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LOGISTICS SERVICE FOR COMPANIES BY WAREHOUSE FACILITIES WITH DIFFERENT CONFIGURATIONS IN THE LOGISTICS NETWORK

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Abstract

The paper presents an approach to the logistics service for companies by warehouse facilities with different configurations in the logistics network. Through the warehouses it is possible to combine internal logistics functions such as ordering, unloading, product receptions, confectioning, order picking. The occurrence of warehouse facilities and suitable strategy also affects the volume of stocks, because they allow for combine reserves and compensates for fluctuations in demand. Optimal control of the amount of inventory reduces the demand for warehouse space and associates storage costs. The appropriate configuration of the warehouse facilities in the logistics network is therefore critical for effective logistics service of manufacturing companies. In such logistics network, individual subsystems are related to each other by different types of relation. From these interconnections result logistic tasks performed by company logistics system. Their implementation is caused both externally and internally, wherein the first considerations arise from the environment, the other from production. External logistic task is the boundary conditions for storage process in manufacturing company. The configuration of storage process determines the execution of internal logistics tasks for the company. The article also presents the logistics network configuration taking into account both direct and indirect services.

Keywords: *logistics service, warehouse facilities, logistics network*

1. Introduction

Importance in manufacturing entities serving, regardless of the functional structure become warehouses or logistics centres. Processes for handling manufacturing entities regarding to the distribution of orders for individual supplies and outsourcing of logistics services in the supply of raw materials (supply centres) and receipt of finished products (distribution centres or warehouses for finished products which not involved in the distribution, mainly storage and to dispatch a large number of finished products) are analysed by many authors [5, 8, 12]. Special analysis was made for the problem of the choice of location for warehouse facilities and distribution centres, which significantly affects not only the distance between warehouses and a manufacturing plant, but also the length of transport cycles for external transport resulting from the execution time of transport and frequency of shipments.

Storage facilities allow combining needs, including the consolidation of many smaller orders into larger ones. To reduce the services cost orders are sent in the form of larger shipments to

warehouses or logistics centres. The same is in the supply of warehouses customers. This approach allows using for more efficient of production capacity and reducing the cost of preparing for order handling and execution of manufacturing operations, warehouse and shipping [7].

Through the warehouses, it is possible to combine internal logistics functions such as ordering, unloading, product receptions, confectioning, order picking, etc. [7]. Combining these features helps to increase their efficiency and to enhance the quality of services and reduce their costs. Thus, the storage facilities at the production level affect the growth of efficiency and effectiveness of logistics processes and also service levels not only for the customer, but also for companies. It also causes the reduction of logistics costs.

Logistics operators can efficiently manage a fleet of vehicles, reducing the number of freight traffic, which in turn affects the number of vehicles on the road. This has a positive impact on the environment by eliminating emissions and other pollutants from the vehicle in service. Less cars are also a less damage to the road infrastructure [8, 11].

Shipments consolidation affects the effectiveness of the use of transport means in distribution systems. Shipments that are consolidated in the storage facilities are provided to customers regarding to delivery schedule. This approach allows for rationalization of operations and reduces the number of transport processes, i.e. reducing the frequency of deliveries. At the same time, improves the amount of goods per one shipment. This strategy allows for effective use of loading units for example pallets and containers, which determines better overall use of means of transport.

It is also possible to use means of transport with large cargo capacity, among others, semi-trailers, swap bodies and containers, especially in the lines between warehouses and consolidation/deconsolidation centres of shipments. The use of loading units increases the degree of mechanization, which shortens the time of loading, unloading, handling and manipulation, and increase efficiency of workload. A suitable location and use of warehouse facilities and logistics centres also contribute to minimizing empty runs. Vehicles delivering goods from storage facilities to the recipient on the way back can take the goods from the recipient or the nearby another sender to the warehouse or logistics centre. This avoids empty runs, which reduces transportation costs.

The occurrence of warehouse facilities and suitable strategy also affects the volume of stocks, because they allow for combine reserves and compensates for fluctuations in demand. Optimal control of the amount of inventory reduces the demand for warehouse space and associates storage costs. This approach also affects the performance of transhipment warehouse, which increases through a combination of many decentralized inventory in one or more logistics centres [7].

The size of stocks influences the financial capital therefore lower stocks level is also less aside capital. The funds generated by the company as a result of such a strategy, inventory control can be used for other purposes, for example associated with the development of the company or increase its competitiveness on the market.

