

A systematic literature review on the economic impact of digitalization technologies in transport logistics

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ARTICLE INFO

Keywords:

Impact
Performance
Digitalization technologies
Systematic literature review
Transport logistics

ABSTRACT

In the domain of transport logistics, digitalization technologies are recognized as a high priority, demanded by stakeholders such as legislators, customers, and partners. Concurrently, the industry contends with escalating challenges, including persistent cost pressures and emergent crises such as pandemics and geographical conflicts. To address these multifaceted challenges, the transport logistics sector seeks solutions through the adoption of digitalization technologies. Nevertheless, the widespread implementation of these technologies, often associated with substantial investment costs, necessitates clear evidence of transparent economic benefits and potential remedies for current crises. In order to enhance the understanding of the economic impact of digitalization technologies in transport logistics, this paper presents a state-of-the-art systematic literature review (SLR). The review encompasses 64 papers from leading journals, providing an insightful overview of the field's thematic diversity and developmental trajectory. Employing content analysis, the study reveals emerging themes. Key findings indicate that the research field is still in its early stages but is experiencing discernible growth, with a significant focus on emerging technologies. Finally, several promising future research areas and possible research questions are identified based on these findings.

1. Introduction

One industry that is often viewed in the business world as a necessary but rather peripheral means of achieving a business goal is transport logistics [1].

The fundamental and, at the same time, vulnerable tasks, such as the timely delivery of goods for the entire supply chain, that transport logistics performs are often overlooked by management personnel and stakeholders [2]. Thus, the whole supply chain of a company can collapse if there are problems in transportation logistics [2,3].

This scenario was abruptly made aware by crises such as Covid-19, the Ukraine war, or the employment shortage [4,5]. Minor changes in finely tuned processes, often characterized by high dependencies on individual actors and their interdependencies, have caused these fragile supply chain processes to collapse, resulting in supply disruptions and thus increased costs [2,6].

Growing challenges, such as ever-increasing cost pressures and staff shortages are met by transporters' opaque cost structures and short planning horizons [2,7].

According to the annual Material Handling Industry Report [8], one

of the ways in which the transport logistics industry wants to meet these challenges is through the use of digitalization technologies to achieve cost savings, increase the level of automation to help overcome labor shortages or enhancement and processing of more information to increase transparency and thus longer planning horizons and more resilient supply chains [8–11]. Therefore, digitalization technologies focus on converting information into digital form or processing, storing and transferring it, and aiming to positively change existing processes [12].

As a result, there is a clear recognition of the importance of the possible use of digitalization technologies in the field of transport logistics [9,10]. Nevertheless, many of the activities in this field are still analog and manual, and the widespread use of these digitalization technologies is not taking place [13]. With all of this in mind, the question arises as to why digitalization technologies are not yet widely adopted, as they can be used to address growing challenges, and their importance in transport logistics is recognized.

Barriers to adoption can be various, such as a need for more technological expertise [14] or sometimes complicated selection processes [15]. An essential motivation for decision-makers in transport logistics to adopt digitalization technologies is the potential positive economic

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<https://doi.org/10.1016/j.team.2024.04.001>

Received 22 December 2023; Received in revised form 22 March 2024; Accepted 6 April 2024

Available online 12 April 2024

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impact and return on investment [16].

According to different studies such as Tu [11], Kumar Dadsena and Pant [17], Agrawal et al. [18], Movahedipour et al. [19] and Binsfeld and Gerlach [20], there is a lack of clarity and understanding about the economic impact of digitalization technologies in transport logistics.

This classic business question of the return on investment of the technologies has not yet been comprehensively investigated and can hinder their use [19–21].

Given the importance that transportation companies attribute to new disruptive technologies about the challenges above, it is essential first to develop a good understanding of the economic impact of digitalization technologies that have already been studied and to verify whether they lead to economic benefits and thus provide a remedy for the current problems [9,10,22]. "Economic impact" is a term often used in economics, business and management to describe the consequences or effects of a particular economic activity or investment on a specific region, industry, or entity [23]. It typically refers to the changes in economic indicators such as costs, productivity, revenue, process improvements, and risk reductions that result from the activity in question [23,24]. The knowledge gained of the economic impact of digitalization technologies can contribute to realistic expectations and a more targeted use of these technologies. Furthermore, targeted research could take place in promising directions through the knowledge base created and the understanding that comes with it.

In this context, it may be useful to consider the method of a systematic literature review in order to create a better systematic scientific understanding of the economic impact of digitalization technologies in transport logistics [22,25].

This seemingly promising idea has been obviously taken up by researchers in the field, which has led to a number of reviews on the subject already appearing in the literature.

Although there are several reviews on the economic impact of digitalization technologies, they either deal with the whole supply chain management (SCM) and not specifically with transport logistics [26–29]. Furthermore, they focus on a few digitalization technologies, such as Blockchain or 3D printing [30–32].

In addition, many studies focus on specific aspects of digitalization technologies' economic impact. These technologies are examined, for example, for their contribution to resilience [33], business sustainability [34], competitive advantages [35], market power [36], and strategic management [37].

In order to provide a better overview of the related work on this topic, the existing reviews were divided in Table 1 according to their focus on the three main topics, digitalization-, management- and the SCM- component. The authors analyzed which exact topic related to digitalization was covered, such as entire digitalization technologies or individual-specific technologies such as AI, digital transformation, or Industry 4.0. For management topics, the focus of the reviews was categorized according to specific aspects of business and management, such as performance or business sustainability. The SCM category indicates whether the review focuses on SCM as a whole, the logistics sub-sector, or the transport logistics sub-sector. The authors followed the approach of Williams and Moser by using a non-linear process for qualitative research to identify these themes [38].

As a result, it can be said that existing reviews are either very narrow in perspective, focusing on individual futuristic technologies or specific economic impacts, or too broad and focusing on SCM as a whole.

The many different reviews on the subject could indicate the growing interest in the economic impact of digitalization in the broad field of SCM.

Nevertheless, there is a need for an overview that attempts to identify, evaluate, and summarize all the digitalization technologies that have been studied to date and the associated economic impact in the specific field of transport logistics [26]. Transport logistics is believed to exert a considerable influence on a company's performance; thus, a targeted emphasis on this subject category is deemed prudent [56–58].

