CHAPTER 5
WAREHOUSE PROCESSES IN ENTERPRISES

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Abstract

The chapter presents warehouse processes in a enterprise and selected factors which affect them. A enterprise is a link in a logistic chain. A enterprise's warehouse has an essential role, and its functioning determines how smooth the flow of material items in logistic systems is. The warehouses of today must apply appropriate technologies and manage processes in an effective manner. The study presents warehouse processes as divided into four major stages: receipt, storage, picking and shipment. The chapter describes the present status and directions of the development of warehousing, considering a warehouse as an organisational unit, value, management and warehousing technology. Directions of development have been discussed on the basis of three examples: identification of items flowing within the logistic chain by a GS1 logistic label, storage on cantilever racks loaded/unloaded by a shuttle platform and forklift fleet management system at a warehouse. Results of a study analysing benefits of implementing a logistic label compliant with the GS1 system, carried out at four enterprise, have been presented. Installation of a storage system composed of cantilever racks loaded/unloaded by a PROMAG shuttle platform at a production enterprise has been described and its effects have been shown. The FleetManager 4.x system by STILL for managing warehouse forklift fleets has been described. The chapter is concluded with a summary of benefits of implementing this Internet application at two enterprise.
Keywords: warehouse management, GS1 logistic label, warehousing technology

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5.1. Introduction

Every enterprise is a link in a logistics chain, which is a physical structure reflecting logistic services provided to suppliers and recipients. Its role consists in carrying out logistics-related activities by commercial entities which cooperate in handling the physical flow of products and items.

The flow of materials uses linear elements of logistic infrastructure, whereas the processing or gathering of inventories of products and goods takes place in its nodal elements.

Nodal infrastructure includes spacially separated facilities for stationary load handling (loading docks and loading points, ports, logistics centres) and means fo transport (Fertsch, 2016).

Points of logistics infrastructure are links of supply chains, between which products flow. The characteristic points of supply chains are their links, i.e. enterprise performing specific tasks as part of a product manufacture and delivery process (Fechner, 2007).

In enterprise, warehouses play an exceptional role in the performance of tasks required by logistics chains. Their proper functioning is an essential condition ensuring the smooth flow of material goods in logistics systems, which forces them to apply appropriate technologies and to manage warehouse processes in an effective manner (Richards, 2014).

5.2. The process of warehousing

Warehousing comprises a number of actions related to temporary receipt, storage, picking, transport, maintenance, monitoring and shipment of material goods – inventories (Fertsch, 2016).

The fundamental process of warehousing includes four major stages: receipt, storage, picking and shipment of stored inventories (Niemczyk, 2015a).

The main tasks performed as part of the first stage include unloading, identification, sorting, inspection in terms of quantity and quality, preparing goods for storage and moving the delivery to storage.

The major element of storage is putting the inventory of items away. The storage stage covers collecting goods from the reception zone, putting them away in a storage zone, storage of goods, interim inspection and releasing the goods to the picking zone or the shipment zone. Factors which influence proper and effective work of a warehouse include meeting applicable storage requirements, storage technologies, methods of locating items on racks, and assignment of

storage places, assortment group turnover parametres and types of a unit load in storage. The free allocation method allows up to 30-per cent better use of space within a warehouse than the permanent allocation method.

If unit loads are shipped in the same form as they had been accepted to the warehouse, they are moved from the storage zone directly to the shipment zone. They may also skip the storage zone (cross-docking). If accepted units are disassembled, the process of picking takes place. At the picking stage, inhomogenous unit loads are created. They may be formed out of homogenous collective packages or inhomogenous collective packages (which contain different unit packages). The picking stage comprises: preparing unit loads for the purpose of picking, picking orders, inspection in terms of quantity, ¬packing and forming transport units, and moving them to the shipment zone.

