

SMART TECHNOLOGY APPLICATION IN LOGISTICS SERVICES

Adeboye Joseph OLUWOLE, Vytautas Magnus University Agriculture Academy, Faculty of Bioeconomy Development, email: adeboye.joseph.oluwole@vdu.lt

Abstract

This article explores the application of smart technologies in logistics, aiming to analyze current trends in business operations and how smart technologies can help address limitations that are not feasible to solve with traditional methods.

Furthermore, the paper highlights the factors affecting the application of smart technologies in the Supply Chain and Logistics Industry and explores internal and external barriers hindering their implementation. The study followed these objectives: to explore technological and organization factors affecting the adoption of innovative technologies in the supply chain and logistics industry. The research has been undertaken by using secondary methods and a systematic literature review; specifically, in that connection, it discusses the significance of smart technologies since they improve operational efficiency, customer experience and innovation in the logistics sector.

Keywords: smart technology, logistics, trends, challenges

Introduction

Smart logistics, also known as “intelligent logistics” or “logistics 4.0” has no unified definition, and it is generally recognized as a more intelligent and efficient way to plan, manage, and control logistic activities with intelligent technologies (Feng & Ye, 2021). One of the key importance of smart technologies lies in their ability to provide real-time visibility and transparency throughout the supply chain. Thus, smart logistics in substance is optimization of existing logistics chains, with the involvement of new technological and organizational capabilities. Smart technologies have greatly improved the use of logistics services by making them smarter, more accurate and more satisfying to customers. Advancements in recent years have included deploying of real-time tracking with Internet of Things (IoT) devices, using of autonomous vehicle for last mile delivery and the implementation of an automated warehouse system. The fact is innovation and speed are the key factors for all businesses in all sectors also in the field of logistics, in today’s competitive business environment. The advent of innovative technologies in logistics is drawing strong interest not only because such technologies can automate process, eliminate waste and produce other advantages, but also because of its introduction into the industry’s technological base enables the enhancement of its competitive position on the international market. Smart technology serves crucial purposes throughout logistics functions including inventory control and packaging methods and warehouse operations besides transportation management and data processing and predictive analysis and product acquisition and customer service support. A particular technology serves each activity because it enables streamlined operations with optimized resource utilization to achieve enhanced overall efficiency. Companies that adopt smart technology systems gain a competitive advantage through external environment adaptation which sustains their long-term business competitiveness.

The integration of smart technologies helps businesses obtain competitive advantages through adaption to external environmental changes which ensures their long-term business success. Moreover, technology serves as a fundamental tool for organisations to meet their short-term business targets including better financial performance together with market expansion and new market entry and decreased production expenses. Companies can achieve these objectives through new smart technologies that provide real-time visibility, predictive analytics, and automated processes, effectively addressing challenges that are difficult to resolve using traditional methods. Companies cannot ignore the value added with new smart innovations. The four key technologies that support to realize smart logistics are Big Data and Machine Learning, the Internet of Things (IoT), cloud computing and artificial intelligence (Song et al., 2021). Integration of these technologies enables automation, data-driven decision-making, and improved resource management, contributing to sustainable development and improved quality of life. However, firms should carefully assess the added value of smart technologies in each aspect of logistics operations to identify the most important initiative worth investing in.

This paper will examine recent advancements in smart technologies within the logistics industry, explore the challenges associated with their implementation, and analyze potential solutions to overcome these obstacles and the benefits their integration can offer.

Research aim: to analyse the possible use of smart technologies to improve logistics operations to analyze the potential use of smart technologies to improve logistics operations and propose solutions for implementation.

The following **objectives** have been set to achieve the aim:

1. To examine how emerging business operation trends are influencing the adoption of smart technologies in logistics
2. To identify the most common barriers to adopting smart technologies in logistics

Research object and methods

Research object: smart technology in logistics

The research methodology for this study was mainly secondary research methods, focusing on the analysis of existing scientific literature related to smart technology in logistics. A wide range of sources was utilized, including

academic journals, books, reports, and online databases such as Google Scholar and ScienceDirect, to gather relevant information. By reviewing and synthesizing existing research findings, this study combined studies together to explain the current uses of smart technology for a better logistics operation that meets today's business operations. The method of content analysis was applied to compare information and study relevant trends, ultimately leading to the formation of conclusions. Additionally, our research analyzed smart logistics benefits and found its barriers for implementation through a complete evaluation a systematic literature review.

