VILNIUS TECH
Vilnius Gediminas Technical University

14th International Scientific Conference "Business and Management 2024"
May 16–17, 2024, Vilnius, Lithuania

NEW TRENDS IN CONTEMPORARY ECONOMICS, BUSINESS AND MANAGEMENT

ISSN 2029-4441 / eISSN 2029-929X
eISBN 978-609-476-363-2
Article Number: bm.2024.1158
https://doi.org/10.3846/bm.2024.1158

III. BUSINESS TECHNOLOGIES AND SUSTAINABLE ENTREPRENEURSHIP *https://vilniustech.lt/bm*

APPLICATION OF DIGITAL TECHNOLOGIES IN THE EU LOGISTICS SECTOR

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Received 17 January 2024; accepted 18 March 2024

Abstract. Logistics is currently undergoing a transformative phase due to rapid digitalization, prompting a profound exploration of both theoretical potentials and practical challenges within the industry. This comprehensive review delves deeply into the growing interest in digital technologies within logistics, with a specific emphasis on their practical applications. This study aims to conduct a bibliometric analysis to explore the growth and academic focus on the logistics digitalization. Academic literature is studied from the Web of Science database for 2020–2024. Literature review and bibliographic analysis of selected articles are performed using VOS Viewer. It was identified that one of the clusters comprise keywords related to logistics and information technology. The analysis of investments in digital technology reveals experiences of the logistics sector seeking to figure out how investments impact labor productivity. The descriptive analysis results indicate that companies implementing technology can achieve up to a 20% increase in labor productivity, signifying the importance of technology investments for business competitiveness increase. These findings illuminate how various logistics sub-sectors respond to software and computers investments and the pace at which these technologies influence labor productivity metrics. These empirical findings considerably fortify the theoretical framework, offering practical implications and stressing the critical necessity for logistics firms to seamlessly adopt digital technologies into their operational frameworks. In conclusion, as the logistics landscape teeters on the brink of a digital revolution, businesses must navigate and fully embrace digital solutions to maintain competitiveness.

Keywords: logistics sector, digitalization, labor productivity, investments.

JEL Classification: N7.

1. Introduction

The logistics sector's swift transformation via digitalization has emerged as a critical element in securing competitive advantages within today's dynamic global market. This shift towards digitalization offers numerous benefits, such as enhanced information accessibility, optimized logistics practices, real-time data collection, improved inventory management, and heightened transparency (Henke et al., 2020; Pirogova et al., 2020). In the advancing field of logistics characterized by Smart Logistics and Smart Supply Chain, technologies like artificial intelligence, blockchain, cloud computing, and the Internet of things drive automation and planning to a level of partial autonomy and cross-organizational information sharing (Chen & Zhao, 2019). However, reaping the benefits of these integrated systems requires organizations to align their internal technology implementation with external stakeholders' pace. To succeed in this transformation, organizations must invest in emerging technologies, closely govern digital technology adoption, and understand the opportunities and interactions within logistics processes (Albrecht et al., 2024).

This literature review explores the increasing interest in digitalization within logistics, as the integration of digital technologies into logistics remains pivotal for industry growth (Osmolski & Kolinski, 2020). These technologies have the potential to revolutionize traditional processes, streamline supply chain operations, and propel business success (Calatayud et al., 2019). Embracing digitalization is crucial for logistics companies to provide efficient, responsive services to customers (Helmke, 2022; Kuteyi & Winkler, 2022).

This study aims to comprehend how digital transformation reshapes the logistics sector and becomes critical in gaining a competitive edge in today's

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dynamic market (Parfenov et al., 2021; Zaychenko et al., 2021). The shift driven by digital technologies offers various advantages, including enhanced information accessibility, optimized practices, real-time data collection, improved inventory management, and increased transparency (Hoberg et al., 2015; Wade & Marchand, 2014).

The paper intends to bridge the gap between theoretical concepts and practical application in the logistics sector, exploring the escalating importance of digital technologies and their transformative potential. It also outlines the empirical study's objective, focusing on the impact of investments into software and computers on labor productivity in the logistics sector.

The paper is structured into four chapters. It commences with an introduction. The first chapter focus on literature review which examines the application of digital technologies in logistics sector. The second chapter presents research design and research results, and provides results of descriptive, statistical, and regression analysis. Finally, the paper ends with discussions and conclusions.

2. Literature review

In examining the logistics sector's current state and future prospects, it becomes clear that promptly embracing and smoothly integrating new market demands are crucial for gaining a competitive edge. Understanding the evolving trends of digital technologies and their direct impact on logistics management operations is vital for achieving business efficiency (Boute & Udenio, 2022; Jahagirdar, 2022). Within the current sector landscape, the assimilation of digital technologies emerges as a pivotal challenge. Digitization entails adopting innovative technologies and transforming traditional processes into digitized formats (Brunetti et al., 2020). These emerging digital advancements encapsulate the latest innovations expected to reshape corporate strategies and societal environments profoundly.