Order picking is carried out in a detached picking zone, but may also take place in the storage zone. The basic method of picking is picking according to orders. During the picking stage, all elements of assortment ordered are retrieved. Another method – picking according to assortment – requires passing the picking stage with retrieving items for several orders. The second step of the method consists in dividing picked goods to individual orders. Picking orders are given to employees by means of a picking list, radio terminal or batch terminal, pick by light technology, labels or pick by voice technology. The order should include material index, name, required amount and detailed location or goods to be picked. While allocating items, results of the ¬ABC analysis according to the frequency of retrievals should be used. Goods from group A, which are most frequently retrieved, are placed closest to the shipment zone, which streamlines the process of picking and shipment. If there are several batches of retrieved goods in the warehouse, employees may apply the FIFO rule, LIFO rule (which is rarely applied), or, for goods with specified expiry date, FEFO rule.

The last stage of the process is the shipment of items from the warehouse. At this stage, items are packed and formed into transport units, inspected and loaded to a vehicle (Frazelle, 2002).

The process of warehousing with typical functions and flows has been presented in Figure 5.1.

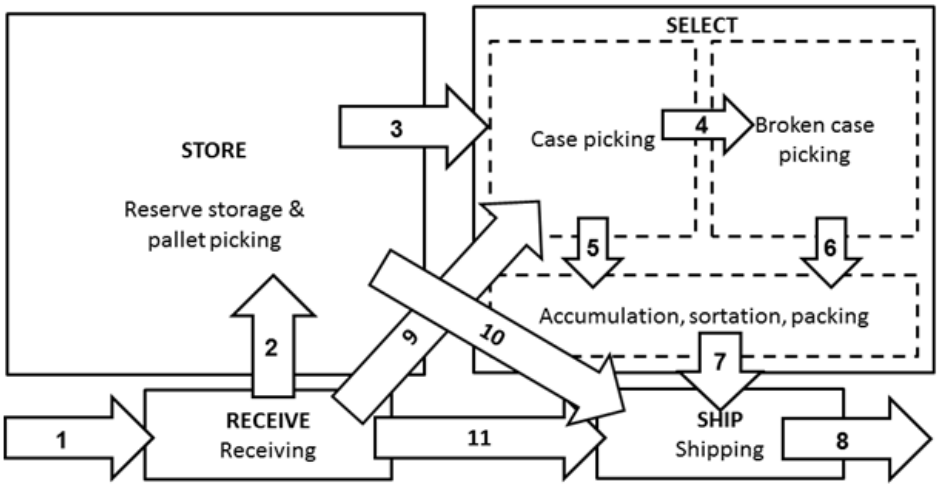

Fig. 5.1. Typical warehouse functions and flows
Source: own study based on (Tompkins, White, Bozer, Tanchoco, 2010)

Markings:
1 From suppliers
2 Direct put away to reserve
3, 4, 5, 6, 7 Replenishment
8 To customers
9 Direct put away to primary
10 Replenishment to shipping
11 Cross - docking

5.3. Directions of development in warehousing

As it has previously been mentioned, the functioning of warehouses requires the application of proper technologies and effective management of processes. The development of both of these elements has an evolutionary form. Directions of development against the present status have been presented in Table 5.1. For the purposes of the publication, present status means the most frequent status occurring in warehouses. Certain solutions and features presented as the future status are already applied in warehouses under construction (Niemczyk, 2015a).

Tab. 5.1 Selected directions of development in the area of warehousing

PRESENT STATUS	FUTURE STATUS
WAREHOUSE	
– with separate space of buildings, – intended for the storage of material items, – with specified technology, – equipped with appropriate equipment and technical means.	– with specialist structure of the building, – used for storing and reshaping material items in compliance with customers' needs, – with specified, advanced technology, – equipped with appropriate equipment and technical means, controlled automatically.
SIZE	
– one warehouse, – division into functional zones, – high storage zone, – separate zones with different storage conditions, – large receipt – shipment zone, – low flexibility in terms of warehouse development.	– one warehouse, – very high storage zone, – small receipt – shipment zone, – warehouse built to fulfil specific functions without the possibility for development.
MANAGEMENT	
– management by a team of people, – process management partially assisted by an IT system, – partial integration with a enterprise management system.	– management by a specialist IT system dedicated to warehouses, – controlling automated processes inside a warehouse, – an IT system managing the flow of materials in a warehouse fully integrated - with an entire logistics distribution chain management system, – enterprise's warehouse managed by an external operator.
TECHNOLOGY	
– permanent or free allocation method, – storage in devices of various types, – automation of processes, – automatic identification based on barcodes, – limited use of printed documents, – common use of unit loads, – electronic exchange of selected documents between partners, – differentiating between batches.	– free allocation method, – high storage, – automated warehouse processes, – self-operating warehouses, – automatic identification and traceability of batches of materials, logistic units and individual packages in an entire logistic delivery chain on the basis of the GS1 global system, in the scope of barcodes and EPC/RFID, – using the ECR strategy, – continuous monitoring of flows, – automatic monitoring of processes, – exclusively electronic exchange of standard documents between partners.

