

**INFLUENCE OF MODERN TRANSPORTATION DEVICES ON THE
COMMODITIES FLOW IN HIGH CEILING WAREHOUSES
WPŁYW NOWOCZESNYCH URZĄDZEŃ TRANSPORTOWYCH NA PROCESY
PRZEPIYU TOWARÓW W MAGAZYNACH WYSOKIEGO SKŁADOWANIA**

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Streszczenie: W artykule przedstawiono problematykę przemieszczania towarów w nowoczesnych magazynach wysokiego składowania. Szczególną uwagę zwrócono na zagadnienia związane z automatyzacją obiektów magazynowych, a także porównano je z klasycznymi, obsługiwanymi i zarządzanymi przez ludzi przestrzeniami składowania towarów. W części praktycznej artykułu przedstawiono korzyści płynące z automatyzacji na przykładzie dużych potentatów branży żywnościowej i handlu internetowego.

Abstract: The article presents the issue regarding commodities flow in modern high – ceiling warehouses. It is focused on matter concerning warehouses automatization which were compared with the manual stores. The practical part of the article shows benefits of using automatic devices in warehouses on example of huge food and e – commerce enterprises

Słowa kluczowe: magazyn wysokiego składowania, automatyzacja, urządzenia transportu bliskiego

Key words: high – ceiling warehouse, automatization, material – handling equipment

INTRODUCTION

During last two decades the storage of goods influenced on the anatomy of many enterprises, which ought to improve the efficiency of their management system by using: quality policy, targets focused on quality, audit results, data analysis, correcting activities and management review (Świdorski 2011). Modern conceptions of production and supply management such as JiT (Just in Time) supposed sustaining as small quantity of goods as possible, in order to reduce costs of storage (Szymonik, 2013). On the other hand development of e – commerce and still growing customer expectations makes keeping more storage reserve obligatory. Due to that fact that operators are very dependent on their environment, which requires greater sensitivity to the changes taking place in it (Foltin, Gontarczyk, Świdorski and Zelkowski, 2015). In connection with that there is more focus on high – ceiling warehouses, which are not perceived as the weakest link of supply chain.

The aim of the article is the analysis of modern material – handling devices used in automated high – ceiling warehouses. There were showed the advantages of that solution in order to manual controlled movement facilities in classic storehouses, when the main role in commodities rotation is still given by people.

During preparation of this article many research method were used, including literature analysis (which was extracted to present functioning of high ceiling warehouses and their cargo – handling equipment), descriptive modelling (used in describing gathered information) and synthesis (allowing sum up the article and draw the conclusion).

1. TRANSPORTATION PROBLEMS IN HIGH CEILING WAREHOUSES

The high ceiling warehouses belongs to the specific structures, which height causes a lot of problems connected with storage, essentially with the internal movement of commodities. In spite of that their amount is still growing, because the cost of extending warehouse surface in level is more expensive than vertical (Bartosiewicz, Waśniewski, 2015). In order to stillage capacity and size there is obligatory to use a specific transportation devices and implement particular stores management methods to provide efficient flow among the warehouse areas. In connection with that there are three types of transportation problems in high – ceiling objects.

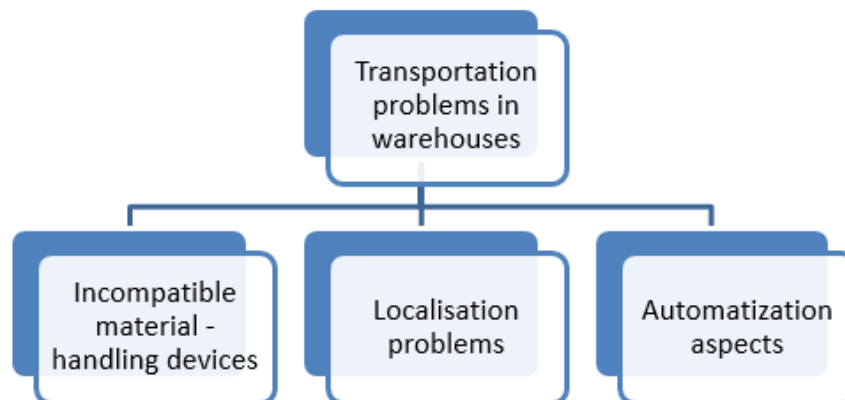


Fig. 1. Types of problems in warehouses

Source: own compilations

This problems could be characterized by:

- problems caused by inappropriate transport devices and their lack of compatibility with the stillages (in case of forklifts – having too short mast) or insufficient movement abilities, which limits their operations in the storage area (e. g. during reversing among racks with commodities);

- localization problems, come from the lack of information regarding commodity location. This kind of problems makes storage operations much longer because there is no option to find it quickly on the warehouse stock and give it back to the picking zone;
- problems connected with the lack of automatization of material – handling devices used in high – ceiling warehouses (applying manual steered devices causes more wastes of time).

