

IMPROVING WAREHOUSING PROCESS WITH DIGITISATION SOLUTIONS

Sai Sujith CHINTHAMANENI, Vytautas Magnus University, Agriculture Academy, Faculty of bioeconomy development, email: sai.sujith.chinthamaneni@vdu.lt

Abstract

The complexity of globalised supply chains and the rise of e-commerce have also increased the need for more efficient and technologically advanced warehousing operations. The current research is focused on the improvement of warehousing operations through the implementation of digitisation technologies. The purpose of the current research is to identify the potential of digitisation in enhancing the efficiency of warehousing operations and to propose a framework for digitisation implementation. The research methodology of the current research is based on a scientific analysis of the latest scientific literature on the topic, along with secondary research. The research findings of the current research have identified that the implementation of digitisation technologies such as Warehouse Management System (WMS), barcode and RFID technologies, automation tools, and data analytics tools has a significant impact on enhancing the efficiency of warehousing operations while reducing human error and operation costs. The research findings of the current research have also identified that digitisation is a critical success factor for enhancing the efficiency of warehousing operations and provides a competitive advantage in supply chain management.

Keywords: supply chain management, warehouse management system, warehouse automation, inventory management, rfid technology, barcode systems, logistics efficiency.

Introduction

The warehouse operations process refers to a series of related processes that are associated with the movement of products in the warehouse. This includes the receiving of products into the warehouse, placing the products in the warehouse, storage, inventory control, picking orders, packaging, and transporting the products from the warehouse to customers (Tubis & Rohman, 2023).

In the last few years, the rise of global trade and the ever-increasing nature of electronic commerce have added more complexity to the operation of supply chains. Warehouses form an integral part of the supply chain and play a vital role in the smooth operation of the supply chain. However, the majority of the existing warehousing operations have been carrying out manual operations, and the information systems have been in disorganised form, leading to inefficiencies in the operation of the supply chain (Ivanov et al., 2021; Kembro et al., 2022).

The growing need for speed, accuracy, and transparency within logistics operations has led to a necessity to modernize processes taking place in warehouses. The use of digitalization has proven to be effective as it allows for immediate information access, operational process automation, and better decision-making capabilities. Tools used in warehousing operations, including WMS, barcode systems, RFID, and automation have gained recognition due to their effectiveness (Nils Boysen et al., 2022).

The need for modernisation of the operation of the warehouse has been felt in the context of the increasing demand for speed, precision, and transparency (Dmitry Ivanov et al., 2021). In this context, the role of digitalisation in the operation of the warehouse has emerged as a solution to the existing problems. The opportunities offered by the implementation of technologies such as the Warehouse Management System, Barcodes, and RFID have the potential to improve the operation of the supply chain (Nils Boysen et al., 2022).

Despite the potential benefits of digital solutions, many organisations face difficulties in their implementation due to the high costs of investments, a lack of technical knowledge, and organizational inertia. In addition, there is a lack of a systematic approach to the implementation of digital solutions into existing warehouse operations (Winkelhaus & Grosse, 2020).

Research aim – to investigate the impact of digitization on warehousing and design an effective model for implementing digital technology in warehousing.

In order to fulfil the research aim of the current paper, the following specific objectives of the paper have been formulated:

- 1.To identify of the existing scientific literature in the context of the proposed solution.
- 2.To identify of the most important digital technologies applied in the context of the operations of the warehouse.
- 3.To evaluate the effect of digital technologies on the operations of the warehouse.

Research object and methods

Concerned with the optimization of the warehousing process by means of digitalisation technologies; more precisely, the effect of information technologies upon operational efficiency and performance will be considered. In order to accomplish the aims of the investigation, it is necessary to apply a mixed approach which includes both qualitative and quantitative research methods. Analysis and synthesis of the scientific literature will be used as means to explore and analyse the current state of affairs and to summarize the latest achievements in the sphere of warehouse management,

digital transformation and logistics technologies. Systematic review of scientific literature will be accomplished by means of scientific articles retrieved from reputable data bases such as Scopus, Web of Science and Google Scholar, published during the period from 2015 till 2025. The retrieval will be done through the use of keywords which are relevant for the topic such as "warehouse digitalisation," "Warehouse Management Systems," "RFID in logistics," "warehouse automation" and "data analytics in warehousing." The next step is the selection of the most pertinent sources among those found. Content analysis is a tool used to evaluate scientific articles, industry reports and cases.

