INCREASING THE EFFICIENCY OF A PRODUCTION ORGANIZATION THROUGH MANAGEMENT OF PRODUCT AND MATERIAL LAYER FORMATION PROCESSES

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Introduction

The problem of effective management of product and material stocks is of particular importance for production organizations, since stocks are an integral component of production and commercial processes, and their improper management can lead to inefficient use of resources, a decrease in the organization's efficiency and competitiveness. Considering the cost of inventory formation, storage and management processes, it is necessary to develop a system for their management that will ensure the continuity of the organization's production process, financial stability and efficiency of operations.

The main inventory management systems are those operating with a fixed order size and a fixed time interval between orders. In the first case, the amount of the order for replenishment of inventory is constant, in the second case, the time interval between orders.

Methodology

The research used mathematical, comparative and factor analysis methods. In particular, the mathematical method was used in the case of basic inventory management systems when presenting changes in different levels of inventory over time. And the methods of comparative and factor analysis were used in the process of analyzing the main systems of managing product and material resources in a manufacturing organization, identifying their advantages and disadvantages, and assessing their effectiveness.

Literature review

There are different approaches in the professional literature on resource management. According to some theorists, the formation of large-scale reserves is a direct necessity for the effective organization of the production process [Kagaev, 2024, 1958]. According to the opposite position, the volume of reserves should be minimized, even excluded, which will have a positive effect on the efficiency of the use of financial resources. Such a resource management system is the "Kanban" system, according to which the product should be prepared and delivered when the consumer demands it, and the raw materials should be purchased when it is necessary to produce the product [Biryukova, 2012, 45]. Moreover, in this case, the accuracy and continuity of the supply process is of great importance. According to some theorists, it is necessary to ensure the optimal volume of reserves, the size of which depends on the specifics of the organization's activities, financial capabilities, and the level of efficiency of the resource management system [Glavatskikh, 2023, 31]. The formation and effective management of commodity and material reserves is of key importance for a manufacturing organization, as it ensures the constant overload of workers, being the main factor in ensuring the effective operation of the organization.

Research novelty

Among the applied scientific results obtained as a result of the research, the following can be distinguished as a scientific novelty: a comparative analysis of the main commodity and material reserve management systems was carried out, their economic efficiency was assessed, and it was substantiated that in the case of a fixed order size and a fixed time period between orders, the existing resource management systems provide adequate efficiency, and their selection and application in different organizations depends on the organization's field of activity and the specifics of the production and technological processes being carried out, and the type of production. New methodological approaches are presented to determine the main indicators of the considered inventory management systems.

Analysis

Harmonious and effective activity in logistics chains is ensured when it is possible to form mutually agreed relationships between all the links and organizations that form them. To solve this fundamental problem, it is necessary to form appropriate organizational and organizational layers in various areas that form the logistics chain. The optimal design of the structure and composition of the supply chain will allow not only to create internal relations between all departments and organizations involved in the chain, but also to significantly reduce logistics costs and contribute to increasing the level of efficiency throughout the system [Mohamed, 2023, 3]. It is believed that the costs associated with the formation of supply chains make up a significant part of logistics costs. According to statistics, these costs account for 12-40% of total logistics costs. Therefore, solving the fundamental problem of optimal organization and structure of the supply chain in material flows is one of the important directions for increasing the efficiency of the organization of processes implemented in the logistics system [Fomishin, 2019, 1458].

The correct implementation of the technology (system, model) of supply chain management in production is greatly influenced by the nature and structure of production, the specifics of the implemented and applied organizational and production-technological processes, the implemented methods of organizing production and work, etc. [Lukinsky, 2025, 14]. The effective solution of the basic problems of the formation and management of commodity supply chains at all stages of the product life cycle will make it possible to form such a structure and composition of resources at lower costs, which will create the necessary conditions for the effective implementation of the current and future tasks of the export organization.

The material properties of the products have various forms of appearance, which are determined by the production-technological phases characterizing the production of the finished product and the peculiarities of the technological processes being implemented [Erchak, 2023, 4]. The effective functioning of the system of formation and management of tasks determines the smooth functioning of the production organization at all stages of the chain "delivery - production - delivery", as well as contributes to the integrated performance of material flows carried out in the logistics system of the organization.

