The role of warehouse in e-business

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***Abstract*— The expansion of the application in the up-to-date information technologies has significantly contributed to the intensification of electronic business in all areas of modern life. Nowadays, the terms e-payment, e-commerce, e-scheduling, etc. are increasingly applied. E-business is based on the use of the internet in connecting companies with their suppliers, warehouses, customers, and other entities. The basic application of solutions based on e-business involves the integration and coordination of information, goods, and energy flows, including the implementation of new business models. Observed in this new context, the warehouse as an essential component of supply chains faces new challenges. Therefore, the main goal of this paper is to review/redefine the role of the warehouse in e-business. Some forms of e-business and their impact on the warehouse are especially explained. For the identified requirements, which e-business makes towards the warehouse, corresponding concepts/solutions of such warehouses applied in practice have been analyzed.**

Keywords —— e-business, warehouse, information technology, warehouse management system

I. INTRODUCTION

For a long time, modern business involves the application of the Internet and new information technologies. E-business replaces traditional business, which involves the use of many paper documents. As a comprehensive term, it refers to any method of using digital information and communication technologies to support or simplify business processes. However, it can refer more precisely to business processes related to e-commerce. The above interpretations lead to the problem that a precise definition of e-business does not exist. This term is most often identified with e-commerce. E-commerce means to trade in products and services via the Internet, which is only one part of e-business [3].

Through one of the most common definitions of e-business, it can be concluded that it is a general term that refers to all forms of using digital information and communication technologies to support and optimize business processes. In contrast, e-commerce represents only the sale and purchase of products and services over the Internet, which represents only one segment of e-business [1].

E-business has an important impact on supply chain management. The faster flow of information significantly facilitates and improves the management of supply chains in all its segments. Therefore, it also affects the warehouse business.

Previously, warehouses were places that generated additional costs. However, they are now seen as points where the value of goods is added. Relocation of production to countries where production costs are lower and intensifying e-commerce lead to changes in the warehouse business. As a result, warehouses are becoming very important segments of the entire supply chain [3].

In the domain of warehousing processes, modern technologies are used to speed up the flow of goods through the warehouse, better control of receipt and shipment, reduce the cost of warehouse operations, just to mention some of them. As a term, the warehouse implies a function, logistics activity, and system that realize the storage of goods. It is an integral part of every logistics system and has an irreplaceable role in connecting production, transport, and consumption. A typical warehouse was a place to store goods, however, while today the movement of goods is the dominant activity in the warehouse [2]. Modern warehouse is a very complex system in which different processes are implemented. Therefore, the aim of the paper is related to the optimization of some processes in the warehouse, using various forms of e-business.

In the basic processes in the warehouse related to the receipt/dispatch, processing, and storage of goods, e-business can be applied in various forms. In the process of receiving and shipping goods, process automation contributes to speeding up the realization of these processes and reducing errors. Within the processing of goods, e-business is most pronounced in commissioning processes. The effects of the application of e-business in this process are the same as in the previous ones: faster realization of the process, increase of accuracy, i.e. minimization of errors, which will be specially analyzed in the paper.

II. METHODOLOGY

The paper is divided into several sections. After the introduction the second part is related to methodology. The third section deals with e-business. Within that, the basic concepts and places of possible application are mentioned. The fourth section deals in more detail with the impact of e-business on supply chain management. The fifth section builds on the previous one and describes in more detail the impact of e-business on one segment of the supply chain - the warehouse. In the sixth section, concrete examples of electronic business in certain processes in the warehouse will be presented. In addition, the effects of their application will be discussed, that is, how modern technologies affect the realization of these processes. In the conclusion, the previous observations will be summarized, and the possibilities of further research will be considered too.

III. E–BUSINESS

E-business is a comprehensive business concept, which has gained increasing importance in the last few years for the

successful management of supply chains. The term "e-business" was introduced by IBM in 1997. It is defined as "the transformation of key business processes using Internet technologies". The definition of e-business refers to the use of the Internet to connect with customers, suppliers, and other connected partners. However, the term also implies the transformation of existing business processes to increase their efficiency. Organizations that are successful in e-business can convert data from their background systems into a commonly readable format. Thus, they can exchange information and perform electronic transactions with their business partners via the Internet. E-commerce can be considered a subset of e-business. Although e-commerce covers the whole spectrum of online information exchange, e-commerce covers only money transactions [4].

