Abstract: Stock management as an element of enterprise strategy. There are discussed various aspects of stock management in the enterprise. There are presented the basic problems resulted from the need to assure operational continuity of the production and trade firms. The stock function is shown as a significant factor in enterprise management with consideration to financial aspects connected to the need for stock creation and the resulted limitations.

Key words: stock, kinds, division, costs, management.

INTRODUCTION

Management of stock is one of the most important elements in enterprise management. They are necessary material stock; without them the firm can not be called a venturesome enterprise [Kwiatkowski 2000]. They are a significant factor that determines proper functioning of enterprises operating especially in the field of production and trade. On the one hand, their level should allow for production and trade operations smoothness that determines profitability, on the other hand, involvement of financial inputs cannot be a burden that makes difficult development of the firm. Their volume should allow for activity at possibly minimal costs. The stock expression includes all goods that are not utilized at the moment [Ignasiak 1996], however, the prompt realization of customer orders calls for gathering a certain level of safety stock of volume dependent on, among other things, the possibility of supply delay resulted from transport retardation, breakage of production lines or inaccessibility, and the like. This form of stock makes a group of disposable means in the enterprise to be used any time, e.g. when the orders occur, and the like. A method for stock level calculation takes into consideration the stock “on the way” [Fertsch 2003]. After summing up of all supplies, the stock in the entire supply chain are often in excess in relation to the needs [Krzyżaniak 2005]. Therefore, creating of stock is not advantageous – it is a necessity resulted from difficulties in proper synchronization of supplying and receiving flows [Pierścieńek and Saryusz-Wolski 1999].

Stock is created in various areas of the firm; one of them is the supply sphere [Christoper 1996]. The stock in this area allows for continuity of production, assembling and product processing, and also protects against the costs of lost sale. Creation of stock in supplying results mainly from the purchase scale economy. The firms tend to get purchase savings and order the large quantities of needed materials (raw materials or final products); therefore, they can get price discounts from the suppliers. It can also result from market reasons, e.g. from raw materials availability and purchase
ease. If supplies are realized only in spring, while production is carried out throughout the year, maintaining of stock is obvious. If their level is high, meeting the customer’s requirements is not risky, although it involves an increase in stock storage costs, that are generally lower than the savings from purchasing of bigger batches [Bardi et al. 2002]. These aspects and necessity of permanent selection with the risk of losses is often a great problem for employees in charge of logistic processes in the enterprise. At present, a wide idea of modern production firms management assumes the need for minimization of stock in all possible locations. According to some opinion, the most profitable production method (towards reduction of final products reserve) can involve application of the shorter production series, with simultaneous searching for the solutions that reduce the costs of production lines reorganization [Bardi et al. 2002].

KINDS OF STOCK

The stock can be classified basing on many criteria. One of them is the kind division usually related to production firms (Fig. 1) and connected to particular phases of logistic processes existing in the [Skowronek and Saryusz-Wolski 2007]. According to this division one can distinguish the following kinds of stock: raw materials and materials for production or assembling, stock of production in progress, final products and goods. The first two groups realize the subjects’ internal needs, while the final products and goods meet the customer needs. The recent years observations point out at quantitative changes in particular kind groups. The present trend is an increase in stock of production in progress and of final products. It may result mainly from market reasons, e.g. from raw material availability, thus, the purchase ease. Allocating to one of groups affects the selection of appropriate method for the stock control.

In production plants the greatest attention is paid to unfinished production, since it is the most complex group of stock. Volume of needed production materials is affected by the scale of production, the organization and technical solutions, as well as application of information solutions [Ficoin 2005].

The enterprise management processes should consider a defined strategy and developed operational plans with appropriate means for realization of the projects, e.g. materials, goods, financial resources, labour, and the like. In op-

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**FIGURE 1. Division of stock (own elaboration, according to Skowronek and Saryusz-Wolski [2007])**
erational planning of data base there are usually forecasted the purchase scales [Prognozowanie... 2000]. This planning in stock management often becomes a key factor that determines the effectiveness and profitability of the enterprise. It is an indispensable element in management of the enterprise that aims at distributive activity [Ciesielski 2006].