Against this background, this paper complements the existing literature by focusing on all economic impacts and digitalization technologies in precisely transport logistics.

The central objective of this review is to systematically examine and present the current state of research on the economic impact of digitalization technologies in transport logistics and the concepts, methods, and approaches used to evaluate them.

Thus, within the framework of the systematic literature review, the following central research question will be answered:

What is the current state of research regarding the economic impact of digitalization technologies in transport logistics?

The central research question is subsequently subdivided into further research questions (RQ) to create a granular and stringent basis for further action:

RQ1: What is the current state of research regarding methods, concepts, and approaches to assess the economic impact of digitalization technologies within the transport logistics supply chain?

RQ2: What are the main researched economic themes of digitalization technologies in transport logistics?

RQ3: What are the potential avenues for future research in this area?

To the best of our knowledge, this SLR is the only one that attempts to examine the current state of research on the economic impact of digitalization technologies in transport logistics and the approaches, methods, and concepts of how the impact was researched.

2. Methodology of literature review

Following the proposal of PRISMA [59] and Keele [25], the research objective was first structured using the PICO (Population, Intervention, Comparison, and Outcome) approach to develop a strategy for literature review and the overarching research question presented earlier.

Population (P): Economic impact of digitalization technologies.

Intervention (I): Concepts, methods, or approaches to assessing economic impact in transport logistics processes.

Comparison (C): Concepts, methods, or approaches for assessing economic impact outside transport logistics processes.

Outcome (O): A clear grouping, description, and evaluation of the economic impact of digitalization technologies in the transport logistics environment. In addition, an overview of the current state of research within the research area under consideration.

2.1. Sources

The core topic of this study was the economic impact of digitalization technologies in the transport logistics industry. To ensure a comprehensive coverage of the relevant literature, the meta-database Web of Science (WoS) was explicitly used for the search, which concentrates pertinent and leading journal publications from the focused and thematically related subject area across different platforms [60]. Various reviews, such as Al Mashalah et al. [61], Durst [62] or Sanchez et al. [63], confirm that WoS has proven to be sufficiently comprehensive and thus adequate as the chosen search database.

2.2. Search process

The central main terms were first derived from the research objective to construct them into search strings [64–67].

The defined terms (PICO elements) were then combined into corresponding search strings using Boolean operators allowed on the electronic search database.

The same search strings could be developed for research questions 1; 2; and 3 because the same research had to be conducted for these research questions.

The PICO elements for deriving the search terms were thus:

- Population (P): Economic impact of digitalization technologies.

Table 1
Related work.

Author	Digitalization themes				Management topics													SCM categories		
	Digital transformation	Digitalization technologies	Industry 4.0	Specific emerging digitalization technologies	Performance	Sustainability	Economic impact	Market power	Business sustainability	Competitiveness	Risk management	Economic potentials	Resilience	Enablers/Barriers	Processes	Strategy	Traceability	Logistics	Total SCM	Transportation logistics
[39]				X		X												X		
[40]	X					X					X		X		X				X	
[41]		X			X													X		
[42]				X			X												X	
[43]	X						X	X											X	
[44]				X			X					X							X	
[28]		X			X														X	
[45]		X					X												X	
[35]	X					X				X								X		
[46]		X									X	X							X	
[26]	X				X														X	
[30]				X								X		X						X
[47]	X											X						X		
[48]				X			X												X	
[49]			X										X						X	
[50]			X						X										X	
[32]				X								X				X				X
[51]		X												X	X				X	
[52]				X		X								X					X	
[29]		X			X									X					X	
[53]				X										X					X	
[54]			X		X		X			X				X					X	
[55]		X															X		X	
This Paper		X					X													X

- Intervention (I): Transport logistics.
- Comparison (C): "NOT" transport logistics.
- Outcomes (O): Grouping, description, and evaluation of the economic impact of digitalization technologies in the transport logistics environment.

Table 2 tabulates the search terms and variants based on the identified PICO elements from the research questions.

Subsequently, as described above, the individual keywords were linked to form complete search strings. The following keywords had to be included in the title, abstract, author keywords, and keywords plus of the articles on WoS to generate a manageable number of results and to exclude irrelevant articles from the beginning.

Search strings for the research questions:

- 1) "performance*" AND "digital*" AND "logistic"
- 2) "impact*" AND "digital*" AND "logistic"

The search resulted in publications found for the search string 1) – 1104 and 2) – 1015. These 2119 articles were subjected to a relevance screening in the next step, explained in more detail below.

2.3. Relevance screening

The inclusion and exclusion criteria were defined in advance, as shown in Table 3. Based on the specified criteria, the publications to be considered were extracted.

After filtering the initial 2119 articles using the previously defined inclusion and exclusion criteria, there remained for search string 1) – 151 and for 2) – 182 papers.

In the final step of the relevance screening, 333 publications were checked for duplicates, availability, and thematic focus on the research questions. The thematic review took place by analyzing the abstracts and, if unclear, the full texts. This was to ensure that digitalization technologies and their economic impact in transport logistics were covered. The result of the relevance screening initially revealed 85 relevant publications. In the later full-text analysis, another 21, either not thematically pertinent or not available papers, were found.

This resulted in a total of 64 publications considered in the following analysis. The process of relevance screening is shown in a Prisma flow chart in Fig. 1.

2.4. Data extraction

The data extraction section deals with the systematic extraction of information defined in advance as relevant, which was taken from the remaining publications. These then form the basis for the subsequent synthesis phase. Following Okoli [22] and Okoli and Schabram [68], the extracted data were oriented to the research questions. Creating a detailed extraction form was emphasized to meet the replicable, comparable, and methodological nature of the SLR [69]. The approach taken was that of Okoli [22] and Okoli and Schabram [68], followed first to develop a basic extraction form and then iteratively revise it again and again through the learning effects elaborated in the previous phases. As a result, a detailed extraction form could be developed.

Based on the developed extraction form, the data were collected. This involved reading the full texts of the publications and documenting the results of the data extraction in a Microsoft Excel spreadsheet program [22,68,70].

Table 2
Search terms.