The researchers Verbivska et al. (2023) examined the impact of new digital technologies on creating valuable business opportunities for logistics companies. The study's findings form the basis for suggesting alternative strategic options to innovate logistics chains and enhance competitiveness.

Research indicates that integrating information technology in a collaborative approach can significantly enhance productivity and efficiency within warehouse operations. Christopher (2022) highlights the impact of information technology on productivity and competitive advantage in logistics. The productivity-based view remains the most commonly used indicator for evaluating performance (Falciola et al., 2020; Yang & Lirn, 2017).

The knowledge gathered from various sources unmistakably demonstrates that information technologies transform the logistics sector and provide strategic added value to companies. Their integration into collaborative processes significantly enhances productivity and efficiency within warehouse operations (Abdul Rahman et al., 2023; De Backer & Flaig, 2017). Moreover, these technologies have become fundamental tools for creating a competitive advantage in the logistics field. Supporting productivity, efficiency, and innovation becomes a cornerstone of competitiveness in logistics (Chung, 2016; Li & Wang, 2021; Mena et al., 2007). This signifies that effectively managed information technologies optimize current operations and lay the groundwork for future development and competition (Porter & Porter, 1998).

2.1. Application of digital technologies in the logistics sector

This study aims to explore digital technologies and logistics by scrutinizing relevant articles to identify emerging trends and changes. The research comprises articles focusing on digital technologies and logistics. The data collection in the present review is conducted in three stages: data collection with the help of relevant keywords, data formatting, and data analysis with the help of relevant tools.

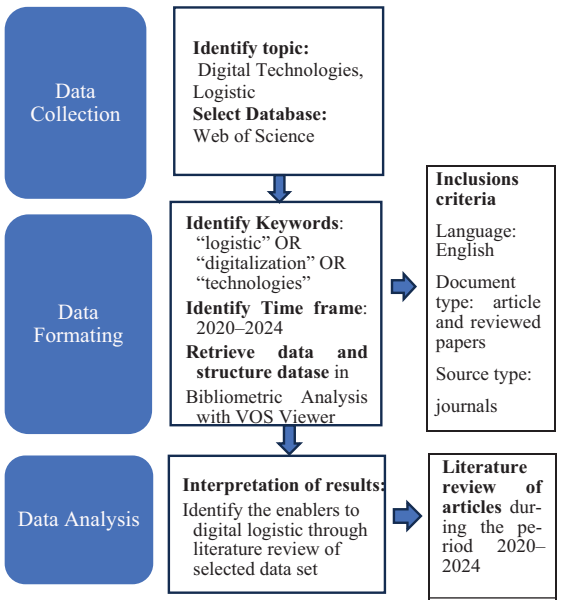

Figure 1. Research process adopted in the study (author's compilation)

The data has been systematically filtered based on language, and only articles written in English language were chosen for further analysis. In the initial phase, we focused on document types to ensure the inclusion of peer-reviewed articles, with individual scrutiny applied specifically to journal articles. The data collection framework is illustrated in Figure 1.

Web of Science stands out as a key database, encompassing a significant percentage of available academic literature (Mongeon & Paul-Hus, 2016). The study employs

a multi-stage methodology to achieve a conceptual understanding of the phenomena. Initially, knowledge is collected from publications on the topic, utilizing several methods to reach this goal. Firstly, a bibliometric analysis is performed to study and analyze the selected literature through statistical methods. Web of Science is currently the primary database hosting much academic literature. Table 1 provides details regarding keywords and the database used for data collection.

Table 1. Key components of the selected dataset (authors' compilation)

Database used	Web of Science
Keywords used	"logistic" OR "digitalization" OR "technologies"
Time span	2020–2024 (till March)

The analysis is based on the dataset of 1377 published articles selected after applying rigorous and systematic inclusion criteria (Figure 2).

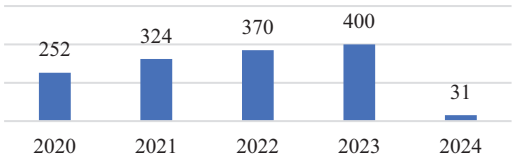

Figure 2. Trend publications (author's compilation)

As seen in Figure 2, the highest number of publications, 400 units, occurred in 2023. In 2022, a slight decrease in publications is noticeable, with 370 units, and the lowest number of publications, i.e., 252 units is observed in 2020. This table illustrates the fluctuations in the number of publications over the years. Notably, there was an overall increase from 2020 to 2023, but 2024 stands out with fewer publications.

