ASSESSMENT OF THE MANAGEMENT OF WAREHOUSING PROCESSES IN A MANUFACTURING COMPANY USING THE *WERC* EFFICIENCY MODEL

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Annotation

The article examines the possibilities of evaluating the management of warehousing processes of a manufacturing company using the WERC efficiency model. It has been established that assessment models based on quantitatively determined indirect indicators, which can be calculated and interpreted in different ways, are mostly used in scientific works and practice. The assessment model used in the study includes more direct indicators, which by comparing them with the reference values of the best practice allow to better identify problems in the management of warehousing processes and monitor changes in this activity.

Key words: *Warehousing process, sub-processes, management of the warehousing process, WERC model.*

Introduction

Recently more often than ever the broken supply chains and the volatile consumer market make it important for production companies to have a warehouse. A warehouse is one of the most important places in a production company - it ensures the ability to perform supply, production and distribution functions (Minalga, 2008). It is not only a storage place for raw materials or finished products, but also one of the most important links between the company producing the product and the end user. However, just having a warehouse is not enough; it is important for companies to take into account the logistics processes taking place there not only the costs are incurred to ensure them, but also the added value is created for the company. Many processes or the management of these processes can be made more efficient improved and thus save the company money and time. Therefore, warehousing issues are constantly relevant for companies from determining the amount, place and time of stock storage to the efficiency of processes. According to S. Khafili and M. Lotfi (2015) warehouses play an important role in taking care of available resources and supply. Proper warehouse adaptability can provide a high level of customer satisfaction without interrupting the flow of supply and demand. N. Pontius (2018) also supports that of any size warehouse optimization is the key to efficient warehouse management. Warehouse optimization includes solutions to save time, space and resources while reducing errors and improving flexibility, communication, management and customer satisfaction. The aspects of resource and time saving and management are especially relevant for production-type companies with warehouses. Not only the warehouse premises must be important for companies, but also the storage itself the processes and operations taking place in the warehouse and their management. According to V. Davidavičienė (2012), proper management allows the company to improve the performance of complex processes. Only effective management of storage processes which includes planning, organization and control enables the warehouse to work efficiently, economically and with greater added value.

Every manufacturing company strives for its warehouse to meet the highest standards of efficiency, to be modern and up-to-date. Although, it seems that these problems can be solved by implementing information technology, it is also useful to improve the management of warehouse processes. Many warehouses often face problems related to inefficient use of warehouse space, poor supply planning, delays in stock information etc., but there is no unified methodology for evaluating warehouse processes. The Warehousing Education and Research Council (hereinafter *WERC*) has the greatest experience in this field which has been summarizing the accumulated experience in this field in special guides since 1977. They can be used by businesses and other organizations seeking to evaluate and effectively manage warehousing processes worldwide.

The aim of research. The evaluation of the management of the warehousing processes of the production company is carried out by applying the *WERC* efficiency model.

Tasks of research:

1. To examine the evaluation models of management warehousing process and it's sub-processes applied in business enterprises.

2. To evaluate the management of warehousing sub-processes by applying the *WERC* guide model on the example of the furniture production company.

The research was carried out by combining the qualitative research strategy with the calculations of certain quantitative indicators that allow to evaluate the efficiency of warehouse process management. The methods of analysis, observation and semi-structured interview research of company documents (raw material warehouse plan; waybills, invoices, warehouse parameter documents) were applied. Data analysis was performed using the benchmarking method.

1. Warehousing sub-processes, their management and potential problems

The most important warehousing sub-processes are the reception of material flow, transfer to storage, storage, collection, packaging and shipping (R. Banelienė, R. Strazdas *et al.* 2020). V. Popovas (2013) has a different approach and distinguishes the sub-processes of unloading and initial cargo acceptance, cargo acceptance according to quantity (final) and quality, transportation inside the warehouse, transfer to storage and storage, order preparation and dispatch, order transportation and forwarding, collection of loose goods carriers and delivery. Each sub-process is important to ensure proper warehouse operation and efficient storage.

Initial receiving is one of the most important initial sub-processes in warehousing. R. Palšaitis (2010) states that unloading from vehicles, registering information about stocks, identifying defects, checking the amount of cargo according to the waybills and issuing various documents takes place in this sub-process. Other authors (Zinkevičiūtė, Vasiliauskas, 2013) also attribute unloading to this sub-process. According to R. Banelienė, R. Strazdas *et al.* (2020), the initial receiving sub-process is understood as the transfer of goods to the warehouse. D. Sapronienė and S. Paškel (2014) indicate that acceptance can be understood as determining the identity, quantity and quality of goods.

The receiving sub-process is of great importance to the operation of the warehouse because it is from it that the storage itself begins. In this sub-process it is important to prevent potential errors as they can remain unresolved and accumulate throughout the storage process. Some of the most common potential problems in this sub-process are related to improper transfer of information, lack of qualification of employees, failure to verify factual information. For example, warehouse workers should be able to check whether the required shipment and quantity have been received. Also, whether the delivered cargo has no defects or quality problems. It is important to ensure that the loads are assigned to the correct racks and have identification numbers. Failure to do so or doing it incorrectly can have a negative impact on all subsequent operations (Banelienė, Strazdas *at al.* 2020).

Planning, organizing, leading and controlling make up the management of the admission process. It is important to plan the admission sub-process in advance after receiving the documents accompanying the cargo. In addition, it is important to assign a storage location in advance so that it does not happen that there is no place to store the arrived cargo because the warehouse is overloaded. It is also important to properly organize this sub-process: employees must know in advance what kind of cargo they need to unload and where. Managers must ensure that all necessary information about the received cargo reaches lower-level employees. Control is also important after receiving the cargo it is important to ensure their quality and check the necessary information because there are cases when the cargo is unidentified the necessary information is not transmitted to other departments.

Transfer to storage is the next sub-process after initial receiving. It is a sub-process during which products are delivered to a place for their storage (Palšaitis, 2010). V. Zinkevičiūtė and A. Vasiliauskas (2013) point out that at this stage proper technical equipment with loading equipment is very important because then it is possible to give the stocks for storage as soon as possible. V. Popovas (2013) said that it is important to pay attention not only to suitable means of loading, but also to the duration of transportation. It should be minimal and the route line as straight as possible. R. Banelienė, R. Strazdas *et al.* (2020) state that the optimal place in the warehouse should be chosen. In this sub-process the cargo travel to the places prepared for them which are assigned during the receiving sub-process. As it was mentioned, if in the previous sub-process, the place for storing the cargo was not chosen properly, decrease in the work productivity of the warehouse is possible. The lack of free spaces and storage space information systems that would help assign (preferably automatically) the most optimal place to store cargo is another common problem in this sub-process. For example, sometimes goods are placed where there is free space in smaller warehouses so when searching later you can forget where it was placed wasting time.