E-business encompasses several categories, but the two most common are B2C and B2B. B2C implies transactions between companies and users, while B2B implies transactions between two companies. The initial growth of e-business was in B2C supply chains. The most famous example is Amazon, which sold books over the Internet, and later expanded its business to music, toys, electronics, software, etc. However, a significant part of e-business is focused on companies. Some of the first to focus their business online were Dell, W.W.Grainger and Intel Corp.[5].E-business has several components, including BI (business intelligence), CRM (customer relationship management), ERP (enterprise resource planning), SCM (supply chain management), etc. Areas of great importance for e-business are illustrated in Figure 1, which are [6]:

- e-procurement
- online stores
- online market
- Internet communities
- Internet companies.

Figure 1 - E-business components [6]

An integral part of e-business is the electronic business model. This model consists of several components. An electronic business model can be defined as a way of describing how a company functions by providing services or products and how it generates profit. Moreover, it also defines how the company will create and adapt to new technologies or markets. Current business models are unthinkable without new technologies. All components of the business model work together for a successful business. The structure of the electronic business model is shown in Figure 2.

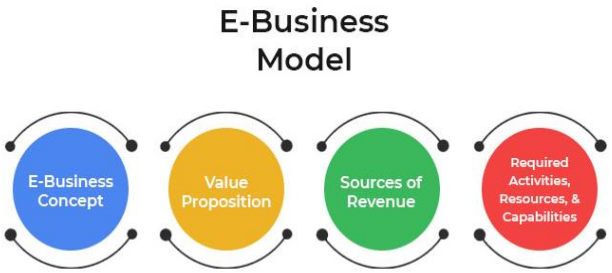

Figure 2 - E-business model [6]

Based on the Figure 2, it can be noticed that the e-business model includes the following components [6]:

- E-business concept - analyzes basic information about the company, including goals, vision, products, and offers from which to generate revenue; the concept of effectiveness is based on market analysis that will identify the interests of customers to purchase products;
- Value Proposition - this is the value that the organization or company will provide to its customers.
- Sources of income - E-commerce refers to the purchase and sale of services/products. It also includes online payment options and a great online shopping experience.
- Activities, resources and opportunities - to complete a specific task, it is necessary to implement various activities and provide specific resources; for example, it requires the engagement of employees with defined skills or abilities to successfully perform certain business activities.

IV. THE INFLUENCE OF E-BUSINESS ON THE SUPPLY CHAIN

There are numerous definitions of supply chain and supply chain management in the literature. In the context of e-business, the following can be stated. The Supply chain (SC) is a two-way flow of information, products, and money between suppliers and end customers through different entities in the chain [7]. Thus, supply chain management (SCM) represents the integration of business processes from the end-user through original suppliers who provide products, services, and information and thus adds value to customers and other actors. The goal of SCM is to produce and distribute goods in the right quantities, in the right places, and at the right time to reduce costs across the system [8].

For a successful SCM, it is necessary to ensure the fast, efficient and reliable realization of information flows. Therefore, the integration of information and communication technology (ICT) into business systems is vital for improving SC performance [9]. The Internet facilitates the exchange of information, which means that communication can take place at almost zero cost [10].

In some papers describes that managing information flows in the supply chain is one of the most important activities of SCM because the flow of materials and money usually

drives the movement of information [11]. Some authors point out that coordination in the supply chain is achieved by communicating orders, inventory levels, and demand feedback [12]. Poor information flow management leads to a so-called bullwhip effect that affects the retention of excess inventory. Visibility of high demand plays a strategic role in reducing inventory levels [11]. Efficient network communication structures in the supply chain can compensate for these losses. Supply chain and e-business are interconnected if integrated e-business functions allow undistorted and accurate information exchange. In this way, optimal alignment of business functions is a means to the basis for developing an effective SCM strategy.

Supply chain transactions related to e-business include flows of information, products and money. Realizing these flows are realized benefits such as [5]:

- providing product information to various actors in the supply chain;
- order information is provided to suppliers;
- users are enabled to create and track order flows;
- filling and delivery of orders to customers;
- payments from users.