2. The role and tasks of warehouse facilities in logistics network

Warehouse facilities represent buffer subsystems placed at the entrance and exit of the logistics system of the company. This helps stabilize the production process, i.e., the continuity of these processes. Tasks of warehouse facilities derive to its location in the logistic system. Storage can be located in the area of supply, distribution, or warehouse functions to meet the operational production systems. In the area of supply, main operational tasks include delivery materials necessary to produce in enterprise, their storage and moving to the first stand of manufacturing line at the time of determining their use. In the production area, warehouse operative allows to maintain inventories of work in progress and implementation of internal transport of material flow in the production process. Operational tasks warehouse in the area of distribution include the movement formed in the production process of materials, half products and manufactured goods to consumers.

In the logistic system of the manufacturing are conditioned by the specific nature of the company. Thus, it may be logistics of spare parts, which includes purchasing, inventory management and the use of spare parts as part in the maintenance. In the sphere of manufacturing waste flow also exists reverse logistics [13] in which transport and storage of waste materials and the possible transfer of these materials to the places of their processing or disposal is realized. In this area, other processes in order to minimize the volume of waste generated often are also carried out (e.g. waste paper pressing). It should be noted that an important aspect of the waste flow process in production are recycled and redevelopment of waste.

Manufacturing company operating in the assumed environment performs certain tasks. Logistics task for manufacturing facility based on a two-step conversion of raw material streams and connected information streams. In the first step of the logistics task occurs transformation of raw materials streams, packaging, etc. arriving to manufacturing facility from the suppliers to the streams entering the production, to provide for a continuous and rhythmic production process understood as supplying. In the second step, transforming is carried out of raw materials streams in the production process into finished products leaving the company in such to meet the requirements of consumers understood as sales.

Assuming that in a given manufacturing entity can be distinguish suppliers ***D***, storage areas ***M***, recipients ***O*** and production system ***SP,*** then the logistics system, can be represented as an organization of subsystems (Fig. 1):

- supply, whose members are providers of materials,
- production service, whose elements are the individual production facilities,
- storage, whose elements are storage areas, e.g. in production area, packaging are or storage area for finished products,
- distribution, whose elements are the distribution centres,
- transport, whose elements are for example area to transport between storage,
- management of the company and resources, which include area of headquarters.