STRUCTURE OF STOCK

In the trade and industrial enterprises with own distribution networks, the main kind of stock are goods at sale. The properly executed stock analysis should consider their economic usefulness and sale dynamics. The stock usefulness depends on a degree of their utilization in order to maintain sale. The useless stock should be determined together with possibility of their use. The goods and other kind of stock of justified maintenance, independently of their place in a logistic chain and nature, can be grouped into [Krzyżanik 2005]:
• rotating,
• non-rotating,
• excessive.

Structure of stock in the graphical form is presented in Figure 2. It is evident that the rotating stock (ZR) is most valuable for the enterprise, while the excessive stock (ZN) is totally unjustified.

Proper management of stock should aim at:
• maintaining of rotating stock at economically justified level,
• determining of security stock of volume needed to meet the requirement,
• removing of excessive stock.

The rotating stock (so called current stock) is the main kind of stock consisted of raw materials, materials or goods that allow for continuity of sale or other form of activity [Dębski 2000]. This stock is restocked by purchasing and its level is frequently changed; it is highest at the moment of delivery, then it gradually decreases till the next order. In evaluation of stock management strategy realization, correctness of assumed aims, sensibility of maintaining of appropriate stock level, effectiveness of their utilization, there are used many indices connected with the stock structure and other aspects associated with their existence in the enterprise:

![Figure 2. Structure of stock](image-url)
1. Stock rotation index that illustrates effectiveness of stock management, determined as a quotient of sale and stock volume:

\[ W_r = \frac{S}{Z_s} \]

where:
- \( W_r \) – rotation index in turnover,
- \( S \) – income of operational activity,
- \( Z_s \) – average stock within determined period.

The stock rotation index points out how many times the stock was converted into the final products. Its low value means that the stock level is too high and the enterprise carries unnecessary storage costs. An increase in this index means that the stock is sufficient for lower and lower number of sale days.

2. Stock rotation index in days is calculated as the inverse of stock rotation index multiplied by number of days in the investigated cycle (\( n_d \)). This index shows number of days till restocking in the enterprise:

\[ W_{rd} = \frac{Z_s}{S} n_d \]

The high index value points out that the stock turnover is too slow; the optimal index value is connected with nature of a given branch. The index value determined per year (365 days) should range from 37 to 52 [Zaleska 2005].

The rate of stock turnover depends mainly on kind of products being sold. The products of earlier expiration date are characterized by sooner exchange; the product quality is important, since it influences the rate of sale and increases rotation index value.

The method of activity organization and its localization are important factors that affect the rate of stock rotation. Possibility of storing goods, distance to suppliers or kind of transport means can enhance creation of large stock quantities or can force the current orders. In highly urbanized regions, maintaining of high stock level can be better justified than in suburbs. The trade enterprises tend to achieve a high rotation of goods; it enables to reduce storage costs and promotes better capital availability. The high stock rotation should be combined with well-fitted sales proposals based on demand analysis and appropriate supply regularity.

**Security stock** enables to avoid the results of lack of stock in the case of unexpected increased demand or late delivery. A decrease in the stock level beyond security level can lead to difficulties in realization of basic processes in the enterprise [Dębski 2000]. Because a security margin is used to meet requirements in unexpected moment, its level is calculated with the use of statistical rules. In determining of minimal security stock level one should consider:

1) Standard deviation of demand forecast error in restocking cycle duration (sPT). To calculate this, one should know:
   a) average forecasted demand value,
   b) standard deviation of demand forecast error (s),
   c) time of restocking cycle (\( T \)),
   d) standard deviation of restocking cycle time (\( \sigma_T \)).

2) Assumed level of customer’s servicing.
3) Method for restocking.

