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Current Trend of Industry 4.0 in Logistics and Transformation of Logistics Processes Using Digital Technologies: An Empirical Study in the Slovak Republic

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Abstract: *Background*: The digital transformation towards Industry 4.0 has become a necessity for businesses as it makes them more flexible, agile and responsive. Logistics is no exception, as it is constantly undergoing a significant transformation supported by revolutionary Industry 4.0 technologies that are fundamentally changing logistics processes and operations. *Methods*: In the construction of the paper, the following classical scientific methods were used: analysis, synthesis, induction, deduction, analogy, specification and comparison. Among the special scientific methods, the method of classification, concretisation, graphical methods, questionnaire survey and statistical methods were used. *Results*: The analysed enterprises perceive digital transformation in logistics. In the analysed enterprises in Slovakia, the Industry 4.0 strategy is implemented in logistics. Industry 4.0 in logistics has the largest representation in production logistics in each enterprise category. In implementing Industry 4.0 in logistics, enterprises confront the biggest barrier, namely, investment costs. *Conclusions*: Through one-way analysis of variance (ANOVA) and Pearson's correlation coefficient, several significant relationships were confirmed. The significant relationship between manufacturing logistics and selected Industry 4.0 technologies was demonstrated. The significant relationship between procurement logistics and selected Industry 4.0 technologies was also demonstrated. The statistical analysis also confirmed a significant relationship between distribution logistics and the selected Industry 4.0 technologies.

Keywords: digital transformation; Industry 4.0; Industry 4.0 technologies; Logistics 4.0; statistical methods

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1. Introduction

The business environment is facing a dizzying transformation, rapid change and dynamic development. The logistics industry has seen many changes over the years, and as technology continues to transform the world, its impact on logistics will only expand. This is expected to cause a paradigm shift in how enterprises deliver their goods to customers quickly and efficiently. In the wake of the global pandemic, the logistics industry is under more pressure than ever to improve its processes. Everyone needs seamless logistics flows without any dangers or disruptions. Industry 4.0 is having a profound impact on the economy of every country, as it is revolutionising not only logistics, but also fundamentally changing society itself and the economy of the world. Industry 4.0 represents the use of automation and digitalisation with the application of new revolutionary technologies. Industry 4.0 is based on the interconnection of the Internet of Things with modern devices that communicate with each other through cyber-physical systems and are independent of humans. The actual implementation and subsequent use of Industry 4.0 and its technologies in the enterprise concerns not only logistics, but the entire supply chain. Industry 4.0 brings transformational changes that offer significant challenges and opportunities that affect many operational aspects of logistics.

The intention of the paper was to identify and explain the definitions and terminology that identify Industry 4.0 in logistics, based on the analysis of the literature, and also to interpret the research results that analyse the current state of the ongoing digital transformation of logistics through digital technologies in enterprises in the Slovak Republic.

Research and studies carried out in the field of digital transformation of logistics towards Logistics 4.0 still have a limited presence in the scientific sphere. Partial studies have been realised elsewhere in the world which highlight the importance of digital technologies in logistics for the sake of a continuous flow in logistics and to ensure an efficient management of logistics processes and activities with elements of artificial intelligence. It is this gap in research that has created a prerequisite for an in-depth analysis of the issue in the conditions of the Slovak Republic, where no similar research has been conducted in small, medium-sized and large enterprises through a questionnaire which has been evaluated by descriptive analysis and inferential analysis.

In the first part of the paper, a comprehensive and in-depth analysis of the views on the conceptual framework for Industry 4.0, the role of technology in the Industry 4.0 era, and the digital transformation of logistics is conducted through classical scientific methods. In the next part of the paper, the methodology of the paper is identified, which includes a review of similar research conducted in the world, thus establishing the theoretical basis for the construction of the research question and hypotheses. Subsequently, the paper conducts a descriptive analysis of the questionnaire survey and an inferential analysis of the questionnaire survey, where one-way analysis of variance (ANOVA) and Pearson's correlation coefficient is used. The last part of the paper is the summary of the research and identification of the research limitations.

2. Literature Overview

Digitalisation represents a complex and radical change in which enterprises need to identify and implement digital measures [1]. Digital transformation affects different dimensions of enterprises while enabling the creation of new business models through digital technologies [2]. Digital transformation focuses on creating added value for customers through smart technologies [3]. Digital technologies have changed the nature of business processes as they create new methods of management whereby the enterprise achieves a competitive advantage in a network of stakeholders [4]. In a study by Mittal et al. [5], Pfohl et al. [6] include among digital technologies: augmented reality, virtual reality, cyber-physical infrastructure, cloud computing, Internet of Things, artificial intelligence, big data analytics, additive manufacturing, smart sensors, autonomous robots and systems, and mobile technologies. Digitalisation in the logistics and supply chain management industry is increasingly inflected as it is of strategic importance to enterprises and is impacting established paradigms and business models [7,8]. Fragapane et al. [9] state that new technologies are emerging, especially in the Industry 4.0 era. These technologies include cloud operations and artificial intelligence, while creating new flexible manufacturing systems. The essence of flexibility lies in the ability of the enterprise to respond to customer demands in a timely manner while increasing productivity, without incurring excessive costs and overcommitting resources. Schniederjans et al. [10] state that digitalisation is a current trend in the logistics industry. The opportunities associated with digitalisation have enabled the entire supply chain to access, store and process large amounts of data, whereby enterprises are able to capture individualised customer data to personalise the sales process, product and service design.

We are currently in the Fourth Industrial Revolution, which is characterised by the implementation of smart technologies that interconnect the physical and biological worlds with the digital world [11]. The Fourth Industrial Revolution represents the integration of manufacturing with intelligent information and communication technologies, which enable the manufacturing of products according to individual customer requirements. They also allow production in batches of one piece, but at the cost of mass-produced goods [12]. The Fourth Industrial Revolution differs from the First, Second and Third

Industrial Revolutions because technology plays a much greater role in it. A significant factor is the establishment of technology policy to create an innovation ecosystem [13]. The Fourth Industrial Revolution is also defined as Industry 4.0. Its essence is based on the rapid development of digital technologies. Industry 4.0 digital technologies include the Internet of Things and cyber-physical systems [14]. The Fourth Industrial Revolution is causing changes, especially in manufacturing, as it sees a shift from mass production to personalised production. At the same time, this leads to greater flexibility in production processes while providing tools with which to more efficiently cater to individual customer needs [15]. The Fourth Industrial Revolution has seen significant advances as it embraces robotics and artificial intelligence, whereby machines do the heavy lifting and automated robots carry out constantly repetitive operations [16]. In the Fourth Industrial Revolution, a digital revolution is underway that is fundamentally changing the way individuals work and the way they use the advanced technologies that are integral to manufacturing processes [17]. Industry 4.0 is considered the Fourth Industrial Revolution. It is driven by the automatization of production processes and also by their digitalisation [18]. The Fourth Industrial Revolution enables a higher level of manufacturing efficiency through new, disruptive, smart technologies. These technologies also aim to influence the social and environmental sustainability of enterprises [19].