Appopriate management allows for the optimal execution of the sub-process of transfer to storage. The organization function is very important at this stage especially in large

warehouses. The warehouse team needs to be well organized in order to properly manage large cargo flows. In addition, it is important to ensure process control: the arrival of the cargo at the storage location must be visible in the business management system.

Storage is the third sub-process that forms the "core" of warehousing. The goods are stored in the appropriate place of the warehouse during it (Zinkevičiūtė, Vasiliauskas, 2013). V. Popovas (2013) points out that there are two groups of principles that allow optimal storage of goods:

1. Principles of equipment use as the equipment must ensure the maximum utilization of the height of the building and the appropriate determination of working areas is important.

2. Principles of storage as the place must have an individual code; it is useful to store seasonal storage goods higher, large goods are stored closer to the entrances etc.

The storage sub-process is one of the most significant warehousing sub-processes as its duration can be very long. Also, according to R. Palšaitis (2010), the warehouse of a production company occupies from 30 percent up to 35 percent all company territories so the loads must be placed efficiently and optimally to take up as little space as possible. However, various problems may also arise in this process: the warehouse space is not fully utilized, the accounting of the stored cargo is not carried out etc. Adequate conditions for cargo storage may not be ensured thus the cargo may be damaged.

The management of the storage sub-process is simpler because it does not require complex organization or management, but periodic control is important. Periodic accounting must be kept, the warehouse must constantly know how many and what kind of cargo is stored, how many free places are available etc. Knowing this data makes it easier to plan the admission for storage and collection sub-processes would be simply impossible without this data.

Another warehousing sub-process is *collection*. It is the sub-process by which production quantities are collected from storage areas, packed and prepared for shipment (Janilionis, 2015). Several collection methods are known such as single order collection, batch collection, zone collection and undulating collection (Bahrami, B., Aghezzaf H., Limere, V., 2019). J. Bartholdi and S. Hackman (2014) state that in many warehouses this sub-process consumes the most labor resources. It is also one of the most cost-intensive sub-processes difficult to automate, to plan and the largest part of the cost is the travel time to pick up the cargo (Richards, 2014). R. Banelienė, R. Strazdas *et al.* (2020) emphasize that this sub-process aims for accuracy as it helps to reduce the costs required for this sub-process.

The management problems arising in this sub-process can be very expensive in terms of funds, labor resources and time due to the too long journey to the desired cargo. Also G. Richards (2014) points out that a very common problem is the inappropriate selection of the collection method. Another problem can be the lack of information for the workers when they do not see the list of the loads to be collected. Therefore, proper planning of this sub-process is very important, the loads must be completed according to the prepared plan and the most optimal route must be selected. In addition, the organization and management of work is important, optimal distribution of routes between employees can significantly shorten transportation time. *Packaging* - putting materials into a package for consumption, storage and transportation of products (Visuotinė lietuvių enciklopedija, 2021) as shipment formation is often mentioned in the literature (Zinkevičiūtė, Vasiliauskas 2013) is a sub-process during which stocks are assembled to order and prepared for delivery to the customer. The goods are collected, packed, then loaded into the shipping area and labelled. Instructions for carrying out loading work, transportation, sender and recipient information, package contents are specified (Palšaitis, 2010). It is important to ensure in this sub-process that the product will be maximally protected from damage when it is taken out of the warehouse. There may be problems with packaging due to choosing the wrong packaging or additional packaging that may not even be needed at all. Also, companies sometimes have unused loading equipment, manual work still prevails, which reduces efficiency and complicates work.

Selection of process planning, suitable packaging allows to ensure that the process will run optimally. Proper organization and management in this sub-process allows you to save time when packing products and control allows you to avoid errors and damaged goods during packing.

The last, but not least warehousing sub-process is *shipping*. This sub-process is final. According to R. Banelienė, R. Strazdas *et al.* (2020) shipping includes sorting, loading, sending to the right customer and on-time delivery. G. Richards (2014) points out that efficient and proper loading, utilizing the entire trailer is very important in this sub-process. This is especially relevant due to the increasing costs of transportation such as the price of fuel and various taxes.

Problems encountered in this sub-process are due to mistakes made in other sub-processes. Packages may not be properly packed, not fit in trailers etc. In addition, problems can also arise during loading into the vehicle if the warehouseman is not well qualified; the

cargo can be damaged and it can also be put in the wrong way. It is also important to inform the customer about the already arriving cargo.

Managing this sub-process is critical to ensuring that customers receive their shipments on time. Proper planning ensures that the cargo will not be collected too late. Organization and management - that the cargo will arrive at the loading point on time. Control is also required to avoid errors such as mix-ups or damage when loading onto vehicles.

In summary, it can be said that all warehousing sub-processes are important and have great significance in ensuring the proper functioning of the entire company's logistics system. It is known that the largest costs are incurred in the collection sub-process. Warehousing sub-processes are closely related to each other so if mistakes or problems are made in one sub-process the same mistakes or problems can persist in other sub-processes. It should be noted that it is the successful management of sub-processes that ensures that the warehouse will work flawlessly. In addition, process management must include all processes together they must be coordinated with each other, for example, proper planning in the storage sub-process facilitates the receiving and collection sub-processes.

2. Evaluation models of managing of warehousing

Several warehousing sub-processes and their management evaluation models can be singled out, most often found in the scientific literature. Lithuanian scientists I. Meidutė ir A. Vasiliauskas (2007), V. Popovas (2013) provide simpler ways to evaluate of warehousing sub-processes and their management (see Table 1).

Table 1

Evaluation criteria for warehousing sub-processes

Criterion	Explanation
Quantity of storage space units	Shows the stock level of the given product in the warehouse
Number of orders per time unit	Shows the number of orders to be processed - the amount of production selected for further processing during one production reception.
The number of orders processed per unit of time	Shows system productivity.
Flexibility	It shows whether the warehouses have the possibility of adaptation which would allow processing not one type of stored product, but a wide range of it or the type of product that is currently in the highest demand.
Order fulfilment time	Shows the time required to process a complete order.
Time required for assembly	Shows the maximum time required to complete an order.
Employment rate	Shows at what loads the given subsystem can still work in coordination with other subsystems.
Structural flexibility	Shows how the warehouse can react to ongoing changes in the range of stored products.
Level of automation	Shows the level of warehouse automation.
Use of human resources	It shows how many and what categories of employees are needed for the normal functioning of the system.