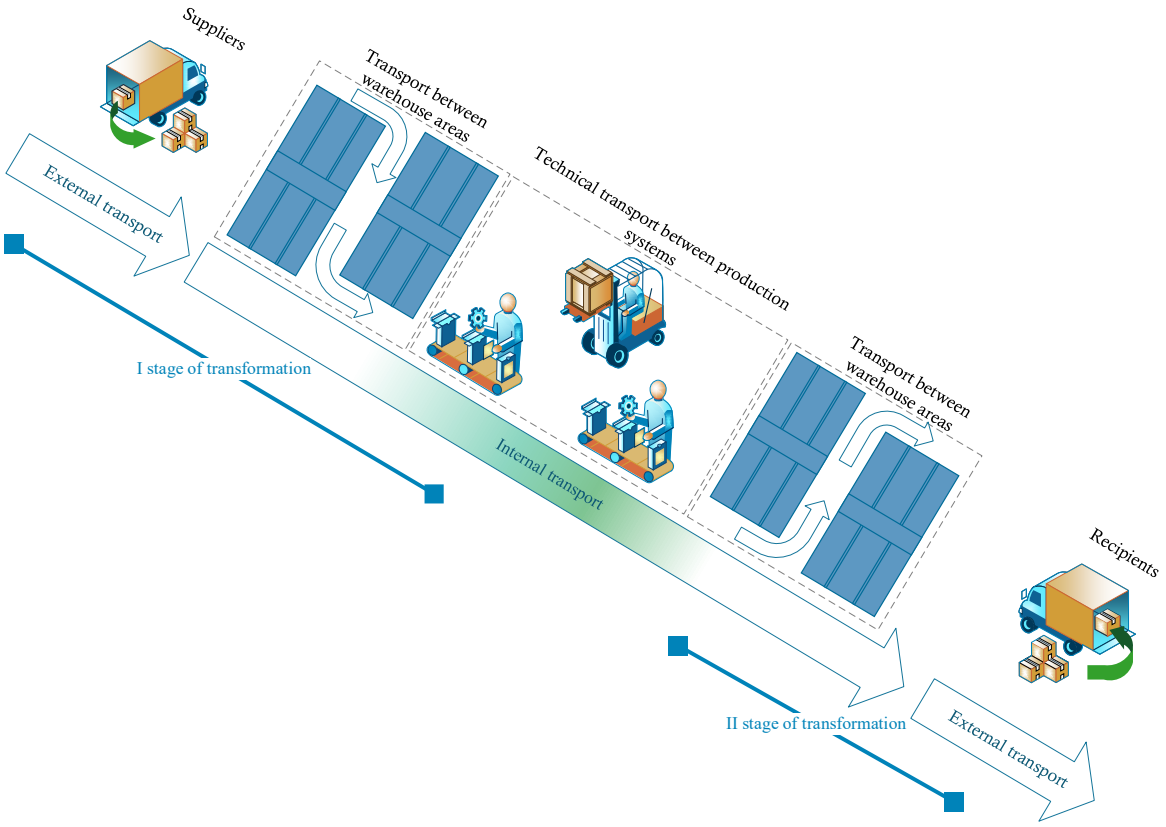

Fig. 1. Diagram of logistics tasks for manufacturing facility (source: Own development)

External logistic task is the boundary conditions for storage process in manufacturing company. The configuration of storage process determines the execution of internal logistics tasks for the company. The material streams from suppliers are the entrance to the warehouse of raw materials. Streams of finished products according to the specifications of customers are warehouse output.

Individual subsystems are related to each other by different types of relation. From these interconnections result logistic tasks performed by company logistics system. Their implementation is caused both externally and internally, wherein the first considerations arise from the environment, the other from production.

For the purpose of research assumed that are given:

- a set of the goods types or manufactured products ***R***, in form: $\boldsymbol{R} = \left\{ r: \quad r = 1,2,...,r'...,\overline{R} \right\}$,
- a set of the suppliers **D**, in form: $\boldsymbol{D} = \left\{ \ d_s : s = 1,2,...,\overline{S} \right\}$,
- a set of the storage objects **M**, in form: $\boldsymbol{M} = \left\{ m_k : k = 1,2,...,\overline{K} \right\}$,
- a set of production subsystems **SP** , in form: $\boldsymbol{SP} = \left\{ sp_p : p = 1,2,...,\overline{P} \right\}$,
- a set of recipients **O**, in form: $\boldsymbol{O} = \left\{ o_d : d = 1,2,...,\overline{D} \right\}$.

Assuming that the individual flows between the various subsystems are defined as follows:

- $\boldsymbol{\lambda 1}\left((d_s, m_k), r\right) \in R^+ \cup \{0\}$ – volume of supplies of *r*-th type of good from *s*-th supplier to *k*-th storage objects,
- $\boldsymbol{\lambda 2}\left((m_k, sp_p), r\right) \in R^+ \cup \{0\}$ – demands of *p*-th production subsystem from *k*-th storage object on *r*-th good type,
- $\boldsymbol{\lambda 3}\left((sp_p, m_k), r'\right) \in R^+ \cup \{0\}$ volume of r'-th type of products produced by *p*-th production subsystem directed to *k*-th storage object,
- $\boldsymbol{\lambda 4}\left(m^k, o^d, r'\right) \in R^+ \cup \{0\}$ volume r'-th type of products directed to *d*-th recipient from *k*-th storage object.

the size of all deliveries between the various subsystems can be written:

- a matrix **QD** in form: $\mathbf{QD}=[\ \boldsymbol{\lambda 1}\left((d_s, m_k), r\right) \in R^+ : \quad d_s \in \boldsymbol{D},\ m_k \in \boldsymbol{M},\ r \in \boldsymbol{R}]$,
- a matrix **QSP** in form: $\mathbf{QSP}=[\ \boldsymbol{\lambda 2}\left((m_k, sp_p), r\right) \in R^+ : m_k \in \boldsymbol{M},\ sp_p \in \boldsymbol{SP},\ r \in \boldsymbol{R}]$,
- a matrix **QW** in form: $\mathbf{QW}=[\ \boldsymbol{\lambda 3}\left((sp_p, m_k), r'\right) \in R^+ : sp_p \in \boldsymbol{SP},\ m_k \in \boldsymbol{M},\ r' \in \boldsymbol{R}]$,
- a matrix **QZ** in form: $\mathbf{QZ}=[\ \boldsymbol{\lambda 4}\left((m_k, o_d), r'\right) \in R^+ : m_k \in \boldsymbol{M},\ o_d \in \boldsymbol{O},\ r' \in \boldsymbol{R}]$.

Material stream transformation processes require designing from the point of view performance, expenditures and costs. Important issue regards for this becomes designing of cargo and information flows on the types of work technology, operations, equipment and manpower. Such approach is the basis for the dimensioning of designed logistics system.