Economic impact	"impact*" OR "performance"
Digitalization	"digital"
Transport logistics	"logistic"

Table 3
Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
All published papers until 2023/04/04	Published papers after 2023/04/04
Written in English	Not written in English
Peer-reviewed	Not peer-reviewed
Types of documents: articles, reviews, early access	Books, conference papers, dissertations, and grey literature
Published in WoS categories: Management, Business and Transportation	Papers without a focus on Management, Business, and Transportation
Available full text online	No available full-text online

2.5. Data synthesis

Various analysis methods were applied to the previously extracted publication data to develop an understanding of the economic impact of digitalization technologies in transport logistics and present the current state of research [54,71,72].

The data synthesis process was divided into a quantitative and a qualitative main block. As described in Fig. 2, the authors started with a frequency analysis and then identified and explained emerging categories in the papers [54].

The frequency analysis starts with the publication activity over time to show the relevance and trend of the research topic. Subsequently, an analysis of the journals and the corresponding domains is used to check whether the topic is accepted in high ranked journals and for which domains the issue is relevant. Furthermore, an analysis of the methods used in the papers is presented to show the current state of the different approaches to studying the topic. It concludes with the last quantitative analyses of the studied companies, digitalization technologies, and subject categories of the papers in order to gain a better understanding of these research subjects on the topic of the economic impact of digitalization technologies in transport logistics. The companies analyzed in the publications have been subdivided according to the size categories of the European Commission [73]. The digitalization technologies have been assigned to the respective thematic ecosystem in which they are located according to the definition of Rad et al. [27]. For example, big data technologies include a range of technologies that enable the analysis of large amounts of digital data, but these are categorized in the thematic ecosystem of big data [27].

Within SCM research there are classifications into different components based on specific aspects or functions within the broader field of SCM [74]. The content of the papers was categorized, according to Croom et al. [74], either in the subject category transport logistics or general SCM without a subcategory. Since the review focuses on the economic impact of digitalization technologies in transport logistics, the scope is transport logistics and not other sub-areas of SCM.

After the frequency analysis, a qualitative content analysis following Chauhan and Singh [54] and Holsti [75] of the literature in line with our research questions, was carried out with particular attention to the subsequent areas:

- Main topics/themes; and
- Major findings.

The authors examined the topics and themes in the papers and created codes to identify key themes related to the economic impact. After coding the papers based on the full text and the documentation of the results in a Microsoft Excel spreadsheet program, the authors discussed and matched the codes and categories. Any differences were resolved by re-reading and re-coding the papers and the consensus procedure [54, 69]. If a paper covered multiple themes, the authors reviewed it under both. This process yielded the following categories and subcategories of emerged themes from the paper:

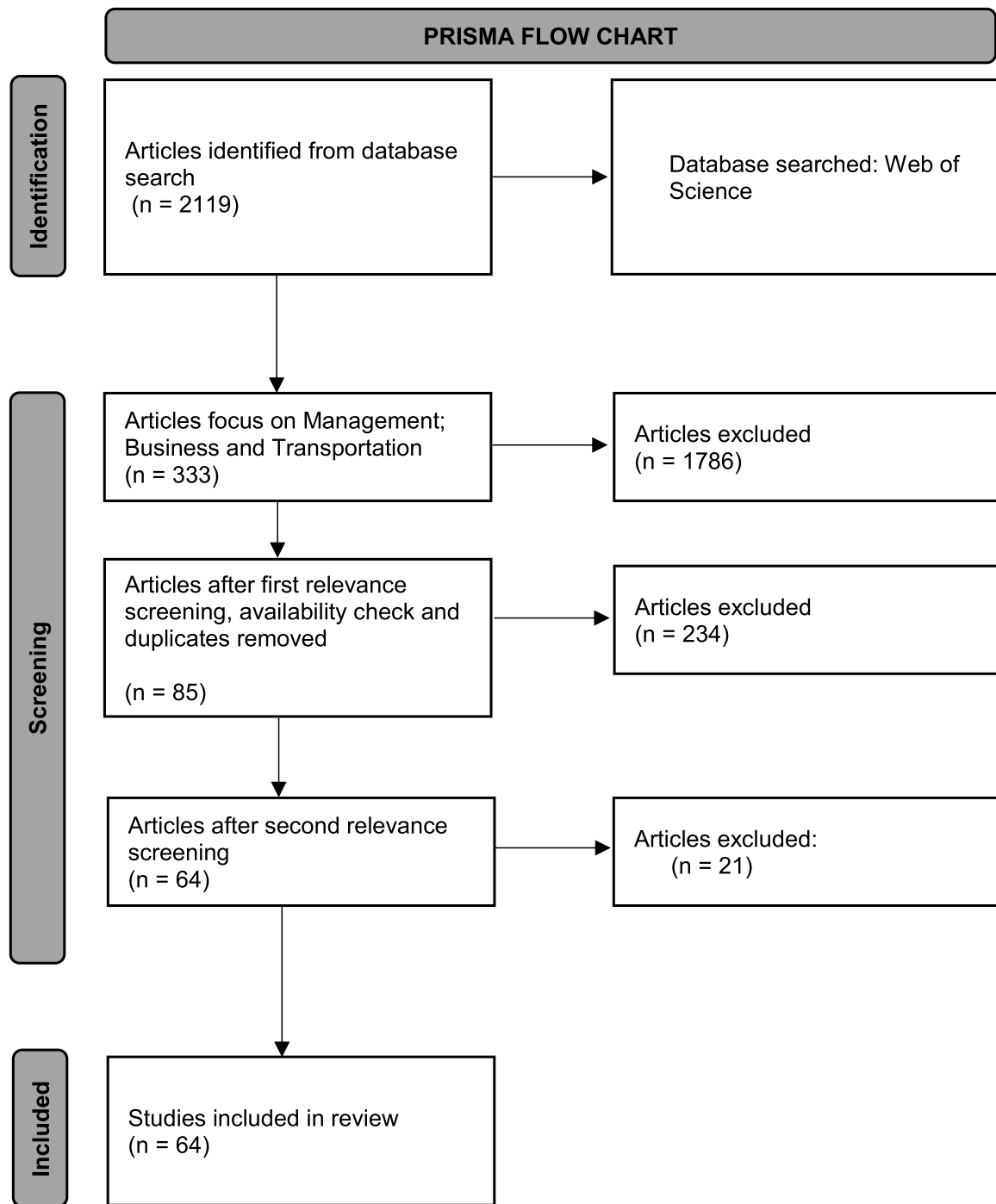


Fig. 1. Prisma flow chart.