2.1. Conceptual Framework for Industry 4.0

Industry 4.0 represents a new level of organisation and control of the entire product life cycle value chain. It also focuses on increasingly individualised customer requirements. Industry 4.0 is a visionary yet realistic concept. Industry 4.0 encompasses the Internet of Things, smart manufacturing and cloud manufacturing [20]. Industry 4.0 encompasses an industrial revolution that is based on cyber-physical systems. Industry 4.0 envisages the interconnection of physical and digital systems, all in real time with the help of new enabling technologies. These technologies are changing the way work is done and the way work systems are used. Industry 4.0 is changing the traditional way of doing enterprise, including agility, flexibility and quality [21]. Industry 4.0 focuses on the automation and digitalisation of processes and systems and the exchange of data across the enterprise. The main goal of Industry 4.0 is to create a smart factory to increase productivity in the production system [22]. Nierostek and Horváthová [23] see the success of the enterprise and its future in the Industry 4.0 concept, as Industry 4.0 transforms enterprises and replaces old technologies and processes. Porubčinová and Fidlerová [24] assume that the essence of Industry 4.0 is in the interconnection of the different technological components, with machines, people and products interacting with each other. Mokrá et al. [25] consider it important in the current revolution to take care of efficient employees, who represent a decisive role in business processes. Industry 4.0 is a new industrialisation strategy. Within it, cyber-physical systems, big data, cloud computing, the Internet of Things and the Internet of Services are applied [26]. Industry 4.0 represents a technological revolution where industrial automatization, simulation, integration systems, IoT, cloud computing, additive manufacturing, and augmented reality have important roles to play. It is these technologies that represent the main drivers of the technological revolution [27]. With the help of Industry 4.0, it is possible to connect all elements related to manufacturing processes. The implementation of advanced technologies, techniques and management methodologies specific to Industry 4.0 covers the entire manufacturing process. The intention is to achieve the creation of a Smart Factory [28]. Fidlerová et al. [29] connect the implementation of Industry 4.0 with the introduction of innovations that aim to increase the competitiveness of sustainable business. Imran et al. [30] define Industry 4.0 as the increasing digitalisation and automatization of manufacturing. At the same time, digital value chains are being created that communicate between products, business partners and their environment. Industry 4.0 is creating smart factories that combine physical and cyber technologies. At the same time, technologies are becoming more complex and precise, making manufacturing more efficient, controllable, quality, and transparent [31]. Industry 4.0 is associated with disruptive innovation [32]. These innovations have an important impact on radical changes in technological processes. In order to face the digital transformation, the enterprise has to deal with many challenges, which include fragmentation of the value chain, integration of production systems, and globalisation and decentralisation of manufacturing [33–35]. Industry 4.0 represents the era of digitalisation, where there are digital business models, digital environments, digital production systems and digital machines. In digitalisation, physical flows are implemented and continuously mapped on digital platforms. The higher level of automatization is represented by systems and software that enable communication with intelligent information and communication technologies. This ensures a digital factory not only internally, but also externally as it reaches all elements of the value chain [36].

2.2. Role of Technologies in the Age of Industry 4.0

The pillars of Industry 4.0 are an essential part of this. The core pillars of Industry 4.0 include: the Industrial Internet of Things, cyber-physical systems, vertical and horizontal software integration, augmented reality, predictive techniques, autonomous robots, additive technologies, mass individualisation, innovative methods for collecting and processing big data, and many other real-time data analytics techniques that exploit the potential of cloud computing [37]. Tutak and Brodny [38], Pivoto et al. [39], and Sony and Naik [40] agree on the nine core technology pillars of Industry 4.0. According to the authors, it is these nine pillars that significantly influence the activities in the industry and service sector. These pillars include optimisation and simulation, cloud technologies, virtual and augmented reality, big data analytics, horizontal and vertical system integration, industrial IoT, autonomous robots, incremental technologies, and cybersecurity. The integration of Industry 4.0 technologies into business processes has sparked the transformation of tangible objects into intangible ones. This transformation has made objects more portable and accessible [41]. Industry 4.0 includes artificial intelligence, Internet of Things, augmented reality, additive manufacturing, advanced robotics and cobots, human-machine interfaces, machine-to-machine communication, blockchain, data stored in the cloud, the Internet of Services, autonomous vehicles, and drones [42]. The core technologies of Industry 4.0 include: simulation, industrial IoT, big data analytics, cloud technologies, additive manufacturing, autonomous robots, augmented reality, cybersecurity, and business intelligence [43]. The key elements of Industry 4.0 that are creating disruptive change include: advanced simulation, nanotechnology, biotechnology, neurotechnology, artificial intelligence, Internet of Things, cloud computing, big data, industrial IoT, smart factory and intelligent factory, autonomous robots, cybersecurity, additive manufacturing, virtual reality, smart sensors, drones, vertical and horizontal systems integration, renewable energy and advanced energy storage, machine-to-machine communication, 5G network, quantum computing, mobile devices, predictive maintenance, advanced human-machine interface, and digital twin [44]. The key pillar of Industry 4.0 is new technologies that are fundamentally changing business processes. Industry 4.0 technologies include: simulation, nanotechnology, cloud computing, virtual reality, 3D printing, big data analytics, radio frequency identification, Internet of Things, cybersecurity, machine-to-machine communication, robots, and drones [45–47]. The main advantage of Industry 4.0 technologies is to ensure the implementation of different capabilities depending on the needs of the production system. The level of complexity of the decisions to be made, the amount of information to be processed or the autonomy of the systems to be able to apply decisions without human intervention are taken into account. Industry 4.0 and related technologies are increasingly presented as essential for the increase of productivity in manufacturing enterprises. By focusing on instantaneous communication between machines and objects, it is possible to make manufacturing systems more responsive to product changes and better able to react to unpredictable events [48].

2.3. Digital Transformation of Logistics-Logistics 4.0

In order for logistics systems to respond flexibly to the dynamic changes in the globalised international environment, it is essential that logistics systems become more and more efficient, flexible and secure [49]. Enterprises can achieve this by implementing Industry 4.0 technologies in logistics. The challenge in modern logistics is also supply chain management is the automation of supply chain processes [50]. It is the automation of logistics processes that is still one of the most pressing needs and to manage the current crisis that is also affecting logistics [51]. The trend towards digitalisation has made Industry 4.0 inevitable and is playing a decisive role in the development of new logistics and manufacturing concepts [52]. The ongoing digital transformation of logistics, including the whole supply chain, is a source of competitive advantage [53]. With the support of autonomous and digital Industry 4.0 technologies, faster delivery and minimised logistics costs will be achieved in logistics [54]. With the concept of Industry 4.0, the terms smart logistics and Logistics 4.0 are inflected in logistics. These terms are associated with the Industry 4.0 phenomenon in logistics and describe the interconnection of logistics with the Internet of Things and cyber-physical systems. The main aim of Logistics 4.0 is to speed up logistics processes by sharing information in real time and minimising inaccuracies. The benefits of Logistics 4.0 in the enterprise include: simplified monitoring of logistics systems, increased environmental considerateness, increased logistics awareness, minimised waste of costs, time and energy, creation of new business models, creation of flexible logistics processes that respond promptly to consumer demands [55]. The benefits of Logistics 4.0 are especially noticeable in resource planning, transportation management systems, warehouse management systems, and intelligent transportation systems superstructure [56].

