Analysis of Performance Processes
Material Management

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INTRODUCTION

The target of every enterprise, not just a commercial one, is to maximally meet the client's needs. Currently, he is the most important in the strategy of each enterprise. Only this behavior allows you to maintain regular customers and attract new ones. The second important factor affecting the functioning of the company is increased competition. It motivates enterprises to constantly take new actions conditioning their survival and development. Competitive management can provide a competitive advantage. In turn, it requires reliable and fast information, various types of analyzes and hints resulting from the economic calculation. In manufacturing enterprises, it is particularly important to manage the process of supplying goods. The rationalization of the purchasing process leads to more effective operation of enterprises (Brodny, J. and Tutak, M. 2018a).

Impact not only on the financing of the company's current operations, but also on its development and progress. Trading companies are therefore forced to pursue a proper purchasing policy. This is due to the fact that the most financial resources are engaged in inventory of goods. The importance of planning and controlling the entire procurement process is growing. It can therefore be concluded that properly conducted logistics activities are currently one of the most important factors affecting the proper functioning of the company.

Tasks and problems in the supply process.

The supply process can be defined as part of the logistics process in which the necessary goods are supplied. It is very important because it affects: rationalization of trade in goods by accepting a specific level and amount of costs associated with goods supply; level of customer service; degree of independence of the retailer from suppliers of goods. The organization of the supply process is therefore aimed at minimizing costs and at the same time maintaining correct supplies and warehouse inventories (Brodny, J. and Tutak, M. 2016b).

In the purchase process, the trading company undertakes both strategic and operational activities. The first of these relate to a longer period of time (several years). They mainly include the identification, finding and use of cost-effective

sources of supply. Currently, it is also necessary to take into account factors related to ecology or time. Problems at the operational level relate to the current organization of physical flows in order to minimize costs, ensure proper warehouse management, a more favorable means of transporting goods and achieving a high degree of readiness to fulfill orders (Biały, W. 2017).

Purchases and supplies are responsible for the effective implementation of the flow of supply goods from their suppliers to customers. Real flow is conditioned by the proper flow of information and control instructions. Purchasing includes all activities related to identifying needs, locating and selecting suppliers, negotiating conditions and observing the contractor to make sure that he meets the performance conditions. Cost is not the only factor to consider. Purchased goods and services can have a large impact on various performance dimensions, including quality, reliability of deliveries and the ability of companies to use new technologies (Biały, W., Wedzicha. J. and Nordin V. 2018). Purchase purchases considered from the point of view of a given company become more important to it as it evolves from a typically transactional function towards a strategic function. In practice, the importance of purchasing purchases is determined by: structural and determining factors. The first are related to the position in the organizational structure occupied by the person responsible for purchasing purchases. Determining factors include: the perception of the purchasing function of the top management, the annual impact of purchasing on company expenses (Bendkowski, J. and Radziejowska, G. 2005). Supply goals resulting from the basic aspiration of the company to achieve a certain level of profitability and competitive ability on the market and its potential, i.e. impact on costs, quality, reliability of supply, use of technology are important factors in perceiving supply as an important function in enterprises (Bołoz, Ł. Midor, K. 2018).

SUPPLY LOGISTICS

Uses existing sourcing options, coordinating the flow of goods and information to provide the enterprise with materials used for production or for trade. Supply activities extend beyond the enterprise, abroad – they are undertaken internally, but affect the external preparation of material needs through appropriate systems – MRP. Three principles of external material supply have a significant impact on the costs arising in supply logistics (Fretsch, M. 2003).

- Individual supply in the case of demand – there is no need for material storage, low capital involvement and storage costs, the disadvantage is the possibility of production downtime with delayed deliveries, as a result of the lack of optimal use of production equipment, often occurs in the case of unit production under the customer's accepted order e.g. ventilation ducts with a diameter of 3m made of black sheet metal with special parameters.
- Inventory supply – materials are kept in stock at their own enterprise, intended for covering internal material supply, available at any time after

demand, especially used in the case of imports of raw materials from the Far East, e.g. rattan mats, bamboo.

