024). Artificial Intelligence in Logistics Optimization with Sustainable Criteria: A Review. *Sustainability*, *16*(21), 9145. https://doi.org/10.3390/su16219145

4. Chung, S. (2021). Applications of smart technologies in logistics and transport: A review. *Transportation Research Part E Logistics and Transportation Review*, *153*, 102455. https://doi.org/10.1016/j.tre.2021.102455

5. Das, S., & Mukherjee, S. (2024). Navigating cloud security risks, threats, and solutions for seamless business logistics. In *Advances in information security, privacy, and ethics book series* (pp. 252–275). https://doi.org/10.4018/979-8-3693-2081-5.ch011

6. Devi, D. P., Allur, N. S., Dondapati, K., Chetlapalli, H., Kodadi, S., & Perumal, T. (2023, November 11). *Digital twin technology and IoT-Enabled AI using Real-Time analytics for smart warehouse management and predictive inventory optimization*. Retrieved March 12, 2025, from https://ijmm.in/index.php/ijmm/article/view/208

7. Ding, Y., Jin, M., Li, S., & Feng, D. (2020). Smart logistics based on the internet of things technology: an overview. *International Journal of Logistics Research and Applications*, *24*(4), 323–345. https://doi.org/10.1080/13675567.2020.1757053

8. Enrique, D. V., Lerman, L. V., De Sousa, P. R., Benitez, G. B., Santos, F. M. B. C., & Frank, A. G. (2022). Being digital and flexible to navigate the storm: How digital transformation enhances supply chain flexibility in turbulent environments. *International Journal of Production Economics*, *250*, 108668. https://doi.org/10.1016/j.ijpe.2022.108668

9. Gupta, H., Yadav, A. K., Kusi-Sarpong, S., Khan, S. A., & Sharma, S. C. (2022). Strategies to overcome barriers to innovative digitalisation technologies for supply chain logistics resilience during pandemic. *Technology in Society*, *69*, 101970. https://doi.org/10.1016/j.techsoc.2022.101970

10. James, & James. (2024, October 6). 14 recent cyber attacks on the transport & logistics sector. *Wisdiam |*. https://wisdiam.com/publications/recent-cyber-attacks-transport-logistics-sector/

11. Jefroy, N., Azarian, M., & Yu, H. (2022). 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

12. Kauf, S. (2019). Smart logistics as a basis for the development of the smart city. *Transportation Research Procedia*, *39*, 143–149. https://doi.org/10.1016/j.trpro.2019.06.016

13. Khan, Y., Su'ud, M. B. M., Alam, M. M., Ahmad, S. F., Ahmad, A. Y. a. B., & Khan, N. (2022). Application of Internet of Things (IoT) in sustainable supply chain management. *Sustainability*, *15*(1), 694. https://doi.org/10.3390/su15010694

14. 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

15. Ship operations. (2020). In *Routledge eBooks*. https://doi.org/10.4324/9781003000754

16. Song, Y., Yu, F. R., Zhou, L., Yang, X., & He, Z. (2020). Applications of the Internet of Things (IoT) in smart Logistics: A Comprehensive survey. *IEEE Internet of Things Journal*, *8*(6), 4250–4274. https://doi.org/10.1109/jiot.2020.3034385

17. Tan, W. C., & Sidhu, M. S. (2022). Review of RFID and IoT integration in supply chain management. *Operations Research Perspectives*, *9*, 100229. https://doi.org/10.1016/j.orp.2022.100229

18. Xu, J., Guo, S., Xie, D., & Yan, Y. (2020). Blockchain: A new safeguard for agri-foods. *Artificial Intelligence in Agriculture*, *4*, 153–161. https://doi.org/10.1016/j.aiia.2020.08.002

19. Zhan, J., Dong, S., & Hu, W. (2022). IoE-supported smart logistics network communication with optimization and security. *Sustainable Energy Technologies and Assessments*, *52*, 102052. https://doi.org/10.1016/j.seta.2022.102052

20. Zong, Z., & Guan, Y. (2024). AI-Driven intelligent data Analytics and predictive Analysis in Industry 4.0: Transforming knowledge, innovation, and efficiency. *Journal of the Knowledge Economy*. https://doi.org/10.1007/s13132-024-02001-z