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FLOW OF GOODS IN THE WAREHOUSE MANAGEMENT SYSTEMS–PROBLEM ANALYSIS

A b s t r a c t: The main subject of the article is managing of warehouse flow processes. Various technologies have been presented to support works performed through the entire supply chain. Which is aimed at reducing the time needed from the moment of receipt of the goods to its release. Increasing the efficiency of warehouse operations and reducing the cost of maintaining and operating the facility. The article also introduces the concept of intralogistics as applied to internal systems.

K e y w o r d s: storage systems, warehouse management.

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1. INTRODUCTION

In the twenty-first century, we can see a growing desire to get rich among the society. Progressive consumerism contributes to the need for dynamic development of storage spaces and innovative devices necessary to improve their service. Currently, it is difficult to find a product that is not stored at least once on the way to its final destination around the world. This made warehouses one of the most important links in the supply chain. Warehouse management is responsible for product storage, order picking and controlling flow of goods. Which makes it a key element in distribution processes. One of the tasks of logistics in this area is to deliver freight, in a specific quantity and quality, at the right place and time. Obtaining the desired efficiency of these processes is possible by minimizing the total costs of operations and ensuring the expected level of warehouse service. Due to the organization of the warehouse's work and its efficient operation, it is important to properly arrange the goods in the storage

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area so as to improve the cycle of implementation of warehouse operations and properly arrange the goods in the warehouse. Location of warehouse space depends on the specifics of the enterprise to which it will belong. The distribution of warehouse space of large enterprises depends on the transport infrastructure of a given agglomeration and the availability of free land. Other criteria for warehouse location are used in production plants. The production processes use raw materials that, in order to ensure smooth production, should be collected in appropriate quantities in a place from which they can be quickly delivered to the production line. And thus, the distance between storage warehouses should be as small as possible in relation to production facility. Owning a warehouse is associated with high financial and operating expenses and costs incurred for the provision of additional services, which is why many smaller companies use the storage space of other distribution centres. Warehouses, regardless of their location in the logistics system, must receive and at the same time provide a set of necessary information regarding the quantity of goods available and the demand for them in a given storage space. It is important that the information provided reflects the actual state of the warehouse. Storage systems support movement and work in warehouses. The flow of goods in storage systems is therefore aimed at improving all processes related to the receipt, storage, completion and release of goods.[1][7]

2.RECEIVING GOODS

Acceptance of goods to the warehouse involves having the necessary documentation confirming the transfer of cargo, the process of unloading the goods and its further registration in an internal IT system. Then the product is subjected to identification and pre-sorting, in which the most important feature of the division are storage conditions. An important element is also quality control, thanks to which it is possible to check the compliance of the supplied range with the requirements. The goods are accepted into the warehouse for further storage on behalf of the appropriate institutions and units. Without an efficient system inside the warehouse, its smooth operation would be almost impossible, and the use of traditional methods is more likely to make a mistake and increases the amount of work needed to perform the same activity. These factors influenced the development and introduction of innovation when accepting goods into warehouses. [8]

One of the systems supporting the receipt of documents is the automatic data collection system (ADC). It is used to collect and collect data in a direct way, i.e. one thanks to which we do not have to use the keyboard to enter them. One of the technologies used here is voice control equipment. Its use provides an easy two-way communication between the computer system and its user. This significantly improves logistics management by optimizing logistics processes, automating

warehouse work and monitoring supply chains. The use of ADC techniques significantly improves logistics communication and improves the functioning of the entire system by exchanging information between system users in real time, reducing the workload and the time needed to complete individual operations. It also allows you to quickly locate goods in large areas and reduce costs associated with process optimization. The role of warehouse systems for automatic data collection is, among others, supporting communication between the warehouse and the supplier by assigning an appropriate unloading gate, depending on the means of transport and the transported goods. It organizes the reloading process and allows to increase the efficiency of unloading gates. The factor that should determine the choice of gate for unloading is the smallest distance that unloading units must cover between the reception area and the final location in the storage area. This gives you the ability to quickly arrange goods in the warehouse and reduce the time needed for unloading.