Moreover, quantitative analysis of secondary data can be conducted in order to examine the influence of digital technologies on key performance indicators, including order accuracy, inventory accuracy, order processing time, and productivity. In addition, the case study method will be applied in order to conduct an analysis of practical examples of warehouse digitalisation, which will make it possible to learn about the process of implementing digital technologies and their potential advantages and disadvantages. Moreover, a comparative approach can be applied in order to highlight the differences between traditionally-operating warehouses and those that use digital technologies.

Case study

To justify the results of the research, it was decided to conduct a case study analysis of the implementation of digitisation solutions at Delhivery - a logistics company that operates in India (Delhivery Ltd., 2023). Digital solutions such as the WMS system, barcoding, and data analytics tools were introduced in the company's warehouse management.

As a result of the case study, it was discovered that the introduction of the WMS solution contributed to improving the process of controlling inventory and coordinating warehouse processes, which led to high inventory accuracy and reduced discrepancies in the stocks (Ivanov et al., 2021). Barcoding helped to increase the speed and accuracy of inputting information, while reducing the probability of mistakes in order processing. Besides, the application of data analytics allowed for optimising warehouse processes and making decisions (Boysen et al., 2022).

It should be noted that digitisation has positively affected the speed of order processing. Moreover, due to increased efficiency, the company has improved its customer service performance (Delhivery Ltd., 2023).

Research results and discussion

It is possible to conclude from the research that there is an important positive influence of using digitisation solutions on the effectiveness of warehousing. It is clear that digitisation improves the performance of warehouse management significantly according to the analysis of scientific works, secondary information, and the case study results.

The introduction of WMS solutions positively affects inventory management and the control of warehouse activities, which is achieved through data processing and monitoring performed in real-time. This leads to higher accuracy of inventories, decreased differences, and the rational use of storage area. In addition, the use of such technological tools as barcodes and RFIDs helps to capture data quickly and with high precision.

Additionally, automation technology such as automated picking and sorting technologies makes operationally efficiency possible through reduced labour and faster workflows processes, hence reducing the order fulfilment time and increasing productivity. The use of data analytic technologies ensures the effective analysis of massive amounts of data regarding the operational process and the ability to use such insights to optimize decision-making.

Discussion

Various types of digitization technologies are deployed according to their relevance to particular warehouse tasks for increasing efficiency and precision in performance (Tubis & Rohman, 2023). For instance, WMS is deployed in the organization and control of all warehouse operations that range from inventory management and tracking to order fulfilment. Barcode and RFID technologies are mostly relevant to receiving, inventory management, and order picking tasks in a warehouse (Nils Boysen et al., 2022). Automation technologies, which include sorting and automated picking, are mainly employed in order fulfilment and shipping tasks within the warehouse. In addition, data analytics are used throughout all warehouse tasks through the analysis of operational data to identify inefficiencies (Johan Kembro et al., 2022).

The digitisation initiatives have a positive effect on improving warehouse performance. Nevertheless, the case study also sheds light on the issues that may arise during the implementation process, such as staff training, systems integration and financial investment. This indicates that the success of digitisation processes is determined by various factors.

The results obtained would be significant for studying the role of digitization in increasing the efficiency of warehouses and the whole supply chain process. As follows from the scientific literature and practices of the sphere, many companies work according to the traditional scheme and do not possess sufficient level of efficiency because of manual processes and information systems. At the same time, the use of digital technology makes it possible to enhance the efficiency of operations of firms (Winkelhaus & Grosse, 2020).

It is also noted in the present analysis that one of the key findings is related to the application of various digital technologies to improve the accuracy of inventory management and tracking. For instance, the application of WMS, barcode scanning systems, and RFID systems enables businesses to improve the accuracy of their practices and make faster decisions. On the other hand, the application of automation technologies also enables businesses to improve the speed of their practices and reduce their dependence on manual labour. The discussion also highlights the need for data

analytics in the current warehouse environment. Digitalised systems tend to produce a lot of data regarding the operation of the warehouse, and this data can be used to improve resource utilisation and consequently reduce costs of operation.

Despite the numerous advantages of implementing digitisation solutions in an organisation, there are also various challenges associated with their implementation. Some of the major challenges facing many firms include the high costs of investment in digitisation solutions and the lack of technical know and organisational change resistance. Integrating new technology into the existing legacy systems is also a challenge for many firms. This shows that the change process is not only a technological change but also an organisational change. Another significant aspect is the need for a framework of implementation, and this is implied by the study, as it suggests a step-by-step procedure, where the organisation should assess its processes, select its technology, and then implement it. Another significant aspect is the workforce, and this is significant for the success of the technology (Ivanov et al., 2021; Boysen et al., 2022).