The stated advantages that are realized by e-business are traditional tasks, which were carried out decades earlier. E-commerce, however, has enabled them to be executed in a much more efficient way, with the Internet playing a key role. For example, some companies have previously mailed catalogs to potential customers and using e-commerce they can publish their catalog online, at no extra cost.

Competitiveness is monitored today at the level of the entire supply chain. The essence of understanding supply chain management knows how organizations can use the skills, abilities, and resources of their suppliers, distributors and achieve competitive success. Thus, an organization's ability to effectively manage its supply chain is a key strategic challenge. This is reflected in the speed of the supply chain functioning in an e-business-based environment [5].

V. THE IMPACT OF E–BUSINESS ON WAREHOUSE

The warehouse is a hub in the logistics system where companies store their raw materials, semi-finished and finished products in different periods. It can be defined as a separate system, a logistics subsystem, and a function. It has a significant role in connecting commodity flows, in terms of their spatial and temporal transformations. Numerous processes related to the receiving, shipment, storage, and processing of goods are realized within the warehouse. In a traditional warehouse, the processes are not well enough connected and problem points arise. These problems need to be rationalized. This can be achieved by interconnecting storage processes. By connecting all processes, the warehouse operates as a unique, which eliminates many problems: faster order processing, shorter warehousing time, there is a clear insight into all goods in stock, and so on. All these benefits are provided by the application of WMS (Warehouse Management System). his software represents only one possibility of implementing e-business in warehouses. However, some other types of e-commerce in the warehouse are also mostly associated with WMS. Recently, an increasing number of warehouses are opting for the application of WMS. The reason for this is the benefits it achieves. The reason for this are the benefits achieved. Using WMS can contribute to reducing paperwork, better services to users, accurate inventory data in real time, reducing errors, reducing costs, simplified storage processes [3], [13].

The role of warehousing in modern logistics is becoming increasingly important. The reason for this is the rapid increase in e-commerce transactions and the need for reduced inventory and faster response times to customer requests. As a result, efficient management of the warehouse business can be crucial to the overall performance of the supply chain to which they belong. In response, several models of decision support have been developed. They assist managers in decision-making processes in managing the warehouse. One of the crucial and most complex processes in the warehouse is order picking. Order picking is the allocation of a certain range and quantity of goods to meet customer requirements. When it comes to picking, in traditional warehouses, pickers get a picker list of goods that need to be stored and disposed of in a defined place. Each picker receives one picker list and it takes him a long time to find all the items from that list. With the application of modern technologies, all these jobs are accelerating. It requires less manpower, which reduces costs, and at the same time increases the accuracy of the realized purchase order. Modern technologies used to help pickers are radio frequency identification (RFID), pick by voice, pick by light, and automated picking. RFID is a technology for identifying objects using radio waves. Data is exchanged between tags and readers depending on the frequency. The usual use of this technology was related to libraries or toll collection. Use in the supply chain was limited. However, after some research in the US military, changes are taking place. The system allows you to read multiple items at the same time, unlike bar codes. The bar code should be read individually for each product, which significantly shortens the time of receipt of shipment. As RFID allows the reading of multiple tags simultaneously, it thus finds application in warehouse systems [3].

The use of *pick by voice* technology is increasingly used in warehouses, especially when picking, although it can also be used in other processes such as disposing of goods or replenishing stocks. For a long time, instead of paper sheets, many companies have used voice communication and bypassed bar code scanning. The equipment needed is a headset and a microphone for the commission agent as well as a mobile terminal that attaches to a belt or wrist. The equipment of this technology is shown in Figure 3. The system works by sending a message to the computer over a radio frequency, using transmitters placed along with the entire warehouse. Messages are converted to voice and the picker hears them through headphones. Also, the picker uses voice messages, which are recorded via a microphone, and then converted into appropriate data that is transmitted to a computer. By applying this technology, the picker communicates directly with the computer, which reduces the number of intermediaries and the number of places for errors to occur. This technology was first used in refrigerators because low temperatures and the use of gloves prevent the use of scanners or paper [3].

