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# DEVELOPMENT OF A DESIGN ALGORITHM FOR THE LOGITICS SYSTEM OF PRODUCT DISTRIBUTION OF THE MECHANICAL ENGINEERING ENTERPRISE

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**Abstract**

The purpose of this research is to represent the results of the development of the design algorithm for the logistics system for the distribution of products of a mechanical engineering enterprise, which would determine the characteristics of the production distribution channel, the optimal arrangement of the elements of the logistics system of product distribution in the environment, and also to optimize the resources flow with regard to the limitations. The main content of this research is the analysis of publications of Russian and foreign scientists and specialists in the field of production management, modeling and optimization of organizational structures and production processes, design of logistics systems. The practical significance of the research is the possibility of the appliance of the presented algorithm by the management team of a mechanical engineering enterprise in a market environment. It would permit to improve the efficiency of using the existing resources of the enterprise. This article is addressed to specialists in the field of theory and practice of production organization

**Keywords**

*Logistics system, distribution, design, algorithm, mechanical engineering, enterprise, product*

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**Introduction.** Rational planning by the management of a mechanical engineering enterprise for the processes of marketing and sales (distribution) of its products is one of the conditions for the organization to achieve high results, sustainable and efficient development. Planning for the distribution of products, the performance of work and the provision of services are a set of steps, processes and methods for determining, selecting and attracting consumers, identifying rational

distribution channels and means of supply of products in accordance with the terms of the contract and the choice of sales and sales forms [1–3].

A high level of competition in a market environment requires the management team of a mechanical engineering enterprise to design a logistics system for the products distribution [4, 5]. Decisions about the choice of the distribution channel and its characteristics, about determining the location of the elements of the logistics distribution system are some of the relevant solutions to the problems of distribution logistics [2, 5–8].

The choice of a distribution channel for the products of a mechanical engineering enterprise depends on three parameters [5, 9, 10]: 1) the number of salespoints; 2) the costs of distribution processes; 3) the level of product control within the process of the delivery to the consumer via the distribution channel. If the distribution chain consists of a small number of links, the enterprise retains a high level of product control, but it is able to cover a less wide segment of the market and incurs costs associated with the storage of finished products in a warehouse, transportation, marketing of sales (distribution) of products. If the distribution chain consists of a large number of links, the enterprise covers a wider market segment and bears the costs of the manufacturer, but reduces the level of product control due to complicated distribution processes.

**Methods.** The theoretical and methodological basis of the research is the publication of Russian and foreign scientists and specialists in the field of production management [1, 3, 7–10], modelling and optimization of organizational structures and production processes [6, 11–13], design of logistics systems [2, 5, 8, 13–15].

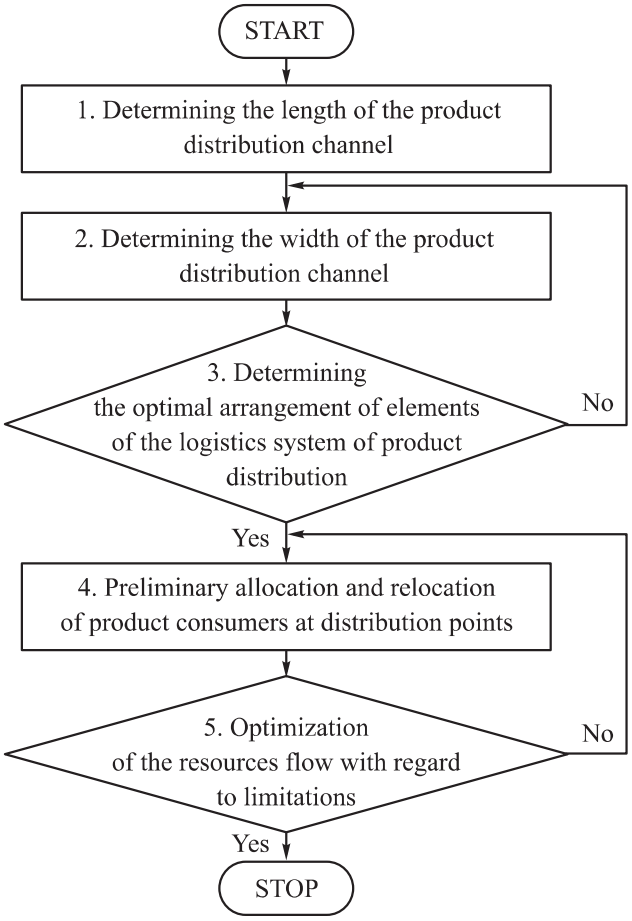
The methodological basis of the research is the application of methods of structural analysis and design, design of organizational management structures, logistics design and management of production and commercial systems, applied theory of optimal control. The general methodological basis of the research is a systematic approach.

**Results.** The flowchart of the design algorithm for the logistics system of product distribution of the mechanical engineering enterprise is shown in the figure.

*Step 1.* The implementation of the processes for determining the length of the distribution channel, i.e., the number of products distribution levels, is based on received data (information) from the analysis of the internal and external environment of the mechanical engineering enterprise, and long-term forecasts of the demand for products.