The above discussion, it is quite obvious that one of the drivers for modernisation within the warehouse is digitisation. This is because, as implied by the discussion, the use of technology is significant for efficiency, and this, in turn, will lead to competitiveness. This, however, will be achieved by striking a balance between two significant aspects: one related to technology and one related to organisation. It can be seen that digitization has a very positive effect on the performance and success of the warehouse management process. It is evident from the results that digitization technology, including WMS, barcodes, RFID systems, automation, and analytics, plays a major role in achieving improvements in terms of performance, especially in accuracy, processing time, visibility, and productivity. Also, digital warehouses outperform ordinary warehouses concerning their capability to provide data analysis in real-time, make decisions, and manage resources (Winkelhaus & Grosse, 2020).

Moreover, the automation technologies can significantly contribute to minimising the required manpower while increasing efficiency of workflows. The evidence from the use of case studies in the research also illustrates the above-mentioned benefits since companies implementing digitised solutions are able to benefit from cost-saving opportunities, improved customer services, and improved customer satisfaction. On the other hand, the study has also revealed some of the drawbacks of implementing digital technologies, such as high investment costs, poor technical knowledge, and reluctance towards organisational change.

Table 1 presents the key digital technologies used in warehouse transformation, their functional importance, and their advantages.

Table 1. Digital Technologies Used in Warehouse Transformation

Technology	Main Function	Benefits
Warehouse Management System (WMS)	Manages inventory and warehouse operations	Improved inventory accuracy
Barcode Scanning	Automated product identification	Faster data entry
RFID Technology	Real-time product tracking	Improved inventory visibility
Automation Systems	Automated picking and sorting	Increased operational efficiency
Data Analytics Tools	Analysis of warehouse data	Better decision-making

Source: according to Ivanov, Dolgui & Sokolov (2021), Boysen, de Koster & Weidinger (2022), Kembro, Danielsson & Smajli (2022), Marchet, Melacini & Perotti (2021).

The analysis indicates that each technology enhances various aspects of warehouse operations. For example, WMS helps in controlling and coordinating warehouse operations, barcodes and RFID assist in improving the accuracy of data collection, automation helps in enhancing the efficiency of warehouse operations, and data analytics helps in enhancing decision-making through the use of real-time data.

Table 2 illustrates the expected performance improvements that can be achieved by the implementation of digitization solutions in warehouse operations.

Table 2. Expected Benefits of Digital Warehouse Transformation

Performance Indicator	Traditional Warehouse	Digitised Warehouse
Order accuracy	90 - 92%	98 - 99%
Inventory accuracy	85 - 90%	97 - 99%
Order processing time	High	Reduced
Operational visibility	Limited	Real-time monitoring
Productivity	Moderate	Significantly higher

Source: according to Boysen, de Koster & Weidinger (2022), Ivanov, Dolgui & Sokolov (2021), Marchet, Melacini & Perotti (2021).

It is clear from the comparison of traditional warehouse operations and digitized warehouse operations that there are significant performance improvements in the key performance indicators. Specifically, there are significant improvements in order accuracy and inventory accuracy up to near optimal levels. Furthermore, there are significant reductions in order processing times and increased operational visibility through real-time monitoring. In addition, there are significant improvements in overall productivity.

Conclusions

1. This study has confirmed that digitization is a vital aspect of improving warehouse processes and supply chain performance. It has also been established that traditional warehouse management processes are inefficient and often

involve a number of errors. In contrast, the integration of digital technologies has a significant impact on improving efficiency and decision-making capabilities.

2. The study has also confirmed that the integration of digital technologies, such as Warehouse Management Systems, barcode systems, automation systems, and data analysis tools, has a significant impact on improving efficiency and decision-making capabilities. It has also been confirmed that the integration of digital technologies has a significant impact on improving efficiency and decision-making capabilities.

3. However, at the same time, it also highlights the point that for the effective implementation of solutions for digitisation, it is important to understand that the process of digitisation is not only related to the adoption of technology but also involves certain other issues such as high costs of investment, lack of skills, and resistance to change, which need to be addressed accordingly. It is important to have a structured approach for the implementation of digitisation strategy.

4. It is important to highlight the point that digitisation is an important factor for warehouse optimisation in the current world. It is important for any organisation to adopt and use technology for the efficiency and quality of service to remain competitive in the complex and dynamic world.

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