Source: own study based on (Niemczyk, 2015a)

Economic entities strive to integrate as part of logistic chains. It requires enterprise to implement SCM (Supply Chain Management) systems Supply Chain Management), manage their own warehouses better and adapt them to their customers' expectations (Długosz, 2009). In 2015, there was a visible direction towards using GS1 logistic labels and expecting broad, and later common, exchange of electronic documents (EDI - Electronic Data Interchange) in supply chains.

5.4. Selected elements of development in warehousing

In order to illustrate elements of development in warehousing, the chapter describes examples related to:

- identification of goods flowing within a logistics chain,
- technology of storage on cantilever racks loaded/unloaded by shuttle platforms,
- forklift fleet management system in a warehouse.

The flow of goods in logistic chains is mostly based on the shipment of unit loads placed on pallets. The global GS1 system ensures clear identification among all enterprise, goods, loading units, locations and services. Each logistics unit may be identified this way by means of a GS1 logistic label. Each logistics label must have a unique SSCC (Serial Shipping Container Code) number, also called logistic or transport number. An example of a GS1 logistic label with a description of the data provided thereon has been presented in Figure 5.2. The label is possible to be read automatically owing to the use of Application Identifiers (AI), expressed in the form of barcodes. Application Identifiers (AI) identify provided business data and their formats. Most important Application Identifiers used to describe a unit load are: AI 01 or 02 – identifier of items, AI 10 – production batch number, AI 15 or 17 – best before date or expiration date, AI 37 – number of commercial units contained in a logistic unit (when AI 02 is applied).

Numbers of the GS1 system are also of great significance in logistic processes: GTIN – Global Trade Identification Number and GLN – Global Location Number (Hałas, 2012).

The Institute of Logistics and Warehousing conducted a research of benefits of implementing a logistic label that meets the criteria of the GS1 system. One of the studies analysed the process of receiving items to a warehouse in four enterprise:

- a manufacturer of building ceramics, marked as B,
- a distributor in the FMCG industry, marked as D,
- two manufacturers in the FMCG industry, marked as P and R.

