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DIGITAL TRANSFORMATION PERSPECTIVES IN WAREHOUSING – INITIAL STEPS AND PROJECTIONS[2]

Warehousing is an essential part of any logistics system, and warehousing activities are seen as a source of competitiveness. In the context of current trends in digitalisation and digital transformation, the problems concerning the usage of information systems and technologies in warehousing are expected to be in focus. The objective of the research paper is to summarise the level of digital transformation in the field of warehousing in Bulgarian trade and manufacturing enterprises, and on that basis to define some common perspectives. The study is based on data collected from a survey focused on warehousing management. The current article defines several discussion areas such as digital transformation and smart warehousing, knowledge about warehousing management, and the importance of warehousing software and consulting market potential.

Keywords: warehousing; digital transformation; IoT; information systems and technologies; software
JEL: M15; M19; O31; O32

1. Introduction

Logistics systems are important for the movement of material flows in the supply chain. At present, while the complexity of consumption is growing and the competition is more intense than ever, the efficient management of these systems is becoming more important. Transport and warehousing systems are the foundation of logistics systems (Ballou, 1992). These subsystems form a significant part of the total logistics costs and their management is a challenge. One of the classical approaches to analysing a logistics system is to view it as a set of points at which material flows stop their movement and links are formed between them (Coyle, Bardi, Langley, 1992, p. 25). The set of points includes storage and processing places, and the set of links includes transport. Warehouses play an important role in the logistics system and cannot be presented with a single definition. They are defined as a vital link within today's supply chains (Richards, 2018, p. 27).

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Commonly, warehousing covers processes from receiving material flows to their dispatch. This logistics activity is related to integrated management of information systems and technologies, storage areas and layout design, strategies and methods for order picking, as well as the use of storage systems and material handling machines (Dragomirov, 2020). To ensure proper management of these processes and materials, data and information management in the warehouses is essential. Warehousing is directly related to the information flows in the supply chain and is directly influenced by the degree of use of various information solutions.

Recent years are the time of Industry 4.0 and related sub-topics such as Logistics 4.0 and Warehousing 4.0; that is why the number of scientific publications is growing. Now we are witnessing the emergence of terms such as Logistics 4.0, which is defined as an obvious consequence and the next stage of Industry 4.0 (Sternad, Lerher, Gajsek, 2018). Defining Industry 4.0 is a complex question, but it is revolutionary, involving the use of technologies such as autonomous vehicles, robots, the Internet of Things (IoT) etc., as pointed out by Marr (2018) and the systems are more than interconnected; they communicate, analyse, and use the information to drive intelligent action in the physical world (Deloitte Insights, n.d.). Logistics 4.0 deals with modern technical and technological issues (Domański, 2019). There is also the appearance of Supply Chain 4.0 (Krykavskyy, Pokhylchenko, Hayvanovych, 2019) and warehousing sub-topic as Order picking 4.0 (Winkelhaus, Grosse, Morana, 2021). All of this is expected to be influenced by the tendencies for digitalisation and digital transformation. These digitalisation trends are a challenge for existing business models, processes and logic (Kersten, Blecker, Ringle, 2017, p. ix).

The topic of information problems of warehouses in logistics is central. The objective of this article is to present the current state and trends in the use of information systems and technologies in Bulgarian enterprises and to use that data to reveal some potential roadmap areas that could be applied to other systems. The structure of the article is as follows: (1) to reveal the role of information systems and technologies in warehousing and to clarify their meaning for the digital transformation of warehousing; (2) to develop a research methodology for defining the current state and practices of warehousing management; (3) to analyse received results and define problem areas; (4) to provide discussions and recommendations about following the global trends.

2. Role of Information Systems and Technologies in Warehousing

In scientific theory, there are several definitions of information systems, but they mostly gravitate around the understanding of Laudon (2013, p. 48) that they cover organisations, management, and technologies. These solutions seek synergies on the one hand in the use of information technology, providing the collection, processing, storage, and exchange of data and information, as well as software with the common goal of supporting the management of business processes. Information systems in logistics can be classified into separate groups based on the different phases of material flow movement – systems focused on supply, operations, distribution, and logistics activities – transport systems, warehousing, order processing, inventory management, etc. (Dragomirov, 2015). Based on this logic, the

information systems in warehousing are part of the information systems in logistics, and they can function both relatively independently and in conditions of interaction with other information systems in the organisation. Their role is to support warehousing processes, and for this purpose, various information technologies are used. In logistics theory and practice, there are different approaches to the management of warehousing systems, but according to the well-established classification of information systems in logistics, it is possible to conclude that the main alternatives for warehousing management are:

- Warehouse management systems – WMS.
- Enterprise Resource Planning – ERP.
- Other types of information systems focus on solving specific or micro warehousing problems.

The two main types of systems provide different approaches to warehousing process management. While ERP systems seek to cover the organisation's functional areas and synchronise their work, WMS systems enter the warehousing processes within the warehouse. WMS systems focus on the orders and interface with the ERP system (Son, Chang, Kim, 2015). That is why WMS could be a single solution or part of enterprise resource planning systems (Richards, 2014, p. 189).