Logistics processes themselves are also under the influence of Logistics 4.0. The logistics paths most affected by the Fourth Industrial Revolution are procurement, inventory management, warehousing and transport. The definition of these logistics processes is identified in Table 1.

Table 1. Definition of logistics process 4.0.

Author	Logistics Process 4.0	Definition of Logistics Process 4.0
Nicoletti [57]	Procurement 4.0	Procurement 4.0 uses technologies such as warehouse robots, self-driving vehicles to enable the introduction of processes that do not require operators and minimise human labour. The main intention is to integrate automation and information and communication solutions.
Kozma et al. [58]	Inventory management 4.0	Inventory management 4.0 represents the processes of warehouse and stock management, which are becoming more transparent and predictable with the development of the Industrial Internet of Things. Inventory management 4.0 is subject to monitoring and controlling the use of space by means of information and communication devices, for example, actual pallet location data is transmitted via RFID technology.
Tutam [59]	Warehousing 4.0	Warehousing 4.0 represents intelligent, automated and connected systems and represents a transformation to autonomy in industry by removing human participation. Autonomous systems, which require less space and operate 24/7, complement mechanical, electromechanical and automated systems by increasing productivity, efficiency, flexibility, modularity and agility, making warehouses more efficient.
Brach [60]	Transport 4.0	Transport 4.0 involves more autonomous transport, the core of which is based on automation and autonomy. Transport 4.0 concentrates on reducing the negative impact on the environment, on the process of movement along with all transport activities that are dominant in the networked environment.

Jeschke [61] defines Logistics 4.0 as the application of smart technologies within Industry 4.0. These technologies include advanced robotics, cloud computing, artificial intelligence, big data and the Internet of Things. Amr et al. [62] says that Logistics 4.0 is a new technological direction that combines technologies with the intention of making the entire supply chain more efficient and effective, while changing the focus of enterprises on value chains, maximising value for consumers and customers by increasing competitiveness through digitalisation. Logistics 4.0 is a combination of smart technologies whose applications are in the areas of inventory management, warehousing, distribution and transportation [63]. Logistics 4.0 represents intelligent logistics, which includes connectivity and integration, real-time localisation, automated data collection and processing, automatic identification, and business and analytical services. Through the new generation technologies, logistics processes are being industrialised through rationalisation and standardisation [64]. Strandhagen et al. [65] defined Logistics 4.0 through Industry 4.0 technologies through which the need for warehousing is reduced, leading to optimised inventory management, information exchange and no information disruptions. Logistics 4.0 is a strategic logistics system that is characterised by flexibility, perfect adaptability to the market, minimisation of costs and meeting customer requirements [66]. Logistics 4.0 consists of autonomous subsystems that interact with each other in order to achieve individual goals and to ensure the efficient behaviour of individual entities [67]. Logistics 4.0 includes networking and integration, data collection and processing, self-organization, decentralisation and independence [68].

Logistics 4.0 mainly uses the following Industry 4.0 technologies: virtual reality and augmented reality, big data, Internet of Things, advanced simulation, artificial intelligence, smart sensors and autonomous robots. These technologies perform an indispensable role in procurement logistics, production logistics and distribution logistics in the context of the Fourth Industrial Revolution. The characteristics of these technologies are presented in Table 2.

Table 2. Definition of Logistics 4.0 technologies.

Author	Logistics 4.0 Technologies	Definition of Logistics 4.0 Technologies
Gattullo et al. [69]	Virtual Reality and Augmented Reality	Virtual Reality and Augmented Reality are complementary Industry 4.0 technologies. With the help of virtual reality, users are transported, via a headset, into a virtual world. But with augmented reality, applications present the illusion of multiple graphical layers of information layered on top of each other over a specific part of the user's field of view.
Diniz et al. [70]	Big Data	The large amount of structured and unstructured data from different types of sources, which may come from interconnected objects, describes a large amount of data. A fundamental characteristic of Big Data is performing analysis on this data.
Kamble et al. [71]	Internet of Things	Internet of Things is creating an industrial system that enables a combination of intelligent machines, advanced predictive analytics, and machine-human collaboration to promote productivity, efficiency, and reliability.
Klee and Allen [72]	Advanced simulation	Simulation is a common method of analysing the behaviour of complex systems. Simulation is a classical technology whose foundations date back to the era of analog computers.
Sigov et al. [73]	Artificial intelligence	Artificial intelligence involves building intelligent machines capable of performing tasks that typically require human intelligence. The essence of artificial intelligence lies in reasoning, knowledge representation, planning, learning, processing machine learning approaches including artificial neural networks.
Kumar and Nayyar [74]	Smart sensors	Smart sensors act as manufacturing assets that collect large amounts of data about products and their environment. This is data for example to measure temperature, humidity and smoke in the air. Smart sensors can detect anomalous activities and can provide the ability to communicate wirelessly, making the data synthetic through a cloud interface as well.
Graetz and Michaels [75]	Autonomous robots	Autonomous robots perform autonomous manufacturing more precisely and can work alongside humans or even in places where humans are constrained. Autonomous robots have the ability to complete tasks on time and accurately, with a focus on flexibility, safety, versatility and collaboration.

3. Research Methodology

The main objective of the present paper was to determine and explicate the definitions and terminology that identify Industry 4.0 in logistics based on a literature analysis and to interpret the research results that analyse the current state of the ongoing digital transformation of logistics through digital technologies in enterprises in Slovakia. In providing a comprehensive view of the issue, it was necessary to define the partial objectives of the paper, which included:

- The comparative overview of views on a conceptual framework for Industry 4.0,
- The comparative analysis of views on the role of technology in the age of Industry 4.0,
- The comparative review of views on the digital transformation of logistics-Logistics 4.0,
- Descriptive analysis of the questionnaire survey,
- Inferential analysis of the questionnaire survey,
- Summarisation of the research issues.