The first group of problems occurs in storehouses built at the beginning of XXIth century, which were pioneers in the field of high – ceiling warehousing. That objects were not automatized at all, because system of transportation devices was not taken on board during designing of its construction, but only at the end of the building. As a consequence the storage areas of that warehouses was equipped with high stillages, but without appropriate movers and conveyers to put the goods on or out of rack. The role of that specific devices is handed over to the forklifts, which have limited features determined by following factors:

- height of lifting, amounted to maximum 15 meters;
- limited view of the operator, who is not able to properly estimate localization of forks of device and taking commodity, especially when it is stored up on heights over 10 meters;
- necessity of making complicated moves with the devices, particularly in storage zones, where the surface between stillages is not big enough (problem does not occur, when lateral forklifts are used);
- risk of damage warehouse construction while putting on and off or moving the commodities.

Second group of problems occurs in warehouses mostly manned by people, where computer management system is restricted to the data recording and reporting. Inside not – automated high – ceiling objects smooth commodities flow is possible only when particular workers of storage zone are constantly deployed to their areas. It is necessary to realize capable movements of stored goods, because this workers are crucial in localizing pallets put on the stillage (especially in places, which are situated out of the eyeshot). In case of warehouses with the big diversity of the stock, localization of the commodities is impossible without computer tools support (exception storehouses, where special forklifts with lifted operator cab are used, which makes him able to look on the packet mark at every level of stillage).

The last group of problems connected with the automatization concerning the time wastes, caused by the lack of the automatic solutions improving efficiency of work in warehouses. It is vital aspect of commodities flow optimization in high – ceiling objects and it should be weigh against modern supply management methods. It is directly connected with necessity of abiding by deadlines of deliveries and reduction of storage operations costs. Manual steered transportation devices cannot fulfil that requirements, because they generate wastes in following phases of warehouse flow:

- putting commodities on the stillage;
- putting commodities off the racks;
- movement between the storage, picking, entrance and release zones.

That is the reason to use material – handling devices, which parameters are dedicated to work in high – ceiling warehouses and could equally influence on many aspects of efficiency, such as: energy – intensity, material consumption and economic (Łagowski, Świdorski, 2016) of processes holding within that storehouses.

2. CHARACTERISTICS OF MATERIAL – HANDLING DEVICES

Material – handling devices used in modern warehouses could be divided into two following groups:

- automatized devices dedicated to the particular type of storehouse and cooperating with IT tools optimizing storage operations;
- manual steered cargo – handling devices.

The second group of devices is consisted of almost all material – handling equipment exploited in warehouses during the last few decades. It contains self – propelled and hand – operated facilities. The first one involves following devices (compiled on the base of data presented by Office of Technical Inspection – UDT):

- cranes;
- warehouse booms;
- forklifts;
- roll and belt conveyors.

Hand – operated devices, which are being powered by people muscles or by using the gravity, contains following facilities:

- manual forklifts;

- gravity conveyors.



Fig. 2. Gravity conveyor, moving commodities by using the g – force.

Source: www.primacon.pl

Automated material – handling devices are an integral part of the warehouse management system and a storage building, but only when they are matched with the particular object. In connection with that most of actual built storehouses are geared with full – automated cargo – handling system, which is planned during the construction designing. However, it is possible and profitable to reorganize and rebuild older warehouses. Automated warehouse of the Salvesen Logistica enterprise (the leader of the food distribution in the Spanish market) could set an example of such modernization. That high – ceiling storehouse is an integral part of the logistic center in Sevilla, which was rebuilt by Polish producer of the material storage solutions to the full – automated object. The entrance zone was fitted with the automatic unloading system, which is able to unload one semitrailer into two minutes (data comes from the Mecalux Company, producer of that solution). Commodities moved from the truck are transported by roll conveyors to the checkpoint, which checks their condition, dimensions and weight. Then the pallets with goods are sending to the storage zone by the

gravity conveyors, which move it directly to the area of working automatic stacker cranes, responsible for putting them on and off the stillage.