ERP systems register the movement of material flows between the separate points in the logistics system. This type of system reflects the acceptance and removal of certain quantities of products in warehouses. Still, it does not cover the processes that take place in warehouse acceptance, preparation for storage, storage, preparation of orders, etc. WMS systems fill in these issues by covering warehousing processes in-depth – acceptance and incoming control, preparation for storage, picking (preparation of orders – collection of goods and completion of orders), packaging, labelling, shipping, and others. In this case, each employee is under the constant control of the WMS system, constantly receiving tasks from it (Bradford, 2015, p. 179). The choice of system is based on the specifics of material flows and the scale of the activity, followed by system maintenance and development. For ERP systems, it turns out that project management is the most often mentioned critical success factor (Barth, Koch, 2019). Regardless of the system type, it should evolve in scope and integration with other systems and technologies over time in the form of projects for an upgrade.

It should be noted that WMS systems have a direct connection with process efficiency. For example, for the critical indicator of accurate and correctly executed orders in the warehouse, it can be noted that better results of organisations using WMS are clearly visible (Partida, 2012). Another important point is the integration of the systems with the other information systems in the organisation. Such an extension of ERP systems modules' scope for order processing and warehouse process management, even in the production stage, is known (Sumner, 2013, pp. 99-101). In practice, different combinations of information system integration can occur (Tjoa et al., 2018, p. 86). These and many other forms of interaction of information systems and technologies indicate digitalisation and digital transformation. It is important to point out that digitalisation and digital transformation reflect effectiveness and efficiency in SCM (Boyanov, 2019). In logistics, the digitalisation process is related to and dependent on the digitisation of other processes (Demirova, 2019).

WMS systems offer realisation and control of various special tasks in the part of picking strategies and picking methods. They could be applied only by the implementation of WMS and particularly interesting are the methods of paper picking, pick by a label, pick by voice, pick by light, using barcodes and radio frequency identification (RFID). For some of them the ERP systems do not offer such functionalities because it is not within their scope. Now the WMS systems have become more important for creating intelligent forms of management (Woźniakowski, Jalowiecki, Zmarzlowski, 2018). Nevertheless, the level of application of each method of picking orders indicates the nature and condition of the entire warehousing management; also, it is tightly related to the digitalisation and digital transformation problems.

Relevant technologies are an integral part of the information problems of the warehouses. The main types of warehousing information technologies are reduced, usually to those for automatic identification barcodes and RFID. Their logistics application cannot be random but should follow specific rules, such as those of GS1, which for many years work enabling identity and creating visibility in supply chains (GS1, 2020, p. 6). The degree of knowledge of different types of terms and definitions from the standards' fundamental formulations indicates the warehousing activity.

In the field of warehousing systems, the application of the two presented fundamental technologies for automatic identification is based on marking locations or units and using various approaches to identify these places. Depending on the degree of application of modern information systems and technologies, barcodes or RFID tags can be used to mark: Locations – pallet places in racking systems, ramps, storage areas, etc.; Units – pallet units, cassettes, containers, boxes, as well as separate layers of packaging, etc.; Moving units in the warehouse – personnel, material handling equipment, and individual parts, etc. Accordingly, the identifying (reading) devices can be used by both the employees and the warehouse machines, as well as their elements. Some authors propose that a smart warehouse environment is more complex, including shelves that are tracked by an RFID-based system (Zhou, Piramuthu, Chu, Chu, 2017). The topic of the development of smart warehousing systems is important because of the need to achieve higher efficiency of warehousing processes. It is very broad, and the content of such warehousing systems cannot be defined easily. Smart warehouses use different technologies such as automated guided vehicles, augmented reality, the IoT and robotics (van Geest, Tekinerdogan, Catal, 2021). The topic of intelligent storage systems is very wide. However, some of the leading technological solutions that are mentioned in the research practices are:

- Artificial intelligence (AI);
- Augmented reality (AR);
- Automated systems & Robots;
- Big data;
- Blockchain;
- The Internet of things (IoT);

- Real-Time Locating Systems (RTLS);
- Others.

The IoT is an important technology in logistics, which is mentioned in several research papers (Bigliardi, Casella, Bottani, 2021; van Geest et al., 2021; Weng Chun Tan, Manjit Singh Sidhu, Sharulhizam Mohamad Shah, 2021; Yang, Fu, Zhang, 2021). In short, the IoT is a collection of different enabling technologies, including RFID (Gubbi, Buyya, Marusic, Palaniswami, 2013), sensors, sensor networks and others. RFID is an important basic component (Mostafa, Hamdy, & Alawady, 2019), that is combined with other digital systems. RFID and IoT applications are important for localisation, tracking and positioning (Tejesh, Neeraja, 2018), which are essential for warehousing. In the field of logistics and supply chain management, some aspects of RFID and GS1 are revealed by Rejeb, Keogh, & Treiblmaier (2019).

Each of the mentioned modern technologies has its own characteristics, but due to the significant and fast development of each technology, there is relatively poor detailed knowledge about each one and this gap is a prerequisite for determining future intentions in warehousing systems management. The list of technologies can be expanded, for example, with the application of unmanned aerial vehicles in warehouses, which could lead to several advantages (Fernández-Caramés, Blanco-Novoa, Froiz-Míguez, Fraga-Lamas, 2019). Still, the more recognisable ones are included in the present study. AI, AR, automated systems, robots, big data analytics, blockchain and the IoT are the most relevant technologies for the next five years, as pointed out by Toy et al. (Toy, Gesing, Ward, Noronha, Bodenbenner, 2020). These results could be used to categorise the technologies as imminent and future applications.

