The Possibilities of Digitizing the Preparation Process for Shipping Batteries in a Distribution Warehouse—A Case Study

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Abstract Modern technologies are gaining more and more importance in supply chain management, leading to the transformation of its three elements: network structure, business processes and management components. Enterprises use the potential of digital technologies as sources of value and transform supply chains to varying degrees and in various ways. Certainly, the development of digital technologies is one of the sources of building competitive advantage of enterprises and supply chains in the twenty-first century and is an important subject of research. Digitalization of storage related processes can contribute to the organization receiving multiple benefits—in terms of time and cost. This type of solution will be discussed as a part of the case study in this article. The aim of chapter was the analysis of the effects of digitisation of the sub-process of preparing goods for shipment in the distribution warehouse (including picking, labelling, quantity and quality control, packaging and loading). The analysis of the research material was based on the use of the following research methods: Exide case study, key performance indicators (KPI's), as well as elements of investment profitability assessment (ROI).

Keywords Distribution warehouse · Digitization of processes · Digitization in storage · Improvement of storage processes

1 Introduction

New business circumstances are related to openness to way of operating that are different from the traditional ones (Barton and Thomas 2009; Aztori et al. 2010; Bughin et al. 2011; Columbus 2015). The ability to efficiently use the potential of digital technologies and the digital competences of organisations are becoming the

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source of competitive edge of entire sectors and economies. In 2020, the global economy saturation level will reach 25%, whereas in 2005 that was only 15% (Concoran and Datta 2016).

Contemporary logistics (an in particular the functioning of distribution warehouses), which has already become global in its nature, must be flexibility and capable quick identification of business chances brought about by new tech, including the ability to use all available information (Ballou 2007; Carmichael et al. 2011). The ever-growing scope, complexity and dynamism of logistics processes fosters the need to implement new solutions in logistics. Logistics is affecting, directly and indirectly, the economy to a higher and higher degree, and the changes within it (Barton and Thomas 2009; Detlor 2010; Coyle et al. 2010; Boyes 2016) create new challenges for logistics to face.

The growth of informational technologies and digitisation of warehousing processes have a massive impact on the way enterprises and entire economy sectors function. Among enterprises, these relations can be seen on three operating levels: (a) within the scope of creating value in new business relations; (b) within the scope of creating value in processes that use the concept of managing the customer's experience and (c) within the scope of creating the enterprise's fundamental capabilities (Dörner and Edelman 2015). In every sphere of business activity, new tech can support its growth, on one hand, and change this specific sector and the prevailing balance of forces, on the other one. Some enterprises are thus forced to expand their activity to another sector, some others to find new business models creating value in their present sectors.

Such approach aims to bring benefits not only within the area of improving production processes, but also in logistics and transport. Increasingly more often, both directly and indirectly, the new tech impact logistics within logistics processes, driving its never stopping evolution and new challenges (Wodnicka 2019).

The phenomena affecting the transformation of logistics include, among else, the ones related to economic development in global scale (globalisation and internationalisation of activity) and the digitisation era combined with the fourth industrial revolution (Industry 4.0), which bring about transformations in the way enterprises cooperate and the control of processes in the supply chain in the scale of industries and sectors (Chopra and Meindl 2007; Johnson et al. 2008; Wood 2010; Wu et al. 2016; Uton 2017). It is therefore worth listing such phenomena as:

- the use of ICT solutions, including satellite and radio identification system that enable the coordination of the flows of products and information in time and space;
- standardisation and automation of economic processes, their processes require increased discipline of deliveries and continuity of stock optimisation processes;
- product customisation, allowing the personalisation of products, requires that a higher quantity of them must be in turnover, there are more selection options, the quality and shopping convenience are accelerated, all of which implicates production flexibility, as evidenced by signals from the market, as well as the search for and development of distribution channels;

- the higher number of large area shops that keep lower stocks and require better service from their suppliers;
- the change of nature of distribution processes which, going beyond the current limits of enterprises, require the collection and analysis of data, the expansion of the chain of information resources for integrating, in real time, the data from external business partners, suppliers or clients;
- the expansion of forms of ties among manufacturers, the implementation of new business model concepts, translating into the rising tendency to outsource logistics services (the increase in the share of external service costs in the business cost structure, the alteration of the material cost structure and stock maintenance, the reduction of investment outlays and the increase of variable costs). This results from the pressure to reduce costs as an element of the growth of competitiveness of businesses (Szukalski and Wodnicka 2016);
- the reduction of the market life cycle of products which imposes temporal discipline on the production process and the process of implementation of new products, because clients do not want to wait long for new or improved products.