A model for determining the length of the channel for the products distribution of a mechanical engineering enterprise: $C + PC + P_1C + P_2C + ... +$

$+P_{(k-2)}C \le R$, where $C$ is the manufacturing cost of the production; $P$ is the basic level of products profitability; $P_k$ is the level of products profitability with regard to the number $k$ of level of products distribution.




The flowchart of the design algorithm for the logistics system of product distribution of the mechanical engineering enterprise

As part of the step of the design algorithm of the logistics system of product distribution of a mechanical engineering enterprise, an additional model could be used to determine the length of the products distribution channel with regard to the specifics of the marketing policy of the mechanical engineering enterprise [4, 11].

*Step 2.* The implementation of processes for determining the width of the distribution channel, i.e., the number of participants in the of products distribution levels, is based on received data (information) about transportation tariffs and costs, which are not related to the transportation of products of a

mechanical engineering enterprise, as well as the area covered by its logistics distribution system.

After determining the width of each products distribution channel, an analysis of the number of structural elements of the designed logistics system of product distribution of a mechanical engineering enterprise should be done to understand the number of distribution points and the level, which would be necessary for effective distribution of products.

*Step 3.* The implementation of the processes for determining the optimal arrangement of the elements of the logistics system of products distribution in the environment is based on the calculation of the optimal coordinates of distribution points according to the criterion of the minimum total transportation costs [7, 9]:

$$\sum_{i=1}^{n} V_i T_i D_i + \sum_{j=1}^{m} V_j T_j D_j \to \min,$$

where $n$ is the number of suppliers of materials and components of products; $V_i$ is the supply volume from the $i$-th supplier to the distribution point; $T_i$ is the tariff for transportation of the supply volume from the $i$-th supplier to the distribution point; $D_i$ is the distance from the supplier to the distribution point; $m$ is the number of consumers of the output products; $V_j$ is the supply volume from distribution point to the $j$-th consumer; $T_j$ is the tariff for transportation of the supply volume from the distribution point to the $j$-th consumer; $D_j$ is the distance from distribution point to the $j$-th consumer.

The coordinates of the elements of the logistics system for the products distribution of in the environment $x$, $y$ are determined by iterative formulas

$$x = \frac{\sum\limits_{i=1}^{n} \frac{V_i T_i x_i}{D_i T_i} + \sum\limits_{j=1}^{m} \frac{V_j T_j x_j}{D_j T_j}}{\sum\limits_{i=1}^{n} \frac{V_i T_i}{D_i T_i} + \sum\limits_{j=1}^{m} \frac{V_j T_j}{D_j T_j}}; \quad y = \frac{\sum\limits_{i=1}^{n} \frac{V_i T_i y_i}{D_i T_i} + \sum\limits_{j=1}^{m} \frac{V_j T_j y_j}{d_j T_j}}{\sum\limits_{i=1}^{n} \frac{V_i T_i}{D_i T_i} + \sum\limits_{j=1}^{m} \frac{V_j T_j}{d_j T_j}}.$$

Here $x_i$, $y_i$ are the position data of the $i$-th supplier of materials and complementary parts of products; $x_j$, $y_j$ are the position data of the $j$-th consumer of the output products.

*Step 4.* Preliminary allocation and relocation of product consumers at distribution points is characterized by the necessity to consolidate product consumers of mechanical engineering enterprise at distribution points of the highest level. Distribution points of a higher level should be allocated at distribution points of a lower level. It becomes possible to perform the first iteration

of determining the optimal location of the distribution point by calculating, at first, the position data of distribution points of all levels, except for the distribution point of the lowest level. This calculation is based only on the position data of distribution points of a higher level. When calculating the position data of the lower level distribution point, the position data of the suppliers of materials and complementary parts of products of mechanical engineering enterprises should be considered. After that, re-iteration is carried out in regard to previously determined position data of the distribution point location.

It is proposed to relocate product consumers of a mechanical engineering enterprise beyond a distribution point based on the boundaries of its sales zones [10, 15]. The algorithm step is characterized by a large number of iterations. There is a return to determining the optimal location of the elements of the logistics system for the distribution of products of a mechanical engineering enterprise, in regard to new data (information) on the structure of demand for distribution points. When the improvement over the iteration is less than the required value, which is specified in the parameters of the designed logistics system of product distribution of the mechanical engineering enterprise, we should proceed to the step of optimizing the resources flow with regard to the limitations.

*Step 5.* Optimization the resources flow, with regard to the limitations, is characterized by the possibility of adapting the designed logistics system of product distribution of the mechanical engineering enterprise to real conditions [16–18].

As part of the design algorithm step of the logistics system for the distribution of products of a mechanical engineering enterprise, an additional model of resource allocation could be used, with regard to the cost of the use of capital [13, 14].

**Conclusion.** An algorithm has been developed for designing a logistics system of product distribution of a mechanical engineering enterprise, which allows one to determine the length and width of a product distribution channel, the optimal arrangement of elements of a logistics system for product distribution in the environment. Besides, it gives the opportunity to optimize the resources flow with regard to the limitations. The practical implementation of this algorithm would improve the efficiency of using the resources, which are available to the management team of the enterprise.

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