The digital transformation as a term appeared firstly among business professionals and it was later studied by academics (Reis, Amorim, Melão, Cohen, Rodrigues, 2020) in their literature review on the digitalisation problems. Digital transformation is related to implementing digital capabilities to support business model transformations (Henriette, Feki, Boughzala, 2015). Technology is seen as an important driver for digital transformation for logistics and supply chain management, adding capabilities such as integration, visibility, real-time, decentralisation, automation and autonomy management (Junge, 2019). The usage of different types of information solutions (technologies and systems) can also be used as an indicator of the maturity level of Logistics 4.0. Data-driven services, big data (data capturing and usage), RFID, RTLS, and IT systems (ERP, WMS, cloud systems) are defined as Logistics 4.0 dimensions and they represent an area of evaluation (Facchini, Oleśków-Szłapka, Ranieri, Urbinati, 2019). It is important to note that high warehouse productivity is not only the result of technology; there are other factors. Studies have found that human and technological factors are interrelated in smart warehousing (Wanjari, 2020), which is a potential area for future research. Also, it could be mentioned that digital transformation is related to an economy's success, but there is a question about the cost in social terms (Borissova, 2021).

For the purpose of the research, we can summarise that for Logistics 4.0 and the appearance of Warehousing 4.0, digital transformation is very important, but a complex problem at the

same time. It is not so easy to present a single definition, but it could be noted that the digital transformation of warehousing is closely related to the level of usage of a variety of information systems and digital technologies in warehousing processes. In the studied literature, no already built model was found that fits the purpose of the article, which is why the focus of this paper is only on the main aspects of the studied problems. Nevertheless, according to the used literature, the author's vision is that RFID and the IoT are imminent, and the other technologies vary in the specific case needs.

3. Methodology

The established conceptual model of the participants in the logistics processes of the economy (Dimitrov, 1999, 2013, p. 91) is the basis of several studies in the field of logistics and supply chain management in Bulgaria. Several groups of participants can be distinguished in it. Accordingly, logistics research can be focused on trade and manufacturing enterprises, logistics service providers, logistics technologies vendors, software and consulting companies, etc.

Trade and manufacturing enterprises are prominent participants in the logistics processes. The management of logistics activities has a strong impact on the management of warehousing systems. The group of manufacturing enterprises includes enterprises that are producing products for production purposes and that are targeting the end-users. The group of trade enterprises consists of both wholesalers and distributors, as well as retailers. For all types of enterprises, the prerequisite for the presence of a warehouse and management of warehousing processes is imposed/mandatory.

3.1. Research scope

The scope of the study includes Bulgarian trade and manufacturing enterprises in which warehousing is objectively performed. All types of company ownership and company size are included – small, medium and large enterprises. A necessary prerequisite for inclusion in the research is the existence of primary self-managed warehousing processes. Outsourcing is not included; also, logistics service providers are not covered by the study.

3.2. Data collection methods

For data collection, we used an electronic questionnaire form that was built using the open-source platform Limesurve. The questionnaire contains different question groups that cover problems concerning the management practices of the warehousing systems and following different trends in warehousing. In the survey, Likert scale questions are mainly used (1 – Strongly disagree, 2 – Somewhat disagree, 3 – Neither agree nor disagree, 4 – Somewhat agree, 5 – Strongly agree) for evaluation of the current situation and for the plans for the next three years. In addition, multiple-choice questions are used in the questionnaire. The collected data is exported directly in a file format that is supported by statistics software.

3.3. Research questions and data analyses

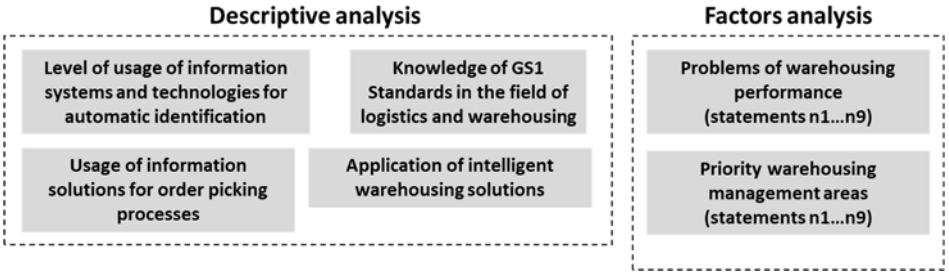
According to the literature review, digital transformation is related to the usage of different information systems and technologies. On that basis, the analyses are divided into two groups:

- Descriptive part – evaluation of the current state.
- Finding patterns in the answers to understand the results in more details

This is the foundation on which guides and recommendations for a more successful digital transformation of warehousing are defined. The research problems and questions which have been covered in the study are separated into two main groups. The first one contains four sub-groups, while the second contains two sub-groups, as shown in Figure 1. The main hypothesis in the research is that the digital transformation perspectives for the warehousing processes are relatively good, but there are a group of factors influencing warehousing management to follow the modern trends.