- Economic potentials
 - More sustainable business models.
 - Higher GDP growth for a country.
 - Improved overall supply chain.
 - Increased transparency.
 - Reduced overall costs.
 - Improved resilience.
 - Increased competitiveness.
- Impact on performance
 - Improved cost performance.
 - Improved revenue performance.
 - Enhanced cost benefit ratio.
 - Optimized service performance.

- Increased sustainability performance.

3. Results

The quantitative and qualitative analysis results of the 64 publications are described below. To ensure a structured and stringent structure, general findings are explained first, followed by successively more specific findings.

3.1. Publication activity over time

The analysis of publications over time suggests a growing interest in the economic impact of digitalization technologies in transport logistics,

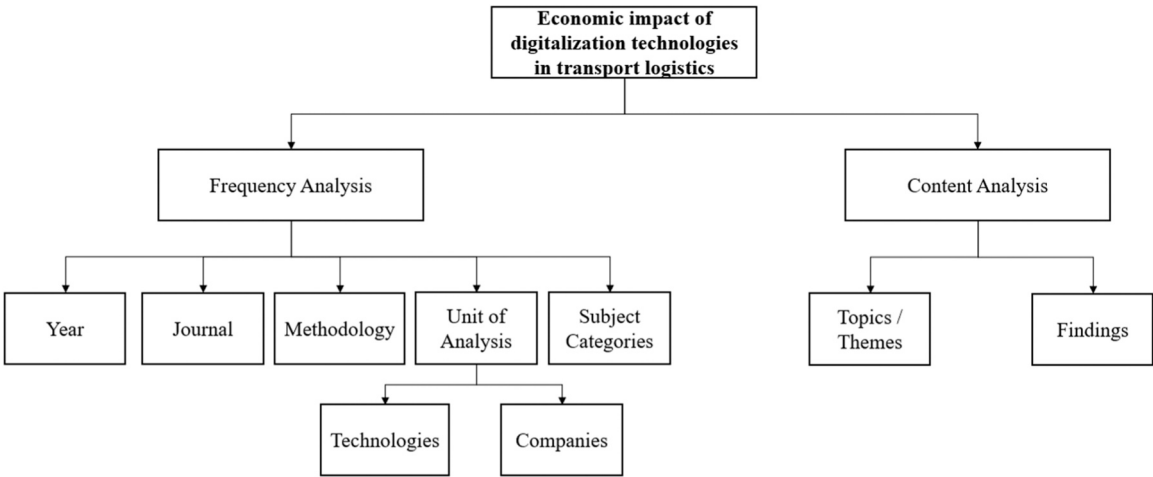


Fig. 2. Research methodology.

as seen in Fig. 3.

Beginning in 2006 and continuing through April 2023, an increasing trend line can be seen. The peak in the number of publications was reached in 2021.

The analysis shows that the topic has become increasingly relevant in recent years and is developing as an emerging field of research. This is also supported by the already relatively high number of publications in the first three months of 2023. If this trend continues for 2023, a new peak in publications in this research field will be reached in 2023. The number of publications thus indicates that this is still a young field of research with increasing growth spurts.

The publication of papers on the economic impact of digitalization technologies started not until 2017. This is comparatively late, considering that the topic of "digitalization" gained relevance after 2011 with the coining of the popular term "Industry 4.0" [76]. A possible explanation for this could be that the assessment of impacts is always preceded by a primary activity from which the impacts are assessed. The study of the economic impact of digitalization technologies is preceded by the use of the technologies in practice [7,77]. Therefore, the economic impact research is based on the use of digitalization technologies, as described in Fig. 4. However, it took some time between the coining of the buzzword "digitalization" and the use of these technologies, which

could explain the time lag between the emergence of the term and the publications on economic impact [7,77].

3.2. Distribution by journal

The 64 publications analyzed were published in 32 different journals. Of the three journals with the most publications, *International Journal of Logistics Management (IJLM)*, *International Journal of Physical Distribution & Logistics Management (IJPDLM)*, and *Logistics Basel*, the first two are among the leading journals in the logistics field [78].

Analysis of WoS journal rankings showed that 80 % (64 % - Q1; 16 % - Q2) of publications were published in Q1 and Q2 journals. This shows that topics related to the economic impact of digitalization technologies in transport logistics are accepted and published in high-ranking journals.

The analysis of journal domains also revealed that most publications were published in pure logistics journals (58 %), then in pure business journals (19 %), and with the same number in the business/engineering domain (19 %), as described in Fig. 5. This result is not surprising, since the issue is the economic evaluation of technologies in logistics. Therefore, these three areas of Business, Engineering, and Logistics are also reflected in the journals.

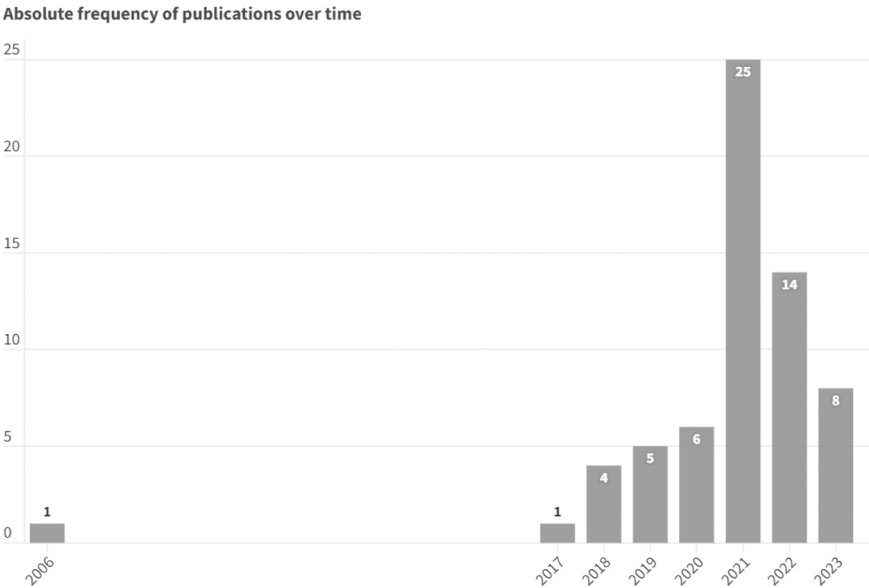


Fig. 3. Distribution of publications by year.