• Delivery synchronized with production or consumption – the supplier must deliver the material on dates that result from the course of production in the supplied enterprise, current daytime supply is usually directed directly from the means of transport to the production places, warehouse stocks are kept only in the form of small safety reserves, thanks to such a system, capital commitment and storage costs are low, deliveries are synchronized with production.

Production companies often use a minimum of two principles of external material supply, and sometimes all three. The supply process connects participants in the supply chain and ensures the desired quality created by Supply and Production Logistics – the impact on the distribution logistics of suppliers in this chain. The quality of materials and services "entering" the system affects the quality of "finished" finished products from it, thus affecting customer satisfaction and company income (Górniak, A., Midor, K., Kaźmierczak, J. and Kaniak, W. 2018). We can define supplies in a narrower sense as an act of purchasing goods and services for an enterprise, and in a broader sense as a process of acquiring goods and services for an enterprise. The supply process is the implementation of a cycle of activities, activities that must be carried out in order to purchase goods and services in accordance with the requirements. The main task of supply is to ensure that the materials necessary to maintain production continuity are delivered when they are needed (Gajdzik, B, and Sitko, J. 2014). The condition for efficient operation of supply logistics is a close IT connection – planning and controlling deliveries between enterprises as well as advanced IT integration between the supplier and the recipient, aiming at the use of electronic data exchange (EDI). In practice, this means that enterprises, authorities and other organizations can easily cooperate with each other using computers. It is treated as a single area of information technology. An important feature of this system is that the computer receiving the data can interpret incoming messages. The message has a specific form, which enables its automatic transmission and further processing in the receiving system without any manual interference (Gajdzik, B. 2013). Supply logistics should be managed so as to ensure an uninterrupted production process and at the same time to allow material stocks to be kept low. Inventory management aims to maintain inventory in a specified size, e.g. sufficient to guarantee the continuity of supply of goods to the market. Realization of this goal requires cooperation with supply, production and distribution systems (Hąbek, P. 2014). Inventory management is particularly dependent on the size and structure of distribution channels.

PRODUCTION LOGISTICS

The target of production logistics is to ensure the flow of information and materials throughout the entire production process. The tasks, however, include the organization, control and planning of the flow of raw materials, parts,

cooperative elements and materials during the production process. Starting from supply warehouses, through position and department warehouses, and ending with finished goods and sales warehouses (Krzyżaniak, S. 2001). Stocks based on logistic assumptions are also defined as partly undesirable interruptions in the flow of goods. Based on the above statements, it can be assumed that warehouse inventories perform, among others, the following functions:

- provide protection against the uncertainty of supply for industrial and commercial enterprises, which could disrupt the production or sales process; this uncertainty may relate to the size of the delivery, its receipt and quality,
- ensure continuity of supply for seasonal production and year-round consumption; an example is the production based on the processing of agricultural products enabling to meet the peak demand for year-round production and short-term high consumption,
- enable the purchase of a batch of raw material caused by the seller's dominance over the recipient, when the minimum sales exceed the recipient's needs,
- allow you to run a market game using the boom and the price downturn in various aspects,
- they enable narrow specialization of production, because in warehouses there is a conversion of high primary production ranges into a rich commercial range, it consists of flowing into a production warehouse from many factories, in this way a range of various assortments, often complementary, of market demand and size fluctuations is accumulated in the inventory consumption of raw materials in manufacturing enterprises,
- allow the inventory to be adapted to the needs arising from customer preferences, – enable the sale of large batches of products,
- they are a factor that alleviates the effects of spatial dispersion of suppliers and customers on a national and global scale,
- they constitute an important element of distribution channels, enabling shaping a specific level of customer service,
- allow to equalize fluctuations in supply and demand on the market and fluctuations in the amount of raw material consumption in manufacturing enterprises.