3. Location configuration of warehouse facilities in logistics network

Transportation services for manufacturing entities can be differently configured. This is usually the direct or indirect service by the local distribution warehouses to individual recipients (Fig. 2).

Thus, under this type of service, each of the suppliers send goods directly to each manufacturer, and each manufacturer can send finished goods to each of the recipients. This type of service is characterized by high total cost of logistics services, a large number of routes generating increased demand for transport, larger orders of goods from each supplier, which

increases stocks and the high costs of cargo preparing for delivery and the costs associated with the recipience of the load.

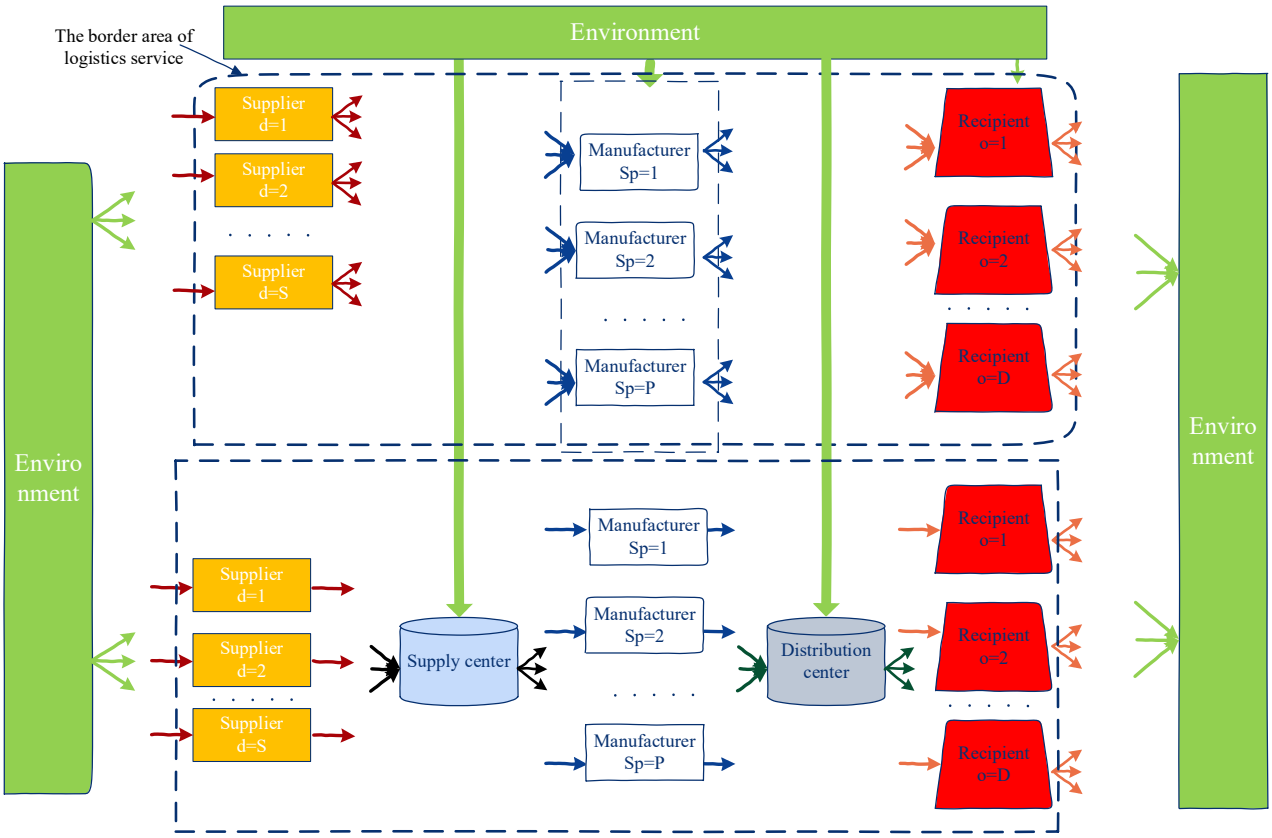

Fig. 2. Direct and indirect service (source: own work based on [1])

Operation of this type also generates some benefits, e.g. a direct contact with the supplier or greater flexibility of supply and faster response time to customer requirement.

Another type of transport service is indirect service. This type of service is carried out by indirect elements, such as supply centre or distribution centre. Within the indirect service each of the suppliers send goods to a supply centre from which manufacturers are supplied. Manufacturers, in turn, send goods to a distribution centre from which then recipients are supplied.