Based on the above, a conclusion can be made that the challenges faced by logistics are not just limited to transport or warehousing, but are also related to processes of managing and coordinating activities among companies within the supply chain, in real time—the ability to react to the rapidly changing demand.

Industry 4.0, mentioned before, means the integration of smart solutions covering the equipment and IT resources, new work methods and new roles of human resources (Schwab 2016; Word Economic Forum 2016a, b). The diffusion of Industry 4.0 is connected to three phenomena (Paprocki 2016):

- the common digitisation and maintaining continuous communication between individuals themselves, between individuals and devices and between devices themselves;
- the increasingly more often implemented disruptive innovations that allow incremental increase of efficiency and effectiveness of functioning of the social and economic system;
- achieving such a level of development of machinery that they gain the ability to behave autonomously thanks to the use of artificial intelligence in their control processes.

The rapid acceleration of developments in IT and the transposition of their use lead to the formulation of the fourth industrial revolution thesis, although it is vocally disputed whether to consider it evolution or transformation (Neubauer 2011; Cohen and Kietzmann 2014). For quite some time, ICT have been reaching a more mature form, combining physical systems with the Internet of Things, Artificial Intelligence, Big Data and cloud computing.

The awareness of the ground-breaking nature of technological solutions and the vision of application of new possibilities become a challenge for many businesses and encourages to change the paradigm of conducting business.

The following are listed among the fundamental premises (Still 2018):

- global networks connecting production plants, machinery and warehouse management systems;
- autonomous exchange of information in cyber-physical systems, within which the equipment and data bases may operate jointly and control each other;
- identifiable, real time localized "smart products" that know their own history, status and paths for reaching their destinations.

Digitization makes information and communication available anywhere, anytime, within any context, and for any user using any device and type of access (Rappa 2004; Manyika et al. 2013; Kayikci 2018; Pluralsight 2018). The functioning of modern organisation within global economy requires the use of management methods and development strategies that are adequate to the new management conditions in the stage of digital transformation. Put shortly, numerous solutions and tools are being implemented in organisations. Especially, if they function in global scale. This article presents an example of digitisation of processes in Exide Technologies S.A. It should be noted that currently, most businesses, including SME's and large businesses operating locally, regionally or internationally, support their processes with IT solutions. Although the entire process is now commonly managed with electronic tools, there is still potential, or room, for further digitisation at the level of sub-processes or even particular activities. This also applies to entities that are leaders in their respective sectors (in global view). The analysed improvement is an example of this sort of approach—namely, the sub-process of preparation of goods for shipment (a part of the process of warehousing in the organisation's Distribution Warehouse). The solution's originality and added value results from showing the identified organisational problems, the implementation of the solution and its effects in preparing shipments to around 20 European states, within the context of the global entity's experience and know-how. The article aims to evaluate the effectiveness of digitisation within the sub-process of preparing goods for shipment from the distribution warehouse.

1.1 Methodology

The article's research purpose is the analysis of the effects of digitisation of the sub-process of preparing goods for shipment in the distribution warehouse (including picking, labelling, quantity and quality control, packaging and loading).

The applied study methods included a case study and a documentation method. The case study, or analysis and description of a single, most usually real case, that allows drawing conclusions on the causes and results of its course and, in a broader sense, a given business model, market specifics, technical, cultural and social conditions, etc. This means drawing conclusions on the basis of a single case. It is a study method consisting in a comprehensive description of a certain group or a unit, approached without any initial hypotheses. The subject of exploration is individual in nature. The case study's most important element, looking from the perspective of

credibility, is the quality of its substantial content. The quality is manifested, among else, by the accuracy of the raised problems, formulated diagnoses and the adequacy of solutions proposed for a given situation (Langley 1999). The documentation method consists in the use of factual information for examination purposes, collected, in advance, for economic practice purposes and recorded in relevant documents.

The improvement project was designed, implemented and evaluated in 2019 (it took six months). The examined entity is Exide Technologies S.A.—Distribution Warehouse in Swarzędz (Wielkopolska province, Poland).