Many of the problems associated with making inventory decisions can be solved using economic criteria. Reducing logistics costs is important for decision-making processes related to logistics systems, related to obtaining the proportion and direction of the system to achieve activities and results (Skowronek, Cz. 1989). In general, it can be said that the more detailed the state and structure of costs and expenses, the wider and clear the calculation of logistics efficiency is. Logistics activities enable significant cost reduction and maximization of company revenues (Sitko, J., Mikuś, R. and Bożek, P. 2018). The horizontal strategy has significant logistical problems that can support the

company's development strategy, which can be listed as follows: selection of contractors,

- election of own transport service of the logistics process or outsourcing,
- development of own warehouses or outsourcing,
- development of distribution networks or outsourcing,
- forming the system of subjective sales of services and products.

In the production company, suppliers are evaluated once a year and on this basis a qualified list of suppliers is created. Control and acceptance testing of raw materials as well as auxiliary materials begins with checking the shipping documents and specifications provided by the supplier and comparing them with the order. From a supply logistics perspective, a manufacturing company should only rely on qualified suppliers to make the system run smoothly.

The planning and control of material resources in the foundry (based on cupolas) is a combination of such ranges as forecasting and determining the size of orders, deadlines for the delivery of materials, determining the size of the production batch, determining the time of production start and the volume of inventories in warehouses and in the production process (Sitko. J. 2007).

Material requirements planning plays a significant role especially in the case of the demand for materials, raw materials, parts for production, for which the demand depends on the demand for a specific final product.

From the point of view of manufacturing and service enterprises, planning includes:

- direct production materials necessary to perform the planned production or service in the foundry, such as: foundry equipment, molding sand, pig iron, cast iron scrap, foundry coke,
- auxiliary materials needed to properly maintain the production cycle, such as modifiers, protective covers for molds, spare parts for machinery and equipment, etc.

METHODS FOR PLANNING MATERIAL NEEDS

The industry uses various methods and techniques for planning material needs adapted to the current conditions of the company. When choosing a planning method, various factors are generally taken into account, in particular the type of production (mass, serial or unitary) and the associated length of the production cycle (Mazurkiewicz, J., Szymszal, J. and Ścierski, J. 2003). They also play an important role:

- the nature of the consumption of directly production materials (foundry pig iron, molding sand) and auxiliary materials, coal dust,
- size of the range of materials,
- sources of material purchase and related delivery conditions.

These factors significantly affect the detail and planning technique as well as the accuracy of the supply plan arrangements. Material needs (P_m) determine

three basic elements: planned consumption of materials – H_P, fixed safety stock – Z_B, actual stocks at the beginning of the period covered by the plan – Z_P.

The following relationship exists between these elements:

$$P_m = P_\dot{z} + Z_B - Z_P \tag{1}$$

This relationship can be applied both to the planning of the demand for a specific material assortment and to a group of materials or the entire material needs of the plant. Material consumption planning is based on material consumption planning. Depending on the nature of material consumption (basic or auxiliary materials), different planning methods and techniques are used.

The consumption of basic materials necessary to perform the planned production is determined on the basis of production plans and the structural structure of products and consumption standards.

The planned consumption of basic materials is determined by the relationship:

$$P_\dot{z} = S \cdot N_\dot{z} \tag{2}$$

where:

$P_\dot{z}$ – planned consumption of materials in the given period,

S – production volume of castings in a given period,

$N_\dot{z}$ – material consumption per unit of casting.

In the case of assembly processes understood as combining components (e.g. details, subassemblies or assemblies) into a product, the basis for calculating material consumption is the material list. This is a description of the complexity of choice made by expanding its structural structure, and then adding up the repeating elements and placing them once in the description (Pfohl H. 1998). The material list is available in two varieties: analytical, where materials are grouped according to the components in which they occur, and synthetic, in which all materials included in the finished casting are included.

For production processes understood as processes in which there is a change in physicochemical properties, shapes, dimensions, etc., the planning of material consumption is determined by the formula:

$$P_\dot{z} = S \cdot N_t \tag{3}$$

where:

$P_\dot{z}$ – planned consumption of materials in the given period,

S – production volume of castings in a given period,

N_t – technical material consumption standard.