In the two main models for stock control, the security stock can be calculated with equation:

$$ZB = \omega \cdot s_{PT} = \omega \cdot s\sqrt{T}$$

where:

$\omega$ – security coefficient (dependent on determined level of servicing).

**Excessive stock** is a reserve beyond the enterprise’s needs; it can result from irregular production, too big orders or delivery not realized on time. This stock is characterized by increased variable costs of maintenance, while it brings about no added value to the process. It can be used in further activity of enterprise, along with a decrease in purchase. The excessive stock can be often transformed into a dead stock, of no value for enterprise, e.g. when production technology is changed, new assortment is introduced, or the product goes out of fashion (e.g. equipment with implemented modern technologies) [Niziński 1999]. The method for disposal of dead stock is to sale it to other firms within the branch or to introduce it to other markets, e.g. abroad [Dębski 2000].

**Promotion stock.** Various advertising campaigns or prize promotions attract usually more persons willing to buy a given product. Successful marketing actions largely depends on effectiveness of logistic channels. During promotion the chain participants, from producers to manufacturers and retail buyers, collect the products of increased demand. It is especially valid in the case of retail salesmen that get in touch directly with the final receiver.

The material stock aims at assuring of production continuity and can have various nature with respect to degree of processing, similarly to production stock in progress – that are created at various stages of production process. The structure, volume and rate of production restocking in progress greatly depend on technical advance of production process, as well as on the methods for management of organization and production process.

**COSTS OF STOCK**

The costs of stock are one of total logistic cost elements. With respect to stock significance for enterprise profitability, they need to be controlled in details [Dobija 1997]. One should aim at reduction of their level in order to decrease a lock-up capital in the stock, since their high level increases costs, but simultaneously assures production continuity or availability for sale. Taking into consideration all possible costs enhances the chance for proper determination of parameters that are indispensable in stock controlling. The stock cost classification is presented in Figure 3.

**Costs of stock creation** result from physical gathering of stock in the enterprise and from various aspects connected to essential communication aimed at purchasing. The expenses for stock purchasing are not included. The stock creation costs involve the fixed costs – resulted from restocking and independent of operational decisions, and the variable costs – dependent on the number of orders and the state of stock, e.g. costs of documentation, getting information, fuel
for transport means, costs of external contractors, etc. From the viewpoint of stock management, the fixed costs are more important and they should have decisive importance during purchase planning.

**Costs of stock maintenance** consist of costs of capital, storage, risk and stock manipulation [Lambert 1976]. Total cost of stock maintenance often increases along with stock volume or its value.

*Cost of capital* is mainly expressed in interest on stock financial value; it determines amount of collected stock potential and the cost of locking-out assets that cannot be used for investment or other economic market activity [Krawczyk 2001]. According to some opinions, this cost should be considered only in relations to investment inputs connected to stock [Lambert and Stock 1993]. In calculations of capital value there is most often used the method that uses the refund rate of a given venture.

*Storage costs* are connected with securing of constant availability of goods during changes in availability of materials and products [Gubała and Popielas 2005]. The storage inputs can include the costs of:

- storage facilities,
- depreciation of buildings and their maintenance and repairs,
- use charges (e.g. rent, lighting),
- stock records and identification,
- maintenance of appropriate storage conditions,
- theft,
- pay for storage employees,
- implementation of new solutions.

Storage costs can vary depending on kind of stock. Some raw materials do not lose their value during storing in open area, while other materials (e.g. electronic products) should be protected against moisture. The costs are also affected by a change in stock level, therefore the enterprises should consider mainly the variable costs in their calculations.

Maintenance of stock is also connected with the risk costs, since many products often lose their value. In the case of agricultural products, it can result from good harvest in a given year and subsequent decrease in prices. The industrial products, especially technologically advanced, are subjected to quick ageing and the trends in fashion. Connecting
the stock to a possible risk determines its value and costs of maintenance.

An important component of stock maintenance costs are handling costs; they are important element of logistic costs and their level is significant in enterprise management strategy. They involve taxes and insurance premium; most often they are connected with rarely available stock of a high risk.