2.2. The bibliometric analysis

The present study has applied a bibliometric approach to understand the academic landscape of digital technologies in logistics. The bibliometric analysis aids in exploring and analyzing selected literature using various statistical methods. We employed VOS Viewer for bibliometric analysis. The study encompasses the period from 2020 to 2024 (until March 2024), allowing for a comprehensive exploration of the concept's evolution. VOS Viewer facilitates a graphical representation of the dataset, making it easier to interpret the extensive data. A bibliographic map is generated with the most frequently repeated authors of the articles, used by the most commonly repeated words in the articles. Typically, circles on bibliometric maps can be of different colours, which separate clusters with the purpose of showing which keywords are closer to each other as circles are also demonstrated in various sizes that indicate the importance of the word; the brighter the meaning of the word is, the more important. The lines indicate the relationships between the keywords. The brightness of the lines suggests the strength of the connection, and the different distances between the keywords define the intensity of the interface. The closer the circles are to each other, the greater the interface between them. The links attribute indicates the number of co-occurring links of given keywords with other keywords. The authors, with the help of VOS Viewer, constructed 4 clusters. Figure 3 shows their visualisation.

Articles discussing logistics, information technology, technology, and supply chain management.

The keywords associated with each cluster are presented in the Figure 3. The first cluster consists of articles primarily focused on factors, adaptation, themes related to the logistics industry, and blockchain technology.

In contrast, the second cluster features articles discussing logistics, innovation, technology, and supply chain management.

The third cluster revolves around the common theme of study design, logistic information systems, and implementation.

The fourth includes articles that discuss about Internet of Things (IoT) technology. Notably, the second cluster encompasses keywords related to logistics and information technology. The second and fourth clusters are closely intertwined and highly interconnected.

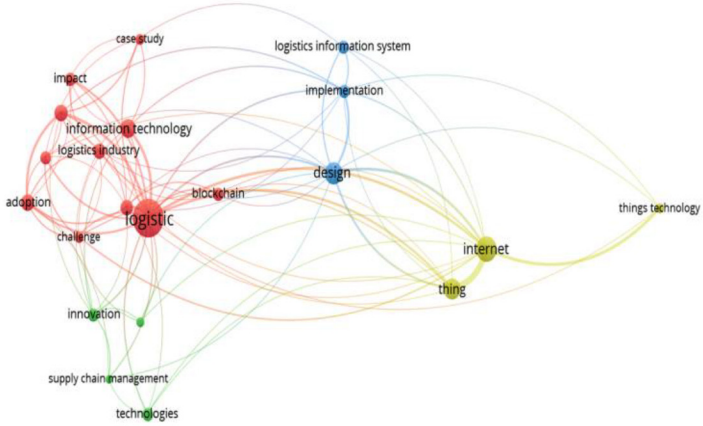

Figure 3. Keyword analysis of authors' keywords (author's compilation)

3. Research design and results

3.1. Research design

The study is based on a multi-stage methodology, which aims to reach a conceptual understanding of the phenomena. First, the knowledge has to be collected from the data describing advances in implementing digital application technologies through approach. Several methods were used to reach the goal. The authors employ a three-stage methodology. In the first stage, they utilize statistical analysis to express and interpret collected data through statistical measures. This method aids in understanding and analyzing trends between variables and provides a foundational basis for subsequent research. Moving to the second stage, the authors employ descriptive analysis, a research approach to establish facts and describe an object or phenomenon without delving into in-depth explanations or assumptions about effects. For the third stage, the authors incorporate regression analysis and used heteroskedasticity and autocorrelation consistent (HAC) standard errors defining method. Regression analysis explores the relationship between two or more variables and examines the relationship line between dependent and independent variables, enabling the prediction of the dependent variable based on the independent ones.

During the statistical analysis, the authors compared labor productivity across EU logistics sectors and identified labor productivity gaps between them, with the productivity index being taken from Estonia, one of the leading investors into digital technologies in the Baltic region. In the regression analysis, the authors presented regression equations formulated for seven logistics subsectors, illustrating diverse effects resulting from the application of digital technologies. Empirical data was used for 2005-2020 to underscore the growing emphasis on digitalization within the logistics domain, particularly in terms of labor productivity. The regression analysis shows changes in labor productivity, and the year of the change is mostly visible concerning the different types of investments (i.e., computer and software) within each logistics sub-sector.

Regression analysis results indicates that analyzing the impact of investments in software and computers on labor productivity involves utilizing a regression equation (1).

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \varepsilon, \quad (1)$$

x_1 – investments into software, x_2 – investments into computers, y – labor productivity, $\beta_0, \beta_1, \beta_2$ – coefficients of the regression equation, – residuals.

The authors collected data from Statistics Estonia (2023) on investments into software and computers by logistics sector companies (such sub-sectors as Postal and courier activities, Warehousing and support activities for transportation; Transportation and storage, Transportation by different modes, etc.). Over the years, there was a wide variation in investment intensity.

The authors collected data on labor productivity, which is calculated by dividing Gross Value Added by the number of persons employed, expressed in thousand euros, from Statistics Estonia (2023) separately for each logistics sub-sector.