Figure 3 - Pick by voice technology - equipment for the picker [14]

Since light is faster than sound, *pick by light* technology has certain advantages over pick by voice technology. The advantages are reflected in the speed of perceiving light signals. Light signals are placed on shelves, racks or other places for storing goods. This system is mainly used in a certain warehouse area where there is usually one commission agent. When the commission agent scans the bar code from the commission list, he receives information about the next order number to process. After scanning the code, the system receives a notification that the commission agent is ready to execute the purchase order and sends the information to the appropriate active commission zone. By that, all the locations from which he needs to pick up the goods are illuminated at once. In addition to the lights, there is a digital screen that indicates to the picker the number of goods he needs to pick up from that location. When he has performed the download from a certain location, the picker turns off the light signal and thus confirms the realization of the work. When the picker separates the products in his zone, the order is forwarded further. Some systems require scanning of each product after being placed on the transport pallet, however, this takes a lot of time. Although accuracy increases, it is sometimes not profitable. Figure 4 gives a visual representation of this technology placed on the shelves.

Figure - 4 Pick by light technology [15]

Pick to light technology can be used for picking. In cases when batch piking (realization of entire purchase orders for a larger number of users) or zonal picking (realization of parts of purchase orders for a larger number of users) is performed, this technology contributes to the acceleration of sorting. It is mainly used for goods of smaller dimensions. The system consists of shelves that are open on both sides (Figure 5). On the one hand, the picker disposes of the goods for certain users, whereby they are signaled by light signals where to dispose of the goods. On the other hand, packaging workers take the goods, pack them, and put them on pallets depending on the direction of shipment. The disadvantage of this technology is that it requires a larger number of workers and that the packaging of goods is done manually [16].

Figure 5 – Pick to light sorting system [16]

Table 1 shows certain parameters based on which the previously described technologies were compared with the standard order picking method. The parameters compared are the number of products that can be stored in one hour by one picker, the cost of installing the system and equipment, and whether the picker's hands are free or occupied by the equipment.

TABLE I. COMPARATIVE OVERVIEW OF TECHNOLOGY CHARACTERISTICS [3]

	Classic order picking	RFID	*Pick by voice*	*Pick by light*
Number of products (per hour)	<100	200-300	100-250	250-450
Costs	Low	Medium	Medium	High
Hands free	No	Yes	Yes	Yes

In the last two decades with the advent of computer systems, the application of information and communication technologies has often been proposed as an efficient solution for warehousing operations management. Recently, technology that has attracted the attention of researchers and practitioners in terms of its potential to support production and logistics processes has become an augmented reality (AR). Augmented reality involves a combination of the physical and digital worlds in real-time through a mobile device. Augmented reality is a broad term that defines a method for adding virtual elements, objects, or real-time information to the physical world. It can be supported by various technologies (e.g., computers, TV, smartphones and tablets, glasses, wearables). The term is not limited to the visual aspect, as it may also include sound or involve other senses of the user [17].

Order picking is by far the most studied area because it accounts for more than 50% of storage costs. The research that can be found in the iteration focuses on how the direction of the human operator can be improved by using AR. This is the most efficient way to point out the storage location to the picker. From an industry perspective, companies like Knapp, Intelligence DHL have started developing solutions focusing on the various hardware and software elements of AR solutions. The goal is to enable fast, error-free order picking and easy customization while managing the human operator. However, some aspects are

lacking in industrial solutions, especially about bar code readers and real-time 3D projections. Most existing solutions with wearing glasses only manage to show the equivalent of a printed picker list in front of the user's eyes. The advantages that the application of AR brings in the order picking process are multiple; some of them are [17]:

- informs the picker of the new task assigned to him
- displays the image and details of the item to be selected
- shows the storage location of the item to be selected
- shows the reading route
- indicates the physical location where the desired product is located
- notifies of errors and interruptions
- scans the product bar code to be assigned to the download cart or to see additional information
- indicates the place where each product should be placed on the sorting trolley during picking
- provides information to prevent congestion in passages
- monitoring the condition and performance of the picker.

In the research, which consists of interviews with practitioners, the interlocutors identified seven characteristics that are very important for the future adoption and success of augmented reality applications. Table 2 summarizes these characteristics. As for research and the development of technology, further research is needed.