Source: compiled by the author based on I. Meidutė and A. Vasiliauskas (2007, pp. 15-18).

Based on the criteria presented in Table 1 it can be stated that I. Meidutė and A. Vasiliauskas (2007) focus mainly on qualitative criteria combining them with relative (quantitative) indicators and recommend them for evaluating warehouse operations. Also, the authors mention that it is important to set goals and only then to choose the appropriate evaluation criteria, according to which to evaluate processes and warehouse activities. The greatest attention is paid to the criteria of time, because one of the most important things in warehousing is to reduce the waste of time in unnecessary operations.

V. Popovas (2013) provides even more evaluation criteria for warehousing sub-processes (receiving, storing, packing, sending, etc.). The author focuses more on quantitative (relative) indicators such as the work productivity of individual activities and the share of inefficient work (errors), the average value of cargo processing, the duration of the logistics cycle and turnover. The volume of cargo handling in the warehouse, intensity of movement, warehouse capacity, capacity and efficiency of space utilization for operations are also evaluated.

One of the best-known warehousing process management models is V. Popovo's (2013) *structured analysis and design technique* (SADT), which reflects the four functions of warehouse management: planning, organization, control and regulation and their characteristic elements (see Table 2). The warehouse logistics process begins with planning. In this model planning has 12 input elements (process indicators) and 7 output elements. Effective planning begins with a general warehouse cost plan, inventory level determination, company plan, etc. In order to organize the planned logistics process of the warehouse, 3 elements are necessary: the plan-schedule of deliveries to the warehouse, the requirements for the unloading of goods and the services provided by the warehouse. The following elements of the organizational

function are important for proper control: execution of the goods dispatch schedule, execution of the goods delivery schedule, control of customer service costs, warehouse operating costs, customer service indicators and accompanying documents. In order to properly implement the regulation of the warehouse logistics process the following control elements are required: delivery schedule (deviations), cost level (deviations), customer service level (deviations). The model shows that management functions are closely related to each other - without regulation it is impossible to properly plan storage and vice versa. Based on this model it is possible to evaluate the management of the company's warehousing processes by evaluating each element of the model separately, for example, stock levels or service delivery policies.

Table 2 presents the process indicators of the management model. Many of them are focused on determining and measuring stock levels and costs and making continuous adjustments.

Table 2

Warehouse logistics management processes and their indicator

Nr.	**Planning**	**Nr.**	**Organization**
1	total warehouse costs (plan)	9	development of a storage system
2	stock levels	10	division of warehouse space into zones
3	company plan	11	the prices of services provided
5	service provision policy	12	information about norms
6	customer orders	17	plan-schedule of deliveries to the warehouse
7	orders to suppliers	18	requirements when unloading goods
8	information about competitors	19	services provided by the warehouse
33	cost level adjustment	30	adjusting deliveries
34	adjustment of the service complex	31	cost level adjustment
35	adjusting plans	32	adjusting the level of customer service
Nr.	**Control**	**Nr.**	**Regulation**
13	expenses	27	delivery schedule (deviations)
14	customer orders	28	cost level (deviations)
15	contracts with suppliers	29	customer service level (deviations)
16	normative acts		
21	shipment of goods according to the schedule		
22	delivery of goods according to the schedule		
23	customer service costs		
24	warehouse operating costs		
25	customer service indicators		
26	accompanying documents		

Source: V. Popovas (2013, pp. 85)

Thus, the quantitative assessment of management processes enables to determine which process is problematic, inefficient and to look for gaps in process management. However, a qualitative assessment is also necessary. J. Azavedo et al. (2015) state that the evaluation of warehousing processes can be divided into "hard" and "soft" metrics. "Hard" for example, it is the time of collection of orders, prices, etc. And "soft" for example, the manager's insights, his personal assessment of processes, user satisfaction, etc. The authors claim that these are direct and indirect indicators that allow a correct and objective assessment of storage processes and their management. Direct indicators are time, quality, price and productivity which help to evaluate storage efficiency are presented in Table 3 and indirect indicators are shown in Figure 1.

Table 3

Direct indicators for evaluation of management of storage processes

Direct indicators	
Time indicators	*Quality indicators*
Order delivery	On time of delivery
Admission	Customer satisfaction
Assembly	The accuracy of assembly
Delivery to store	Cargo damage rates
Delivery	Emission rates
Rows	Perfect deliveries
Loading	The accuracy of storage
Equipment downtime	Stock rates
Price indicators	*Productivity indicators*
Inventory	Work
Order processing	Throughput
Work	Shipping
Distribution	Use of transport
Supervision	Use of the warehouse
	Assembly

Direct indicators	
	Inventory space utilization
	Turnover
	Receipt

Source: compiled by the authors based on J. Azavedo et al. (2015, pp. 23-30).

These indicators make it possible to evaluate the management of warehousing processes and find out whether the management is effective and appropriate. For example, productivity indicators allow you to evaluate work, throughput, shipping, transport utilization, warehouse utilization, turnover, etc. After receiving the results, it is possible to draw conclusions about whether the process management is efficient or perhaps, for example, the transport is not filled enough so its use is managed inefficiently, unsuitable loaders are chosen for placing cargo in warehouses, etc.

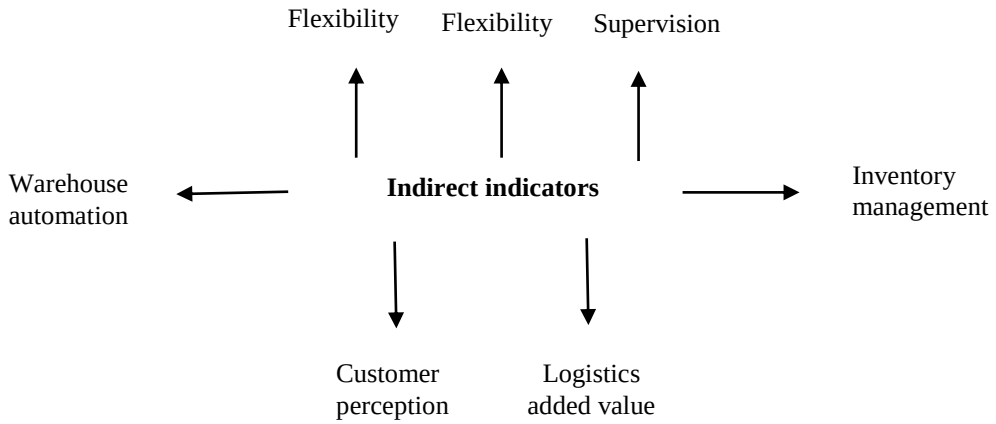

Figure 1. Indirect indicators for the evaluation of storage process management. Compiled by the authors based on J. Azavedo et al. (2015, pp. 23–30).