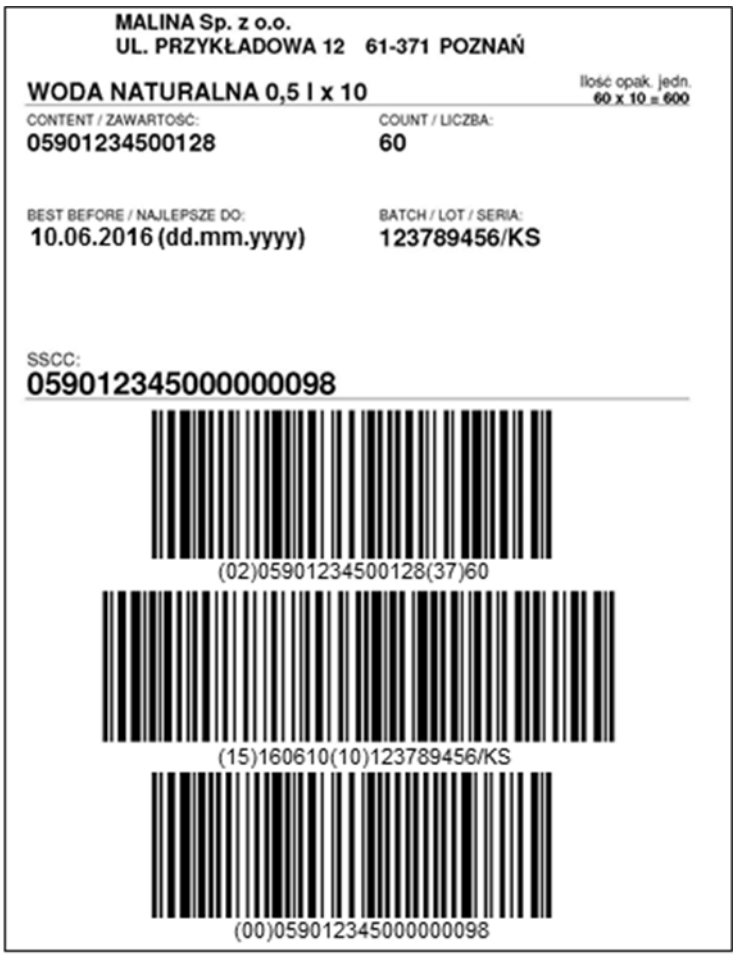

Fig. 5.2. Example of a logistic label
Source: own study (Niemczyk, 2015a)

Markings:

(02)05901234500128 is AI 02, which represents GTIN 05901234500128 of a multipack of -10x0,5L bottles of mineral water,

(37)60 is AI 37, providing a number of 60 multipacks of 10x0.5L bottles of mineral water in a logistic unit,

(15)120610 is AI 15, which defines best before date – best before 10.06.2012,

(10)123789456/KS is AI 10, which provides production batch number: 123789456/KS,

(00)059012345000000098 is AI 00, specifying the number of a logistic unit: SSCC 059012345000000098.

The study analysed the influence of using a GS1 label on such elements as:

- identification of items,
- quality of the process,
- speed of the process,
- batch management and traceability.

The enterprise had different data describing the process and monitored them in different ways. It prevented clear-cut parametrisation of results presented in Table 5.2. Comments to individual results have been placed under the Table.

Tab. 5.2 Results of analysing benefits of implementing a logistic label compliant with the GS1 system

No.	STUDIED FEATURE	ENTERPRISE / COMMENT NO.			
		B	D	P	R
1.	Identification of items	1B	1D	1P	1R
2.	Quality of the process	2B	2D	2P	no comments
3.	Speed of the process	3B	3D	3P	3R
4.	Batch management and traceability	4B	4D	4P	4R

Source: own study based on the research of Institute of Logistics and Warehousing

Comments concerning the results of the identification of items:

- 1B placing a logistic label on unit loads formed on the production line and inhomogenous unit loads created in a warehouse of finished products in the process of picking,
- 1D full identifiability,
- 1P fast identification,
- 1R identifiability of items, possibility to trace units from a factory to a customer.

Comments concerning the quality of the process:

- 2B improved quality of internal processes, level of complaints dropped below 1% of all commercial transactions,
- 2D full and reliable knowledge on the processes, number of errors dropped from approx. 200 to about a dozen within a month,

- 2P automated and improved quality of processes of item reception, order execution level grew by 6 – 7% (achievement of 97 – 98%).

Comments concerning the speed of the process:

- 3B reception process at least 50% faster,
- 3D efficiency increased by approx. 10 – 20%, reception time shorter by approx. 40%,
- 3P immediate increase in production, even five times shorter time of reception of an external delivery (from 70 – 80 minutes to 15 – 20 minutes), increase of operated flows by approx. 20% without employing more staff,
- 3R streamlining the reception process.

Comments concerning batch management and traceability:

- 4B batch management and traceability is not a burden to distributors, possibility for the customer to complement the order with an additional amount of items of the same production batch,
- 4D detailed information on individual elements of assortment, production batches and expiration dates with the history of every logistic unit,
- 4P reliable information as part of traceability,
- 4R possibility to trace units from a factory to a customer.

The study fully confirmed the benefits resulting from the implementation of GS1 logistic labels on unit loads flowing in logistic chains (Niemczyk, 2015b).

A number of different storage systems are applied in warehouses. The systems for the storage of pallet unit loads applied so far provide, among others, for the use of different types of racks: adjustable pallet racks, drive-in or drive-through cantilever racks, pallet racks loaded/unloaded by stacker cranes, drive-through and flow racks. For several years, self-supporting racks have been applied in warehouses in Poland. Cantilever racks loaded/unloaded by shuttle platforms are a new solution in the Polish market.

