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Modeling the supply chain market participants: calculation of the optimal order size

Abstract: modern conditions are highly dynamic macroeconomic environment in which there are market participants. Due of the globalization process there is a necessity of introduction of innovative methods and technologies. It is obvious that the formation of an effective model instrumentation in the field of logistics. It is a necessary condition for the creation of information and analytical basis to support an efficient decision-making.

Keywords: methods and technologies, economic-mathematical instrumentation, Economic Order Quantity, management, optimal order size.

Analysis of the existing theoretical and methodological platform for formalization of the decision-making process in this area suggests that, on the one hand, a vast economic-mathematical instrumentation for modeling the supply chain has been accumulated. On the other hand, is remained a wide field of activity from the point of view of its adaptation to the solution of a specific type of application tasks. Thirdly, the problem of information-technological support of the practical use of economic-mathematical tools is relevant and at the same time very complex.

Structuring of the models and methods used in the theory of logistics, allow us you to divide them into three groups:

- economic-mathematical methods and models (EMM);
- forecasting methods
- informal methods.

EMM include mathematical methods and models, models of economic cybernetics (table 1).

Table 1 - Models and methods of the logistics scientific basis [3, c.85]

General discipline	Name sections
Mathematics	probability theory, mathematical statistics, random processes theory, mathematical optimization theory, functional analysis, of matrices theory, factor analysis.
Operations research	linear and nonlinear programming, game theory, statistical decision theory, queuing theory, inventory management, simulation, network planning.
Technical Cybernetics	large systems theory, forecasting theory, general management theory, the theory of Autonomous regulation, graph theory, information theory, communications theory, scheduling theory, optimal control theory.
Economic Cybernetics	optimal planning theory, economic forecasting methods, marketing, management, strategic and operational planning, operations management, quality management, pricing, personnel management, finance, accounting, project management, investment management, social psychology, economics and transport organization, warehousing, trade.

One of the most common models of applied theory of logistics is the following model – optimal order size EOQ (Economic Order Quantity) [1, c.135]. The EOQ calculation is based on the total cost C_{Σ}, which can be represented as a function:

$$C_{\Sigma} = C_{К} + C_{З} + C_{Х} + C_{Д} + C_{Л}\ , \qquad (1)$$

where C_c is the cost of consumption determined by the constant or variable value, when considering wholesale discounts depending on volume of the order per unit of output;

C_{or} is the cost of ordering, it represents fixed costs associated with ordering from suppliers and transportation;

C_s is the cost of storing inventory, it reflect the cost of maintaining and handling of stock in stock; C_s costs include both a percentage of invested capital and the cost of storage, maintenance and care;

C_{s-o} are losses from stock-outs including the potential loss of revenue due to the lack of stock and the possible loss due to the loss of consumer confidence.

The overall dependency is another kind of cost, "hidden" or "latent". These costs really exist, but are not included in the estimated models (the cost of storage of goods in containers, cars or railway carriages during unloading of vehicles arriving at the warehouse). Hidden costs reflect the interdependence and interaction between the current and the insurance reserve.

Consideration of the different constituents in the equation (1) leads to many formulas for determining the EOQ.

Under the formation of the basic model for the calculation of EOQ, the optimization criterion is the minimum total cost C_Σ including expenses for execution of orders C_{or} and the cost of storing inventory in stock C_s within a certain period of time:

$$C = C_{or} + C_s = \frac{C_0 A}{S} + \frac{S}{2} C_n i \rightarrow min \qquad (2)$$

C_0 - the cost of performing a single order;

A – the need for the ordered product within this period, pieces;

C_n - the unit price stored in the warehouse, rubles;

i – the share of the price C_n,attributable to the cost of storage;

S – the value of the order, pieces.

Figure 1 presents the costs C_{or} and C_s and the total cost C_Σ depending on the size of the order.