It was exploratory case study data collection method accompanied by additional data collection method such as interviews, tests etc. Advantages of case study method included data collection and analysis within the context of phenomenon, integration of qualitative and quantitative data in data analysis. Due to this approach it was possible to capture complexities of real-life situations so that the phenomenon was studied in greater levels of depth. Case studies involved both qualitative and quantitive research methods.

On one hand things were measurable and were expressed in numbers, on the other survey questions were in most cases closed-ended and created in accordance with the research goals, thus making the answers easily transformable into numbers. Used methods to collecting data: direct observation, archival records and personal interviews. The research was conducted by project team.

The improvement project is the outcome of the research. Based on the research we discovered different possibilities how to optimise the operations, how to reduce time to pick orders, but also how to eliminate activities which does not add any value.

Exide Technologies is an American multinational lead-acid batteries manufacturing company. It manufactures automotive batteries and industrial batteries. Exide's predecessor corporation was the Electric Storage Battery Company, founded by Gibbs (in 1888 year). Exide produces batteries and accessories for the Transportation markets with applications in the original-equipment and aftermarket channels for Auto/Truck/SUV, Heavy Duty, Lawn and Garden, Marine/RV, Golfcarts and Powersport, using Absorbed Glass Mat (AGM), Flooded, Enhanced Flooded Battery and Gel (VRLA) technologies. Exide also markets lithium-ion batteries for motorbikes in Europe (Exide 2020a). Exide has production plants in 89 countries and is one of the largest producers of automotive batteries in the world (Exide 2020b).

In Poland, Exide supplies batteries as the so-called first equipment to manufacturers such as: FCA Poland, VW Poznań, CNH in Płock, MAN in Niepołomice and Same Deutz-Fahr near Lublin. The Poznań-made batteries are also exported and used in the newest models of cars manufactured: by Jaguar and Land Rover in England and Slovakia (Nitra), TPCA in Kolin (Czechia), VW in Bratislava, Škoda (plant in Mlada Boleslav and Kvasiny), Volvo Cars in Belgium and Sweden, Audi (Ingolstad, Germany). Additionally, Exide makes batteries for Scania, MAN and Volvo Trucks, all made in Europe. The company's aftermarket brands are Centra and Exide. The Poznań-based producer's most important buyers are from Western Europe and the Commonwealth of Independent States (Ukraine, Moldova, Kazakhstan, Azerbaijan, Georgia and Armenia) (Exide 2020b).

1.2 Results

The analysed improvement project covered the process of preparation of goods for shipment in the distribution warehouse. It should be noted that, prior to digitization, there were multiple problems related, among else, to the use of various pallet labels, the circulation of printed documentation, determining responsibility for inconsistencies (for goods for which clients filed complaints). The result of the described change was the introduction of scanners in the picking process, standardization of the supplementation and picking of batteries, creation of a set of KPI's and monitoring of pallet movements of load units within the warehouse (Table 1).

The analysed improvement project contributed to improved parameters of the evaluation of the sub-process of preparation of goods for shipment in the organization's distribution warehouse. Most importantly, a positive change was noted with regard to the number of quantitative errors (decrease from 5.8 to 3.2%), generic errors (decrease from 3.8 to 2.1%) or the preparation of incorrect pallets (reduction to 0%). Digitization also allowed to reduce the number of employees involved in the process (from 54 to 49). Additionally, the savings for 12 months were EUR 90,000 (the cost of implementation was around EUR 35,000) (Table 2).

Referring to the analyzes related to the use of digitization in the broadly understood logistics processes, enterprises use the potential of digital technologies as a source of value and transform supply chains in various ways and in various ways. At the same time, it is pointed out that the implementation of digital technologies requires strategic changes in both the business model and the operational model of the company (Bock et al. 2017). The main challenge for the development of applications of these technologies are threats in global cyberspace, which significantly increase the negative risk regarding data security or transmitted information (Boyes 2016). Barriers to the implementation of digital technologies also include: a lack of sufficient knowledge about the nature and importance of digitization, an incorrect assessment of its potential, a lack of capital for investments in technologies and a lack of confidence preventing the exchange of information (Sherman and Chauhan 2016).

It is indicated that currently 76% of enterprises use social media, in addition 63% of entrepreneurs say that analytical tools allow them to gain a competitive advantage. As many as 92% of entrepreneurs are satisfied with the services used in the cloud and plan to increase their use, and 54% of mobile phones are smartphones (Słowik 2015).