While applying the descriptive method, the authors identified nine studies that exemplify the implementation of high-productivity digital technology, specifically voice-picking technology, aimed at improving logistics management efficiency.

The heteroskedasticity and autocorrelation consistent (HAC) standard errors were utilized in the research to model and analyze time-series data, providing a robust framework for understanding the intricate temporal relationships within the dataset and solving autocorrelation and heteroscedasticity issues. This method incorporates the autoregressive and moving average components of a time series and integrates additional exogenous variables, contributing to a more comprehensive and accurate analysis. By employing the HAC, the study aimed to unveil patterns, trends, and dependencies, enabling a nuanced exploration of the influence of values of the dependent variable. The results were validated by using test statistics.

3.2. Review on the EU logistics sector

The statistical analysis affirmed the substantial impact of high-productivity digital technology on operational logistics efficiency, productivity, and accuracy in various industries. Companies adopting high-productivity digital technology experienced notable enhancements in workforce performance, reduced training durations, and minimized error rates in logistics operations. This highlights the transformative potential of cutting-edge, high-productivity digital technology across diverse business landscapes for managing logistics.

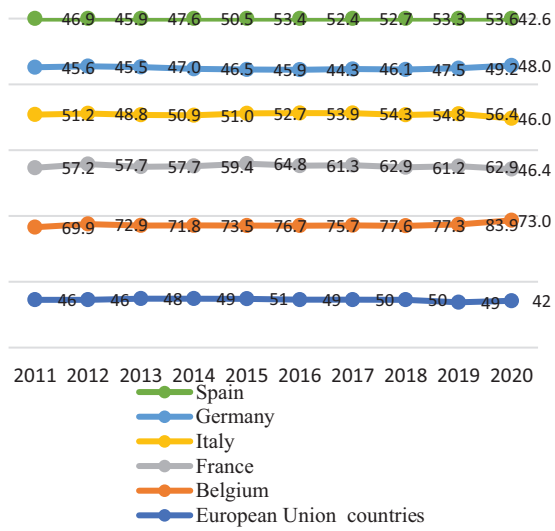

Figure 4. Labor productivity in the logistics sectors of European Union countries (source: Eurostat, 2020)

Figure 4 highlights labor productivity indicators, specifically within the logistics sector for European Union countries from 2011 to 2020. These figures represent the scale of labor productivity within the logistics domain. For example, Belgium's metrics range from 69.9 to 83.9 over the specified period, Germany's from 45.6 to 49.2, and so on for each country. These figures reflect the efficiency in generating output concerning the resources employed, elucidating the output produced per unit of resources within the logistics sector. The fluctuations observed across these countries reveal distinct trends in labor productivity within the logistics industry. Belgium consistently maintains one of the highest labor productivity levels within the logistics domain, with its indicators consistently above 70 for a significant portion of the assessed period. However, considering the entire European Union, the overall average labor productivity within the logistics sector is around 50. Belgium's high labor productivity in the logistics sector suggests that they might have undertaken various measures to achieve such remarkable indicators. They were investing in advanced digital logistics technologies, like voice picking systems, automated warehouses, or sophisticated inventory management systems, to optimize operational processes and increase efficiency. Large logistics companies and warehousing facilities in various countries, including Germany, France, Spain, and others, have integrated voice-picking technology into their operations. This implementation streamlined order preparation and enhanced warehouse efficiency using voice-controlled digital technology, enabling employees to pick items efficiently. Undoubtedly, this technology has changed significantly.

Figure 5 provides labor productivity indicators within the logistics sector for Baltic countries. These values represent the percentage scale of labor productivity levels, specifically logistics. For instance, Estonia's figures range from 28.2 to 34.7 over the specified period, Lithuania's from 17.1 to 23.9, and Latvia's from 18.2 to 23.

The fluctuations across these Baltic nations unveil distinctive trends in labor productivity within the logistics industry. Estonia demonstrates a relatively consistent enhancement, maintaining productivity levels above 30 for most of the examined period. Conversely, Lithuania and Latvia showcase varying patterns in their logistics-specific labor productivity levels. Estonia consistently displays comparatively higher productivity levels within the logistics sector among these Baltic countries. Estonia invested in advanced digital technologies in the logistics sector. This includes automation, robotics, smart solutions, and data analytics, which help optimize processes and enhance efficiency in the logistics sector.