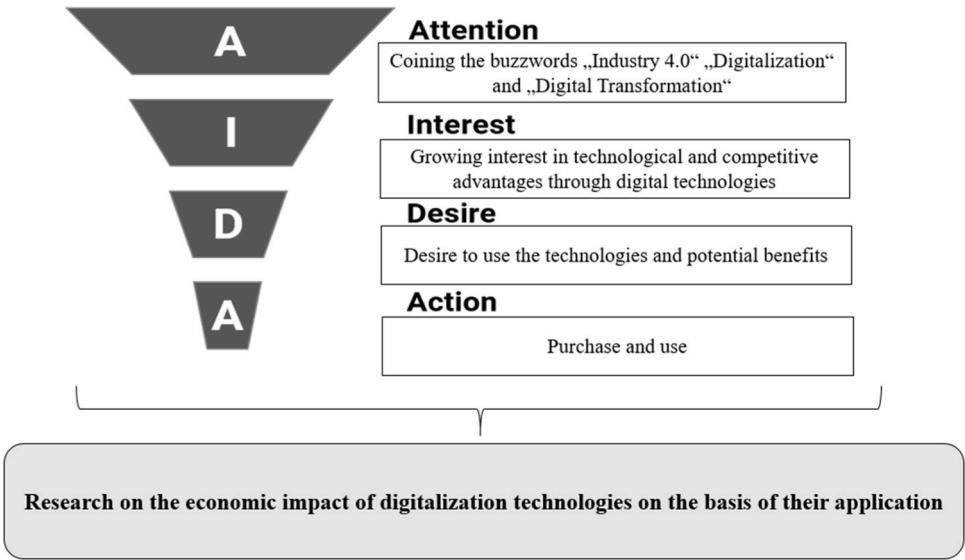


Fig. 4. AIDA Principle in the context of digitalization technologies and economic impact [77].

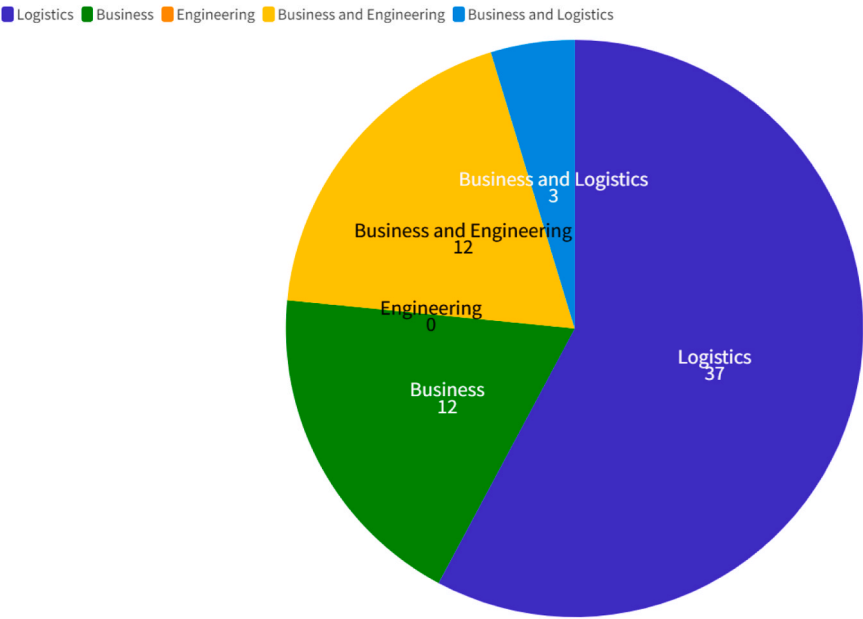


Fig. 5. Absolute distribution of publications by journal domain.

3.3. Methodologies used in the articles

The different papers can be classified into five different categories of methodological design, as described in Fig. 6.

Most papers can be classified as quantitative research, with 26 papers (41 %). It is striking that review papers follow in second place with 16 (25 %) and only then qualitative research with 12 (19 %) papers. At the end of the ranking are mix-method papers with eight (13 %) and conceptual papers with two (3 %) mentions.

To take a more realistic view of the heterogeneous topic of quantitative and qualitative aspects of economic impact, it may be helpful to consider using more mixed-method approaches.

3.4. Classification of subject categories in the research field

The content of the 64 papers was categorized either in the subject category transport logistics or general SCM without a subcategory,

following the framework of Croom et al. [74]. Strikingly, most of the papers (59 %) can be classified in the supply chain management (SCM) domain and only 41 % in transport logistics, although the keywords specifically focused on transport logistics. However, when analyzing the content of the papers with SCM reference, it can be seen that they would instead fit into the transport logistics domain. This suggests that publications in the research field of transport logistics are labeled under the buzzword supply chain management to address a broader mass in a more popular research field. As a result, there are fewer specific transport logistic papers in the area, and they are more general to publish in SCM. Nevertheless, these are two distinct fields and should be treated as such [79,80].

3.5. Covered digitalization technologies

As the research field of the economic impact of digitalization technologies in transport logistics is a broad one, it is relevant to know which

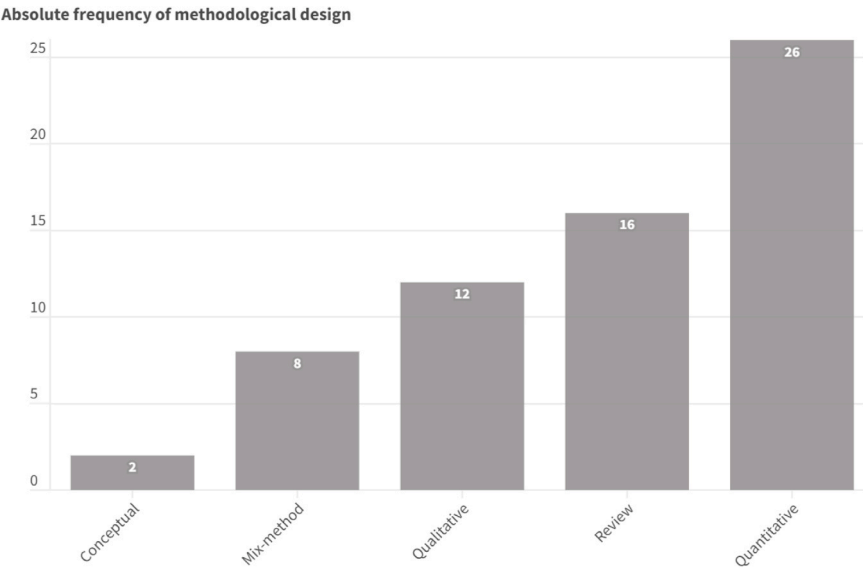


Fig. 6. Methodological design.

technologies have been studied so far. The analysis showed that most papers (60 %) did not focus on specific digitalization technologies and evaluated general digitalization processes.