Indirect indicators which are significantly fewer than direct indicators are presented in Fig. 1. Automation, flexibility, work, maintenance and other indicators are distinguished. J. Azavedo et al. (2015) also mention that it is difficult to define a threshold for classifying indicators. For example, some indicators have the same names but are measured differently. Researchers usually focus on direct indicators both prices and productivity, but they also include indirect indicators in the models. In addition, the authors note that when evaluating these indicators different mathematical tools can be used to evaluate the obtained data. The authors claim that indicators usually have to be translated into equations that would be suitable for analytical models. In addition, it is possible to create a suitable evaluation model for yourself which would be suitable for a specific evaluated company, etc.

G. Richards (2014) provides criteria and norms for storage processes based on the *WERC*[1] efficiency model. According to the presented indicators and the determined median of their values and the average indicators of other companies, it is possible to assess the efficiency of storage processes in a specific company (see Table 4).

Table 4

Warehouse process evaluation indicators according to G. Richards (2014) based on *WERC*

Indicator	Median (in percent)	Top 20 (in percent)
Index of perfect order (POI)	95	>99
Order cycle	24 hours	<8 hours
Accuracy of order collection	99.5	>99.9
Ready for shipping on time [2]	99	>99.9
Average warehouse capacity in use	85	>92.2
Staff turnover	5	<0.1
Ratio of total work to productive work	85.1	92
The cycle from discharge to storage[3]	8 hours	<2.2 hours
Lines collected and shipped within 1 hour.	28 lines/hour	>74.2 lines/hour
Boxes collected and shipped within 1 hour.	67.5 boxes/hour	160,6 boxes/hour

[1] Angl. *Warehousing education and research council*
[2] Angl. *On-time ready to ship*
[3] Angl. *Dock-to-stock*

Indicator	Median (in percent)	Top 20 (in percent)
Pallets collected and sent within 1 hour.	15 pallets/hour	>28 pallets/hour
Inventory reduction % of total available inventory	0.3	<0.01
Accuracy of inventory count	99	>99.9

The author emphasizes that such traditional indicators show efficiency only at a certain point in time. They are useful for comparing performance over time, but due to a variety of constantly changing internal and external environmental factors it is worth considering and reviewing storage goals and measures and changing them with the changing environment. It is important not to forget the management itself as processes can run inefficiently due to poor process management, but first you need to evaluate the warehousing processes and then the process management.

According to the *Warehousing education and research council* (2007) even more indicators can be found that can be evaluated both qualitatively and quantitatively. The model is based on the benchmarking theory the main principle of which is comparative analysis and monitoring - comparing with other companies and improving own processes. In addition, the author advises to select only the indicators needed by the company and to calculate only them when evaluating warehousing efficiency.

WERC publishes guides (2007) that help companies select the necessary indicators and check them against the guide against best companies, process practices, etc. It should be noted that the guide uses both quantitative and qualitative evaluation methods. For example, in order to evaluate the acceptance process, it is indicated that the labelling of cargoes should be evaluated. The guide provides best practices for labelling cargo and recommends quantifying POIs. Such a combination of quantitative and qualitative methods allows for an objective assessment not only of the storage processes themselves, but also of process management as well.

In summary, it can be stated that many authors suggest to evaluate storage processes and their management by calculating quantitative indicators combining them with qualitative ones preferring direct indicators comparing them with already established norms or practices.

3. Research methodology

Research organization and progress. The research was carried out in the warehouses of raw materials and finished products of a furniture manufacturing company. The investigation was carried out from 07/03/2022 until 04/07/2022 The research data were collected weekly and monthly according to the terms stipulated in the company's internal document management rules. A total of three document types were selected. The data presented in the documents were collected and processed within three days from the date of receipt of the documents.

Research ethics. The company's management was informed about the benefits, risks and significance of the study before the study started. Consent to use company data received. Since the interview method was also used the researchers ensured that the warehouse manager participated in the study voluntarily and his verbal consent was obtained.

Research strategy, data collection and analysis methods. A quantitative study was carried out including aspects of the qualitative study from the *WERC* model which are relevant for the management of the storage process of a manufacturing company. Five main sub-processes of the warehousing process were chosen for the study: receiving raw materials, putting them in storage, storing, collecting, packing and shipment. Different information is collected by different methods. The main method of data collection was an unstructured interview with the warehouse manager to obtain data on communication with suppliers, periodicity of transportation, warehouse management problems, etc. The observation used to evaluate warehouse management is an observation protocol which records the results of five observations of all the studied processes. Analysis of inventory reports and other company documents was used to identify stored raw materials and determine the level of raw material stocks. Relative indicators were calculated and analyzed in order to evaluate the percentage of fulfilled orders, the utilization of warehouse capacity and equipment. For the qualitative part the data was analysed based on the criteria of words, context, internal consistency, frequency, intensity of comments and accuracy of answers. The main categories of responses of the interview participants corresponding to the purpose of the study have been distinguished. The result of the study was evaluated by choosing the option that best matches the company's situation in the table of the research instrument from poor to best practice on a ranking scale from 1 to 5: 1 – poor practice (PP), 2 – insufficient practice (IP), 3 – normal practice (NP), 4 – good practice (GP), 5 – best practice (BP). The research data of individual sub-processes and the entire storage process were summarized in comparison with the indicators determined by the *WERC* guide and presented visually in diagrams.