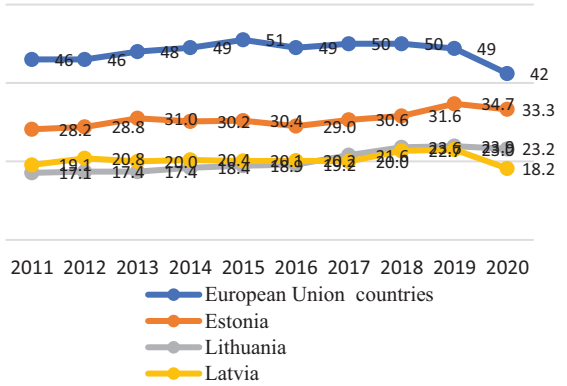

Figure 5. Labor productivity in the logistics sectors of Baltic countries (source: Eurostat, 2020)

3.3. Application of digital technologies

The results of descriptive analysis demonstrate that implementing high-productivity digital technology has revolutionized operations across diverse industries, substantially improving productivity, accuracy, and overall efficiency. Companies in different sectors (healthcare, publishing, etc.) leveraged high-productivity digital technology to streamline their logistics processes, yielding remarkable outcomes. This technological evolution has optimized workforce performance and significantly reduced training periods and error rates, emphasizing the transformative impact of high-productivity digital technology on diverse business landscapes.

Table 2 provides an overview of the application of specific high-productivity digital technology across various industries for logistics operations.

Table 2. Results of high-productivity digital technology application for logistics operations (source: Voxware, 2023)

Firms	Application results
Elsevier	99.72% accuracy, increased employee productivity, and rapid return on investment. In 9 months, return on investments. The average training time to get workers up to speed on the new system was 4 hours, an improvement 2 days with RF Scanning. 75% reduction in training time.
Belron	Increased productivity by 20%, major productivity improvements from hands-free work, higher accuracy rate 99.95%, improved efficiency (savings 1.5 mln. Eur) reduced operating cost.
Simon & Schuster	100% efficiency increase, quick return on investment, 50 temporary positions eliminated. ROI achieved in under 1 year. Consolidate the warehouse into one, productivity and efficiency more than doubled, with 600,000 units shipped per day (150 mln. units annually).
Pierre's Ice Cream	Increased accuracy by 20%, accuracy level 99.96%, higher productivity, rapid employee training: typically takes 7–15 days, with voice picking, it is 4 hours or less, reduction of season hires.
FDL	Enhanced operational efficiency, reduced training time, optimized workforce allocation, and analytics solutions help manage orders and workers and adjust during peak periods, creating a performance-based intensive pay program.

End of Table 2

Firms	Application results
Anacapri Foods	Improved productivity without added staff, reduced errors, rapid employee training, increased volume by 20% without hiring new employees, served more than 1800 pizzerias and restaurants.
Frontier Distributing	Achieved exceptional accuracy of 99.9%, increased productivity, and accelerated employee engagement.
PRSG	25% reduced workforce, better staff management, minimized travel time, increased on-time orders and reduced overtime, better management of priorities, eliminated manual label printing by hand.
Mission Health	Substantial accuracy boosts 30%, enhances productivity, and improves warehouse management, closing more orders, more exact matches on cycle count, better inventory management, and the ability to assign priority work orders.

The results described by the companies listed in Table 2 show a 20% increase in labor productivity. This directly validates its categorization as a high-productivity technology. Integrating high-productivity digital technology into logistics operations significantly enhanced accuracy, productivity, and operational efficiency in these companies. Companies streamlined logistics processes, minimized errors, and optimized workforce management, showcasing high-productivity digital technology's versatility and influence in driving positive changes in logistics operations and operational excellence across sectors.

3.4. The application of digital technologies Estonian logistic sector

To thoroughly examine the impact of digital technologies on labor productivity in Estonia's logistics sector, this section conducts a meticulous analysis spanning from 2005 to 2020, with a specific emphasis on investments in computers and software. The evaluation is based on labor productivity per person employed, measured by turnover per thousand euros. The presented regression equation unveils the relatioship between labor productivity and investments per person employed, quantified in turnover per thousand euros. It is noteworthy that the indicators of investments in computers and software, as well as labor productivity within the logistics sector, due to the application of digital technology. The outcomes of this analysis are presented in Table 3a, 3b.

Table 3b indicates that within the logistics sub-sectors, software investments impact labor productivity in Postal and courier activities, Support activities for transportation, and Warehousing and support activities for transportation sub-sectors.

From Table 3a,3b, we can draw several conclusions. Firstly, different sub-sectors exhibit varied responses to investments in software and computers. Al six sub-sectors indicated a robust reaction to investments in the

Table 3a. Results validation (authors' compilation)

Variables	FTRRS	LTTP	PCA
β_0	78.0285*** 6.1129	64.1775*** 3.9007	26.3128*** 2.6007
β_1	0.0720*** 0.0059	0.0336*** 0.0114	0.0037*** 0.0002
β_2	–0.0275*** 0.0110	–0.0064*** 0.0026	
R-squared	0.3492	0.5999	0.2114
DW		1.5231	
HAC test			
PwlAIC	2		2
BkNW	3		3

Table 3b. Results validation (continue)