The main factors in the organization and implementation of the work on the formation of reserves are their shape, size and duration. Managing changes in the shape, structure and volume of reserves over time is considered the main problem of preserving reserves and ensuring their need. For this reason, orders must have such a composition, structure and volume that it is possible to provide the necessary level of security for the formed order.

The arrangement of orders is carried out in two main directions:
• determining the size of the order,
• determining the size of the time interval between orders [Munyaka, 2022, 19].

In the first case, the order size is fixed, which determines the volume of the supply. In the second case, the fixed time interval between successive orders (the cycle) is fixed, which determines the time of formation of the next order for the supply of the supply. For this reason, two basic systems of supply management are used in the concept of supply management [Matafanova, 2017, 119]. These systems are used when the main production and economic indicators of the activity of the exporting organization are relatively stable, and the supplies are used in equal quantities, constantly ensuring the demand formed among consumers. These systems are:
• Order processing with a fixed order size (first system),
• Order processing with a fixed time interval between orders (second system).

In the first system of order processing, the optimal order size is used to determine the other indicators of the order indicator system. The distinctive feature of the order-by-order method is that the order for the acquisition of material resources is equal to the product of the optimal order size and is formed when the current level of resources equals the previously determined resource threshold (the stock level). In this case, all indicators of the system are determined in such a way that, within the framework of the given starting data, the reserves consistently meet the formed demand. The system is characterized by the following basic accounting parameters:
• insurance reserves,
• reserve threshold (reserve limits),
• maximum desirable level of reserves.

Insurance reserves are formed with the aim of satisfying the need for material resources in the event of a delay in the delivery of goods. The term “delay” refers to the possible delay [Schreibfrieder, 2006, 223]. When determining the cost of insurance products, it is necessary to take into account the possible delay in the execution of the order and the expected average daily consumption of the purchased material resource.

The supply threshold (limit stock level) is the amount of current stocks that, if equaled, requires the implementation of a new order for the acquisition of material resources. The basis for determining the limit stock level is the amount of insurance stocks, the planned duration of supply, and the expected average daily consumption rate of the acquired material resource. The stock limit level should be determined in such a way that the formed order is executed when the current stock level in the organization's warehouses equals the level of safety stocks.

The level of customer satisfaction, without affecting the performance of the system, makes it possible to determine the level of resource allocation that requires the least amount of overhead and contributes to the rational use of all resources of the organization. The basis for determining the level of demand for a particular product is the size of the collateralized demand and the optimal order size.

When applying the basic order-setting procedure, the changes in the different levels of demand over time are presented in Figure 1.

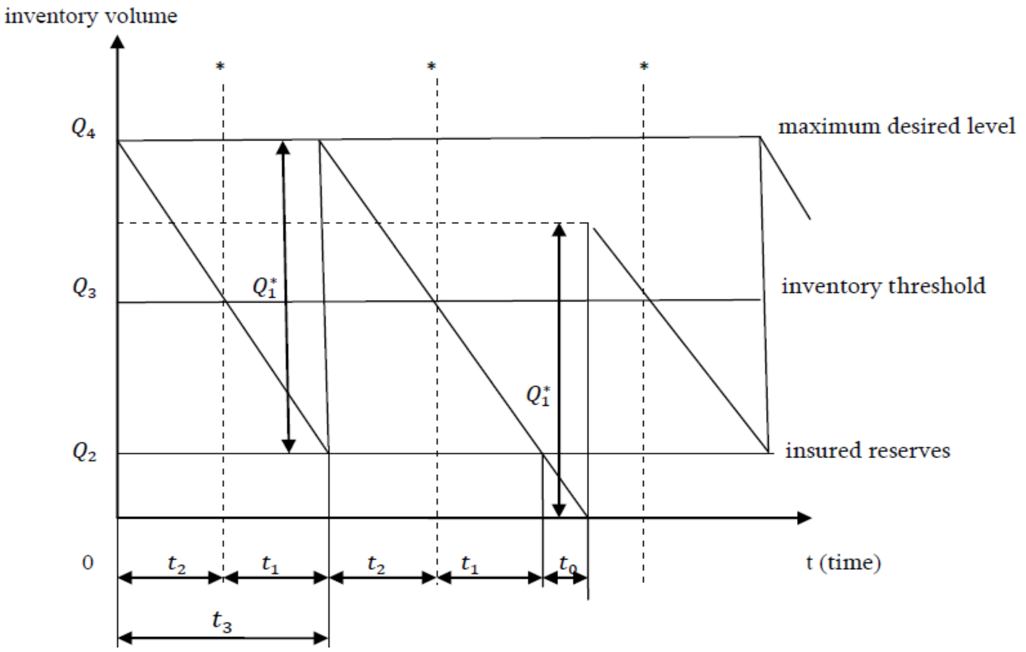

Figure 1. Graphical representation of inventory changes in the case of the first basic inventory management system