3.1. Description of Collection Tool

The research and studies conducted on the digital transformation of logistics towards Logistics 4.0 still have a limited presence in the scientific sphere. It is this research gap that has created the prerequisite for an in-depth analysis of the topic at hand through statistical induction. Perona et al. [76] conducted research in 91 Italian manufacturing enterprises. The results of the research showed that the implementation of Logistics 4.0 is still immature but has a huge potential. Awareness that the goal of Logistics 4.0 is the harmonious and integrated implementation of digital technologies to support logistics processes has not yet spread in Italian manufacturing enterprises. Nobrega et al. [77] investigated the evolution of Logistics 4.0 in Brazilian enterprises. The authors consider that Logistics 4.0 will represent a major disruptive transformation. Technological advances will allow the entire supply chain to be connected and information will be able to be exchanged in real time, providing greater control over information and better decision making. In addition, Brazilian enterprises consider that the implementation of Logistics 4.0 will also increase identification capabilities and provide better commercial demand forecasting, thereby increasing the flexibility of enterprises. Batz et al. [78] conducted research to determine whether Polish enterprises are aware of the Logistics 4.0 concept and whether they use solutions commonly described as Logistics 4.0 solutions. Based on the results of the research conducted in logistics and manufacturing enterprises in Poland, 33% of the surveyed enterprises are aware of the Logistics 4.0 concept, 50% of the enterprises are aware of the big data concept, 83% of the enterprises want to apply automated data exchange systems and are willing to automate their processes as well as to introduce partial robotisation of their processes. Group-IPS [79] analyses the degree of digitalisation of the supply chain in Spanish enterprises. The research shows that 65% of Spanish enterprises have limitations in the visibility of their supply chain. The main priorities of the surveyed enterprises are the digitalisation of their logistics planning, production and execution. The Industry 4.0 technologies considered most useful in logistics are Internet of Things, big data analytics and artificial intelligence. Correa et al. [80] investigated in 108 Brazilian enterprises the level of corporate interest in investing in IoT and big data analytics of Industry 4.0 technologies oriented towards logistics innovation. More than half of the respondent enterprises are already investing in these two technologies. Enterprises intend to use big data analytics to reduce operational costs, predict consumer behaviour and forecasting. The main reason for adopting IoT and big data analytics is to be more competitive. Alamsjah and Yunus [81] investigated the key determinants of supply chain 4.0 maturity in 154 Indonesian manufacturing enterprises. The analysis revealed that supply chain ambidexterity with an emphasis on innovation positively influences firm agility and the level of supply chain 4.0 maturity. Dallasega et al. [82] investigated the level of maturity of Logistics 4.0 implementation in manufacturing enterprises based in Central Europe, the Northeastern United States, and Northern Thailand. Based on 239 responses, they concluded that Logistics 4.0 is a relatively new area of research that requires further development through empirical validation. To the best of the authors' knowledge, there is no empirically validated multidimensional construct to measure Logistics 4.0 in manufacturing enterprises. Woschank and Dallasega [83] conducted research between December 2020 and January 2021 that was distributed in Central Europe. The results of the research confirmed the impact of Logistics 4.0 on the performance of manufacturing enterprises.

The results also confirmed that smart and lean supply chains have a significant impact on logistics performance indicators.

Based on the conceptual framework of the paper, the foreign research realised in the period 2019–2022 and the author's previous research (Richnák [84] investigated Industry 4.0 in the metallurgical industry in Slovakia; Richnák [85] evaluated the current situation in the area of Industry 4.0 in logistics in the machinery and equipment industry in Slovakia; Richnák [86] investigated the rate of innovation adoption in enterprises in Slovakia in the era of Industry 4.0), in the years 2021–2022, the research question was conceived and subsequently the null and the alternative hypothesis was formulated for it:

Research Question (RQ): How is Industry 4.0 affecting corporate logistics?

Hypothesis 1 (H1). *We assume that there is no significant relationship between production logistics and selected Industry 4.0 technologies.*

Hypothesis 1 (H1a). *We assume that there is a significant relationship between production logistics and selected Industry 4.0 technologies.*

Hypothesis 2 (H2). *We assume that there is no significant relationship between procurement logistics and selected Industry 4.0 technologies.*

Hypothesis 2 (H2a). *We assume that there is a significant relationship between procurement logistics and selected Industry 4.0 technologies.*

Hypothesis 3 (H3). *We assume that there is no significant relationship between distribution logistics and selected Industry 4.0 technologies.*

Hypothesis 3 (H3a). *We assume that there is a significant relationship between distribution logistics and selected Industry 4.0 technologies.*

Hypothesis 4 (H4). *We assume that there is no significant relationship between Industry 4.0 and logistics processes.*

Hypothesis 4 (H4a). *We assume that there is a significant relationship between Industry 4.0 and logistics processes.*

In the construction of the paper, the following classical scientific methods were used: analysis, synthesis, induction, deduction, analogy, specification, and comparison. Among the special scientific methods, the method of classification, concretisation, graphical methods, questionnaire survey, and statistical methods were used.

Data collection through a questionnaire survey was conducted between November 2021 and May 2022 through an electronic standardized questionnaire. The questionnaire was distributed to managers of small, medium-sized and large enterprises in Slovakia through e-mail addresses. The questionnaire was structured into several areas. The first area concentrated on the identification of the respondents and then other parts of the questionnaire were related to digital transformation in logistics. The construction of the questions in the questionnaire used identification questions and closed questions where the respondent had a choice of options or selection through a numerical scale from 0–6. Descriptive and inferential statistical analysis was used in the analysis. One-way analysis of variance (ANOVA) and Pearson's correlation coefficient were applied in the statistical analysis.

3.2. Research Design

The research design was a process that consisted of several successive phases. Their development is illustrated in Figure 1 and represents the process of realising the research problem.

Figure 1. Research design of the studied theme. Source: Author's own.

3.3. Descriptions of Research Participants

The object of the research were enterprises located in the Slovak Republic. There were 144 relevant respondents whose answers were included in the analysis. Enterprises were categorised according to size on the basis of the European Commission 2003/361/EC, which defines the small enterprise (10–49 employees), the medium-sized enterprise (50–249 employees) and the large enterprise (≥250 employees). Medium-sized enterprises from industry in Slovakia participated in the survey in the highest proportion (46.5%; N = 67). Large enterprises were represented with the second largest share (44.4%; N = 64). The smallest proportion (9%; N = 13) was from the participation of small enterprises. The summarised data is presented in Figure 2. For the purpose of the analysis conducted, we can conclude that the sample of respondents represented is at a representative level, as medium-sized and large enterprises from Slovak industry are dominant.

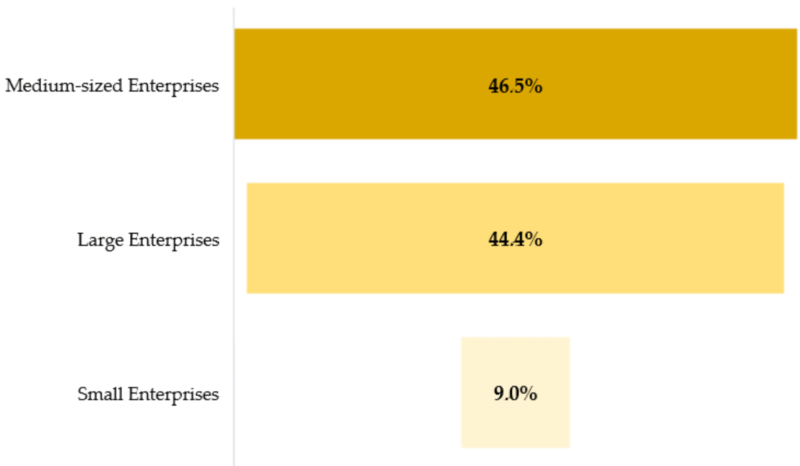

Figure 2. Data file structure by enterprise category. Source: Author's own.

The choropleth map is a graphical representation of the relative quantitative data obtained by the research in the map of Slovakia. The choropleth map is illustrated in Figure 3. By using the most commonly used expression method of thematic cartography, we can monitor the aperiodic representation of individual regions. Coloured shades of yellow-brown indicate identical representation of respondents in the Bratislava and Trnava Regions (20.1%; N = 29). Western Slovakia was represented by the Trenčín Region (17.4%; N = 25) and the Nitra Region (11.1%; N = 16). Central Slovakia was represented by the Žilina Region (9.7%; N = 14) and the Banská Bystrica Region (7.6%; N = 11). Eastern Slovakia, represented by the Prešov Region (8.3%; N = 12) and the Košice Region (5.6%; N = 8), featured the lowest participation.