Variables	SAT	TST	WSAT
β_0	216.2125*** 11.6211	141.489*** 15.5570	198.112*** 10.6550
β_1	0.0077*** 0.0028	0.0020*** 0.0005	0.0070*** 0.0025
β_2		–0.0090*** 0.0034	
R-squared	0.1514	0.4926	0.1615
DW			
HAC test			
PwlAIC	2	0	2
BkNW	3	3	3

Explanation of abbreviations:
FTRRS – Freight transport by road and removal services
LTTP – Land transport and transport via pipelines
PCA – Postal and courier activities
SAT – Support activities for transportation
TST – Transportation and storage
WSAT – Warehousing and support activities for transportation
DW – Durbin-Watson statistics
BkNW – Bartlet kernel, Newey-West fixed bandwidth
PwlAIC – Prewhitening with lags AIC

investment year. Each sub-sector demonstrates a unique connection between software investments and labor productivity. However, in some sub-sectors (i.e., Freight transport by road and removal services, Land transport and transport via pipelines, Transportation and storage), computers investments positively impact labor productivity.

To reveal the impact of investments, regression equations were formulated for seven sub-sectors within the logistics industry, focusing on two investment categories: investments into software and investments into computers. The coefficients in these regression equations indicate the change in the dependent factor when the independent factor increases by one unit (refer to Table 5). The authors created 6 regression equations.

Table 5. Formed regression equations (authors' compilation)

Logistic sub-sector	Regression equation
Investments into software	
PCA Postal and courier activities	$y = 26.3128 + 0.0037x_1$
SAT Support activities for transportation	$y = 216.2125 + 0.0077x_1$
WSAT Warehousing and support activities for transportation	$y = 198.112 + 0.007x_1$
Investments into software and computers	
FTRRS Freight transport by road and removal services	$y = 78.02 + 0.072x_1 - 0.0275x_2$.
LTTP Land transport and transport via pipelines	$y = 64.1775 + 0.0336x_1 - 0.0064x_2$
TST Transportation and storage	$y = 141.489 + 0.002x_1 - 0.009x_2$

These conclusions underscore the diverse impact of software investments on labor productivity across sub-sectors and investment types, emphasizing the necessity of sub-sector-specific strategies when planning investments. The formed regression equations (Table 5) show that the most evident investments in labor productivity are investments in software; all six equations include such investment variables. The analysis highlights the diverse effects of technology investments across various logistics sub-sectors. Additionally, in different sub-sectors, investments in computers had no significant impact on labor productivity. Considering these sub-sector-specific characteristics is crucial when planning investments and anticipating their returns. Each logistics sub-sector possesses unique traits and responds differently to technology investments. Therefore, when evaluating investments, one should consider the distinct nature of each sub-sector. While technology investments can enhance labor productivity in the logistics sub-sector, it's essential to account for each sub-sector's diverse requirements and specificities when assessing these investments.

4. Discussion

Although this review highlights the potential of digitalization in logistics, it also identifies crucial areas for further investigation. Bridging theoretical knowledge with practical applications remains a significant challenge, particularly in integrating digital technologies like AI, automation, and data analytics into day-to-day logistics operations. Investigating the barriers impeding the smooth transition from theory to practice is essential for successful implementation. In the article, several research gaps authors are identified:

a) Sectoral disparities, the analysis explains that different logistics sub-sectors respond differently to various types of investments into digital technologies, emphasizing the need to assess these investments while considering the specifics of each sub-sector. This illustrates how identical investments can affect labor productivity in different sub-sectors of the logistics industry.
b) The effectiveness of digital technology investments can vary greatly depending on the sub-sector. These gaps underscore the importance of paying attention to sub-sector-specific characteristics when planning and implementing investments into digital technologies within the logistics sector.

While acknowledging the role of digital technologies in enhancing operational efficiency, understanding the application of the specific mechanisms that influence labor productivity metrics could provide actionable insights for businesses seeking to optimize their logistics operations.

These proposed areas for further investigation aim to fill existing research gaps and contribute to a more comprehensive understanding of how digital technologies shape labor productivity within the logistics sector.

5. Conclusions

In conclusion, our comprehensive exploration of the impact of digitalization on logistics underscores its pivotal role in enhancing competitiveness within the industry. Specifically focusing on the influence of the application of digital technologies and its optimization of logistics efficiency, we've highlighted the transformative potential of embracing digital technologies. The evolving business landscape demands a profound understanding of emerging trends in logistics management to retain competitiveness. Digitalization, representing a significant challenge and opportunity, offers a spectrum of technologies reshaping logistics processes, improving operational efficiency, and refining business activities.

The literature analysis indicates that the majority of digital technologies in logistics are emphasized. Additionally, the recent approach suggests focusing on the years 2020–2024. The bibliometric analysis emphasizes digital technologies closely linked to the application features.