When receiving the goods, it is important that all documents provided by the manufacturer and the information contained in them related to the specificity of the products are in the system and are consistent with their actual condition. The improvement of this process is influenced by the introduction of automatic identification devices: barcode readers, scanners, terminals, printers. Data collection in databases gives the possibility of efficient editing of required documents and their exchange with other external IT systems. This allows for the elimination of human errors that arose using traditional methods during data entry. A unique bar code is assigned to each product that will be accepted into the warehouse. After reading it, we have data such as: product name, batch number, manufacturer's name, production date, and in some cases the product's expiry date. The terminals are equipped with barcode readers and communicate with the central database by radio. With their help, operators read the system suggestions for the location from which to pick up or to which the goods should be put away. The operator confirms putting the unit back to its final location by scanning the appropriate barcode label.[3][6]

3.STORAGE OF GOODS

Storage of goods is a process in which the accepted load is allocated the right place in the warehouse. Appropriate planning of product placement is necessary to increase the efficiency of warehouse operations. For this purpose, the goods are classified into groups that meet their common criteria. Among the methods and tools used for the classification and distribution of products in the warehouse can be distinguished those that take into account only one criterion, or those that take into account their greater number. Their proper selection depends on the order picking method and product storage system.[6]

Internal transport means are used for efficient communication between different sectors of the warehouse space. Implementation of them increased the efficiency and effectiveness of operators' work. Thanks to automated vehicles it is possible to move more goods at the same time. What's more, the ever-evolving technology allows the introduction of vehicles that do not need to be used by people. Traditional used equipment converted into transport trains, i.e. tractors with the platform and transport applications. This concept allows to minimize empty transport routes. The trolleys are automatically loaded thanks to the Pick-by-Light / Put-to-Light technology, which by means of a visual signal indicates the exact place in the warehouse where the material is needed. In this case, the employee only supervises the processes related to the movement of products inside the warehouse. Products with smaller dimensions and weight can be transferred using drones. Drones have been developed in Pennsylvania that do not need external navigation systems to navigate the warehouse. The machines have a built-in VGA camera and an inertial location system. To transport larger products, the drones connect to assemblies. The university is still working on improving the algorithm so that the system automatically provides the operator with information about the number and type of drones that move objects to the destination. Another solution is automatic high-bay warehouses, in which the role of forklift operators is taken over by warehouse stackers handling pallets on racks up to 40 meters high. When the goods are released into the automated part of the warehouse, they are introduced to the conveyor system. On the way to the storage area, the system tracks the movement of the pallet, while checking the distribution of the same range on the storage racks. The corridor with the least goods is selected. This arrangement allows you to eliminate downtime at work caused by the failure of one of the stacker cranes. After selecting the corridor, the system allocates a storage place where the goods will be located, while generating for the stacker the task of transporting the pallet to the previously reserved storage place. The location of loads is also managed in this case by the IT system. It tracks all warehouse transfers and generates them itself, so if the pallet does not reach its place, the system will signal this fact to the employee. He manages comprehensively entered data: expiry dates of raw materials and products, deadlines for production orders and customer orders. In this way, the time required to load delivery vehicles is significantly reduced. Transport orders are generated and we proceed to prepare all order items, leading to a situation in which the operator's task is only to transport the prepared pallets to the vehicle.[7][10]

Another important process is sorting products, which allows you to position the cargo in such a way as to optimally use the space of the warehouse. The products are arranged in such a way as to reduce the expiration losses as much as possible and in accordance with the FIFO (First In First Out) principle. Thanks to this, no downtime is created in warehouses. The introduction of innovation

in this sector meant that the system itself creates inventory and a distribution map. Thanks to this, employees have continuous insight into the changes that are made during the flow of goods and are able to fill the gaps that arose through its rotation faster. The system also has space for automatic shelving that has become an alternative to traditional shelving. They allow easy access to goods through the introduction of automatic material search, which reduces time losses in the implementation of transport tasks and minimizes completing errors, improving warehouse processes. Another advantage is the limited storage space. Automatic shelving is also used in administration and in the pharmaceutical industry. These solutions focus mainly on intralogistics, i.e. internal logistics defining the flow of materials in the logistics chain within its section from point A to point B, ensuring minimization of flow time, reduction of excessive inventory and elimination of unnecessary movement of goods. The purpose of these activities is to conduct efficient production without large warehouses, both raw materials and finished products.[11][12]

4.ORDER PICKING

Order picking is one of the most important processes taking place in a logistics center proving its efficiency. It is an activity related to the preparation of orders, its purpose is to collect and combine items located in different loading units to create a customer order. It always occurs when a combination of parts, packaging or products is necessary. Nowadays, due to the growing interest in making orders via the Internet, we are facing an increase in the number of order lines, a shorter and shorter time required to complete a customer order, and a still increasing amount of goods flows in the warehouse. In connection with the above, it is necessary to find a suitable solution that will not only improve the order process, but which will also optimize costs.[13]