Research results and discussion

The latest trends and adoption of smart technologies in logistics

Logistics management is key in solving any supply chain, production, or distribution problem and distinguishing the company from its competitors. Many elements play key roles within a logistical operations/structure, and all have differing characteristics and challenges. For example, in many supply chains, finding a balance between delivery time and processing time is a challenge, and if not managed efficiently, it can lead to increased service costs and contribute to unnecessary waste (Strandhagen et al., 2017a). The information flow is another critical element to effectively manage the flow of goods and inventory. The implementation of innovative technologies in logistics such as Internet of Things (IoT) sensors and artificial intelligence (AI) among others, have demonstrated potential promise in enhancing the efficiency and effectiveness in various logistics operations and transportation systems (Feng and Ye, 2021). By investing in smart technologies companies strive for the automation of logistics processes at their various stages - production, transportation, storage, distribution, as well as the management of information flows associated with these operations. Many different studies of Industry 4.0 have underscored future trends of business and customer preferences relevant to Logistic. Recent trends show increasing focus on Individualization and personalization, Servitization, Accessibility, autonomy, digitalization and green logistics (Strandhagen et al., 2017a). The individualization trend drives demand for product customization, allowing products to be tailored to individual preferences. To capture these preferences, on-demand manufacturing and assembly systems are employed (Hong et al., 2021). Smart technologies are a new mode for realizing flexible manufacturing by leveraging cloud computing. The innovative applications of autonomous vehicles like drones and self-driving trucks, will enable personalized deliveries and offer faster and more cost-effective options for last-mile delivery, particularly in urban areas where congestion and traffic congestion are prevalent (Ding et al., 2021).

Application of smart technologies in logistics can be classified into four main areas: decision-making support, identification and tracking, information flow, and automation and robotics (Cimini et al., 2020). The Artificial Intelligence (AI) based decision-making assisted by Big Data analytics conducts assessment of customer demand data alongside inventory conditions and relevant factors within the first functional area. Automated decision processes become possible through this approach since it delivers interpretive data-driven analysis. Big data technology provides advanced analytics for logistics by utilizing the vast amount of fast-moving data that is almost impossible to be analyzed and managed by traditional data processing tools (Govindan et al., 2018). The importance of big data technology lies in its ability to extract valuable insights from large data sets, such as those collected through IoT technology. The system enables product tracing and inventory control alongside materials stock optimization throughout production along with distribution. The IoT system finds its main practical application in logistics through identification and tracking functions. Real-time tracking technologies increase supply chain security while enhancing operational efficiency because they let administrators make decisions in advance and prevent delay occurrences. Industrial Internet of Things applications facilitate information acquisition throughout complete logistics operations beginning from manufacturing through packaging and storage to distribution and transportation (Hopkins and Hawking, 2018). Through complete visibility the monitoring of inventory movement together with delay identification enables enhancements for internal and external logistics management. However, the implementation of IoT relies on various enabling technologies, such as sensor technology, wireless networks, and communication systems (Song et al., 2021).

In addition to improving decision-making and operational efficiency, smart technologies also enhance the overall customer experience by providing greater convenience, visibility, and customization options by transmitting information from multiple sources in order to allow a more responsive real-time production planning and scheduling. As smart logistics technology continues to evolve, there is a shared industry consensus on the need to integrate and share logistics information between all players through "cloud computing." (Song et al., 2021). Cloud technology is a system that integrates millions of sensors, cameras, displays, smart phones and other smart communication devices in cloud data centers (Song et al.,). The main objective of cloud computing is to use huge computing and storage resources under concentrated management. Benotmane, Belalem, and Neki (2017) used a cloud computing platform to provide a link between different technologies, ensuring transmission and reception of through protocols understandable by everyone. The cloud computing is essential in current logistics operations to meet customers' demands on time through a strong collaboration between all players. It has many advantages such as unlimited storage, easy access to information, easier to provide services to multiple consumers and subsequently achieve economies of scale and specialization (Dillion, Wu, & Chang, 2010).