4. Analysis of research results

During the monitoring, it was found that the investigated production company has three warehouses of different purposes: raw materials, semi-finished products and finished products. The study was focused on the warehouse of raw materials since it is one of the most important places of the company on which other processes in the company depend. According to the documents provided by the company the area of the raw material warehouse is ~2240 m^2. The company does not measure warehouse capacity, the total warehouse occupancy is about 95 percent. The warehouse has two raw materials unloading places: the first place is with a ramp; the other place is without a ramp where the truck can end up entering the warehouse. There is a special area at the unloading points to unload the raw materials and organize them before they are ready for storage. The raw materials are then sorted and assigned storage locations. The warehouse is divided into certain zones which are denoted by letter values. Also, the warehouse is divided according to the stored raw materials since the raw materials warehouse contains three main raw materials – wooden parts, fabrics, leather as well as parolone and sintepon. Raw materials are placed as close as possible to the workshop that will need the raw material such as cloth and leather raw materials are kept as close as possible to the sewing room. There are also requirements for stored fabrics - they cannot be stored vertically. The company uses multi-location racks.

Scanners are used to select raw materials and scan barcodes. This is done in order to have a proper accounting of raw materials, as well as for the employee to find raw materials more easily, not to lose them, etc. The company has special software for warehousing.

During the research period, the company had to receive 604 cargoes, of which 399 cargoes were fully received, 122 were partially received and 83 were not received. The total amount of cargo received in units was 1 162 407 (including units, meters and kilograms).

The study evaluated individual storage sub-processes using the *WERC* guide. An interview was conducted with the warehouse manager. The researchers identified the option most appropriate to the company's situation in the table of the research instrument from poor to best practice (see Table 5). The maximum possible score was 45; company's warehousing process scored 40 points. Based on the answers provided the most suitable score was assigned marked with a plus. When choosing the right option, the monitoring protocol, the interview with the warehouse manager and the documents received from the company were taken into account.

Table 5

The results of the assessment of the raw material receiving sub-process

Evaluation table						
The field is evaluated	PP	IP	NP	GP	BP	Company's experience (selected according to *WERC*)
	1	2	3	4	5	
Control of the ramp				+		The vehicles are unloaded at regular intervals usually every 2 hours, but the warehouse workers do not make a plan for the movement and parking of the trailers on the site of the company's territory in advance.
Transactions					+	Receipts are processed immediately with the stock received.
Labeling of products					+	All products are labelled and have barcodes that can be scanned into the system with the assignment of storage locations. Labels are often affixed by the supplier himself.
Advanced communication with suppliers			+			Suppliers send notifications via traditional methods (email, fax, etc.).
Process					+	There is joint responsibility for physical unloading and cargo inspection. There is personal responsibility for inventory accuracy. The process of receiving raw materials is well documented.
Inspection					+	The results of the inspection process are communicated to suppliers and carriers, return procedures are initiated.
Distribution of goods			+			Hand-made lists, distribution according to current orders, informal process.
Indicators					+	Formal performance indicators are established and tracked and indicators are shared with suppliers. Receiving errors are tracked; there is a clear standard for how the company's internal indicators should be published and shared with employees. The published information is used for continuous process improvement.
RFID					+	It has and uses RFID scanners.
Scored:					**40**	

Ramp control was evaluated first. The warehouse manager's response was that vehicles are unloaded at periodic intervals, usually every 2 hours, which equates to best practice. However, the warehouse workers do not make a plan for the movement and parking of the trailers on the site of the company's territory in advance, and this is just a good practice. A lower score was chosen because the best practice lacks a plan for the flow of trailers in the company's territory. The company avoids downtime when unloading vehicles. Further, after analysing the transactions and labelling of the products it was found that the company meets the highest standard. After examining the communication with suppliers, it became clear that the company does not have an automated notification system, only a traditional one, so this is considered a common practice. The process itself in the company is arranged properly, the acceptance sub-process is well documented in the IT system. Cargo inspection in the company takes place continuously and when defects are found, the results of defects are reported to suppliers and carriers, return procedures are initiated and it should also be noted that defects are noted in the cargo documents. In addition, the company pays attention not only to the quality of raw materials received, defects, etc., but also informs suppliers if their packaging is unsafe, does not meet standards or is damaged (even though the raw material is not damaged). It is important to mention that the company constantly collects such indicators of the acceptance process - how many loads arrived on time, how many partial loads arrived, etc. Also, each employee tracks the indicators of personal achievements, which are coded and published on the warehouse board. This enables the employee not only to see his progress and work results - the warehouse manager can better control the employees and motivate them for good personal results. This allows for better management of warehouse processes related to employees, etc. The company scored 40 points out of 45 possible. A comparison with the results determined by the *WERC* model can be seen in Fig. 2. Here, as previously mentioned, benchmarking is used, otherwise comparative analysis.