In contrast, the remaining publications placed their research focus on popular and futuristic technologies such as technologies in the ecosystem of Blockchain (14 %), Big Data (8 %), Additive manufacturing (3D-Printing) (5 %), Artificial Intelligence (3 %), and Digital Twin (3 %), as outlined in Fig. 7.

3.6. Types of companies studied

The topic of the economic impact of digitalization technologies usually always includes companies since they are the ones who ultimately use the technologies in practice and bear the effects of these investments. The authors see relevance in analyzing the different types of companies that are the research focus in the publications. The company analysis revealed that most papers (70 %) do not focus on a specific type of company, as illustrated in Fig. 8. This is not surprising due to the still young research field.

The business area in which the various types of companies studied operate is vast and often without a specific logistics focus. Thus, only seven publications (11 %) dealt with companies whose core business is transportation logistics. The other publications that indicated the business area of the companies studied, transportation logistics was not the core business, as is the case with logistics service providers (LSPs), and logistics was only a supporting tool to achieve a business objective.

3.7. Emerging themes and thematic evolution of the research field

A content analysis of the papers was conducted to identify and map emerging themes to better understand the topic of the economic impact of digitalization technologies in transport logistics [54,75].

A previously conducted keyword analysis with VOSviewer indicated that the concept of economic impact is very heterogeneous and is studied from different perspectives with diverse approaches.

Within economic impacts, categories can be identified that focus on different aspects of this broad concept. The two main categories are the "economic potentials" and the "impact on performance" with a wide

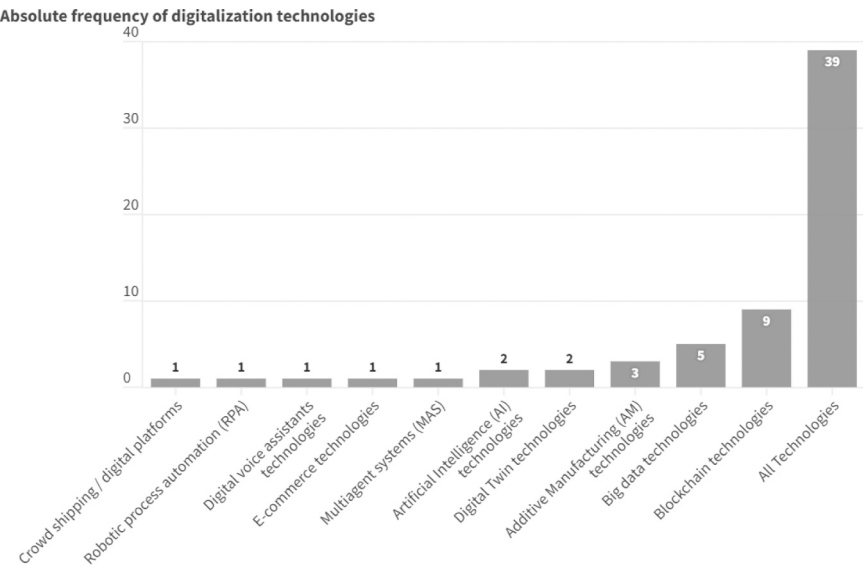


Fig. 7. Covered digitalization technologies.

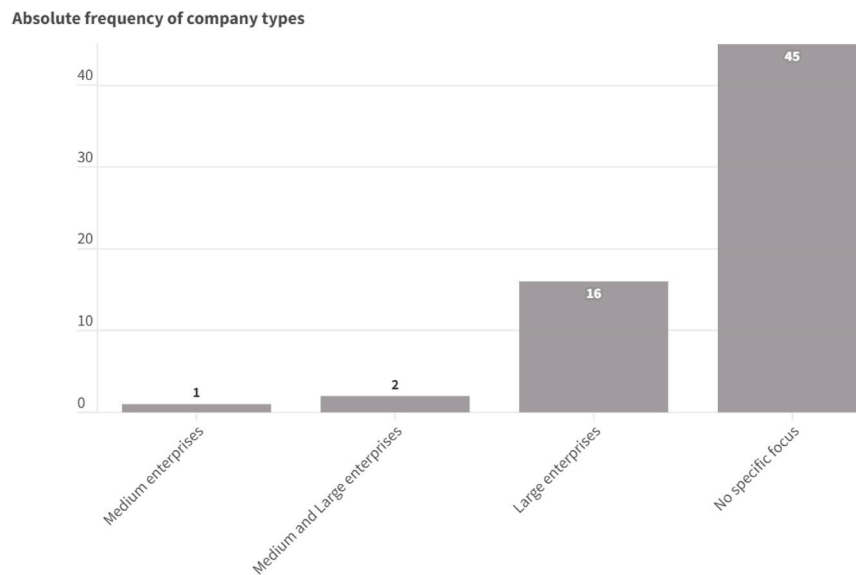


Fig. 8. Types of companies covered.

variety of sub-topics. These papers' content and especially the findings are categorized and summarized below.

3.7.1. Economic potentials

The economic potentials explored in the studies are manifold. For example, it has been confirmed that digitalization technologies positively impact a company's sustainable business model in the logistics sector [81,82]. This is also shown by papers that found a positive impact of the use of digitalization technologies on the GDP growth of a country [83,84]. Furthermore, a positive influence on the entire supply chain could be determined by which activities are simplified and shortened. Thus, the supply chain becomes shorter, simpler, safer, and faster [85, 86]. Another potential of the use of digitalization technologies in transport logistics mentioned in various papers is the increase in transparency [87–92]. In this context, the possibility of increasing the visibility of individual activities is often mentioned, leading to better forecasting, better decision making, and thus better organization [87–92]. Another frequently cited economic potential is the potential reduction in costs [87,91,93–95]. Improved transparency, better decision-making, productivity gains, process improvements, risk reductions, and better predictions that can accompany the use of digitalization technologies are cited as causes of cost reductions [87,91, 93–95]. Another paper examined the impact of digitalization technologies on a company's resilience and showed a positive correlation [96]. The points mentioned above lead, among other things, to an increase in competitiveness in general. This phenomenon is again examined separately in various studies [7,36,97–99].