Figure 1

A research framework for digital transformation perspectives in warehousing



Source: Author's illustration.

In general, the research question covered in the descriptive part of the article could be represented as:

- Level of usage of information systems and information technologies for automatic identification – Main types of software for managing warehouse processes, functionalities of the systems, and application of technologies for automatic identification – barcodes and RFID. The topic is expanded by including the information problems in the warehousing and evaluation of the market for software solutions for warehouse processes management.
- Level of usage of information solutions for order picking processes.
- Knowledge of GS1 Standards in the field of logistics and warehousing.
- Application of intelligent warehousing solutions – the IoT, RTLS, AR, big data, blockchain technologies, warehousing robots, AI, automated control systems, etc.

Descriptive statistics include calculation means and standard deviation, multiple response analyses, grouping etc. Some hypothesis testing, such as independent samples tests are used.

The other part of the research uses factor analysis methods to reveal patterns in the answers. This component analysis (PCA) is applied principally in order to reduce the dimensionality of a data set (Jolliffe, 1986) and it is concluded that this is one of the most popular multivariate analysis methods (Kassambara, 2017). This type of analysis has several restrictions, but it could be used as an initial step for common factor analysis (CFA) (Kim, 2008). For the current research, the available input data and the method is used to reveal some general relations that could be studied in more detail in future. Two groups of variables are analysed following the steps in Figure 2, and their content is:

- Problems of warehousing performance – financial, limited solutions on the market for storage equipment and material handling machines, senior management's insufficient understanding, human resource (HR) hiring, HR training, limited IT resources, level of competition in the country, warehouse security.
- Priority warehousing management areas – warehousing processes, material flows, stock-keeping unit (SKU) types, financial restrictions, software systems, warehousing key performance indicators (KPI), order picking, packing and labelling, and value-added activities.

Figure 2

Applied principal component analysis

Source: Author's illustration.

With these fundamental research approaches, the level of usage of information systems and technologies in warehousing will be revealed, as well as the factors that can speed up digital transformation processes.

4. Results

According to the collected data, the proportion of trade companies is 58.2%, and that of manufacturing is 41.8%, the difference being due to small enterprises. The total number of collected questionnaires is over 200, but only 134 were fully completed and included in the article. Convenience sampling is applied and data was collected through an electronic survey conducted in 2020 during the COVID-19 initial pandemic period.

Regarding the position held in the company, it can be determined that 28.4% of the respondents are representatives of the top management, 7.5% representatives of the production departments, 15.7% representatives of the marketing departments, and over 23% are representatives of the logistics department. For the companies' ownership, it can be noted that according to the self-reports (state, private, foreign, mixed, or combined), the proportion of private companies is 78.4%, state companies 1.5%, foreign companies 24.6%, and

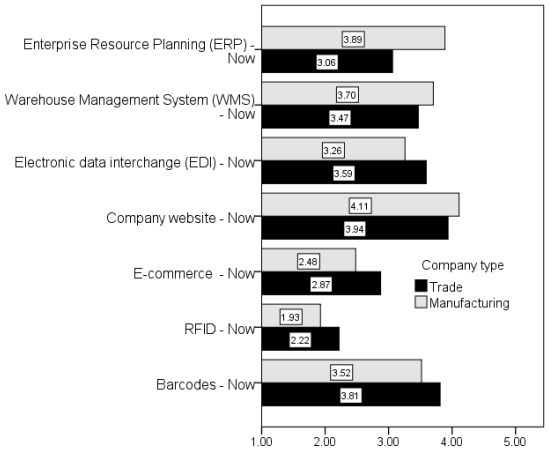
companies with mixed forms of ownership 3.7%. A little over 70% are organisations that state that they manage from one to three warehouses, and those that manage between five and seven warehouses represent a little over 14%. For other organisations, the proportion of the total number is significantly lower.

4.1. Usage of information systems and information technologies for automatic identification

The level of implementation of different information systems and technologies is presented in Figure 3. The ratings are relatively low, which indicates an unsatisfactory level of use of software systems. The reasons for this are varied, including low quality and the cost of the solutions offered in the country (Rakovska, 2017). As a result, Bulgaria has been defined as lagging from EU-average about digitalisation (Chobanova, Kocarev, 2019). These low levels of application of information solutions slow down the construction of modern models such as Omni-channels, a practice which is defined as a source of competitive advantage for the Bulgarian food industry (Vodenicharova, 2020). According to the results, manufacturing companies have a higher degree of implementation of information systems, especially of ERP and WMS systems. On the other hand, the trade is more active in the field of e-commerce. An interesting point is the Electronic Data Interchange (EDI), which is imposed as a requirement by large retailers, and which smaller ones implement as well. The reduction of the document flow in the field of distribution is significant, and this way of working is starting to become preferred. Similar considerations can be made in the direction of automatic identification – the impact of the logistics labels on the distribution and supply chain efficiency requires further research in both literature and business practices (Kolinski, Osmolski, 2019).

Figure 3

Level of implementation of information systems and technologies



Source: Author's illustration.