Indirect service is characterized by, among others, less inventory at recipients and lower transportation costs. In addition, this type of service enables the implementation of JiT systems, which affects the overall costs of the company. The disadvantages of indirect service are smaller flexibility of supplier on the behaviour of the recipient and longer reaction time of supplier on the recipient requirement in the event of assortment deficiencies in supply or distribution centre.

3. The role of computer programs in the implementation of warehouse processes

Effective functioning the producing company mainly depends on access to information. Computer information systems facilitate the work of all the company's employees by providing them required data. Thanks to them, easier and faster is to make optimal decisions, computer data also help in the carrying out activities within the employee's scope of responsibilities. Nowadays, the key to success is fully to exploit the opportunities of integrated information systems. The use of modern information systems has become a necessity for all entities involved in economic activities, including manufacturing entities wanting to operate efficiently in the market.

For the purpose of IT support of logistics area are used mainly three categories of software: [10]:

- ERP systems (*Enterprise Resource Planning*) – supporting the management of the whole company,
- SCM systems (*Supply Chain Management*) – offering supply chain management,
- WMS system (*Warehouse Management System*) – specialized tools used to very efficient management of warehouse process.

An appropriate warehouse management system is the basis for its proper functioning. The main functions of the warehouse management system is issuing of warehouse documents, keeping records of warehouse items and warehouse reporting.

WMS information system consists of a number of specialized tools used to operate the warehouse processes. The system works with the overarching management system of the whole company, which is usually ERP system. WMS information systems support the logistical aspects in detail, resulting from warehouse management, such as logistics parameters of various forms of packaging, class of storage places, warehouse placemarks in the form of barcodes and many more.

The WMS system collects data on the types, quantity and division of storage places, data on articles (such. the expiry dates, hierarchy and structure of packaging, methods of storage, production lots of individual packages, etc.) and many other information necessary to support even the basic warehouse operations.

By using the WMS system it is possible to control the quantity and assortment of taken to the warehouse goods, e.g. for conformance of delivery with the order made earlier and view of entire inventory levels according to freely chosen criteria. WMS systems consist of several basic modules. The modularity of these systems is their basic feature. It decides about the usefulness of the system for various companies and warehouses. The basic modules of WMS system are [11]:

- warehouses management. WMS system in that module supports the storage processes. Warehouses are divided according to the following hierarchy: storage area – row – column – level – storage space. The structure of managed warehouses may correspond to actually existing structure of the warehouse or be a logical structure;
- areas and warehouse space. On the surface of the warehouse are determined defined logical areas. These areas reflect the nature of warehouse operations that take place on a given physical piece of warehouse. These are the loading gate area, order picking area, the main storage area. The areas may correspond to different types of racks for storage. Defined storage areas make the structure of the whole warehouse more transparent and facilitating effective service. The WMS system divides warehouse also into warehouse space, they are defined according to carrying capacity and size. Thanks to this solution can quickly and easily tell which warehouse spaces are best suited for storage of currently received goods. Determining the location of the storage space is done by specifying the coordinates: row, column, rack level and place in the rack;
- contents of warehouse. The WMS system provides fast reliable information about the quantitative state of articles stored in the warehouse;
- warehouse exploration. The WMS system allows you to view and integration the warehouse structure. The user explores a specific database, illustrating the current state of warehouse space and inventory status at this location;
- logistics documents, Generating orders for suppliers and acceptance of orders for clients. Warehouse Logistics is based on warehouse documents. The WMS system must be able to create orders and create orders. In this area, the functioning of the WMS system is complementary to enterprise management system of ERP class. These systems should be coherent in terms of the processing of the same data, and should be maintained database integration (to allow for single data input to the system, and those that were available in places where they are needed).

Conclusions

Proper supply of manufacturing entities requires consideration of their expectations, especially in terms of quantity and quality of supply, their timeliness, and the division of tasks connected with the flow of goods between the supplier and the recipient.

In the analyses devoted to logistics problems occurring in the formulation of logistic tasks for manufacturing companies should take into account aspects such as: order cycle time, stock availability, limitation of size of the order, delivery frequency, delivery reliability, documentation quality, complaint procedures, order completeness and technical and information support regarding the state of the order realization. Such actions aim to increase the level of service of manufacturing facilities with simultaneous their logistics costs.

An important aspect in this area is also the choice of transport service that determines rationalization of logistics system of the company. It should be noted that orders for production materials submitted to the suppliers are long-term and in most cases are distributed for the supplies of a certain sizes implemented in the facility production cycle and in the production cycle at given supplier. In turn, it determines the choice of supply network structure with an appropriately designated warehouse facilities location.

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