Digitalization technologies in transport logistics seem to offer various positive economic potentials. It should be noted, though, that these opportunities are interdependent and complex to attribute to individual factors.

3.7.2. Impact on performance

The impact of digitalization technologies on a company's performance is the subject of numerous studies. This is by no means a surprise because companies expect that investing in digitalization technologies will have various positive effects on different areas of performance. At the same time, the insufficient quantifiable investigation of the performance effects represents a barrier to date [11,17–20].

The area of financial performance, focusing on the analysis of cost and revenue indicators, is one of the subjects of the studies. Various papers such as Carlan et al. [100], Ermagun and Stathopoulos [101], Rai

et al. [28], Raji et al. [102], Loske and Klumpp [103,104], Yu et al. [105] or Binsfeld and Gerlach [20] confirm; that the effective implementation of digitalization technologies can lead to cost reductions and revenue increases. On the other hand, it could also be observed that initially, there is a deterioration in performance followed by a longer-term improvement [104]. This phenomenon could be related to the increased time for changeover that it takes at the beginning of use with the new technology [9,104].

The study by Carlan et al. [100] goes beyond the singular consideration of costs and attempts to create a more comprehensive picture of the added value of digitalization technologies with a cost-benefit analysis. The study concluded that it does not make sense for every company to implement digitalization technologies and that this requires an individual examination and, initially, a cost-benefit analysis [100].

Another subject of investigation is service performance. This includes for example customer satisfaction, productivity, quality, and delivery time [106]. Nevertheless, the subdivision should not be regarded as clearly defined, as an increase in customer satisfaction, for example, is accompanied by an increase in sales and, thus, an improvement in financial performance [107]. The papers confirm an improvement in service performance regarding customer satisfaction [101], productivity [108], quality [108,109], time efficiency [102,110] and utilization [111] through digitalization technologies.

Apart from financial and service performance, studies investigated the effects of digitalization technologies on sustainability performance. Here, too, an improvement in sustainability factors such as less use of harmful materials, minimal waste, minimal resources, more recycling, and emissions produced could be demonstrated when implemented correctly [105,111,112]. Furthermore, an increase in the general firm performance could be observed by achieving sustainability performance, which is even regarded as a decisive factor [112].

4. Discussion and avenues for future research

In summary, the research field of the economic impact of digitalization technologies in transport logistics is still young but growing. The research in the analyzed literature shows that researchers have so far been primarily interested in investigating the "economic potential" and "impact on performance" of digitalization technologies in transport logistics. Due to the fact that the field is still evolving, many studies take an approach that first attempts to identify individual overarching aspects, such as potentials, and further investigate the possible positive

correlation with the use of digitalization technologies. In our view, this approach, which initially focuses on overarching criteria that are affected by the use of digitization technologies, makes sense. Nevertheless, the downstream step of examining the concrete results of digitized transport processes in relation to these aspects has so far been minimal in the analyzed literature.

A specific example is the research on the overarching aspect of service performance with a focus on time efficiency, which various studies have shown to be positively correlated with the implementation of digitalization technologies in transport logistics [102,110]. Nevertheless, only one study used a simulation and a specially developed Key-Performance-Indicator to take a closer look at service performance in the downstream step and concluded that the performance would be temporarily worse, but long-term positive [104]. This valuable insight only came to light through more targeted research into individual overarching aspects of digitalization technologies in transport logistics.

Future empirical research could follow this example and examine in more detail cross-cutting aspects such as improved cost structure, transparency, decision-making, innovation, resilience, barriers, success factors, and sustainable business that can result from the use of digitalization technologies in transport logistics. It should be noted that these aspects can occur in complex chains of effects and, in some cases, in purely qualitative forms, which is why interdependencies must be taken into account. There may be a lack of uniform concepts for measuring and recording the actual performance of digitalization technologies in transport logistics. Concrete suggestions for their appropriate management could be helpful when examining the aspects of obstacles or challenges in implementing digitalization technologies. In general, a more focused and holistic approach to the topics studied, now in the second step, could provide deeper insights.

Another research direction could be a more targeted focus on specific areas of logistics, such as transport logistics. When analyzing the subject categories, it was found that most of the papers are published in the field of SCM, even if they are more focused on transport logistics. This is probably due to the greater interest in SCM topics, mainly due to public awareness and the focus on globally disrupted supply chains caused by the Corona pandemic. However, several authors such as Larson and Halldorsson [79] or Lummus et al. [80] consider differentiating the terminology proper. It is also assumed that transport logistics significantly impacts a company's performance, and therefore, a specific focus on the subject category makes sense [56–58].

Regarding the economic impact of digitalization technologies in transport logistics, disruptive technologies are increasingly the focus of several studies. However, these technologies are currently not or hardly used in transport logistics and are, therefore, difficult to study due to the limited data available and the short period of use. Therefore, the focus on them could be related to the high awareness of these technologies heavily promoted by the media and large consulting companies such as McKinsey and Boston Consulting [8,113,114].

Due to the fledgling nature of the topic, only some restrictions were initially placed on the type or business area of companies using digitalization technologies, which is, in our view, appropriate at this early stage. When a focus was placed on the type of company, it was always a large company. As a result, other specific company types, like Small and medium-sized enterprises (SMEs), have yet to be addressed in the research. However, this is a promising area of research for the future, as SMEs are seen as the main driver of economic growth in most countries, and potential performance improvements through digitalization technologies would have a macroeconomic leverage effect for this type of company in particular [8,62,115,116]. Future research can also focus more on the business area of logistic service providers (LSPs), as they play a crucial role in shaping transport logistics through the concentrated performance of core logistics functions and play a key role in SCM as a whole [117,118].