Software systems in warehousing are mainly used by the respondents for supporting warehousing processes such as: order processing, receiving deliveries, invoicing, inventory

management, and order picking. According to the presented data, it is possible to conclude that the software systems are used in a conventional and basic way. An important activity like forecasting is supported in less than 20% of the cases. It could be noted that there is a gap between understanding about the included activities in the processes and the level of automation that is used. Forecasting, for example, is mainly understood as checking and following the inventory levels instead of having an automated system for forecasting that is connected online with the inventory management systems for the inventory management policy. This reveals the potential for more knowledge in that field. The importance of digital transformation-related knowledge and competencies is mentioned by Furjan, Tomičić-Pupek, & Pihir (2020).

Another point of view reveals the differences according to the organisation size (small, medium or large enterprises). Definitely, with bigger company size, the level of usage of different information systems and technologies grows. Large enterprises have a very high average level of implementation which means that they have fully integrated systems. At that time, small enterprises gravity around the balanced mean scores.

The respondents' intentions are definitely positive, and in general, in almost all areas, the development and broader implementation of information solutions in logistics are expected, as shown in Table 1. It can be noted that solutions such as company websites, barcodes, ERP and/or WMS systems are becoming standard. According to the stated intentions of the organisations, over 70% of them plan to be able to self-determine in three years that ERP has been partly or fully implemented, and in terms of WMS, the results are similar.

Table 1

Level of implementation of information systems and technologies in the next three years (means)

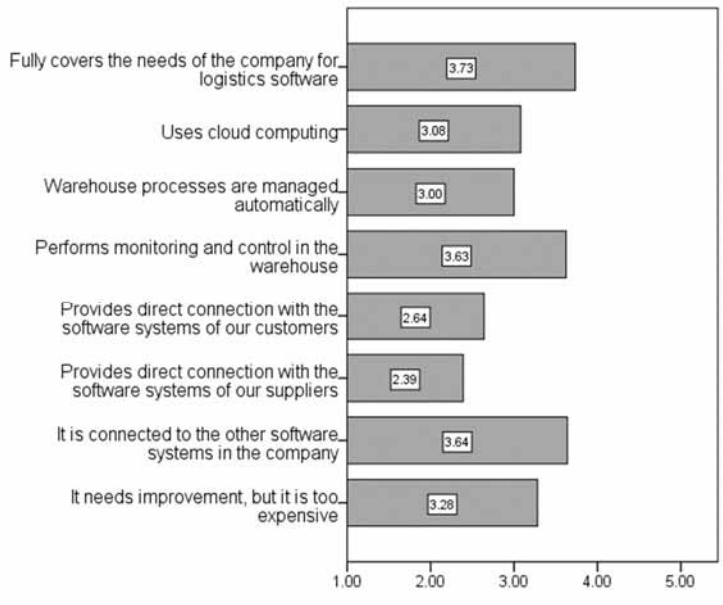
	Mean	Std. Deviation
Enterprise Resource Planning – Next 3 years	4.20	1.112
Warehouse Management System – Next 3 years	4.39	1.072
Electronic data interchange – Next 3 years	4.00	1.280
Company website – Next 3 years	4.43	1.076
E-commerce – Next 3 years	3.63	1.538
Radio-frequency identification – Next 3 years	2.84	1.439
Barcodes – Next 3 years	4.29	1.208

Source: Author.

The development of the topic of the level of application of information systems largely depends on the organisation's current situation and the subjective assessment of the situation. In essence, these answers can be determined as indicating potential factors for starting a change in the organisation. The answers are summarised in Figure 4.

Figure 4

Statements for the warehousing software system



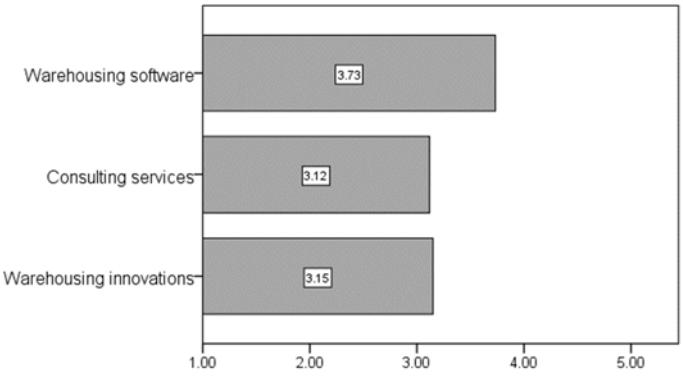
Source: Author's illustration.

In general, potential can be sought in the direction of external integration in the supply chain upon reaching certain higher integration levels within the organisation. Also, the relatively low estimates of automated support of logistics processes may be another opportunity for future development. The question in this direction of reasoning is "To what extent do you comply with the software system when organising the storage areas?" The answers are relatively neutral and gravitate around the mean value of 2.94, with the average value for trade organisations being 2.87 and 3.16 for manufacturing organisations. In both groups, the deviation in the responses is relatively high, over 1.40, and the difference between the two groups in the sample is not significant. In turn, this suggests to some extent that the software has more significant potential for future warehousing management. An interesting point is the relatively low ratings for financial problems in improving systems, which is a signal of a positive assessment by respondents of the use of software in warehousing and shows they are ready to invest for it.

Another point is assessing the supply in the country of various warehousing solutions, especially those related to warehousing software, consulting services, and innovations, as shown in Figure 5.