Based on the cluster analysis of authors' keywords, four clusters have been identified, each with its associated theme: digital technologies in logistics. The second cluster encompasses keywords related to logistics information technology. The second and fourth clusters are closely intertwined and highly interconnected.

Research indicates that high-productivity digital technologies substantially advance company operations, optimize employee activities, reduce error rates, and enhance operational efficiency. From the presented results,

companies have demonstrated a 20% increase in labor productivity due to the application of digital technology. Studies prove that digital technologies significantly impact labor productivity, with each sub-sector affecting it differently. For instance, Belgium from West European countries and Estonia from Baltic countries have showcased results in maintaining high productivity levels through the implementation of digital technologies, efficiently streamlining processes.

Our empirical findings underscore a significant upsurge in productivity across diverse logistics sectors post-technology implementation, emphasizing the impact of investments and potential for future growth. Analyzing the relationship between technology investments and labor productivity guides strategic decision-making, optimizing resource allocation, and fostering best practices within the logistics industry.

Ultimately, embracing the application of digital technology is not choices but necessities for logistics firms aspiring to sustain success in a dynamic landscape. Through this journey of digital adaptation, seamless logistics experiences can be ensured, meeting the evolving demands of tomorrow.

Research has some limitations – the application of digital technology was investigated in Estonia sector, due to data availability issue, although Estonia labor productivity is identified as the highest among Baltic countries.

Funding

No extra funding was received for the research delivery.

Author contributions

The authors declare their participation in the writ-ing of the article: application of digital technologies in EU logistic sector – D. Daškevič, review, and generalization of the article – A. Burinskienė.

Disclosure statement

The authors declare that they have no financial, professional, or personal interests that could influence the preparation of the article.

References

Abdul Rahman, N. S. F., Karim, N. H., Md Hanafiah, R., Abdul Hamid, S. & Mohammed, A. (2023). Decision analysis of warehouse productivity performance indicators to enhance logistics operational efficiency. *International Journal of Productivity and Performance Management*, *72*(4), 962–985. https://doi.org/10.1108/IJPPM-06-2021-0373

Albrecht, T., Baier, M.-S., Gimpel, H., Meierhöfer, S., Röglinger, M., Schlüchtermann, J., & Will, L. (2024). Leveraging digital technologies in logistics 4.0: Insights on affordances from intralogistics processes. *Information Systems Frontiers*, 26, 755–774. https://doi.org/10.1007/s10796-023-10394-6

Boute, R. N., & Udenio, M. (2022). AI in logistics and supply chain management. In R. Merket & K. Hoberg (Eds.), *Global logistics and supply chain strategies for the 2020s: Vital skills for the next generation* (pp. 49–65). Springer. https://doi.org/10.1007/978-3-030-95764-3_3

Brunetti, F., Matt, D. T., Bonfanti, A., De Longhi, A., Pedrini, G., & Orzes, G. (2020). Digital transformation challenges: Strategies emerging from a multi-stakeholder approach. *The TQM Journal*, *32*(4), 697–724. https://doi.org/10.1108/TQM-12-2019-0309

Calatayud, A., Mangan, J., & Christopher, M. (2019). The self-thinking supply chain. *Supply Chain Management*, *24*(1), 22–38. https://doi.org/10.1108/SCM-03-2018-0136

Chen, J., & Zhao, W. (2019). Logistics automation management based on the Internet of things. *Cluster Computing*, *22*, 13627–13634. https://doi.org/10.1007/s10586-018-2041-2

Christopher, M. (2022). *Logistics and supply chain management.* Pearson.

Chung, T. W. (2016). A study on logistics cluster competitiveness among Asia main countries using the Porter's diamond model. *The Asian Journal of Shipping and Logistics*, *32*(4), 257–264. https://doi.org/10.1016/j.ajsl.2016.12.010

De Backer, K., & Flaig, D. (2017). *The future of global value chains: Business as usual or "a new normal"?* (OECD Science, Technology and Innovation Policy Papers No. 41). OECD Publishing. https://doi.org/10.1787/d8da8760-en

Eurostat. (2020). *Annual detailed enterprise statistics for services (NACE Rev. 2 H-N and S95) (2005–2020).* https://ec.europa.eu/eurostat/databrowser/view/sbs_na_1a_se_r2__custom_11836252/default/table?lang=en

Falciola, J., Jansen, M., & Rollo, V. (2020). Defining firm competitiveness: A multidimensional framework. *World Development*, *129*, Article 104857. https://doi.org/10.1016/j.worlddev.2019.104857

Helmke, B. (2022). Digitalization in logistics. In D. H. Hartel (Ed.), *Project management in logistics and supply chain management: Practical guide with examples from industry, trade and services*: *Vol. 15 Springer series in supply chain management* (pp. 179–201). Springer. https://doi.org/10.1007/978-3-658-35882-2_7