The innovative applications in logistics result from integrating information and communications technology with production and automation technology (Kamali, 2019). Warehouses and distribution centers are increasingly incorporating robotics and automation. Automation and robotics concern with the introduction of new devices and smart/intelligent transportation systems able to replace or support the human work in the manual operations (Karabegović et al., 2015). Robots can be used in manufacturing for assembly lines, for picking, packing, and sorting and even robot deliveries for last-mile logistics. Robot technology provides enhanced flexibility together with advanced cognitive abilities that make it possible by incorporating new sensor technology and artificial intelligence techniques and improved computing systems (Akkaya & Kaya, 2019). Autonomous robots can test, select, pack, sort, install, inspect, or transport materials of different sizes and weights faster

and more efficiently than humans. Warehouse robotics, for example, streamlines order fulfilment by automating picking, packing, and sorting tasks, thereby reducing labor costs and increasing operational efficiency (Song et al., 2021).

Most common barriers to adopting smart technologies in logistics

There are usually three main factors influencing the adoption of smart technologies: costs saving, increased efficiency and better service quality. One of the solutions to reach these goals can be innovative technologies which help companies in their day-to-day operations. The question becomes why logistic companies are unwilling to acquire such systems despite the existing advantages. For this purpose, identification of barriers influencing the level of negative impact was considered for this paper. The implementation of intelligent systems in manufacturing enterprises faces many obstacles (barriers). Due to the "innovative" nature of the presented issues and the relatively short period of their "use" in practice (Stanislawski and Szymonik, 2021). Studies regarding the challenges associated with integration of smart technologies usually concentrates on specific systems (e.g. blockchain, AI, IoT), overlooking the issues of a holistic approach to this issue. Nevertheless, some preliminary analysis in this regard is emerging. The most commonly discussed barriers can be grouped according to these restriction's scope: technical, technological and security, resource (human and financial), organizational and social, and environmental or cultural (Ozturk and Yildizbasi, 2020). Numerous excellent papers have demonstrated that, with the support of blockchain technology, organizations can prevent information tampering and enhance transparency. enhances transparency (Choi et al. 2019). However, the implementation of these technologies in logistics faces challenges, such as high initial costs, system compatibility issues, a lack of qualified personnel, and resistance to change (Oladele, 2024). Moreover, Ozturk and Yildizbasi (2020) highlight organizational barriers such as bureaucracy and reluctance to share information due to mainly the need to "extend" its competitiveness in the market, and resistance to internal changes that require significant effort and resource allocation. In terms of "socio-technical" aspects, alongside the development of new smart technologies, proper developments in the human-related aspects must be carried out both at the theoretical and practical level (Cimini et al., 2020). According to Paužuoliene et al. (2024), smart technologies such as artificial intelligence (AI), the Internet of Things (IoT), and blockchain require substantial investments in infrastructure, software, and hardware, creating significant financial challenges, especially for small and medium-sized enterprises. Considering that building a smart logistics system requires significant financial investment to transform existing systems, small and medium-sized companies are reluctant to make huge investments when the gains from such investments are not guaranteed. According to research conducted by Stanisławski and Szymonik (2021) for manufacturing companies in Poland, they have identified that Internal barriers such as lack of adequate resources, unqualified or shortage of staff, and low-risk tolerance have a greater negative impact on the implementation of smart technologies like IoT, Big Data and Cloud Computing. Among these technologies, the Big Data system encounters the highest level of limitation among internal and external barriers. According to the authors, this can be due to the fact that Big Data is somewhat well-known system among the surveyed enterprises, and therefore, they are in a better position to assess the difficulties associated with its implementation.

Concerning the technological complications, according to Paužuoliene et al. (2024) interoperability represents major challenge of implementation of smart systems to automate logistic processes in the enterprises. For instance, IoT systems must align with current transport and warehousing infrastructure to operate effectively. In case if such systems are not integrated seamlessly, they may generate disturbances to the operations, impede data exchange and, in general, deteriorate the efficiency of logistics firms (Paužuoliene et al). Also, smart technologies can also have scalability problems stemming from various factors. Data privacy, security and regulatory compliance raise various concerns regarding use of innovative technologies by logistics firms. Although it is clear that the potential for operations using robotics or other automated vehicle is evident, the risks associated with this must also be considered. Automation achieved does not yield perfect performance neither are there challenges a priori. Autonomous vehicles integration into the logistics operations is aimed at providing a solution that guarantees safety, reliability and adaptability (Ferreira & Reis, 2023).