Order picking support will be provided by a proper computer program, it will improve process efficiency and reduce human errors. The priority task of such an IT program is to present guidelines to the warehouseman. The guidelines must contain a list of items to be issued, as well as information from which location the goods should be prepared for the given warehouse goods issue. The picking route in the warehouse should be planned so that the employee does not have to return to the same places for the order items several times, therefore the IT system is responsible for creating a list of goods to be collected in order to present the optimized picking route of all parts from the client's order . This way, in large-scale warehouses, where forklifts are used, proper route optimization contributes to large savings associated with reduced fuel and energy consumption, as well as increases work efficiency. The overall goal of the system is to make it easier for the warehouse worker to complete whole order in the shortest

possible time without human mistakes. An auxiliary tool is the terminal used by the employee. The terminal displays a list of goods and indicates their location in the warehouse to which the warehouse worker goes and reads the bar code from the item. The installed application on the device controls on an ongoing basis whether the picking process is being carried out successfully by displaying relevant messages. Accordingly, the terminal's scanning of the correct or incorrect product bar code will result in the release being approved by the IT system and the worker will be able to proceed with further orders or the release will not be approved. The picking process uses bar codes as well as more advanced RFID (Radio Frequency Identification) functions, i.e. technology that uses radio waves to identify people and objects remotely. The great advantage of the RFID system is the ability to use the reader to determine whether the entire order has been correctly completed, then the cargo when issued from the warehouse is automatically saved in the system passing by RFID gates. There is no need to rescan manually as it is done with traditional labels. The implementation of an appropriate IT system in the magazine, supporting the order picking process, allows for shortening the picking time, reducing the number of paper documents, eliminating human errors and makes the process more mechanized.[2][5]

5.GOODS ISSUE

The issue of goods involves the transfer of goods to the recipient and is the last link in the storage process. Ready to go product can be created in the process of assembling with single units or in the same form as received at the warehouse.[4]

The goods issue in the warehouse system is carried out by the document Goods Issued Note which register new goods releases. This document is filled at the enterprise to prove the completed sales operation, it contains information such as the buyer's data, invoice number, order number and article data, based on which the load can leave the warehouse. The above-mentioned document must be confirmed by a legible signature of the person authorized to issue the goods. The aim is to completely replace paper documents with electronic documentation, where it would no longer be necessary to sign on paper, and it would be transmitted electronically using a suitable touch device. Then it is proceeded to pack the products in order to the transportation to their final destination. Packaging of goods is primarily used to protect the contents from damage, as well as to protect the environment if the goods are harmful. The formation of such units contributes to the increase in the efficiency of using means of transport and definitely facilitates the order relocation process. The cargo is packed according to the guidelines given by the customer containing information such as: type of carrier, size, weight, way of marking the unit and its protection against devastation. The packaging process can be fully or partially automated with the

help of innovative industrial equipment. Collaborative robots named "Cobots" introduced by Rethink Robotics are equipped with multiple sensors, memory, and are designed to perform more complex movements. The robot is designed to memorize the movements that is initially taught by a human operator. It is ideally suited to perform simple, repetitive tasks. These devices are an excellent tool for carrying out, for example, packaging operations. By using this technology in the warehouse, you can save employees time, which they can use for other tasks at any given time so it contributes to increase efficiency of supply chain. As it is reported by GEODIS company in one of its articles, it has introduced the Sawyer robot to one of its Italian warehouses, which is used to carry out equipping operations and joint packaging. Another optimal way to save space and loading time is to use pallets, i.e. platforms lifted by special machines - forklifts. The goods should be placed on a pallet in such way to maximize the use of its surface, as well as that all products are correctly positioned without creating obstacles which is absolutely necessary so labels or other codes are visible for proper and easy identification. Industrial robots used in automatic palletization allow placing one or several items on a pallet at a time, after needed preparation, this also applies to the entire layer of products. Thanks to the mechanization of the sector responsible for final packaging, it is possible to increase efficiency, pace and safety of work, as well as to prevent or significantly reduce the time of loading delays resulting from manual operation of the process. [14][15][17]

The goods issue process consists in collecting the appropriate number of loading units, checking the compliance of mass and quantity with the delivery order, packing then transferring it to an authorized person, i.e. the Carrier or the consignee's representative for further transport. The release of goods operation is the last step in the storage process.[16]

SUMMARY

Smooth flow of goods in warehouse systems is possible thanks to modern technology implementation into the functioning of supply chain. It allows to increase efficiency of warehouse processes. It changes character of employees work and reduces warehouse maintenance costs. In case of inefficient cargo handling due to lack of goods or delays the entire supply chain can be paralyzed. The introduction of machines affected precision and repeatability of their activities. Robots also don't need any breaks, which gives the possibility of 24 - hour warehouse operation. Thanks to high storage technology, warehouses limit their space and climb up. Modern methods due to the complex nature, difficulty and implementation costs are not widely used by enterprises. However, they are used as elements of internal systems supporting the work of warehouses. Which makes systems automation speeds up various tasks and allows to eliminate most of human errors.

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