Figure 5

Evaluation of the solutions offered by the vendors



Source: Author's illustration.

According to the data, there is a general attitude of low evaluation of the supply of software, consulting, and innovation in the field of consulting, which should be a signal and an opportunity to develop better proposals in the field for Bulgarian trade and manufacturing companies.

4.2. Level of usage of information solutions for order picking

Several processes take place in the warehouses, and the preparation of orders in the warehouses is a leading activity, which is mostly a measure of the performance and evolution of the warehousing system. Order picking is an activity related to the collection of goods and the completion of orders in warehouses. In essence, these are activities related to taking goods from the storage area to prepare the customers' orders. In many cases, the level of usage of information systems and technologies for these processes is crucial for the operator of the warehouse system.

The survey data answering the multiple-response question "What methods do you use to pick orders?" are presented in Table 2. According to the results, nearly 60% of respondents use order picking through paper sheets, which can be defined as a classical approach. Only 45% of them use barcodes, and the rest of the solutions have an extremely low usage, which is unsatisfactory.

Table 2

Popular order picking methods

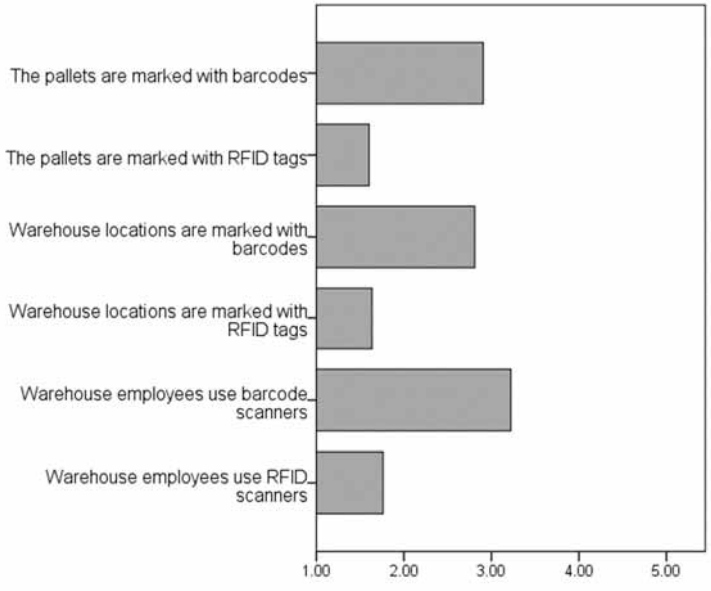
	Percent of Cases
Paper picking	59.5
Pick by voice	1.5
Pick by light	0.8
Barcodes	45.0
RFID	8.4

Source: Author.

The overall assessment of the level of use of individual automatic identification solutions, which is somewhat related to the previous question, is shown in Figure 5. According to the results, the respondents themselves describe the application of automatic identification technologies as relatively weak. The answers to the question show that the level of use of barcodes, which are widespread, is low, and the use of RFID is extremely low. This corresponds to the findings that some logistics activities such as transportation, warehousing, handling, receiving, order picking, packaging and dispatch of orders continue to be labour-intensive (Stefanov, 2020). When examining the answers to the question compared to the answers to another question: "What methods do you use to pick orders? – orders are picked with a sheet of paper (paper picking)" with the Mann-Whitney U-test application, there is a significant difference. Definitely, organisations that are more technologically developed are less likely to apply paper picking.

Figure 5

Statements for the warehousing systems and used automatic identification technologies



Source: Author's illustration.

Another research issue is the organisations' plans for speeding up the process of order picking. The results are presented in Table 3. In general, the plans are to increase the degree of mechanisation and automation in the warehouse, update software systems, and improve HR motivation. No strong correlations can be found between the individual responses. Still, statistically, significant ones can be indicated (at $p = 0.10$) between implementing an automated system, upgrading the software system, and using barcodes or RFID.

Table 3

Plans for improving order picking processes in the warehouse in the next three years

	Percent of Cases
Material handling machines	52.3
Automated storage system	40.2
Software system update	52.3
Increase number of employees	34.1
Motivation and better payment of employees	56.8
Usage of barcodes or RFID	27.3

Source: Author.

Comparing the answers to the question, concerning the software system update, as well as the one for using barcodes or RFID, it can be determined that only 18.7% plan to implement both at the same time. 32.8% of those planning to update the software do not plan to implement the use of barcodes. Respondents who did not mark any of the two alternatives (barcodes or RFID) plan to improve the process by:

- Increasing the degree of mechanisation – 26.5%.
- Developing an automated system – 16.3%.
- More staff – 23.5%.
- Motivation and higher salary of the staff – 29.6%.

It is noteworthy that only 14.2% of those planning to improve the software system are focused on increasing the number of staff. Also noteworthy is the fact that 30.6% of them plan to increase motivation and provide higher pay for staff, which is above average. From the results, it can be assumed that organisations consider software systems a real alternative for warehouse management.