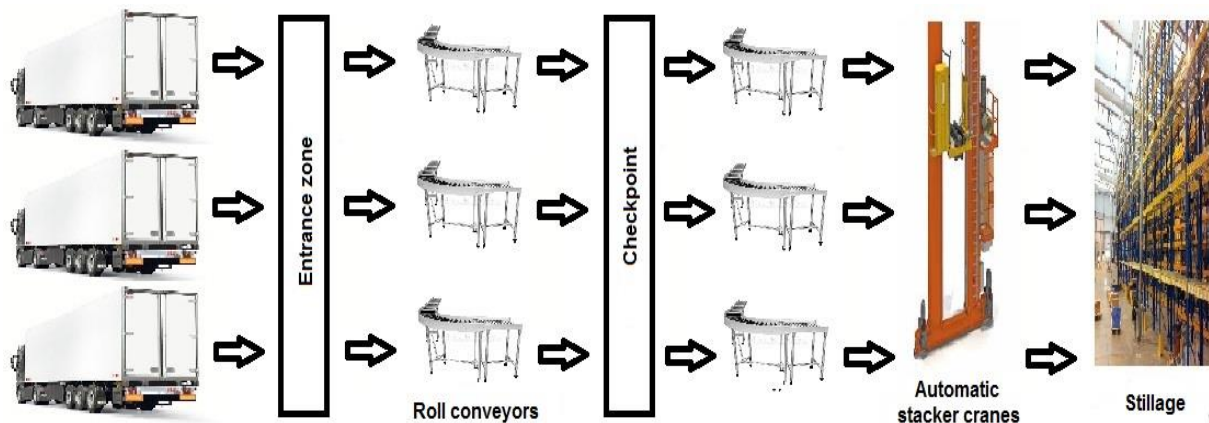


Fig. 3. Scheme of the commodities flow in the automated high – ceiling warehouses

Source: own compilations on the base of data obtained from the Mecalux Company

The example of Spanish food distributor confirms that there are four kinds of automatic cargo – handling devices:

- automatic stacker cranes;
- automatized booms and conveyors;
- intelligent stillage, allowing to store a few pallets in one slot;
- specialized robots, responsible for loading and transportation tasks.

Within the last few years some innovation solution connected with transportation in warehouses appeared. It was a Kiva Robots, which are being used to move the stillage with commodities between the areas of storehouse. The pioneer of introducing such robots was well – known e – commerce company Amazon. The principle of this devices is simple – they are riding under the loaded racks, move it up by using a special stand (fig. 4) and move directly to the place where it is needed (Banker, 2016). The vital information is they are being steered by remote – warehouse management system use them exactly when it is necessary to pick the commodity in the picking area. Recently in the Amazon storehouses works more than 45 000 Kiva Robots and it is 30 000 more than three years ago (Gonzales 2016).



Fig. 4. Kiva Robot at work in Amazon warehouse

Source: www.businessinsider.com

Using automated material – handling devices connected with modern management systems assures smooth and optimized commodities flow inside high – ceiling objects. It makes the surface of storage better extracted too. It definitely solves problems regarding too long moving of goods among the storehouse zones and restrictions in commodity localization (Józwiak and Guciewski, 2017). That is why entrepreneurs around the world pay so much attention to such solutions in warehouses.

3. PRACTICAL EXAMPLE OF USING AUTOMATICAL MATERIAL – HANDLING SYSTEMS

Using the high – tech facilities in high – ceiling warehouses increase constantly. As the example the corporation such as Amazon or Salvesen Logistica could be quoted. The main advantage of automatization is the safety of moved commodities and working people (which are almost not involved in the unit load flow in the storage zone). IT system (which is operated usually by one person) is responsible for realization all operations through the inventory devices integrated with cargo – handling equipment. Warehouse Management

Systems (WMS) optimize all storehouse activities by managing of following data (Malanowska and Fajfer, 2011):

- best before dates of stored goods;
- deadlines of tasks realization;
- validity dates of quality certificates;
- other data characterizing every unit loads stored in warehouse.

In case of growing participation of IT systems in storehouses there is only one task for people. It is connected with preparing cargo units before they are loaded on trucks (in instance of a huge amount of general cargo packing in the picking zone). Due to that fact the number of workers is lesser than in manual – operated warehouses, which significantly reduce costs of work. The scheme of full – automated storehouse is presented on the figure 5.