A system of cantilever racks loaded by shuttle platforms is built similarly to a drive-in cantilever rack. The system comprises load-bearing frames and single beams. They are connected to each other with load-bearing rail beams which form a track available to a shuttle platform. A semi-automatic shuttle platform moving in the channel of the drive-in rack makes it possible to load, move and unload pallet unit loads. The platform is radio-controlled by a warehouse employee with a remote control using several basic functions. The cycle of placing a pallet unit load in the channel of the rack includes several actions:

1. placing the shuttle platform in the channel with a forklift truck,

2. placing a pallet unit load in the channel in front of the rack with a forklift truck,
3. picking a unit load by a forklift truck and moving it to the end of the channel,
4. repeating sequence 2 and 3 until the channel is full,
5. moving the shuttle platform with a forklift truck to another channel.

In the case of channel unloading, actions are similar:

1. placing the shuttle platform in the channel with a forklift truck,
2. picking a unit load by a forklift truck and moving it to the front of the channel,
3. picking a pallet unit load from the front of the rack with a forklift truck,
4. repeating sequence 2 and 3 until the channel is empty,
5. moving the shuttle platform with a forklift truck to another channel.

Examples of the system of cantilever racks loaded/unloaded by a shuttle platform offered by PROMAG (AutoMAG platform) have been shown in Figure 5.3.

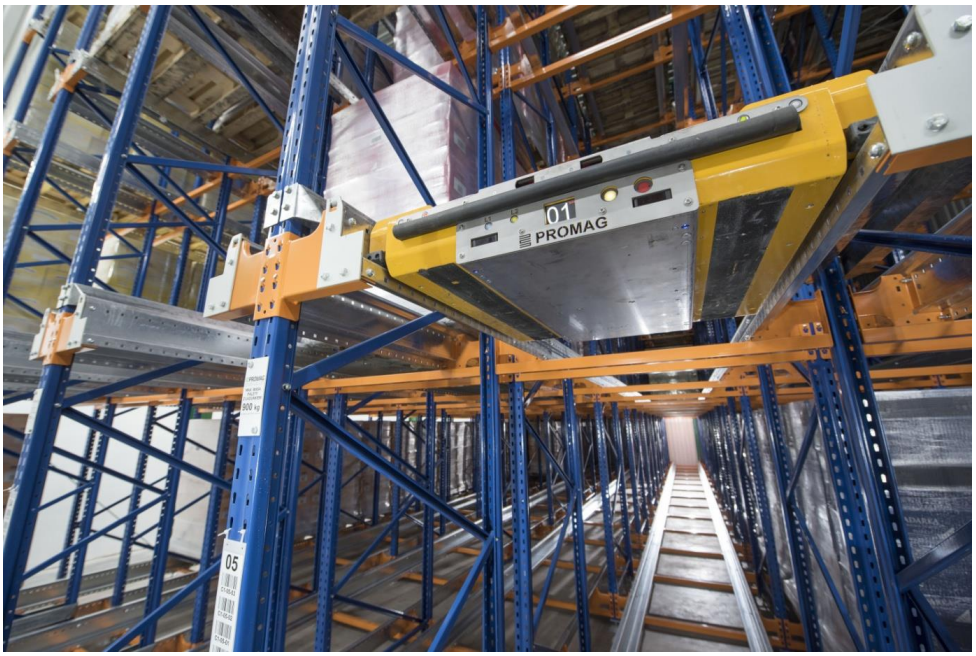

Fig. 5.3. A system of cantilever racks loaded/unloaded by a shuttle platform
Source: materials of PROMAG S.A.

Major advantages of cantilever racks loaded by a shuttle platform in comparison to drive-in racks are:

- better use of warehouse space,
- shorter time spent on loading and unloading pallet unit loads in the rack,
- lower risk of damage to unit loads or the rack,
- eliminating the work of forklift trucks inside drive-in racks,
- less labour-intensive,
- safer work of forklift truck operators,
- less forklift trucks required,
- lower cost of warehouse operations,
- lower cost of storing one pallet.

Features of cantilever racks loaded by a shuttle platform makes them particularly useful in:

- refrigerator and freezer spaces, where particular attention is paid to the optimum use of warehouse space due to high cost of maintaining low temperature inside,
- food industry for fast-rotating goods, especially the ones with short shelf life,
- poorly diversified assortment and large production batches.