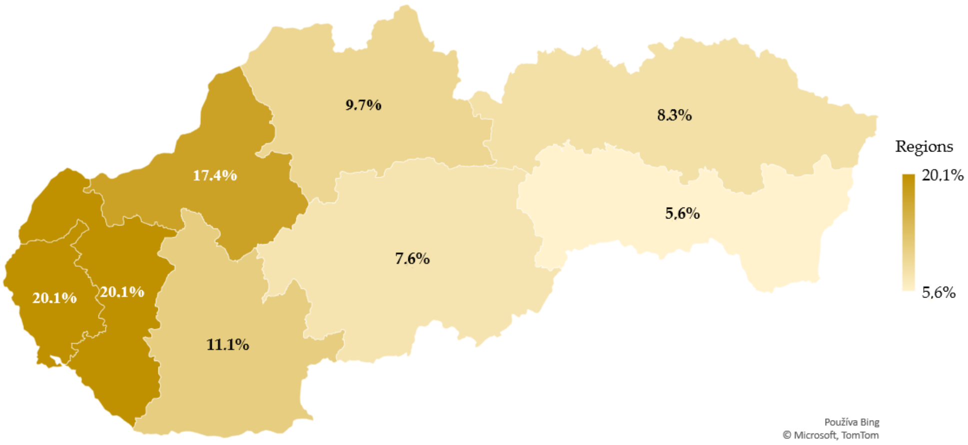

Figure 3. Data file structure by regions of Slovakia. Source: Author's own.

In the research, we wanted to know in which industrial sector the analysed enterprise operates. Figure 4 provides a representation of the different industrial sectors. The largest part of the research sample was the mechanical industry with a share of 19.4% (28 enterprises). The automotive industry and the electrical engineering industry also received a high representation in the research sample, with an identical share of 17.4% (25 enterprises). This was followed by the food industry (15.3%; N = 22), extractive industry (9.7%; N = 14); timber and wood processing industry (6.9%; N = 10), and light industry (5.6%, N = 8). Enterprises from the construction industry and the chemical and pharmaceutical industry (3.5%; N = 5) and the glass industry (1.4%; N = 2) were the least represented in the research.

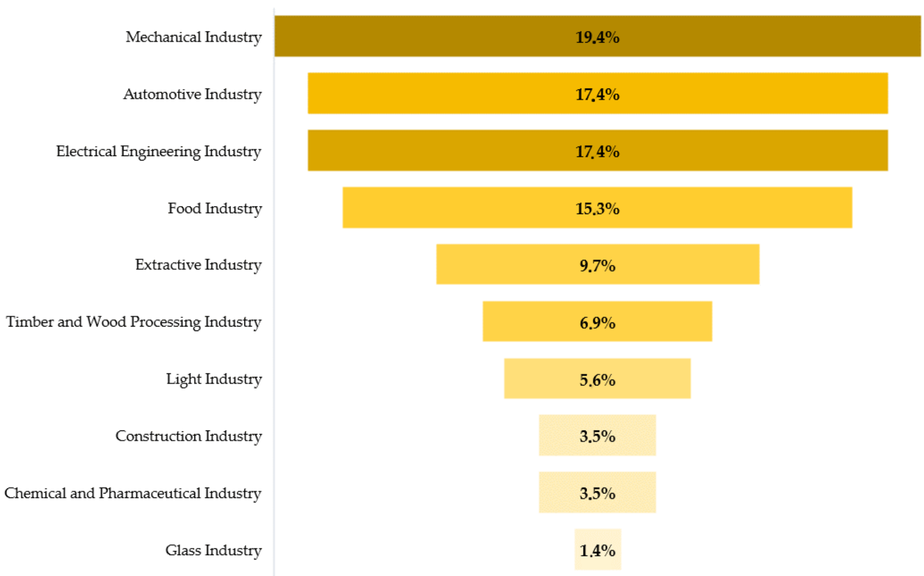

Figure 4. Data file structure by industrial sector. Source: Author's own.

In identifying the research sample, the territorial location of the enterprises was also included in the analysis. The largest representation of enterprises was recorded in transnational markets (76.0%; N = 110). Enterprises operating in national markets occupied the second position (15.3%; N = 22). The lowest shares were observed for enterprises that operate in regional markets (5.6%; N = 8) and local markets (2.8%; N = 4). The results of the descriptive analysis are presented in Figure 5.

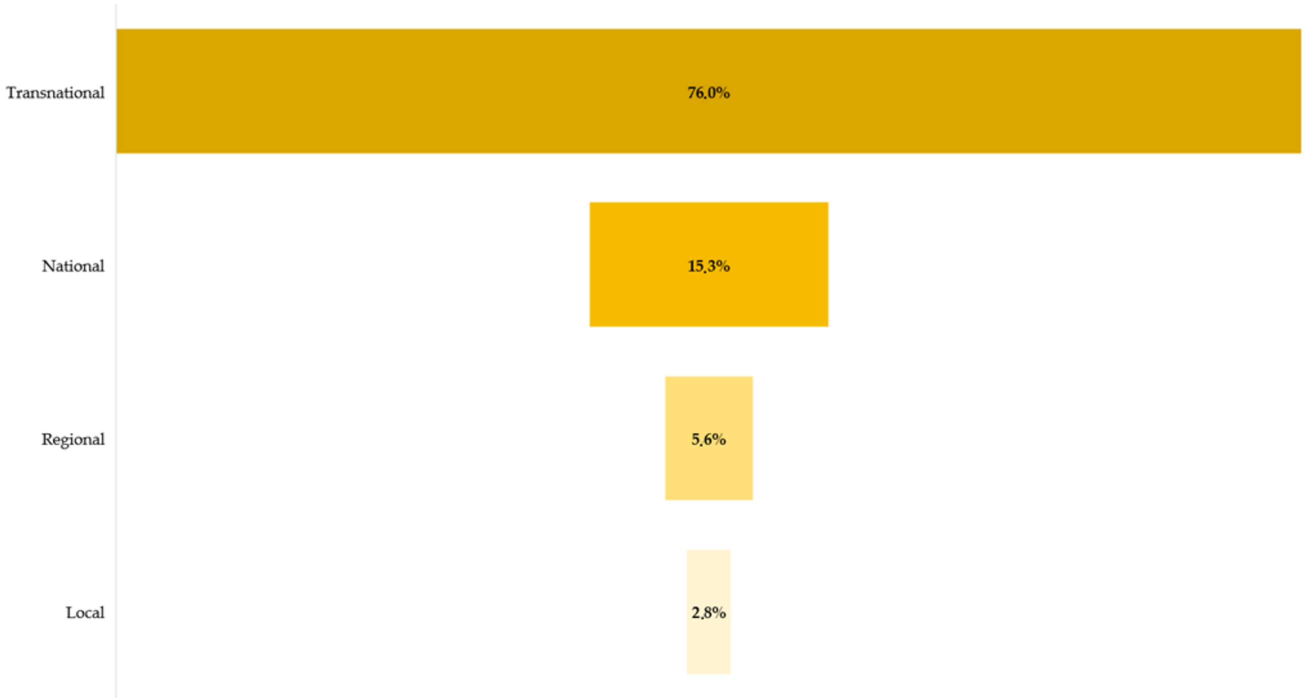

Figure 5. Data file structure by territorial location of enterprises. Source: Author's own.