Additions to Figure 1, where: Q - is the order quantity (volume), Q_1^* - is the specified order quantity for the optimal order size, t is the order execution time, Q_2 - is insurance reserve size, Q_3 - is the limit level of the stock (threshold), Q_4 - is the maximum desired level of inventory, t_0 - is the maximum possible delay in order execution time, t_1 - is the order execution time is the time, t_2 - is the amount of time the product is used until it reaches its limit (threshold), t_3 – is the time to use the resources, * - is the time moment to place orders..

In order to ensure the effective operation of the main supply chain management system, it is necessary to correctly determine and implement the following main indicators: the optimal order size, the order execution time, the duration of the possible delay in the order execution time, the expected average daily consumption of the material resource, the expected amount of material resource utilization during the order execution, the expected maximum consumption of the material resource during the order execution, the insurance premium, the price limit level (threshold), the level of the maximum desired level of demand, the duration of the use of the demand until its limit level (threshold) is reached, the duration of the use of resources.

The size of the annual requirement for a material resource is determined based on the annual production plan of the production organization and the size of the norm of consumption of a given material resource as a percentage of the finished product. In general, it can be determined by the following formula:

$$N = P * H \qquad (1),$$

where P - is the annual (planned period) production schedule of finished goods, H - is the norm of the cost of a given material resource divided by the unit output.

The optimal size of the order for the purchase of the material resource used is determined according to Wilson's formula.

$$Q^* = \sqrt{\frac{2 * c_{11} * N}{c_{21}}} \qquad (2),$$

where c_{11} is the cost of processing a single order, N - is the amount of demand for the product being ordered (during the planned time period), c_{21} - is the cost of maintaining a unit of inventory in an organization's warehouse.

The adjusted yield of the optimal order size (Q_1^*)is determined by rounding the resulting calculated value to a larger number.

The data on the order execution time (t_1) and the maximum possible delay in the order execution time (t_0) are presented in the general terms and conditions of the order, in accordance with the contract concluded with the supplier.

The average daily demand for a material resource is determined by a following formula:

$$\overline{Q} = \frac{N}{D_1} \qquad (3),$$

where D_1 is the number of working days in the planning period (planning year).If necessary, the expected average daily consumption is rounded up to a larger number, and this adjusted consumption is used in subsequent calculations ($\overline{Q}_1$).

The size of the expected consumption of a material resource during the execution of an order is determined by the following formula:

$$Q_0 = t_1 * \overline{Q_1} \qquad (4):$$

The expected maximum size of the consumption of a material resource during the execution of an order is determined by the following formula:

$$Q_0^{\max} = (t_0 + t_1) * \overline{Q_1} \qquad (5):$$

The size of the insurance reserve is determined by the following formula:

$$Q_2 = Q_0^{\max} - Q_0 \qquad (6):$$

The borderline of the resources is determined by the following formula:

$$Q_3 = Q_2 + Q_0 = Q_2 + t_1 * \overline{Q_1} \qquad (7):$$

The maximum desired inventory level is determined by the following formula:

$$Q_4 = Q_2 + Q_1^* \qquad (8):$$

The amount of time a resource will be used until it reaches its limit level is determined by the following formula:

$$t_2 = \frac{Q_4 - Q_3}{\overline{Q_1}} \qquad (9):$$

The duration of use of a material resource (stock) acquired as a result of order fulfillment is determined in the following two ways:

$$t_3 = \frac{Q_1^*}{\overline{Q_1}} \qquad (10) \qquad \text{or} \qquad t_3 = t_1 + t_2 \qquad (11):$$