An example of using the system of cantilever racks loaded by a shuttle platform is a warehouse of Jantoń enterprise from Dobroń near Łódź. It is a family enterprise founded in 1976. Jantoń is one of the biggest manufacturers in the Polish wine industry.

The system, designed and implemented by PROMAG S.A., allows the storage of finished products in the form of 3600-pallet unit loads up to 900 kg in weight, placed on EUR pallets. The system was equipped with five AutoMAG shuttle platforms. Racks are loaded/unloaded with the use of the WMS system.

Nearly a year after the implementation of the system, Jantoń has achieved the following benefits:

- volume of warehouse inventory has been optimised,
- exceptionally high effectiveness of the storage system has been observed,
- speed of warehouse operations has been increased, which has resulted in improving warehouse capacity,
- the number of forklift trucks working in the warehouse has decreased, with simultaneous growth in the rotation of goods,
- the comfort of and safety of forklift truck drivers' work has improved,
- the number of accidents at work and damages to racks has dropped,
- the number of errors in shipment has dropped.

FleetManager 4.x, a system managing forklift fleet in a warehouse, is an Internet application.

Its users have access to such elements as access control, receive information on improper work conditions or may generate a number of reports. The programme also allows sending information automatically to a selected group of recipients.

Major advantages of the FleetManager 4.x system include:

- increased work safety,
- optimisation of forklift fleet,
- reduction of physical damage.

Work safety is improved due to access permission, i.e.:

- a forklift truck is started with a chip, customer card, Fleetmanager Card or a PIN code,
- possibility to define several vehicle users with different driving profiles,
- limited driving speed during training,
- ensuring the inspection of vehicle's technical condition before starting work,
- limited access time,
- automatic logoff function.

Effective use of the vehicle fleet is supported by access to concise information and reports.

Current information concerns the condition of the fleet, work monitoring, system messages, accident messages, access rights and effectiveness of vehicle usage.

Via user interface, users have access to such reports as:

- vehicle usage analysis,
- accident rate analysis,
- power consumed by vehicles,
- determination of the driving and lifting function in %,
- number of mth worked.

Limiting the number of accidents is possible due to the following functions of the FleetManager 4.x application:

- accident detection,
- shock detection with a shock sensor,
- automatic reduction of speed after a collision and sending information to a superior,
- generating a complete incident report, providing for such parametres as driving speed or time,

– raising the awareness of forklift truck drivers,
– generating reports which include incident analysis and details.

STILL tested the implementation of FleetManager 4.x at two of its client enterprise. Test results have been shown in Table 5.3.

Tab. 5.3 Results of testing benefits of implementing FleetManager 4.x

Customer	automotive supplier	paper manufacturer
FleetManager since:	2010	2011
Number of skilled vehicle operators	600	600
Method of operation:	3 shifts from Monday to Friday	5 shifts 7 days a week
Manufacturer; type; number of vehicles	STILL; E/V; 82 pcs	STILL; E; 47 pcs
Functions of the FleetManager 4.x application	- access rights, - shock recorder, - data transmission via GPRS	- access rights, - shock recorder, - data transmission via GPRS
Reducing the cost of damages done	70%	70%

Source: own study based on data from STILL

STILL emphasizes the advantages of the FleetManager 4.x application pertaining to its features:

1. an Internet application:
– no software installation needed,
– access from anywhere,
2. real time analysis:
– access control,
– immediate information on a collision,
3. fleet optimisation:
– increasing drivers' effectiveness,
– reducing cost of repairs by approx. 70%,
4. data transmission:
– GPRS,
– Bluetooth,
5. collision reporting system:
– information on the main page of FLM 4.x,

- sending information via email,

6. cost:

- a single purchase of the application,
- no costs related to data transmission.

5.5. Conclusions

The proper functioning of warehouse in enterprise is a prerequisite for the smooth flow of material goods in logistic systems. Therefore, warehouse management has an important role and directly influences of enterprises and the supply chain efficiency. In the modern warehouse requires the use of better technologies and management methods processes. The examples in this chapter illustrate selected development directions.

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