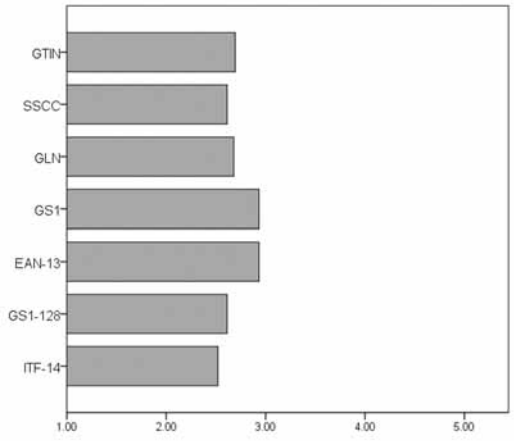
According to the research data, it is expected that small enterprises can be more active in most of the initiatives, excluding the usage of barcodes and RFID. Definitely, there is a significant difference between small and large enterprises with respect to the level of usage of material handling machines and human resource-related activities, which could be explained by their possible future development plans.

4.3. Knowledge of GS1 Standards in the field of logistics and warehousing

Standards for automatic unit identification are essential for ensuring the smooth movement of material flows in the supply chain and to the end-users. Recognising many terms and abbreviations is vital knowledge on the topic and is a prerequisite for the proper functioning of systems. According to the study data, it can be determined that the knowledge is not adequate, as shown in Figure 6.

Figure 6

Level of recognition and knowledge about standards



Source: Author's illustration.

Low average scores mean low levels of knowledge, which is a risk factor for errors in the management of material flows in the supply chain on the one hand, and inadequate use of the advantages of relevant technologies.

4.4. Application of intelligent warehousing solutions

The analysis of intelligent warehousing systems' application includes topics related to the IoT, RTLS, AR, big data, blockchain technologies, warehousing robots, AI, automated control systems, etc. Some of the respondents' average scores for their plans to implement solutions in the next three years are presented in Table 4.

Table 4

Level of implementation of information systems and technology innovations in the next three years (means)

	Mean
The iIternet of things next 3 years	3.63
Real-Time Locating System next 3 years	3.49
Augmented reality next 3 years	2.68
Big data next 3 years	3.17
Blockchain next 3 years	2.60
Warehouse robots next 3 years	2.47
Artificial intelligence next 3 years	2.24
Automated management systems next 3 years	3.30

Source: Author.

The data reveals that the level of the current implementation is extremely low, as is the intention to deploy smart warehousing systems in the future. This, in turn, is a risk factor for

a future delay in the evolution of warehousing systems compared to global trends. However, the Internet of Things with an average score of 3.63, real-time positioning systems with 3.49, as well as automated management systems with a score of 3.30 can be mentioned as future areas of development. The prospects for the introduction of artificial intelligence and robotics are weaker.

The other part of the research methodology is related to PCA analysis. The first step is the factor extractions and descriptive statistics, with the exclusion of missing values. The results show that the Kaiser-Meyer-Olkin measure of sampling adequacy is more than 0.75 and Bartlett's test has a significance of less than 0.05. According to the scree plot, two factors are selected and a second calculation is performed restricted to the number of factors. Factor analysis rotation is also calculated with the Varimax method. The results are shown in Table 5.

Table 5

Rotated component matrix – Extraction method: Principal component analysis. Rotation method: Varimax with Kaiser normalisation

	Components	
Financial	.471	.176
Limited solutions on the market for storage equipment and material handling machines	.626	.228
Senior management's insufficient understanding	.285	.595
HR hiring	.063	.888
HR training	.067	.866
Limited IT resources	.588	.436
Level of competition in the country	.716	.240
Warehouse security	.587	.038
No problems	-.690	.100

Source: Author.

One of the groups is related to the problems of HR, which is expected – HR hiring and HR training. The other group combines limited solutions on the market for storage equipment and material handling machines, limited IT resources, level of competition in the country and warehouse security. From these results, a discussion could be started about problems of warehousing performance:

- Level of competition is a powerful driver for the digital transformation of warehousing.
- The importance of the presence of solutions for warehousing on the market – what alternatives do companies have for developing their warehousing systems? Here, not only storage systems and material handling machines but also IT solutions, consulting services etc., have to be included.
- Security concerns become important.

The other part of the analysis is related to the priority warehousing management areas. This will reveal the level of knowledge and will focus on the important warehousing problems. Dimensions include warehousing process organisation, material flow specifics, SKU types, financial restrictions, software systems, warehousing KPI, order picking (as one of the most important warehousing processes), packing and labelling, value-added activities.

Unfortunately, despite the high value for the Kaiser-Meyer-Olkin measure of sampling adequacy and the good Bartlett's test significance, multiple factors are grouped in the components. The reductions in general reveal:

- Factor one (Warehousing systems development) – financial restrictions, SKU types and packages and software systems – with rotated values more than 0.7.
- Factor two (Intra-warehouse performance) – material flows, order picking, KPI and warehousing processes, all with values more than 0.65.

It could be supposed that the software problems that are highly related to the digital transformation are not related only to the financial resources but also to the SKU types and their packaging in the supply chain. On the other hand, there is a strong focus on warehouse efficiency and it is correct that order picking is included.