TABLE II - THE REQUIREMENTS EXPECTED OF NEW TECHNOLOGIES [17]

Characteristic	Description
User interface	It does not require special knowledge for use, it is easy to use with minimal interactions
Ergonomics	Make the device comfortable to carry (balance, weight, etc.) and not disturb the user's view
Scanning	It should be done quickly and with high precision using a high-precision autofocus camera, bar code, or QR reader
Screen	Large enough to read information, view from a wide field, in a natural field of view
Battery	To make the battery last longer, it is not recommended to carry an optional device
Robustness	That the device can be used in an industrial environment (dust and shock resistant)
Programming	To be easy for programming

They relate to barcode and QR code readers, the delay and quality of the connected camera, the field of view, the miniaturization of existing powerful processors that do not overheat, and the robustness of the device. Most respondents generally saw good potential for AR in warehouses, especially because there are many opportunities and areas in which it could be used. Amazon's research will accelerate over the next 3-5 years. Also, the cost of AR solutions should be reduced to allow for early adoption and use. An important issue is a change in the existing way of thinking of both warehouse managers and operators who need to accept the new technology [17].

VI. THE MOST APPLIED E–BUSINESS SOLUTIONS IN WAREHOUSE

In the previous section, some e-business solutions that can be widely used in warehouses are analyzed. In this one, the emphasis will be on the solutions that have been applied in a specific warehouse. the conditions of the Coronavirus pandemic have led to a significant increase in the volume of e-commerce. Namely, some well-known world companies such as Amazon were not able to realize the increased volume of requests for their services. It is known that such companies have spent a lot of money and time to efficiently implement customer requirements. Amazon, for example, promoted the use of drones; in the conditions of the Coronavirus, more intensive application of this and many other technologies are required to increase resilience, first of all in the realization of storage activities. In their warehouse, drones are used to deliver small materials such as papers and printer cartridges. In addition, drones can be used to control stock in the warehouse. An illustration of the drone in the warehouse is given in Figure 6 [18]

Figure 6 - Drone in warehouse [19]

In addition to drones, Amazon's warehouse also uses an autonomous guided vehicle system (AGVs). These vehicles facilitate and speed up logistics activities because they transport goods independently, without drivers. The main advantages of such vehicles can be seen in the fact that they do not need the support of people in the direct execution of the task and that they do not require the construction of special and expensive paths for movement. An example of the use of AGVs in a warehouse is shown in Figure 6 [20].

Figure 7 - AGVs in warehouse [20]

Another technology that has more stake in the storage business in the supply chain is a vision pick. This technology is based on a visual display that is obtained through a wireless network from the WMS. Using the notebook, the picker receives the necessary information. Pickers wear appropriate glasses that allow them to see the list of activities in the digital format, and store them through allegations navigation systems for route optimization. The glasses also scan the bar codes from the packaging; feedback is sent back to the system by which errors are reduced to a minimum. This technology uses the universal language and requires no special operator training. It has been noticed that companies such as DHL and Samsung are investing in the development of vision pick technology [3]. At DHL, a study was conducted on the effectiveness of this technology. Operators who used this technology were 25% more efficient than others. On average, workers who did not use this technology set aside about 16,000 units of goods in three months, while those who used them set aside about 20,000 units of goods [21].

VII. CONCLUSION

Industry 4.0 solutions have significantly contributed to the humanization of a significant number of activities. In all branches of industry, the aim is to automate jobs, tasks, operations. Automation of logistics operations is especially important, bearing in mind that it requires significant workforce engagement. The Covid 19 pandemic has further contributed to the faster development and implementation of new solutions in order to shorten customer service time. In these new conditions imposed by the pandemic, there are two conflicting objectives: to reduce the interaction between people and to maintain the same competitive position in the supply chain in the strict market conditions

In the warehouse, as well as logistics subsystem, increasingly emphasizes the use of modern solutions in the process of receiving goods, stock control, order picking, etc. This paper presents only a couple of modern solutions used in these processes. A brief description of certain technologies and their potential for possible application is given. All technologies use modern appropriate software, which requires high initial investments and makes their implementation more expensive. For their implementation need to do a cost-benefit analysis and determine the viability of these solutions. These solutions are especially important in the field of humanitarian logistics; the workload of the workforce is reduced, but also the mistakes made by the human factor. Augmented reality is precisely the technology that is increasingly used to make some progress in the field of humanization of work. All this leads to an increase in profits, which measures the success of a company. Leading companies in the field of logistics are investing resources and efforts to create new technologies that would facilitate their work. The directions of further research can be focused on connecting two or more such technologies and determining their cost-effectiveness, as well as other advantages arising from their integrated implementation.

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