4. Results Analysis and Discussion

4.1. Evaluation of Descriptive Analysis

Through descriptive analysis, the following selected results were evaluated, results which dealt with the theme of digitalisation and Industry 4.0 in the logistics of enterprises in Slovakia.

The data analysed is segmented by the size of the participating enterprises. Table 3 clearly summarises the results of the analysis, based on which we can see that 89.1% (N = 57) of large enterprises perceive digital transformation in logistics. Also 77.6% (N = 52) of medium-sized enterprises in Slovakia reflect the ongoing digital transformation in logistics. The interesting findings are that also in the small enterprise category (69.2%, N = 9) there are interests that dominate the digital transformation in logistics.

Table 3. Data file structure by digital transformation in logistics.

Digital Transformation in Logistics		Small Enterprises	Medium-Sized Enterprises	Large Enterprises
Yes	Absolute Frequency	9	52	57
	Relative Frequency	69.2%	77.6%	89.1%
No	Absolute Frequency	4	15	7
	Relative Frequency	30.8%	22.4%	10.9%
Total	Absolute Frequency	13	67	64
	Relative Frequency	100.0%	100.0%	100.0%

Industry 4.0 in logistics requires having the logistics strategy that deals with the digital transformation of logistics processes and logistics activities. In the analysed enterprises

in Slovakia, the Industry 4.0 strategy is implemented in logistics. Large enterprises have it at this level with a share of 59.4% (N = 38). Medium-sized enterprises have the highest share (47.8%, N = 32) of Industry 4.0 strategy in logistics in implementation. Also, small enterprises in Slovakia have the highest share (76.9%, N = 10) of implementation for the Industry 4.0 strategy in logistics. The interesting finding is that there is no Industry 4.0 strategy in only 1.6% (N = 1) of large enterprises and 6% (N = 4) of medium-sized enterprises. Table 4 summarises the results of the analysis.

Table 4. Data file structure by implementing Industry 4.0 in logistics.

		Small Enterprises	Medium-Sized Enterprises	Large Enterprises
Strategy implemented	Absolute Frequency	1	18	38
	Relative Frequency	7.7%	26.9%	59.4%
Strategy in implementation	Absolute Frequency	10	32	17
	Relative Frequency	76.9%	47.8%	26.6%
Pilot initiatives launched	Absolute Frequency	0	13	8
	Relative Frequency	0.0%	19.4%	12.5%
No strategy exists	Absolute Frequency	2	4	1
	Relative Frequency	15.4%	6.0%	1.6%
Total	Absolute Frequency	13	67	64
	Relative Frequency	100.0%	100.0%	100.0%

When implementing Industry 4.0 in logistics, it is important to recognise in which type of logistics it has the largest participation. Based on the results of Table 5, we can determine that Industry 4.0 in logistics has the largest representation in production logistics in each category of enterprise. In large enterprises it is represented with a share of 79.7% (N = 51), in medium-sized enterprises it is represented with a share of 80.6% (N = 54) and in small enterprises it is represented with a share of 38.5% (N = 5). The interesting finding is the fact that procurement logistics reached an identical number (N = 4) in each category of enterprise. On a small scale, large, medium-sized and small enterprises in Slovakia are implementing Industry 4.0 in distribution logistics.

Table 5. Data file structure of Industry 4.0 implementation in various types of logistics.

		Small Enterprises	Medium-Sized Enterprises	Large Enterprises
Production Logistics	Absolute Frequency	5	54	51
	Relative Frequency	38.5%	80.6%	79.7%
Procurement Logistics	Absolute Frequency	4	4	4
	Relative Frequency	30.8%	6.0%	6.2%
Distribution Logistics	Absolute Frequency	4	9	9
	Relative Frequency	30.8%	13.4%	14.1%
Total	Absolute Frequency	13	67	64
	Relative Frequency	100.0%	100.0%	100.0%

When implementing Industry 4.0 in logistics, enterprises face barriers to its implementation. The selected barriers that were most inflected in the research have been summarised in Table 6. From the responses, we determined that within large enterprises, the biggest barrier was the investment cost in implementing Industry 4.0 in logistics (59.4%, N = 38). Also, both medium-sized enterprises (88.1%, N = 59) and small enterprises (84.6%, N = 11) consider investment costs as the biggest barrier. New supply chain upgrading will also be a major challenge for large enterprises (37.5%, N = 24). Enterprises in Slovakia are not concerned about the shortage of skilled labour. Only one large enterprise (1.6%) considers it as a barrier.

Table 6. Data file structure by barriers.

		Small Enterprises	Medium-Sized Enterprises	Large Enterprises
Investment costs	Absolute Frequency	11	59	38
	Relative Frequency	84.6%	88.1%	59.4%
New supply chain setting	Absolute Frequency	1	8	24
	Relative Frequency	7.7%	11.9%	37.5%
Concern about meeting objectives	Absolute Frequency	1	0	1
	Relative Frequency	7.7%	0.0%	1.6%
Shortage of skilled labour	Absolute Frequency	0	0	1
	Relative Frequency	0.0%	0.0%	1.6%
Total	Absolute Frequency	13	67	64
	Relative Frequency	100.0%	100.0%	100.0%

4.2. Evaluation of Inferential Analysis

The studied topic was also analysed by using inferential statistics. One-way analysis of variance ANOVA and Pearson's correlation coefficient were used to evaluate the null and alternative hypotheses.

Research Question (RQ): How Is Industry 4.0 Affecting Corporate Logistics?

The null hypothesis (H1) and alternative hypothesis (H1a) were tested using one-way analysis of variance (ANOVA). The results of the testing are presented in Table 7. Considering the value of statistical significance, there is a significant relationship between the production logistics and the selected technologies in Industry 4.0: Virtual reality and Augmented reality ($F(6, 137) = 2.628$, $p = 0.019$; Drones $F(6, 137) = 3.257$, $p = 0.005$; Big Data ($F(6, 137) = 2.498$, $p = 0.025$; 5G network ($F(6, 137) = 2.567$, $p = 0.022$; Additive manufacturing $F(6, 137) = 5.053$, $p = 0.000$; Internet of Things ($F(6, 137) = 4.180$, $p = 0.001$; Advanced simulation $F(6, 137) = 3.161$, $p = 0.006$; Artificial intelligence $F(6, 137) = 2.818$, $p = 0.013$; Smart sensors $F(6, 137) = 2.962$, $p = 0.009$; Autonomous robots $F(6, 137) = 3.823$, $p = 0.001$; Cloud computing $F(6, 137) = 3.477$, $p = 0.003$; Cyber-physical systems $F(6, 137) = 2.690$, $p = 0.017$.

The null hypothesis (H2) and alternative hypothesis (H2a) were tested using one-way analysis of variance (ANOVA). The results of the testing are presented in Table 8. With respect to the value of statistical significance, there is a significant relationship between procurement logistics and the selected Industry 4.0 technologies: Big Data ($F(6, 137) = 3.282$, $p = 0.005$; 5G network ($F(6, 137) = 3.537$, $p = 0.003$; Internet of Things ($F(6, 137) = 6.247$, $p = 0.000$; Advanced simulation $F(6, 137) = 2.661$, $p = 0.018$; Artificial intelligence $F(6, 137) = 4.760$, $p = 0.000$; Smart sensors $F(6, 137) = 4.341$, $p = 0.000$; Cloud computing $F(6, 137) = 3.705$, $p = 0.002$.