5. Discussion

The research results overall reveal that the level of usage of information systems and technologies in warehousing is not very high. This leads to the conclusion that there is a real potential for improving warehouse performance and warehousing processes. Nowadays, use of Logistics 4.0 and Warehousing 4.0 is increasing and this is leading to the need for fast action in this area. Definitely, companies have to do something fast to catch up with world digitalisation trends. These problems are not unexpected and they may also exist in other countries and economies. The discussion topics in the article could be defined as:

5.1. Digital transformation and smart warehousing

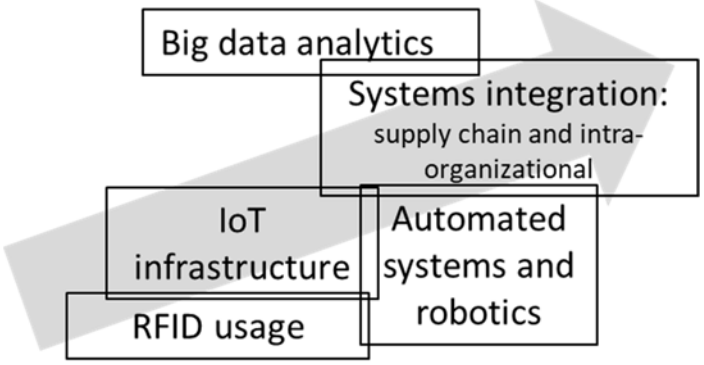
A very important component in the whole process is RFID. Definitely, this technology has many more benefits than the other alternative for automatic identification (barcodes); it is fast, secure, allows multi-item scanning, different scanning ranges etc. RFID is a mandatory part of the IoT and implementing different RFID usages is fundamental to future IoT practices. These processes are tightly related to the warehousing communication infrastructure that will enable the IoT in warehouses. This implementation may support other innovations in warehousing, including unmanned aerial vehicles, which have better performance than humans (Fernández-Caramés et al., 2019). RFID and the IoT will ensure the efficient management of information flows, which will reflect positively on material flows management in warehouses. A related process is the implementation of automated systems and robotics, especially for the picking process.

These processes will generate complex IT structures that could be studied in more detail. The main challenges are related to the integration of the systems with the other supply chain members and the integration of the software systems within the organisation. These huge systems are expected to lead to the appearance of big data and problems with real-time analytics and information security. The processes also have to follow the leading trends for AI, blockchains, cloud technologies, AR and etc. The visions presented in the article are

summarised in Figure 7. It should be mentioned as well that there is no universal roadmap for technology implementation because the approach is unique to each individual case and it is difficult to construct a universal assessment method. The presented ideas represent the general direction of evolution. The IoT in warehousing is a complicated problem that can be studied in more details and directions, as the visions presented by Mostafa et al. (2019) and Tejesh & Neeraja (2018), for example.

Figure 7

Digital transformation and smart warehousing perspectives



Source: Author's illustration.

5.2. Knowledge importance

There could be a discussion about the level of knowledge and about understanding of the real nature of the digitalisation of logistics and warehousing. Many companies have knowledge only of the general meaning of the different information systems and technologies, and the synergetic effect of their usage is not clear. This is leading to a need for education in the field of information systems and technologies for logistics competitiveness. Problems around the level of knowledge in the field of logistics are also revealed by Rakovska (2013, p. 211), while some specific knowledge aspects are considered by Mikova, Mihova, & Stefanov (2020).

5.3. Warehousing software and consulting market development

Digital transformation of warehousing is related to the solutions that could be found on the market. Nevertheless, despite the existence of a variety of technologies worldwide, local companies are dependent on the implementation by local specialists. In the studied case, a significant potential is found for warehousing software market development and more consulting services that must be focused on the warehousing performance.

Another discussion topic on the difference between the organisations' size could be defined. In some answers, there is a significant difference between the answers by the organisation's size and this could be studied in more detail. Large enterprises are expected to be more confident in their warehousing management, with balanced processes and a high level of

usage of material handling equipment, automation, automatic identification technologies and digitalisation. Small and medium-sized enterprises (SMEs) work under higher market pressure and this leads to high motivation to adopt innovations and solutions for improved warehousing performance.

Several further research directions could be proposed. Knowledge is an important factor in digitalisation and this topic could be studied in more detail. A possible direction is the specifics of the SME for the digitalisation of the warehousing process – internal factors and motivation, obstacles, needed solutions, consulting perspectives etc. Another potential research area to focus on is trade enterprises which are in a very competitive environment.

6. Conclusions

From the analyses conducted, several conclusions can be drawn about the digital transformation perspectives in warehousing in Bulgarian trade and manufacturing enterprises, which could be extended to other international studies. The essential conclusions can be summarised in several ways.

In general, the level of use of various information solutions is still low and is not adequate considering modern views on modern logistics and supply chain management. This, in turn, is an indicator of the slow pace of digitalisation and digital transformation of logistics activities in the country. Findings of the study include that the problems are due to low knowledge of the nature and advantages of using information solutions, which shows the need for future development of various information campaigns aimed at increasing knowledge. Apart from that, there are significant opportunities for consulting organisations and software companies to offer innovative solutions. In general, there is a desire to invest in such solutions, but they must lead to real results in the field of warehousing. Nevertheless, important initiatives have been taken and there is a significant potential for future development. These results confirm the main hypothesis that the digital transformation perspectives for warehousing processes are relatively good and that the fundamentals for these processes have been established.

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