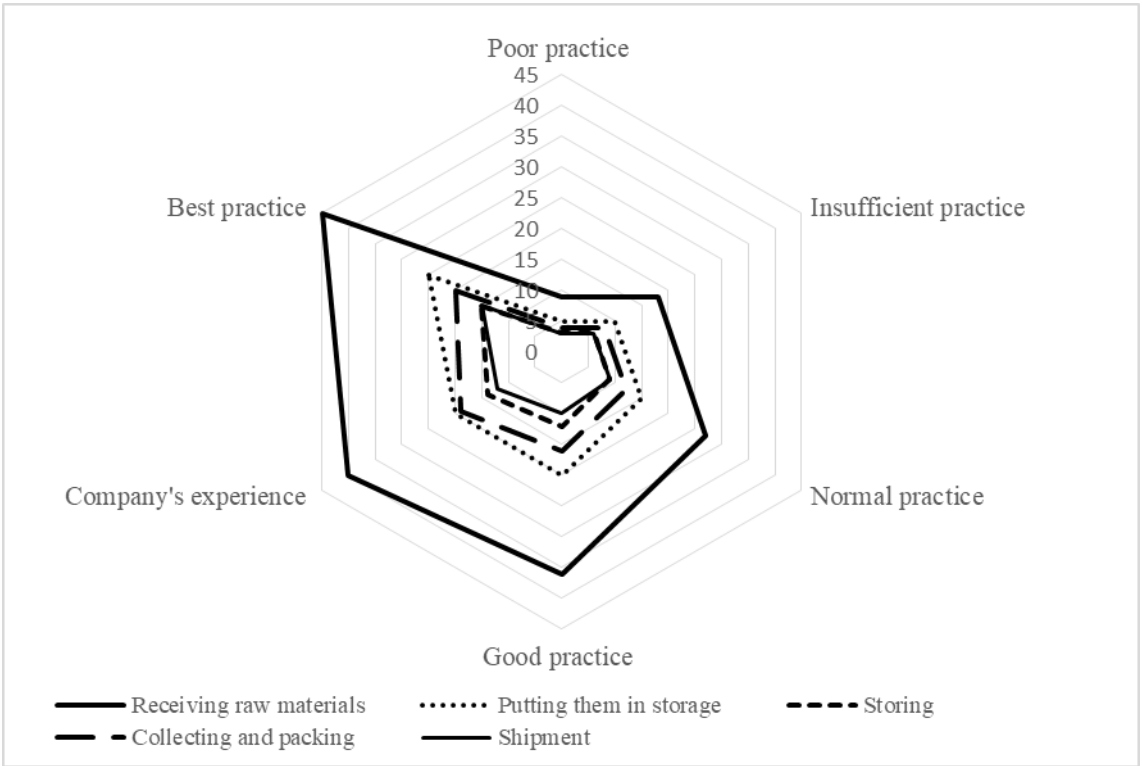

Figure 2. Comparison of company scores for warehousing sub-processes with *WERC* guide reference values.

Table 6 below presents the results of raw material receiving process indicators. It can be seen that the company received all 100 percent of the receipts during the research period. This is a best practice. The company does not calculate POIs during the investigation it was also not possible to objectively calculate POIs due to the fact that the completed orders are administered by another department and due to the lack of data.

Table 6

The results of the raw material receiving sub-process indicators

Indicators of cargo receiving and initial inspection sub-process						
Indicator	**PP**	IP	NP	GP	BP	Company's experience (selected according to *WERC*)
Receipts received on time	<85%	>=85%; <91.4%	>=91.4%; <95%	>=95% and <98%	>=98%	100%
POI	<86.92%	>=86.92%; <95%	=95%; <98%	>=98%; <99.48%	>=99.48%	—

It can be concluded that the receiving process is managed properly and efficiently. For an even smoother process management in the receiving department attention should be paid to communication with suppliers and distribution of goods. In the further stage the sub-process of raw materials placing in the storage was evaluated. The maximum possible score was 25. The results are presented in Table 7. We can see in it that the company handles raw materials properly they are managed efficiently because the warehouse has a zone system and the raw materials are arranged so that they are as close as possible to the required work centre. The manager of the warehouse identified one of the problem areas of the warehouse as maintenance of order and cleanliness. Although the amount of damaged cargo is small and there are no major safety concerns. The cleanliness maintained in the raw material warehouse is not sufficient. It was also observed during the investigation that the workers do not return the forklifts to their designated place after work, but leave them in rows between the racks the loads are also not fully loaded and are simply left in the rows until the next day.

Table 7

The results of the assessment sub-process of raw material placing in the storage

Evaluation table						
The field is evaluated	PP	IP	NP	GP	BP	Company's experience (selected according to *WERC*)
	1	2	3	4	5	
Materials handling					+	Flexible and efficient material handling.
Order and safety			+			Inconsistent cleanliness, many problem areas, low amount of damaged cargo, no safety concerns.
Putting it in place		+				Manually selected locations, clear stopping points and zones.
Indicators					+	There is a clear standard for how the company's performance indicators should be published; the published information is used for continuous process improvement.
Product identification					+	Product labelling is consistent, all products have barcodes.
Scored:					20	

The company scored 20 points out of 25 possible. The company's result is in line with good practice (see Fig. 2). After automation by installing an IT system in the company that would automatically assign a place to the cargo the result could be significantly improved. Also, the company's management should pay attention to maintaining order and cleanliness in the warehouse ensuring that employees take care of cleanliness, order and equipment. This is an improvement aspect of the management of the raw materials storage process.

Table 8 below shows the results of the indicators of placing in the storage area, where the utilization of the equipment is an important indicator.

Table 8

The results of the indicators of sub-process raw material placing in the storage

Indicators of the sub-process of raw material placing in the storage						
Indicator	PP	IP	NP	GP	BP	Company's experience (selected according to *WERC*)
Use of equipment	<40%	>=40%; <65%	>=65%; <76.08%	>=76.08%; <89.2%	>=89.2%	64.25%

The study calculated the utilization rate of forklifts as warehouse equipment. The calculation revealed that the utilization rate of the company's loaders is 64.25%. This represents insufficient practice, but it is important to pay attention to the data obtained. It was found that two loaders no. 10 and no. 12 work only 1.5 and 2 hours per day respectively. It is

recommended for the company to review whether it would be possible to abandon one of these loaders thus making the use of the equipment more efficient and the process of warehousing and storage. After receiving the results, it can be said that the storage process is managed well (see Fig. 2), but the management of sub-processes could be made more efficient by automating the assignment of cargo placement. It is also recommended to review the use of equipment.

Another extremely important sub-process is the storage of raw materials itself. The results are presented in Table 9. A maximum of 15 points could be scored.

Table 9

The results of the assessment of the sub-process of raw materials storage

Evaluation table						
The field is evaluated	PP	IP	NP	GP	BP	Company's experience (selected according to *WERC*)
	1	2	3	4	5	
Location management					+	The warehouse management system (WMS) is adapted to various loads. SVS is integrated into the company's activity monitoring process. Storage areas are regularly reviewed to ensure the best access and the right size. Good rack filling.
Storage control system (SCS)				+		SCS is integrated with the business management system into one common system. Non-integrated transport system.
Storage strategies					+	JIT and Kanban are used in the company. Effective programs for redundancy reduction and management.
Scored:					14	

The storage process is perfectly manageable (see Fig. 2). The raw material warehouse space management is excellent, as the SCS is adapted to various loads and the racks are well filled. In addition, the company constantly reviews its inventory and realigns storage locations as needed. In addition, such raw materials as fabrics must be reviewed, as they lose their properties and become non-liquid when stored for a long time. The raw materials warehouse also carries out preventive excess reduction operations in order to keep only the necessary cargo in the warehouse.

This company‘s sub-process scored 14 points out of 15 possible. A comparison with the results determined by the *WERC* model is presented in Table 10. The company's result in the storage process is excellent. The maximum result could be achieved by improving warehouse process management and integrating the transportation system with other systems.