Figure 4 presents differences in the curves of stock order costs and stock maintenance costs, when the order volume has been changed.

Costs of stock exhaustion are usually connected with the loss of selling possibilities. Under the shortage of a given good, the potential customer accepts delayed delivery or buys from a competitor. In the case of production enterprises, it is easy to calculate the costs caused by the shutdown of production line due to lack of stock. The following factors are usually considered: time of shutdown, number of units that could be produced and profit of a single unit. These costs should be increased by other losses, e.g. the staff wedges. Since determination of the number of customers lost due the lack of goods is difficult, the volume of lost sale can be only assessed with various probability.

MODELS FOR RESTOCKING
Selection of appropriate stock management method calls for learning of the enterprise’s operational conditions. The
basic criterion to be considered is the nature of demand; it can be dependent or independent.

If the demand for any good is caused by the demand for another (final) product, it can be called a dependent demand [Orlicky 1975]. It refers usually to production processes, e.g. when production of the product brings in the demand for its components. The stock management methods under the dependent demand are connected with solutions that improve the production area, involving calculating the combined factors, e.g. planning system of material needs.

Independent demand occurs when requirement for a given stock is not dependent on other items, e.g. it depends on the market trend, customers’ interests, fashion, etc. Such kind of requirement calls for application of other methods connected with forecasting of a future demand.

In the analysis of stock management one should take into consideration their structure, dynamics and manipulation costs [Dębiewska and Tkaczuk 1998]. Stock management is limited by many complex factors, while models applied do not usually reflect fully the reality. It is believed that the best model is based on many assumptions. Therefore, at the stage of its selection or creation one should consider, first of all, its accuracy. There are two basic models for restocking that consider the most important stock management parameters.

**System based on information level** – comes true under conditions of both the constant and uncertain demand. In the first case, calculation of parameters that facilitate undertaking decisions in storage management is more simple. Besides, the conditions of known (certain) demand rarely exist in reality due to sale variability, duration of restocking or damage of products during transport. A general diagram of the system is presented in Figure 5 (s – information level).

A classical model based on information level uses an idea of constant order volume. This method comes true better
in stock management in a separate organization unit than in the entire delivery chain. It can be modified towards its fitting to environmental requirements. According to its name, it consists in submitting orders of the same volume. Realization of this idea in unpredictable demand is possible under certain conditions:

- time of order realization is known,
- supplier is prepared to accept order any time,
- there is permanent access to information on the state of stock at one’s disposal,
- assortment items are not dependent on each other,
- there is no stock “on the way”,
- order volume does not affect the transport costs.

This method is a synthesis of two functions of basic stock costs: creation costs and maintenance costs. On the basis of them one can determine the total cost function as the form of both the costs ratio. The point of its minimal value (intersection of creation and maintenance functions) is most economical volume of order. Another way to facilitate undertaking decisions on the optimal order volume is application of the equation:

$$EWZ = \sqrt{\frac{2P \cdot k_z}{k_u}}$$

where:
- $EWZ$ – economical order volume,
- $P$ – forecasted demand volume within assumed period,
- $k_z$ – cost of single order,
- $k_u$ – specific cost of stock maintenance.

An enterprise that wants to manage the stock effectively with an idea of constant order volume, must determine the right moment for submission of the next order. It is the certain level of stock that becomes a signal for order submission. It should be sufficiently high to prevent against the stock shortage during waiting for delivery [Kozłowski and Liwowski 2007]. If demand is constant, calculation of the next order point (information reserve) is easy; only demand at the time of delivery and the number of days needed for order realization are taken into account. Under the uncertain demand, the enterprise must consider the expected demand during restocking and, additionally, the security stock. The information reserve under undetermined demand can be calculated with equation:

$$Z_i = P \cdot T + ZB$$

where:
- $P$ – demand in restocking cycle,
- $T$ – time of cycle,
- $ZB$ – security stock.