The wear standard, which is an important factor directly affecting the volume of material consumption, should be based on technical considerations. For this reason, appropriate formulas that take into account the properties of materials and technological processes are used to calculate unit consumption standards. Each standard is based on the same principle: the amount of material that the product contains must be supplemented with the sum of allowances corresponding to the size of justified losses and technological waste.

The second element of the material needs plan is safety reserve. It determines the amount of a given type of material necessary to ensure continuity of production between two successive deliveries. In the case of stock

normalization, it is the stock of a specific material adopted as the norm for a given period. The need to maintain a certain level of inventory results from the instability of the company's operating conditions caused, for example, by variability in demand for materials, unevenness and irregularity of supply. Hence, many companies maintain a certain amount of stock as a buffer or safety reserve in the event of disruptions in deliveries or errors in forecasting demand. Therefore, determining the level of safety stock becomes important. To this end, the following resources can be used:

- based on the length of delivery time to restore inventory,
- based on the use of statistical theory.

In the first case, based on the data from the past, the average demand for material is calculated in the period between two deliveries and the maximum demand for products is estimated (Lysons, K. 2004).

The level of safety stock must be large enough to cover the difference between average and maximum demand. Thus, the level of safety stock can be represented as a function of re-delivery time:

$$Z_B = (P_{max} - P_0) \cdot T \tag{4}$$

where:

Z_B – safety stock level,

P_{max} – maximum demand for a time unit,

P_0 – expected demand for time unit,

T – time

The shorter the material delivery time, the lower the level of safety stock may be.

In the second case, it is assumed that the level of safety stock depends on the size of the error, forecasting and probability of its occurrence. The probability that the amount of demand will exceed a given level of stocks during a given supply cycle is determined by means of a normal distribution.

In industrial practice, simplified methods of estimating the level of safety stock are used, increasing the volume of delivery by a certain percentage, e.g. for strategic materials 10-20%, other materials by 5%. The source and formation for determining actual stocks is a report on the state of materials prepared on the basis of the state of the materials.

When characterizing different planning methods and methods, one should not forget about the method of planning material needs based on forecasted demand or customer orders called the MRP method.

The basic principles of this method are based on forecasting, which only covers demand for finished products (independent demand). However, material needs (dependent demand) are calculated directly on the basis of product structure.

The division of needs into gross and net needs is an important element of the procedure.

Gross needs are the needs in terms of materials and product elements resulting from the operative production plan and various standards; they determine the type and amount of materials and elements needed for the production process.

The net needs correspond to the constituent materials actually processed during the given period.

Determining the gross and net material needs is a certain synchronization in determining the time periods of the demand for a given assortment, while agreeing on the dates of this demand and the dates of placing the order. Knowing the order processing cycle from external suppliers or the internal order processing cycle (length of the production cycle), you can very precisely specify the date of ordering materials.

This method allows very precise determination of the moment of the demand for a given element, but also allows determining the amount of this demand. The basic principle of this method is to minimize inventory.

METHODS OF CONTROLLING MATERIAL STOCKS

Material inventory management requires consideration of the following issues:
- you should also choose input materials for which inventory should be kept now and in the future,
- delivery lot size,
- the delivery cycle,
- determining the situations in which stocks may be dropped.

Take into account the fact that each stock, whose maintenance is justified at all, may consist of three parts: rotating stock, safety stock and excessive stock (Urbaniak, M. 2004).

Rotating stock (rotational, current) selection of contractors – its volume is determined by the volume of supplies Q and current consumption:

$$Z_R = 0{,}5 \cdot Q \tag{5}$$

Security stock – its size is determined by the following factors:
- the length of the delivery cycle to restore inventory,
- the probability of exceeding the delivery time and the amount of delivery,
- number of warehouses.

Excessive stock is a cost-adding inventory (mainly variable costs of maintaining inventory), and not adding any added to the whole process.

Shaping the level of inventory depends on the method used to control inventory:
- there are two basic groups of inventory control methods in the supply area: methods based on statistical forecasting,
- MRP material needs planning method.