In the second main inventory management system, the time interval between orders is constant. In this inventory management system, orders are formed at a strictly defined point in time, and the time interval between them is a constant (fixed) value. That is, in this inventory management system, the time interval between orders is constant. Moreover, it must have an optimal size in order to ensure the optimal level of the formed inventory. Since the optimal level of inventory can be formed by ensuring the optimal order size, it is necessary to determine the time interval between orders based on the optimal order size. A distinctive feature of the system's activity management method is that orders for the acquisition of material resources are formed at a predetermined time and are repeated with the same interval between orders. In this case, the order quantity is determined at the time of formation of each order, which should ensure the replenishment of the stock of resources to their minimum desired level. All indicators of the system are determined in such a way that within the given data frames, the demand is provided by the formed demand on an uninterrupted basis.where: is the total cost of forming one order, is the annual (planning period) demand for the ordered product, is the cost of storing one unit of the product in the organization's warehouse. In addition to the time between open orders, this is also characterized by the following two basic accounting indicators:

• insurance reserves,
• the maximum desired level of reserves.

The essence and characteristics of these two accounting indicators were presented when presenting the indicators of the first basic inventory management system. In order to ensure the efficient operation of the second basic order management system, it is necessary to correctly determine and implement the following main indicators: the amount of demand for material resources in the planned inventory management period, the amount of the optimal order size, the amount of fixed time between orders, the order fulfillment time, the duration of the possible maximum delay in the order fulfillment time, the average daily material resource expected consumption, expected use of material resources during order fulfillment, maximum expected use of material resources during order fulfillment, safety stock, maximum desired stock level. The annual material resource requirement and the optimal order size are determined according to formulas (1) and (2) presented in the first system, respectively. The fixed time interval between orders can be determined by the following formula:

$T = \frac{D_1 * Q_1^*}{N}$ (12), where T - is the fixed time interval between orders.

The expected duration of the order execution time (t_1) and the maximum delay in the order execution time (t_0) are presented in the terms and conditions of the order. The expected average daily consumption of the material resource, the expected amount of material resource consumption during order fulfillment, the expected maximum amount of material resource consumption during order fulfillment, and the amount of safety stock are determined according to formulas (3), (4), (5), (6) presented in the first system, respectively. The maximum desired level of stock is determined by the following formula:

$Q_4 = Q_2 + T * \overline{Q_1}$ (13),

The size of the order is determined according to the following formula:

$Q_i = Q_4 - Q_{ti} + Q_{0i} - Q_{Ti}$ (14),

where: Q_i - is the quantity of the i-th order, Q_4 - is the maximum desired level, Q_{ti} - is the quantity of the current resource level at the time of the i-th order, Q_{0i} - is the expected quantity of use of the material resource at the time of the i-th order, Q_{Ti} - is the volume of the resources that has not yet been received but is on the way at the time of the i-th order. When using the second basic inventory management system, changes in inventory levels over time can be represented in the following graphical form (Figure 2).

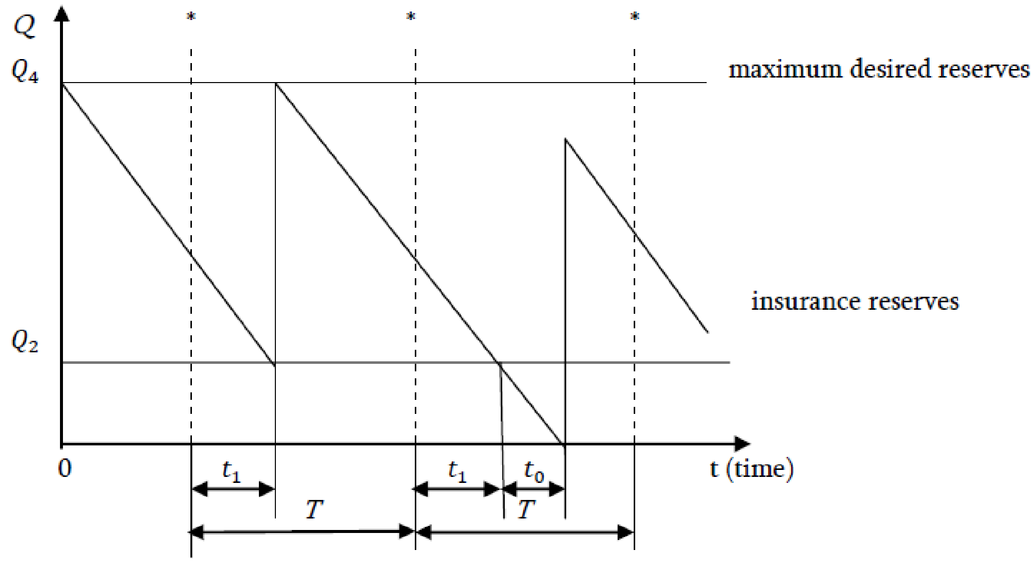

Figure 2. Graphical representation of inventory changes in the case of the second main inventory management system

Additions to Figure 2, where: Q - is the quantity of the resources (volume), t - is the resource management time, Q_2 - is the insurance reserve size, Q_4 - is the maximum desired inventory quantity, t_1 - is the order fulfillment time, t_0 - is the maximum order fulfillment delay duration, T - is the fixed time interval between orders, * - is the order processing time moment.