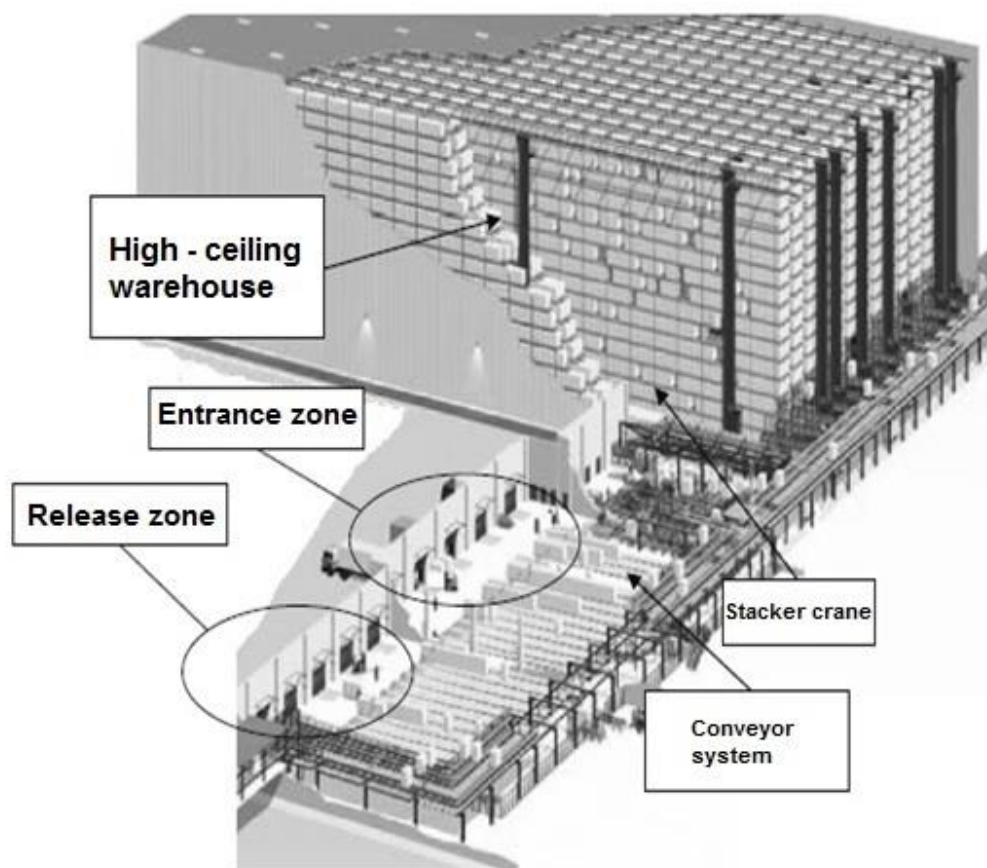


Fig. 5. Scheme of the full – automated high ceiling warehouse

Source: compilations on the base of „SSI Schaefer update” 2008, number 12, page 10.

Total time of store operations seems to be the most vulnerable to optimization. It is shorten many times on every phase of goods flow. Time of transportation commodities in the storage zone operated by automatic stacker cranes (T_{sklad}) could be reduced thrice against hand –

operated devices, such as forklifts (much time needed for putting unit loads on and off, slower moving). Transport of cargo between the storage and picking zones can generate even more time benefits, because in not – automatized warehouse it is realized by pallet jacks. In that situation time of commodity movement (T_{Trans}) is being reduced fivefold. The last phase of transportation in warehouses, namely between the picking zone, release zone and the truck, could be optimized too by using automatic conveyors, which shorten time of such operations (T_{Wyd}) tenfold (using such systems is determined by compatibility of loaded trucks). The chart below presents the time needed for realizing store operations for 5000 and 10000 unit loads (both in automatized and manual – operated warehouses).

Table 1. Summary of goods handling time in traditional warehouses and automatic

	T_{sklad} (s)	T_{Trans} (s)	T_{Wyd} (s)	Total time for 5000 unit loads (h)	Total time for 10000 unit loads (h)
Automatic warehouse	10	10	10	42	84
Manual operated warehouse	30	50	100	250	500

Source: own compilations on the base of data from producers of material – handling equipment

Nowadays management staff pays special attention to systems intended for development and control of processes of physical flow of goods and their informational conditions allowing achieving the highest level of relationship between level of rendered services as well as level and structure of the associated costs (Dudkiewicz – Fierek, Marchlewicz and Świdorski, 2014). During last few years in USA many simulations of warehouse processes was realized. They have taken into considerations all costs of commodities transport inside high – ceiling storehouses. Observations of such research shows that unit costs of cargo flow in such objects are lower about 2 dollars – all activities realized by people in connection with moving one unit of commodity costed \$7,32, and in automatized warehouses - \$5,17 (Banker 2009).

CONCLUSION

The literature presents many kinds of high – ceiling warehouses. They are divided on buildings, which were constructed in compliance with automatic material – handling equipment and storehouses, which were automated after few years of using. Majority of such investments is profitable, because it reduces number of workers and time needed to make

necessary store operations. However, it is not adequate to implement in all enterprises, according to limited flexibility of automated facilities. Furthermore, they cannot be adapted to different commodities, which size and weight is larger than typical cargo unit.

According to the big influence of modern transportation devices on the stored goods flow in high – ceiling storehouses it is recommended continuing of researches in that field. Their results could be used by many enterprises having such objects.

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