Henke, M., Besenfelder, C., Kaczmarek, S., & Fiolka, M. (2020, March 17–20). A vision of digitalization in supply chain management and logistics. In P. Nyhuis, D. Herberger, & Hübner, M. (Eds.), *Proceedings of the 1st Conference on Production Systems and Logistics: CPSL 2020* (pp. 277–286). Stellenbosh, South Africa. Hannover: Publish-Ing. https://doi.org/10.15488/9669

Hoberg, P., Krcmar, H., Oswald, G., & Welz, B. (2015). *Skills for digital transformation* (Research Report). Technical University of Munich, Chair for information systems. https://www.8pillars.com.au/wp-content/uploads/2018/09/Skills-For-Digital-Transformation-UniOfMunich.pdf

Jahagirdar, A. (2022). *Analysis and development of a digital picking system using IoT and Logistic 4.0* [Master thesis, University of Stuttgart]. Publication Server of the University of Stuttgart. http://doi.org/10.18419/opus-12634

Kuteyi, D., & Winkler, H. (2022). Logistics challenges in sub-Saharan Africa and opportunities for digitalization. *Sustainability*, *14*(4), Article 2399. https://doi.org/10.3390/su14042399

Li, W., & Wang, Y. (2021). Dynamic evaluation of logistics enterprise competitiveness based on machine learning and im-

proved neural network. *Journal of Ambient Intelligence and Humanized Computing*, *13*. (Retraction published 2022 *Journal of Ambient Intelligence and Humanized Computing*, *42*, 12–15). https://doi.org/10.1007/s12652-021-03069-0

Mena, C., Christopher, M., Johnson, M., & Jia, F. (2007). *Innovation in logistics services* (Report). Cranfield School of Management, Bedford. https://pdxscholar.library.pdx.edu/cgi/viewcontent.cgi?article=1112&context=busadmin_fac

Mongeon, P., & Paul-Hus, A. (2016). The journal coverage of Web of Science and Scopus: A comparative analysis. *Scientometrics*, *106*, 213–228. https://doi.org/10.1007/s11192-015-1765-5

Osmolski, W., & Kolinski, A. (2020). Logistics 4.0 – Digitalization of the supply chains. *Business Logistics in Modern Management. Proceedings of THE 20th International Scientific Conference Business Logistics in Modern Management*. https://hrcak.srce.hr/ojs/index.php/plusm/article/view/15585

Parfenov, A., Shamina, L., Niu, J., & Yadykin, V. (2021). Transformation of distribution logistics management in the digitalization of the economy. *Journal of Open Innovation: Technology, Market, and Complexity*, *7*(1), Article 58. https://doi.org/10.3390/joitmc7010058

Pirogova, O., Plotnikov, V., Makarov, I., & Grafov, A. (2020). The impact of digitalization on the Intellectual capital formation and use (case of service enterprises). *E3S Web of Conferences*, *217*, Article 06009. https://doi.org/10.1051/e3sconf/202021706009

Porter, M. E., & Porter, M. P. (1998). Location, clusters and the "new" microeconomics of competition. *Business economics*, *33*(1), 7–13.

Statistics Estonia. (2023). *Financial statistics of enterprises*. https://www.stat.ee/en/find-statistics/statistics-theme/economy/financial-statistics-enterprises

Verbivska, L., Zhygalkevych, Z., Fisun, Y., Chobitok, I., & Shvedkyi, V. (2023). Digital technologies as a tool of efficient logistics. *Revista de la Universidad del Zulia*, *14*(39), 492–508. https://er.nau.edu.ua/handle/NAU/59430

Voxware. (2023). *Customer case studies*. https://www.voxware.com/case-studies/

Wade, M., & Marchand, D. (2014). *Are you prepared for your digital transformation? Understanding the power of technology AMPS in organizational change*. International Institute for Management Development. https://imd.widen.net/view/pdf/w2vr4j0zuu/tc005-14.pdf

Web of Science. (2024). *"Logistic" or "digitalisation" or "technologies"*. https://www.webofscience.com/wos/woscc/summary/f82ca132-d096-4a89-9ae1-c8069ebeff6a-f3e44205/relevance/1

Yang, C.-S., & Lirn, T.-C. (2017). Revisiting the resource-based view on logistics performance in the shipping industry. *International Journal of Physical Distribution & Logistics Management*, *47*(9), 884–905. https://doi.org/10.1108/IJPDLM-05-2017-0184

Zaychenko, I., Smirnova, A., Shytova, Y., Mutalieva, B., & Pimenov, N. (2021). Digital logistics transformation: Implementing the internet of things (IoT). In H. Schaumburg, V. Korablev, & L. Ungvari (Eds.), *Lecture notes in networks and systems: Vol. 157. Technological transformation: A new role for human, machines and management. TT-2020* (pp. 189–200). Springer. https://doi.org/10.1007/978-3-030-64430-7_16