In model development, the efficient restocking calls for knowledge of other parameters also, e.g. time of restocking cycle. Changes in demand and their dynamics during restocking are important information in stock management [Krzyżaniak 2005]. The restocking cycle lasts from the moment of finding the need for restocking with the material or product, till the moment of its availability for production or sale. The intermediate activities include (among other things):

- making an order,
- order preparation and dispatching by the supplier,
- acceptance of delivery.
Knowledge of restocking time helps in better fitting of the restocking model to real situation; it is needed for calculations of security stock. Knowledge of the demand during restocking is very helpful also.

The applied models aim at assuring of appropriate level of customer service – i.e. ability of meeting the existing demand by stock at one’s disposal, therefore, at an increase of customer satisfaction [Blaik 2010]. This ability level consists in some kind of information on the results of sale activity [La Londe 1985]. The required service level is a factor that determines the security stock volume and it should be calculated. Determination of service level is usually done by:

a) own experience,
b) calculations that take into consideration the stock costs,
c) reference sources,
d) observing the competitors.

A given level of customer service can be interpreted in two ways:

- The first one determines probability that the lack of good won’t occur during restocking. If the level of customer service is assumed as 80%, the probability of such situation equals to 0.80.
- The second one determines the level of realized orders.

System of periodical inspection results from the fact, that application of constant order volume method could not be possible for various reasons. Therefore, another method used in retail sale involves the restocking in constant time intervals [Harrison and Van Hoek 2010]. As opposed to the previous model, the volumes of particular orders are usually different and depend on the level of stock at one’s disposal at the end of period. The graphical form of this model is presented in Figure 6 (S – maximal reserve).

The system can be applied if the following criteria are fulfilled:

- Inspection of reserve level is done regularly and is connected with simultaneous purchasing of goods;
• Time of order realization does not differ from the one agreed with the supplier.

The main parameter taken into consideration in the system of periodical inspection is maximal reserve. This is a predetermined stock level that should not be exceeded; this greatly determines the order volume. It can be calculated with the equation:

\[ Z_{\text{max}} = P \cdot (T + T_o) + ZB \]

where:
- \( P \) – demand in a given period,
- \( T \) – cycle of restocking,
- \( T_o \) – cycle of stock inspection,
- \( ZB \) – security stock.

If compared with the method of constant order volume, in this method there is no need to observe the stock. If the enterprise has a large assortment, it can bring in a substantial reduction of the good record costs. Additionally, it enables to combine the orders in a single delivery and to reduce transport costs [Ciesielski 1997].

CONCLUSIONS

The stock is an important factor that determines proper functioning of enterprises, especially in the field of production and trade. On the one hand, their level should allow for the fluent production or trade operations that determine the profit creation; on the other hand, engaging of financial means cannot charge the enterprise’s development. Their quantity should allow for activity at possibly minimal costs. Creation of stock is not advantageous – it is a necessity resulted from difficulties in proper synchronization of supply and reception flows. The stock classification can be based on many criteria. One of them is the kind division related to production enterprises, where stock can be divided into: raw materials and materials for production or assembling, the stock for operations in progress, final goods and products. In trade enterprises and industrial ones that are equipped with a distribution net, the main kind of stock are goods subjected to sale. The proper stock control should steer at maintaining of the rotating stock at economically justified leve, and at determination of security stock of volume that is needed to meet the demand and to liquidate the excess stock.

REFERENCES


Streszczenie: Zarządzanie zapasami jako element strategii przedsiębiorstwa. W pracy poruszono różne aspekty zarządzania zapasami w przedsiębiorstwie. Przedstawiono podstawowe problemy wynikające z konieczności zapewnienia ciągłości działalności firm produkcyjnych i handlowych. Pokazano funkcję zapasów jako istotnego czynnika w zarządzaniu przedsiębiorstwem, z uwzględnieniem finansowych aspektów konieczności tworzenia zapasów i związanych z tym ograniczeń.

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