Inventory control models.

In the inventory control process, material needs plans must be replaced with delivery plans. This requires the definition of two basic control parameters:
- the volume of deliveries (order quantity Q) – quantitative aspect,
- the delivery cycle (order processing time necessary to specify the order submission deadline – T), time aspect.

Model based on the level of inventory determining the moment of ordering.

This method is characterized by a constant amount of ordered materials when the stock level drops to the point of re-ordering. The reorder point (ROP) is the level of sufficient supply to meet the needs until the next delivery. The delivery cycle is a variable value. This model requires two sizes:

- the delivery amount,
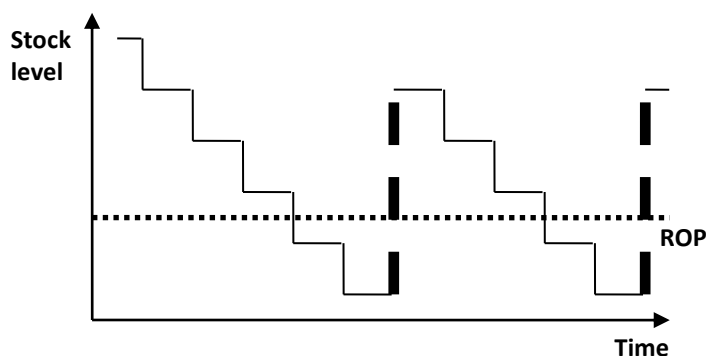- the level of stock indicating the need to place an order (Fig. 1).

Fig. 1 Puncture-based control model ROP

Source: own work

According to the model rules, an order is placed when the actual stock in the warehouse (increased by any delivery on the road) decreases to the ROP level. In turn, the ordered volume is constant and results from the optimal volume of deliveries.

FIXED ORDER CYCLE MODEL

In this method, inventory is controlled at set times and the order is placed in a specific cycle with a fixed period. The order size is variable and determined by the difference between the stock level, called the maximum stock Z_{tmax}, and the actual state of the foundry.

The model requires the calculation of two quantities:

- maximum stock level Z_{tmax},
- review cycle, T_c.

The maximum stock level is calculated from the formula:

$$Z_{tmax} = y_t(T_c + T_{śr}) + k \cdot \delta \sqrt{(T_c + T_{śr})} \tag{6}$$

where:

y_t – forecast of the size of needs in the unit period,

T_c – review cycle,

$T_{śr}$ – average observed delivery time,

k – the value resulting from the assumed risk factor,

δ – standard deviation.

The Tc inspection cycle is determined from the formula:

$$T_c = \frac{t \cdot Q_{opt}}{R} \tag{7}$$

where:

t – time expressed in appropriate units (e.g. 52 weeks),

Q_{opt} – optimal delivery amount,

R – annual demand.

Compared to the basic concept based on Q_{opt}, this model does not require precise observation of the inventory level, which results in lower inventory monitoring costs.

SUMMARY

Efficient supply management in an enterprise requires strategic decisions to be made in a growing market economy, enabling the plant to adapt its capabilities to a given production cycle. Material demand planning in industry is based on three basic types of demand: primary, secondary and supplementary. A conventional or MRP method is used to plan the enterprise's material needs. Both require close links between material needs and the company's production plans. Compared to the conventional MRP method, it is possible to very precisely determine the moment of demand for a given material and the amount of demand, which allows minimizing the inventory necessary to implement a specific batch of products.

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Abstract: Regardless of unit production, mass production – an excellent production plan is always expected to combine the exact amount of materials at the right time with production cells and employees. An accurate production plan saves money by reducing production costs and time. It helps to achieve the goal and generate the best production plan. The article addresses the problems of material resource organization in industrial, mining and processing enterprises, affecting production efficiency. Particularly the problems of planning and preparation of unit, serial and mass production in relation to specific products. Depending on the nature of material consumption (basic or auxiliary materials), different planning methods and techniques are used.

Keywords: planning, economy, organization, product