The relationship between procurement logistics and Industry 4.0 technologies: Virtual reality and Augmented reality ($F(6, 137) = 0.726$, $p = 0.630$; Drones $F(6, 137) = 1.190$, $p = 0.315$; Additive manufacturing $F(6, 137) = 1.298$, $p = 0.262$; Autonomous robots $F(6, 137) = 1.975$, $p = 0.073$; Cyber-physical systems $F(6, 137) = 0.541$, $p = 0.776$ was non-significant.

The null hypothesis (H3) and alternative hypothesis (H3a) were tested using one-way analysis of variance (ANOVA). The results of the testing are presented in Table 9. With respect to the value of statistical significance, there is a significant relationship between distribution logistics and the selected Industry 4.0 technologies: Big Data ($F(6, 137) = 2.774$, $p = 0.014$; 5G network ($F(6, 137) = 2.164$, $p = 0.050$; Internet of Things ($F(6, 137) = 4.439$, $p = 0.000$; Advanced simulation $F(6, 137) = 3.140$, $p = 0.006$; Artificial intelligence $F(6, 137) = 2.703$, $p = 0.016$; Smart sensors $F(6, 137) = 3.041$, $p = 0.008$; Autonomous robots $F(6, 137) = 3.265$, $p = 0.005$; Cloud computing $F(6, 137) = 2.197$, $p = 0.047$.

Table 7. Industry 4.0 technologies used in production logistics.

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
Virtual reality and Augmented reality	Between Groups	58.102	6	9.684	2.628	0.019
	Within Groups	504.836	137	3.685		
	Total	562.937	143			
Drones	Between Groups	84.849	6	14.142	3.257	0.005
	Within Groups	594.901	137	4.342		
	Total	679.750	143			
Big Data	Between Groups	63.194	6	10.532	2.498	0.025
	Within Groups	577.632	137	4.216		
	Total	640.826	143			
5G network	Between Groups	15.581	6	2.597	2.567	0.022
	Within Groups	138.578	137	1.012		
	Total	154.160	143			
Additive manufacturing	Between Groups	135.580	6	22.597	5.053	0.000
	Within Groups	612.643	137	4.472		
	Total	748.222	143			
Internet of Things	Between Groups	97.277	6	16.213	4.180	0.001
	Within Groups	531.383	137	3.879		
	Total	628.660	143			
Advanced simulation	Between Groups	73.336	6	12.223	3.161	0.006
	Within Groups	529.664	137	3.866		
	Total	603.000	143			
Artificial intelligence	Between Groups	69.328	6	11.555	2.818	0.013
	Within Groups	561.831	137	4.101		
	Total	631.160	143			
Smart sensors	Between Groups	63.494	6	10.582	2.962	0.009
	Within Groups	489.444	137	3.573		
	Total	552.938	143			
Autonomous robots	Between Groups	47.976	6	7.996	3.823	0.001
	Within Groups	286.579	137	2.092		
	Total	334.556	143			
Cloud computing	Between Groups	62.366	6	10.394	3.477	0.003
	Within Groups	409.523	137	2.989		
	Total	471.889	143			
Cyber-physical systems	Between Groups	52.693	6	8.782	2.690	0.017
	Within Groups	447.196	137	3.264		
	Total	499.889	143			

The relationship between distribution logistics and Industry 4.0 technologies: Virtual reality and Augmented reality ($F(6, 137) = 1.135$, $p = 0.345$; Drones $F(6, 137) = 1.701$, $p = 0.125$; Additive manufacturing $F(6, 137) = 1.490$, $p = 0.186$; Cyber-physical systems $F(6, 137) = 0.712$, $p = 0.641$ was non-significant.

The null hypothesis (H4) and the alternative hypothesis (H4a) were tested using Pearson's correlation coefficient. Based on the evaluation of the coefficient, we conclude that a positively significant relationship emerged between Industry 4. 0 and logistics processes: customer service ($r = 0.333$; $p = 0.000$), inventory management ($r = 0.328$; $p = 0.000$), logistics communication ($r = 0.341$; $p = 0.000$), material handling ($r = 0.197$; $p = 0.018$), order processing ($r = 0.275$; $p = 0.001$), packaging ($r = 0.168$; $p = 0.044$), procurement/purchasing ($r = 0.172$; $p = 0.039$), transport and transportation ($r = 0.266$; $p = 0.001$), warehousing ($r = 0.353$; $p = 0.000$). The results indicate that we are inclined towards the alternative hypothesis. The values are shown in Table 10.

Table 8. Industry 4.0 technologies used in procurement logistics.

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
Virtual reality and Augmented reality	Between Groups	24.550	6	4.092	0.726	0.630
	Within Groups	772.450	137	5.638		
	Total	797.000	143			
Drones	Between Groups	36.567	6	6.095	1.190	0.315
	Within Groups	701.655	137	5.122		
	Total	738.222	143			
Big Data	Between Groups	70.746	6	11.791	3.282	0.005
	Within Groups	492.191	137	3.593		
	Total	562.938	143			
5G network	Between Groups	91.178	6	15.196	3.537	0.003
	Within Groups	588.572	137	4.296		
	Total	679.750	143			
Additive manufacturing	Between Groups	34.457	6	5.743	1.298	0.262
	Within Groups	606.369	137	4.426		
	Total	640.826	143			
Internet of Things	Between Groups	126.091	6	21.015	6.247	0.000
	Within Groups	460.847	137	3.364		
	Total	586.938	143			
Advanced simulation	Between Groups	57.713	6	9.619	2.661	0.018
	Within Groups	495.224	137	3.615		
	Total	552.938	143			
Artificial intelligence	Between Groups	57.709	6	9.618	4.760	0.000
	Within Groups	276.847	137	2.021		
	Total	334.556	143			
Smart sensors	Between Groups	75.379	6	12.563	4.341	0.000
	Within Groups	396.510	137	2.894		
	Total	471.889	143			
Autonomous robots	Between Groups	12.272	6	2.045	1.975	0.073
	Within Groups	141.888	137	1.036		
	Total	154.160	143			
Cloud computing	Between Groups	107.693	6	17.949	3.705	0.002
	Within Groups	663.745	137	4.845		
	Total	771.438	143			
Cyber-physical systems	Between Groups	18.452	6	3.075	0.541	0.776
	Within Groups	778.548	137	5.683		
	Total	797.000	143			

Table 9. Industry 4.0 technologies used in distribution logistics.