Another promising approach for future research could be to expand the research methods currently used. Current research methods remain somewhat limited in scope, although they have made significant contributions to understanding. This limitation is partly due to the nascent nature of our field. As the field moves forward, there is a need to broaden these methodologies. This broadening is not only about diversifying the tools and techniques. It is also about adopting a more interdisciplinary approach. This shift could address complex questions that the current methods may not fully capture. Future research could also focus on longitudinal analysis of the economic and sustainable impacts of digitalization technologies. Much of the understanding is based on short-term studies or immediate outcomes. However, the long-term implications remain underexplored, especially regarding economic viability and sustainability. Longitudinal studies could provide a more holistic picture, including consequential costs and long-term benefits or harms. This approach is essential for designing policies and strategies that are economically sound and sustainable in the long term. It could contribute to a more balanced and comprehensive understanding of the economic

Table 4
Future research opportunities and possible research question.

Future research opportunities	Topic	Possible research questions
A deeper holistic perspective could complement the overarching aspects presented in numerous studies. This is particularly evident in the emerging themes of economic potential and impact on performance.	Performance	i. How can the performance of digitalization technologies in transport logistics be measured? ii. How does the implementation of digitalization technologies change the performance of transport logistics in the short and the long run? iii. Does the potential performance improvement of digitalization technologies in transport logistics justify the high investment costs?
	Economic Potentials	i. How do digitalization technologies in transport logistics influence decision-making? ii. How do digitalization technologies in transport logistics influence the resilience of companies? iii. Do the benefits of digitalization technologies in transport logistics justify the high investment costs? iv. How can specific sustainability goals be achieved with digitalization technologies in transport logistics?
Future research can focus specifically on areas that have yet to be extensively researched in the literature, or not at all, such as digitalization technologies already in use (Telematics, Transportmanagementsystems, etc.), SMEs, LSPs, and more specifically transport logistics.	Established Digitalization Technologies	i. What are the potential benefits of already established digitalization technologies such as telematics, transport management systems, and cargo monitoring sensors in transport logistics, and how should they be classified in terms of their costs? ii. What is the performance of established digitalization technologies in transport logistics?
	SMEs	i. Does the potential benefits of digitalization technologies in transport logistics justify the high investment costs, especially in SMEs with limited financial and human resources? ii. How can SMEs with limited financial and human resources successfully implement digitalization technologies in transport logistics?
	LSPs	i. What are the potential benefits for LSP in implementing digitalization technologies? ii. Does the potential benefits of digitalization technologies in transport logistics justify the high investment costs in the context of LSP?
Promising approach for future research could be to expand the research methods currently used.	Research Methods	i. How can interdisciplinary approaches be applied to the current methods used in the research field? ii. What are the long-term economic and sustainable impacts of digitalization technologies, and how do they contrast with short-term outcomes?

impact of digital technologies.

In light of the above, we summarize the future research opportunities identified in this study and offer specific research questions described in Table 4.

5. Conclusion

In the past, review papers have highlighted the impact of individual technologies such as AI, big data, and others on various aspects of economic viability in SCM, logistics, and transportation logistics and how they can deliver potential benefits. However, relatively few studies have comprehensively addressed the economic impact of digitalization technologies. To the best of the authors' knowledge, neither review study examines this topic in the specific area of transport logistics. The present study aims to fill this gap.

To the best of the authors' knowledge, the systematic literature review of 64 publications presented in this paper is the first work to address the current state of research regarding the economic impact of digitalization technologies in transport logistics in this form.

In this way, the paper complements existing research that either takes too narrow a perspective, focusing on individual future technologies [30–32] or specific economic impacts focused [33–37], or taking too broad a perspective and focusing on SCM as a whole [26–29].

This Review provides a more holistic economic view of the diversity in the specific research field of transport logistics. As a result, we believe this is the most comprehensive and complete study of the economic impact of digitalization technologies in transport logistics.

We argue that this paper makes a significant contribution to the field of transport logistics and, more specifically, to the economic impact of digitalization technologies in this field. It achieves this by presenting a comprehensive state-of-the-art review that intends to be valuable to researchers interested in making meaningful contributions to significantly advance the young but growing research topic.

As an academic implication, the results of the descriptive analyses identified specific digitalization technologies, such as established ones like telematics or transport management systems, company types like SMEs, business sectors like LSPs, and more specific fields like transport, that can serve as a basis for promising targeted research in this area. In addition, the content analysis identified and described emerging themes, from which research questions were developed to provide the opportunity for deeper and more focused research into these promising topics in the future.

The review results should also be helpful to various stakeholders in transport logistics, such as management personnel in transportation and SCM, digitalization technology providers, environmental advocates, policymakers, and other actors interested in the economic impact of digitalization technologies. Understanding the economic impact of digitalization in transport logistics is critical for these stakeholders to make informed decisions, drive innovation, and ensure the sustainability and competitiveness of companies in the sector. The results of the cluster analysis show, for example, which possible economic potentials and impact on performance can be expected as a company. In conclusion, the understanding gained can lead to better interactions among the various actors, such as customers, partners, and decision-makers, along the supply chain.

To correctly classify the publication, the limitation of the planned, systematic literature review is pointed out.

A limitation of this study is that the authors only searched the Web of Science database. This may have resulted in articles from other databases being overlooked in the specific field of the economic impact of digitalization technologies in transport logistics. The specific keywords used in the search could also have excluded individual articles that may have been relevant.

Another limitation of the present work is that the literature analysis was conducted in the field of transport logistics. Among other things, this field is characterized by a strong pragmatism. As a result, the

documentation and in-depth analysis of the economic impact of digitalization technologies are being applied in practice but may be inadequately captured in the literature. The resulting potential discrepancy between research and practice carries the risk that the literature analysis does not reflect the actual state of the research.

Future research could take a broader approach, using different databases, considering a wider variety of keywords for the search, and including grey literature in the analysis to appropriately address the limitations of the present work. The authors hope that research will continue to build on the developed knowledge to advance the field of the economic impact of digitalization technologies in transport logistics.

CRediT authorship contribution statement

Navid Julian Sardarabady: Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Susanne Durst:** Writing – review & editing, Supervision, Methodology, Conceptualization.

Ethical approval

No restrictions or required approvals regarding ethical concerns.

Funding

The authors of the publication are not funded separately to prepare this study. Funding amounts to the employment relationship with the university.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgment

The authors are very grateful for the dedicated feedback and the valuable exchange with colleagues within the research team.

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