A comparative analysis of the effectiveness of the main inventory management systems can be carried out by presenting the advantages and disadvantages of each inventory management system. According to experts, the advantages of the first main inventory management system are:

• lower level of the maximum desired level of inventory,
• saving on inventory storage costs due to the reduction of warehouse space.

According to experts, the disadvantage of this system is the need for constant control over the availability of inventory in order to determine the right time to fulfill a new order. The advantage of the second main inventory management system is the lack of constant control over the availability of inventory, since orders are formed at fixed time intervals.

For this system, the following disadvantages are identified by experts:

• high level of the maximum desired level of inventory in the warehouse,
• increase in inventory storage costs due to the increase in warehouse space.

The analysis shows that the maximum desired levels of inventory are the same in the two main inventory management systems mentioned above. In the first basic inventory management system, the maximum desired inventory level is determined according to formulas (8), and in the 2nd basic inventory management system, according to formulas (13).

By inserting the values of T and $\overline{Q_1}$ in the formula (13), we can obtain formula (8).

$$Q_4^2 = Q_2 + T * \overline{Q_1} = Q_2 + \frac{D_1 * Q_1^*}{N} * \frac{N}{D_1} = Q_2 + Q_1^* = Q_4^1 \qquad (15).$$

The results show that the main inventory management systems provide adequate efficiency, since $Q_4^2 = Q_4^1$: The inequality of these indicators can only be due to rounding of the calculated values, which can cause certain deviations in the final results. The disadvantage of the second main inventory management system is that it is necessary to determine the size of the order when forming each order. Moreover, each time it is necessary to determine the actual balance of this material resource in the organization's warehouses. Taking into account the fact that modern computer tools and support programs are used in logistics systems, it is possible to quickly and with no additional costs to determine the actual level of material reserves at any time and at any level of supply chain management.

Discussion of the results

The main systems of resource management provide equivalent efficiency, but the choice and application of any of them in the organization largely depends on the specifics of the latter's activities. Moreover, the first main system of resource management is expedient to be used in group production, where it is necessary to ensure the rhythm of the production processes being carried out. In these organizations, the supply of material resources is carried out according to the established production schedules. And the second main system of resource management is expedient to be used in conditions of large group and mass production, where a proportional amount of output is ensured. In these organizations, the demand for material resources is stable and predictable.

Conclusion

The management of material resources is of key importance for ensuring the effective operation of a production organization, since it ensures the constant overload of workers and forms harmonious relations in the "supply - production - sale" chain. The results of the study show that the considered systems of material resources management provide an equivalent level of efficiency. The choice of inventory management systems is determined by the specifics of the field of activity of the manufacturing organization, the type and scale of production, and the production and technological features of the products being produced. Since the processes of formation, maintenance, and management of inventory are costly, in order to increase efficiency, it is necessary to improve their structure, considering the importance of the products being produced and changes in demand.

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Comparative analysis of the main inventory management systems of manufacturing organization

Key words: inventory, manufacturing organization, inventory management system

The efficiency of the activities of a manufacturing organization depends largely on inventory management. The continuity and efficiency of production and technological processes within the organization, as well as uninterrupted operation at all the stages of the «supply-production-sales» chain are impossible without inventory. This study has conducted a comparative analysis of the main inventory management systems operating under fixed order quantities and fixed time intervals between the orders. Key performance indicators of the latter and new methodological approaches to their determination have been presented in the study. The advantages and disadvantages of these inventory management systems have been highlighted. It is substantiated that the existing inventory management systems have the same efficiency in case of fixed order quantities and a fixed time interval between the orders, however, taking into account the specifics of the organization's activities and the conducted production and technological processes, it is advisable to use the first main system under the conditions of group production, and it is advisable to use the second main system under the conditions of mass production.