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
Virtual reality and Augmented reality	Between Groups	32.186	6	5.364	1.135	0.345
	Within Groups	647.564	137	4.727		
	Total	679.750	143			
Drones	Between Groups	44.437	6	7.406	1.701	0.125
	Within Groups	596.389	137	4.353		
	Total	640.826	143			
Big Data	Between Groups	68.096	6	11.349	2.774	0.014
	Within Groups	560.564	137	4.092		
	Total	628.660	143			
5G network	Between Groups	52.202	6	8.700	2.164	0.050
	Within Groups	550.798	137	4.020		
	Total	603.000	143			
Additive manufacturing	Between Groups	47.271	6	7.878	1.490	0.186
	Within Groups	724.167	137	5.286		
	Total	771.438	143			

Table 9. *Cont.*

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
Internet of Things	Between Groups	102.735	6	17.122	4.439	0.000
	Within Groups	528.425	137	3.857		
	Total	631.160	143			
Advanced simulation	Between Groups	70.957	6	11.826	3.140	0.006
	Within Groups	515.980	137	3.766		
	Total	586.938	143			
Artificial intelligence	Between Groups	49.953	6	8.325	2.703	0.016
	Within Groups	421.936	137	3.080		
	Total	471.889	143			
Smart sensors	Between Groups	86.766	6	14.461	3.041	0.008
	Within Groups	651.456	137	4.755		
	Total	738.222	143			
Autonomous robots	Between Groups	78.959	6	13.160	3.265	0.005
	Within Groups	552.200	137	4.031		
	Total	631.160	143			
Cloud computing	Between Groups	43.875	6	7.313	2.197	0.047
	Within Groups	456.013	137	3.329		
	Total	499.889	143			
Cyber-physical systems	Between Groups	4.661	6	.777	0.712	0.641
	Within Groups	149.498	137	1.091		
	Total	154.160	143			

Table 10. Industry 4.0 effects on logistics processes.

	Pearson Correlation	Sig. (2-tailed)	N
Customer service	0.333	0.000	144
Inventory Management	0.328	0.000	144
logistics Communication	0.341	0.000	144
Material handling	0.197	0.018	144
Order processing	0.275	0.001	144
Packaging	0.168	0.044	144
Procurement/Purchasing	0.172	0.039	144
Transport and Transportation	0.266	0.001	144
Warehousing	0.353	0.000	144

5. Conclusions

Digital transformation towards Industry 4.0 has become a necessity for enterprises, as it makes them more flexible, agile and responsive in the current uncompromising competitive environment. Logistics is no exception, as it is constantly undergoing a dramatic transformation with the support of disruptive Industry 4.0 technologies that are fundamentally changing logistics processes and activities.

The aim of the paper was to identify the current state of digital transformation in the form of Industry 4.0 and its technologies in the logistics of enterprises in Slovakia. The object of the quantitative research, which was realised in the form of an electronic questionnaire, were small, medium-sized and large enterprises located in the Slovak Republic. Medium-sized enterprises from the industry in Slovakia participated in the survey with the largest share. The largest part of the research sample was represented by the mechanical industry. The largest representation of enterprises was recorded in the scope of activities on transnational markets. The analysed enterprises perceive digital transformation in logistics. In the analysed enterprises in Slovakia, the Industry 4.0 strategy is implemented in logistics. Industry 4.0 in logistics has the largest representation in production logistics in each enterprise category. In implementing Industry 4.0 in logistics, enterprises confront the biggest barrier, namely investment costs.

Currently, there is no uniform checklist of Industry 4.0 technologies that are used in logistics. Their number and list varies depending on the author's perspective or the capabilities of the enterprise. Some Industry 4.0 technologies are used in small enterprises, and others in large enterprises; other technologies are used primarily in the automotive industry, while others are used in the textile industry. The view of Industry 4.0 technologies in logistics has been compiled by comparing a large number of available sources. Based on the theoretical part of the paper, the following Industry 4.0 technologies have been defined: Virtual reality and Augmented reality, Drones, Big Data, 5G network, Additive manufacturing, Internet of Things, Advanced simulation, Artificial intelligence, Smart sensors, Autonomous robots, Cloud computing, and Cyber-physical systems. These Industry 4.0 technologies were analysed in small, medium-sized and large enterprises in the Slovak Republic. On the basis of inferential analysis, we conclude that in logistics there is a different use of Industry 4.0 technologies according to the type of logistics. It is not possible to compile a unified checklist of Industry 4.0 technologies in logistics. This is also identified by the evaluated hypotheses, which showed dependent relationships between different types of logistics and Industry 4.0 technologies.

Several significant relationships were confirmed through statistical tests. The significant relationship between production logistics and Industry 4.0 technologies, such as Virtual reality and Augmented reality, Drones, Big Data, 5G network, Additive manufacturing, Internet of Things, Advanced simulation, Artificial intelligence, Smart sensors, Autonomous robots, Cloud computing, and Cyber-physical systems was demonstrated. The significant relationships between procurement logistics and selected Industry 4.0 technologies, such as Big Data, 5G network, Internet of Things, Advanced simulation, Artificial intelligence, Smart sensors, and Cloud computing was also demonstrated. Statistical analysis also confirmed a significant relationship between distribution logistics and selected Industry 4.0 technologies: Big Data, 5G network, Internet of Things, Advanced simulation, Artificial intelligence, Smart sensors, Autonomous robots, Cloud computing. The results of the inferential analysis showed a positively significant relationship emerged between Industry 4.0 and logistics processes.

Research and studies on digitalisation of logistics transformation, digital technologies, Industry 4.0 in logistics, and Logistics 4.0 are constantly evolving and are relevant in the light of the ongoing industrial revolution. Also, research and studies on this issue bring new possibilities and opportunities for enterprises, as there are still many gaps at the enterprise level that have not yet been addressed in the Fourth Industrial Revolution. The conducted research of the author in the presented article from the digital transformation of logistics in the conditions of enterprises in Slovakia is one of them. This research is exceptional and unique as no similar research has been published by Slovak authors yet. The validity and significance of the conducted research is confirmed by similar research conducted elsewhere in the world, which were performed in the range of 2019–2022.

5.1. Research Implications

There is currently no uniform strategy or measures for the implementation of Industry 4.0 in Slovakia. It is the results of the quantitative research conducted in 144 enterprises in Slovakia that creates the potential for their use by the Ministry of Economy of the Slovak Republic, which represents the smart industry in Slovakia. Also, the conducted research can be helpful for the Slovak Investment and Trade Development Agency, which is a state agency of the Ministry of Economy of the Slovak Republic. The Slovak Investment and Trade Development Agency can use the research to create studies and documents for Slovak enterprises, which will better ensure the transfer of the most modern innovative technologies into production practice. At the same time, the investigation of Industry 4.0 in logistics in Slovakia is an unexplored research area, which has opened up further possibilities for further research.

In future research, the authors plan to conduct research that would be extended to enterprises in the Visegrad Group countries. These countries (Slovak Republic, Czech Republic, Poland, Hungary) are developing their economies, infrastructure, energy, digitalisation and innovation with the aim of mutual cooperation and transformation of their economies. Also, the author wants to extend the research to include sustainable development goals in the context of the Industry 5.0 concept, as he believes that sustainability will have a significant impact not only on logistics processes and activities, but on the entire supply chain.

5.2. Limitations

The processed research results have several limitations. The first limitation relates to the research sample, which concentrates only on enterprises that are based in the Slovak Republic. Subsequent research would include enterprises from the Visegrad Group countries in order to give the study an international context. The second limitation of the research is the targeting of only one business area-logistics. In further research it would be appropriate to compare the impact of the ongoing industrial revolution in manufacturing as well. As manufacturing and logistics form one inherent corporate unit that intersects with many business processes and activities. The third limitation of the research was the ongoing global pandemic, which reduced the resulting number of respondents who participated in the research due to national lockdowns. For this reason, it would be interesting to conduct future longitudinal research to compare the results of research conducted during and after the pandemic.

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