Table 10

The results of the storage sub-process indicators

Indicators of the storage sub-process						
Indicator	PP	IP	NP	GP	BP	Company's experience (selected according to *WERC*)
Average warehouse capacity utilization	<78%	>=78%; <85%	>=85%; <87%	>=87%; <95%	>=95%	—
Peak warehouse capacity utilization	<90%	>=90%; <95%	>=95%; <98%	>=98%; <100%	>=100%	—
Accuracy of stock count	<95.6%	>=95.6%; <98.4%	>=98.4%; <99.3%	>=99.3%; <99.9%	>=99.9%	95.56%

It should be noted that it was not possible to calculate the capacity indicators since the capacity of the raw material warehouse is not known and the company does not measure it. The calculated average of the indicator (95.56%) is equivalent to poor practice - the company should increase the accuracy of inventory calculation, perform periodic inventories more often. In summary, it can be said that the storage process is well managed in the company, but due to the large volume of data, errors in calculations are possible, so it is necessary to improve their accounting.

Another sub-process was consistently assessed raw material collection and packaging (see Table 11). The packaging sub-process is rarely performed in raw material warehouses as few packaged goods are shipped from this type of warehouse. 20 points were the maximum that could be scored for these two processes.

Table 11

Evaluation results of the raw material collection and packaging sub-process

Evaluation table						
The field is evaluated	**PP**	**IP**	**NP**	**GP**	**BP**	**Company's experience (selected according to *WERC*)**
	1	2	3	4	5	
Strategy and methods					+	The collection strategy is optimized, using undulating collection and task nesting.
Tactics and equipment					+	Collection locations lag behind demand (mostly separate locations). There is specialized automated equipment to reduce the time for assembly and packaging. Ergonomic workplaces.
Collection documents				+		Collection tasks are released in “waves”, scanners are used.
Productivity					+	Productivity targets are set and measured to achieve productivity gains against target.
Scored:					19	

From table 11 it can be seen that the collection and packaging process is also perfectly controlled. The raw material warehouse uses optimized assembly strategies, special equipment is used - the warehouse has a forklift that can climb to the top of the racks with a person. There are also performance indicators for recruitment: the company has set productivity goals and is constantly striving for them. This sub-process of the company scored 19 points out of 20 possible. The company's result compared to the results determined by the *WERC* model is also excellent (see Fig. 2). The maximum result could be achieved if the company collects collection sub-process data every day (for example, how long it takes to collect one cart of raw materials, etc.) and involves employees (pickers, assemblers) in continuous improvement programs.

Summarizing the obtained results, in order to improve the assembly and packaging process, the company should pay attention to the work performance of warehouse workers and start collecting data in order to determine the current situation and set goals for the future. Also, by systematically collecting performance indicators it will be possible to manage employees and at the same time the processes taking place in the warehouse more efficiently.

The sub-process of shipment raw materials from the warehouse was analysed last. This sub-process in the warehouse is encountered when the semi-finished products are transported to the subcontractor and then returned to the warehouse. These operations are handled by the raw materials warehouse. The obtained results are presented in Table 12.

Table 12

Evaluation results of the sub-process of shipment raw materials and semi-finished products

Evaluation table						
The field is evaluated	**PP**	**IP**	**NP**	**GP**	**BP**	**Company's experience (selected according to *WERC*)**
	1	2	3	4	5	
Shipment					+	From the collection and packaging area the cargo travels sequentially to the shipment. A unified system is used, orders are tracked and updated in real time. Many shipping sub-process operations are automated.
Transport management				+		All shipments are tracked through carrier systems. Electronic proof of delivery is available after each pickup.
Productivity management	+					The carrier and the productivity of his work are not monitored.
Scored:					10	

As shown in Table 12, the shipment sub-process in the company is less well managed. The manager of the warehouse should pay more attention to the management of work productivity, since the carrier and his work performance are not monitored, which is especially important when solving the issues of order delays and defective transportation. Modern IT systems allow cargo to be tracked using GPS etc. However, an important aspect is that this is a warehouse of raw materials, so shipments are very rare so a poorer result may be due to a lack of experience. This company's sub-process was rated 10 points out of 15 possible. A comparison with the results determined by the *WERC* model can be seen in Figure 2: the company's position is between normal and good practice. Better cargo tracking could significantly improve the outcome. Table 13 below shows the indicators of the shipment process. Since the raw material warehouse ships almost nothing, the percentage of fulfilled orders is 100% and the percentage of orders without damage is also 100%.

Table 13

The results of the shipment sub-process indicators

Shipment sub-process indicators						
Indicator	PP	IP	NP	GP	BP	Company's experience (selected according to *WERC*)
Percentage of completed orders	< 92%	>=92%; <96%	>=96%; <98.5%	>=98.5%; <99.3%	>= 99.3%	100%
Percentage of completed orders without damage	< 96.24%	>=96.24%; <98.5%	>=98.5%; <99%	>=99%; <99.8%	>= 99.8%	100%

In summary, it can be said that the shipping sub-process is the worst managed, but if the company considers performance management and improves transport management, it is possible to make the process more efficient and better controlled.

The general result of the study of all processes is presented in Fig. 3.

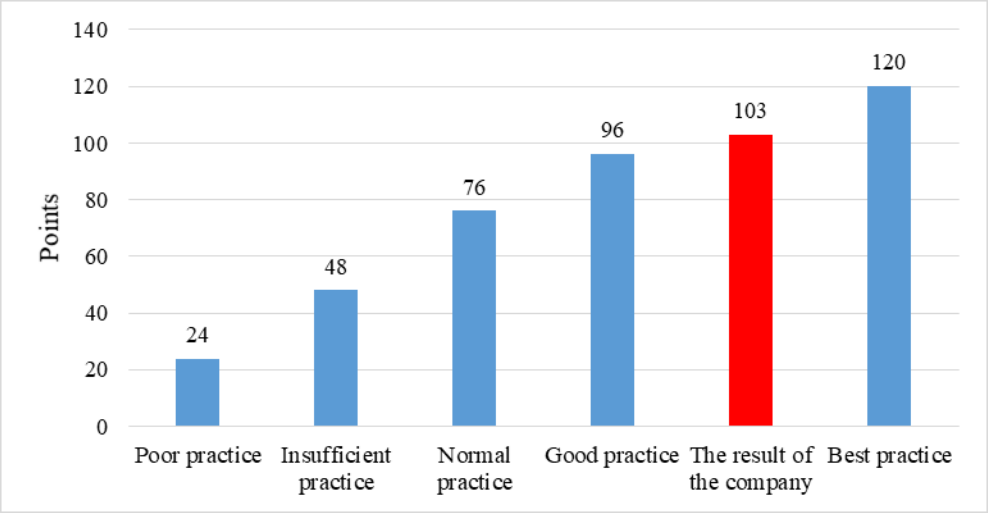

Figure 3 Comparison of enterprise warehousing process management (summarized) results with the *WERC* guide.