The results of a global survey conducted by Ernst & Young indicate that managers in the area of information and communication technologies (ITC) currently spend over 25% of the budget on innovation in the field of modern technologies such as social media, mobile technologies, advanced data analytics and cloud computing (Ernst and Young 2015). These technologies contribute to improving the quality of operations and better meeting customer expectations.

Table 1 Comparison of work organization before and after the change

Work organization before the change	Work organization after the change
There were different pallet labels used in the warehouse Workers prepared batteries using only paper documents Some information on pallet labels were missing e.g. formation codes The planning of operations in the warehouse was based on paper documents/Excel files The correctness of labelling/finishing of batteries was controlled only visually (without any support from the WMS system) Voltage control results were registered on paper The productivity report was prepared in an Excel file The information on the current status of the productivity of the finishing line was not displayed on the screen/seen by the workers The complaints (regardless of the reason) were not easy to investigate for the root cause There were difficulties in implementing an action plan to reduce the number of mistakes Not enough information on the pallet labels Unclear information on who prepared the pallet (illegible signatures) Waste of time due to unnecessary travel within the warehouse (incorrect voltage in the racks, labels not available) Some ready pallets stored in incorrect places Searching for the ready pallets in the warehouse due to missing information in the documents Difficulties in assessment of the workload of a shift Difficulties in assessment and execution of productivity (poor planning based on paper documents, Excel files) Difficulties in executing correct planning and transfer of information at the turn of the shift Different responsibilities of employees	Implementation of scanners for picking Standardization of replenishment and battery picking processes Standardization of the process of picking from the storage Standardization of the label preparation process Crating sets of KPI's for monitoring productivity Creating an application for displaying results Different roles and tasks assigned to employees in the application Tracking and tracing movement in the warehouse Tracking and tracing of preparation of customers' orders Monitoring of tasks assigned to particular users

2 Conclusions

The role and importance of digitisation in business management and improving the functioning of supply chains is a topic widely discussed in the literature. The originality of the article is primarily due to the indication of a practical example of improvement in one of the leading battery manufacturers—Exide Technologies.

Table 2 Evaluation of digitization of the sub-process of preparation of goods for shipment

KPI's	Before the change	After implementation of scanners
Average number of batteries picked by a picker	428	467
Average number of batteries labelled per finishing line	890	997
% of complaints (errors in qty)	0.058	0.032
% of complaints (errors in type)	0.038	0.021
% of complaints (errors in loading wrong pallet)	0.0001	0
No. of mistakes when preparing reports	12	3
Reduction in paper consumption	60	55
No. of employees needed for the process	54	49
Savings in EUR (12 months)		90,000
Money spent (in EUR) on the project	35,000	
ROI	1.57	

The distribution warehouse serves customers from over 20 European countries. The indicated picking solutions have contributed to shortening the time of preparation of goods for shipment, reducing the number of process errors and reducing the costs.

A conclusion can be made, on the basis of the conducted analyses, that the digitisation of processes leads to a multi-dimensional transformation of the nature of the entire supply chain that is subject to virtual imaging through the continued collecting, processing and monitoring of the data from all cells.

Economic changes within the process of digital transformation and the evolution of business relations mean that companies wanting to compete effectively on global markets, thanks to the organization of supply chains, must give crucial importance to their flexibility and its ability to implement innovative business models along with the reorganization of processes. This will ultimately allow for achieving higher levels of digital maturity, which will translate into greater efficiency in the functioning of supply chains during the period of digital transformation—significant changes are already visible in the reconfiguration of logistics processes and business communication.

Referring to the benefits of research, it is worth noting that digitization can contribute to improving the functioning of the organization. This is of significant importance especially at the operational level, where it is possible to study in detail the functioning of individual work stations. Which is also to some extent related to the improvement of the organizational structure from the bottom, as IT tools are usually implemented at the strategic level. However, when it comes to certain limitations of research analyzes, they are primarily associated with the study of a single

organization, which also means that the results of similar activities in other enterprises can generate completely different results. In the aspect of future research, the authors will focus on increasing the research sample of business entities to obtain a broader perspective of potential benefits and threats from the digitization of logistics processes.

It should be noted that even global enterprises have a large potential to introduce improvements with the application of digital tools within sub-processes and operations (parts of the warehousing process in this example). The described solution contributed to improvements both in quality (reduction of errors) and in costs—reduction of time needed to prepare the goods for shipment or the involvement of employees. In the view of global crisis situations (COVID-19 pandemics), this may play a big role for the organisation's survival.

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