Conclusions

1. In logistics, smart technologies enhance predictive analytics, decision-making, and automation, ultimately increasing customer satisfaction, productivity and efficiency. The current limitations of logistics should be addressed through future research that concentrates on the impact of novel technologies such as blockchain and quantum computing.

2. There are certain obstacles, however, hindering the widespread use of this technique. These include resistance to change, increased application costs, interoperability issues, and a shortage of skilled workers. Addressing these difficulties necessitates a strategic approach that encompasses investments in workforce development, regulatory support, and scalable technologies. Policymakers and industry leaders must collaborate to establish frameworks that foster creativity while ensuring the ethical and sustainable use of smart technologies.

3. Companies that effectively integrate intelligent logistics solutions will enhance their operational agility, augment their competitive edge, and promote long-term sustainability within the industry. Furthermore, firms should execute pilot projects and incremental rollouts to alleviate the risks linked to extensive adoption.

References

1. Akkaya, M., & Kaya, H. (2019, October). Innovative and smart technologies in logistics. In *17th International Logistics and supply chain congress* (pp. 97-105).
2. Benotmane, Z., Belalem, G., & Neki, A. (2017). A cloud computing model for optimization of transport logistics process. *Transport and Telecommunication*, 18(3), 194–206.

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.
4. Ding, Y., Jin, M., Li, S., & Feng, D. (2021). Smart logistics based on the internet of things technology: an overview. *International Journal of Logistics Research and Applications*, 24(4), 323-345.
5. Dillon, T., Wu, C., & Chang, E. (2010). Cloud computing: issues and challenges. In *2010 24th IEEE international conference on advanced information networking and applications* (pp. 27-33). Ieee.
6. Feng, B., Ye, Q. (2021). Operations management of smart logistics: A literature review and future research. *Frontiers of Engineering Management*, 8, 344–355.
7. Ferreira, B., & Reis, J. (2023). A systematic literature review on the application of automation in logistics. *Logistics*, 7(4), 80.
8. Govindan, K., Cheng, T. E., Mishra, N., & Shukla, N. (2018). Big data analytics and application for logistics and supply chain management. *Transportation Research Part E: Logistics and Transportation Review*, 114, 343-349.
9. Hong, Q., Chen, Z., Dong, C., & Xiong, Q. (2021, October). A dynamic demand-driven smart manufacturing for mass individualization production. In *2021 IEEE International Conference on Systems, Man, and Cybernetics (SMC)* (pp. 3297-3302). IEEE.
10. Hopkins, J., & Hawking, P. (2018). Big Data Analytics and IoT in logistics: a case study. *The International Journal of Logistics Management*, 29(2), 575-591.
11. Kamali, A. (2019). Smart warehouse vs. traditional warehouse. *CiiT International Journal of Automation and Autonomous System*, 11(1), 9-16.
12. Karabegović, I., Karabegović, E., Mahmić, M., & Husak, E. (2015). The application of service robots for logistics in manufacturing processes. *Advances in Production Engineering & Management*, 10(4), 185–194.
13. Öztürk, C., & Yildizbaşı, A. (2020). Barriers to implementation of blockchain into supply chain management using an integrated multi-criteria decision-making method: a numerical example. *Soft Computing*, 24(19), 14771-14789.
14. Oladele, O.K. 2024. Blockchain Technology in Logistics 4.0: A Comprehensive Review of Applications, Benefits, and Challenges, 27-42.
15. Paužuoliene, J., Kavecke, I., & Pyra, M. (2024). Smart technologies integration and challenges in the context of logistics companies. *European Research Studies Journal*, 27(Special Issue 2), 999-1018.
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.
17. Stanislawski, R., & Szymonik, A. (2021). Assessment of barriers to the implementation of intelligent (smart) logistics on the example of selected systems among manufacturing companies in Poland.
18. Strandhagen, J. O., Vallandingham, L. R., Fragapane, G., Strandhagen, J. W., Stangeland, A. B. H., & Sharma, N. (2017). Logistics 4.0 and emerging sustainable business models. *Advances in Manufacturing*, 5, 359-369.