The research data was obtained after the analysis and the generalized result of the company was determined by evaluating the management situation of each warehousing sub-process in the company. The management of the company's storage processes was evaluated with 103 points out of 120 possible. By comparing the obtained results with the *WERC* guide, it is possible to see how efficiently the processes are carried out in the raw material warehouse. The more efficient the management of each sub-process is, the better and more efficient the whole storage process is, because all sub-processes are interconnected. The results of the study also showed which sub-process management is worse and requires improvement: the dispatch process is determined in the case of the study, as it does not meet the standard provided by the *WERC* guide. If the research was done only in general, i.e., separate sub-processes are not examined, it would not be possible to see this since the generalized processes of the raw material warehouse would be evaluated. There would be no possibility to evaluate such significant sub-processes as transport management or the application of collection methods and strategies etc., which are specific and require different evaluation criteria and indicators. After evaluating the management of these sub-processes, it can be stated that the management of the processes is appropriate in the investigated company since the indicators and the information recorded during the monitoring meet the requirements of good practice established in the *WERC* guide.

Conclusions

Management of the warehousing process (including sub-processes) can be described as a sequence of actions and communications including processes related to the movement of products, goods in the warehouse; as well as planning, organization, control and regulation of actions and communications. Warehousing processes are of great importance in ensuring the proper functioning of the logistics system of the entire company.

Qualitative and quantitative evaluation models for warehousing process management are available. Qualitative one of the most commonly applied is V. Popova's structured analysis and design method model, which reflects four management functions; quantitative models -

indicators and their sets presented by J. Avazed, I. Meidutė, A. Vasiliauskas and other authors. A mixed research model based on the *Warehousing Education and Research Council's* guidance can also be applied, which includes qualitative and quantitative components and allows for a very detailed assessment of the management of warehousing processes.

Most of the company's warehousing process management is adequate as determined by the investigation. Possibilities for improving these processes have been clarified after carrying out an assessment of warehousing processes according to the *WERC* guide: in the management of storage processes it is necessary to improve the maintenance of order and cleanliness of the warehouse, the implementation of modern IT systems, data collection for the continuous improvement process of warehouse processes and their management, and the improvement of transport management aspects in the management of storage processes since they are the weakest aspects of managing the company's warehousing processes. Processes of storage, collection and packaging are managed best in the company as the highest number of points were obtained in the evaluation of these processes. Also, the inventory count accuracy rate was calculated by analysing the storage process, which met the high criteria according to the *WERC* guide

The study confirmed that the *WERC* evaluation guide is appropriate and can be applied in determining the efficiency of warehousing management in a manufacturing company.

References

1. Azavedo, J., Sahin, E., Cursi, J., Silva, D., Follmann, N., Di Mascolo, M., Rodriguez, C., ir Alpan, G. (2015). Global warehouse management: a methodology to determine an integrated performance measurement. Grenoblie: Université Grenoble Alpes.

2. Bahrami, B., Aghezzaf H., ir Limere, V. (2019). Enhancing the order picking process through a new storage assignment strategy in forward-reserve area. Žiūrėta 2021-11-09 internete: EBSCO.

3. Banelienė, R., Strazdas, R., Dzikevičius, A., Maceika, A., Paulienė, R., ir Toločka E. (2020). Pramonės įmonių valdymas: inovacijomis ir lyderyste grindžiamas pridėtinės vertės kūrimas kūrimas. Vilnius: Vilniaus Gedimino technikos universitetas.

4. Bartholdi, J. J., ir Hackman S. T. (2014). Warehouse & Distribution Science. Atlanta: Georgia Institute of Technology.

5. Davidavičienė, V. (2012). Verslo procesų vertinimas ir informacinių technologijų rizikos valdymas. Vilnius: Technika.

6. Janilionis, V. (2015). Logistikos centro cilindrinių automatizuotų transportavimo sistemų kūrimas ir tyrimas. Daktaro disertacija. Kaunas: Kauno technologijos universitetas.

7. Khafili, S., ir Lotfi M. M. (2015). The optimal warehouse capacity: A queuing-based fuzzy programming approach. Journal of Industrial and Systems Engineering. Prieiga per internetą: http://www.jise.ir/article_8740_0c83bab990b19e209eba7f049d794912.pdf.

8. Meidutė, I. ir Vasiliauskas A.V. (2007). Sandėliavimo logistika. II dalis. Vilnius: Firidas.

9. Minalga, R. (2008). Aprūpinimo logistika. Vilnius: Mykolo Romerio universitetas.

10. Palšaitis, R. (2010). Šiuolaikinė logistika. Vilnius: Technika.

11. Pontius, N. (2018). What is Warehouse Optimization?. Prieiga per internetą: https://www.camcode.com/asset-tags/what-is-warehouse-optimization.

12. Popovas, V. (2013). Sandėlių valdymas ir veiklos efektyvumas. Klaipėda: Klaipėdos universiteto leidykla.

13. Richards, G. (2014). Warehouse management. A complete guide to improving efficiency and minimizing costs in the modern warehouse. 2nd edition. Londonas: Kogan Page Limited.

14. Rubinas, V., ir Lileikis, S. (2018). Sandėliavimo šaldytuvuose technologinis procesas. Akademinio jaunimo siekiai: ekonomikos, vadybos, teisės ir technologijų. Įžvalgos 2018 XV-osios tarptautinės studentų mokslinės-metodinės konferencijos straipsnių rinkinys. (p. 218-221). Klaipėda: Lietuvos verslo kolegija.

15. Sapronienė, D., ir Paškel, S. (2014). Logistika. Šiauliai: Šiaulių profesinio rengimo centras.

16. Visuotinė lietuvių enciklopedija. (2021). Pakavimo sąvoka. Žiūrėta internete 2021-11-09: https://www.vle.lt/straipsnis/pakavimas/.

17. *WERC* and supply chain visions (2007). Warehouse and fulfillment. Process benchmark and best practises guide. Prieiga per internetą: http://nklabs.gr/wp-content/uploads/2015/10/werk_prototype.pdf.

18. Zinkevičiūtė, V. ir Vasiliauskas V. A. (2013). Gamybos logistika gamybos vadyba. Klaipėda: Socialinių mokslų kolegija.

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