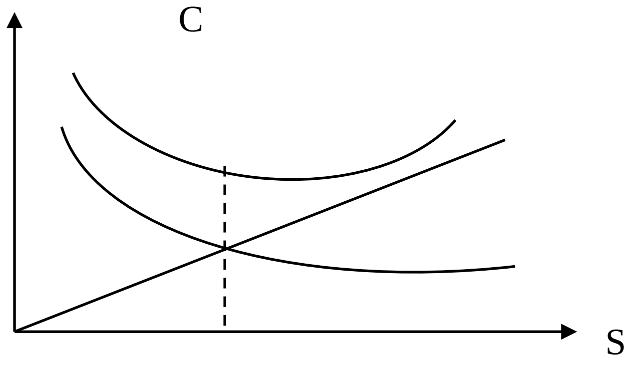

Figure 1 - Dependence of costs on the size of the order: 1 - the cost of execution of the order; 2 - storage costs; 3 - total costs [1, c.113]

The figure shows that the cost of orders execution with the increasing size of the reduced order, subject to the hyperbolic dependence (curve 1); the cost of storing party supplies increase in direct proportion to the size of the order (line 2); the total cost curve (curve 3) is concave in nature, which indicates the presence of the minimum corresponding to the optimal party S_0.

Value S_0 coincides with the point of intersection of the dependencies C_{or} and C_s. This is due to the fact that the abscissa of the intersection point S is solution of the equation

$$\frac{C_0 A}{S} = \frac{C_n i}{2} \qquad (3)$$

т.е.

$$S = S_0 = \sqrt{\frac{2C_0 A}{C_n i}} \qquad (4)$$

Other dependencies C_{or} =f(S) and C_s=f(S) match may not be observed, and in this case it is necessary to apply the optimization procedure. So, for the function (2) find:

$$\frac{dC_\Sigma}{dS} = -\frac{C_0 A}{S^2} + \frac{C_n i}{2} = 0 \qquad (5)$$

Solving equation (5) leads to the formula (4) to determine the EOQ.

Knowing S_0, it is easy to determine the number of orders:

$$N = {}^{A}/_{S_0} \qquad (6)$$

minimum total cost over the period:

$$C_{min} = \sqrt{2C_0 A C_n i} \qquad (7)$$

the time between orders:

$$T_3 = \frac{D_r\, S_0}{A} = \frac{D_r}{N} \qquad (8)$$

D_r - the duration of the reviewed period.

If we are talking about the number of working days in a year, then D_r =260 days, if the number of weeks, then D_r=52 weeks; in the General case D_r=365 days.

Formula (4) is obtained when there is a large number of assumptions [2, c.45]:

- the cost of performing the order C_0, the price of the products supplied C_n and storage costs per unit of output during the review period constant;
- the period between orders constant, i.e. $T_{or} = const$;
- order S_0 running instantly;
- intensity of demand $\lambda = S_0/T_{or}$ - constant;
- storage capacity is not limited.

Considers only the current reserves, other reserves (insurance, training, seasonal, transit) are not taken into account.

In other works, transport costs are not included in S_0 and presented in the form of additional components: the actual transportation costs and costs associated with the inventory on the journey.

Another option of accounting for transportation costs is that they are accounted for in the cost per unit of output C_n received at the warehouse. If the buyer pays the transportation costs and bears full responsibility for the cargo in transit, then the value of the goods stored in the warehouse as stocks, their price should be added to the transport costs.

Initial data transport company «Sharq logistics» was taken:

- the need for the ordered product A;
- the unit price Cn;
- a fraction of the price attributable to the cost of storage i;
- the cost of performing one order C0.

Using the formula (4) find the optimal order size. Using the formula (7) calculated minimum total costs for the execution of orders and storage of products throughout the year. Using the formula (6) define the number of orders. Using the formula (8) identify the frequency of execution of the order. We get the following results, which are presented in table 2

Table 2 - Initial data transport company «Sharq logistics» and optimal order sizes calculated by the formula of Wilson

year	C0	A	Cn	i	S0	N	T_{or}	Cmin
2012	500	1600	500	0,2	126	13	21	12649

We can conclude that the optimal order size will be 126 units, and the total cost of execution of orders and storage of products during the year - 12649 rubles. The number of orders equal to 13 , and the frequency of their execution will be 21 days.

The optimal order size allows you to work with minimal costs for inventory management. In addition, data about the optimal size of the order can be used to select a vehicle with capacity which is the one closest to such a size of the order.

It should also be noted that taking into account the real, more complex conditions and situations you can use various modifications of the proposed article of the formula of the optimal order size in the model supply chain.

List of used sources:

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