## Optimization of the physical distribution of furniture

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**Abstract.** Revealed a significant proportion of the cost of the physical distribution of revenue furniture company. It is shown that the cost of physical distribution includes the company's expenses and capital and current assets. This requires that they be brought to a single dimension. The assumption was made about the use of a pull system to meet regional demand of consumers of furniture and push – to meet customer demand to own furniture stores. Presents economic-mathematical model of optimization of parameters of physical distribution of furniture on the criterion of minimum given expenses. The proposed sequence of decision making in the physical distribution of furniture. [Noskov S.V. **Optimization of the physical distribution of furniture**. *Life Sci J* 2014;11(12s):174-179] (ISSN:1097-8135). http://www.lifesciencesite.com. 34

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## Introduction

The purpose of optimizing physical distribution is the growth of company's efficiency and quality of customer service. Optimization of physical distribution in the supply chain is a complex task configuration distribution and complexity of calculations. [1, 2].

Methods of optimization of physical distribution and economic and mathematical models are widely represented in economic science [3, 4]. There are different classifications of these methods and models - from heuristic to economic and mathematical using computer programs. Carrying out optimization calculations requires the formation of the objective function on the initial data distribution processes companies. The objective function in the formulation of the optimization problem, for example, minimize the stocks, transport expenses on delivery of products to dealers and retail [5]. Optimizable parameters or factor variable is the structure of product inventories on its commodity groups (subgroups species) or batch volume supplied to customers.

If a retail network is property of enterprisemanufacturer, then optimization of physical distribution is possible, on the criterion of the minimum combined expenses on transporting and maintenance of commodity supplies of own retail network. The optimized parameter in this task is a volume of party of delivery from an enterprisemanufacturer.

In practice, the distribution of the supply of products from the factory have to optimize sales by region, consumer groups and channels of merchandising, stages in the life cycle of products, their price categories, types of vehicles and transportation routes. However, in opinion of author, the preferable type of optimization of physical distribution is determination of optimal freight unit, that provides the economy of the combined expenses and height of ROA [6]. In turn, the economy of total expenses of company (expenses, capital and current assets) allows to restrain the costs of manufacturer, dealers and retail.

# Methods

Optimization of physical distribution is based on conceptions of given expenses as costs of completions, capital and the current assets resulted to the single dimension. So, the decline of expenses of distributive processes of furniture company stipulates the height of profit in the index of ROA, and decline used capital and current assets provides the increase of profitability due to reduction of the used assets [7].

The methods of mathematical analysis (differentiation for the search of extremum of function of given expenses on physical distribution of furniture company) and mathematical statistics (regressive analysis for the design of dependence of function of given expenses from influences) are used.

# The main part

The processes of physical distribution of products of furniture industry include both processes and operations and management functions (procedures) by them. In scientific literature the next business processes of physical distribution of products are distinguished: forming and maintenance of a stock, ware-house processing, completing and forming of freight units, technological processes of the use of a lifting-transport and ware-house equipment, maintenance of consumers, transporting and routing of supplying with the prepared products, processes of return of the prepared products, outsourcing of separate business processes of physical distribution. The extended going near the selection of business processes and management functions envisages plugging in their composition of separate functions of marketing (managements by clients, sales, strategic marketing) physical distribution [8].

According to researches, the expenses of manufacturers of furniture on physical distribution have high specific gravity in the revenue of furniture company. So, in a furniture company "Shatura", being in the Moscow region of Russian Federation, charges on physical distribution, including expenses and capital and current assets, 21.9% made from a revenue in 2013 [9]. Methodology of selection of charges on physical distribution was based on analysis of her commercial and administrative expenses on the Russian accounting system, and also the capital and current assets on the asset of balance [10]. Selection of the transaction costs related to asymmetry and lack of information about demand of end-user and retail business, in expenses on physical distribution not envisaged [11].

The separate articles of expenses behaved to the certain groups of expenses on physical distribution. The capital and current assets over of physical distribution were brought to the expenses on the basis of ROA of furniture company in relative units.

So, the maintenance of a stock of finished products as one of the processes of the physical distribution of the furniture company "Shatura" is connected with use of capital assets invested in warehouses of finished products in the amount of 258 million rubles as of December 31, 2013, and current assets – in the amount of 536 million rubles. Commercial and administrative expenses on the maintenance of a stock amounted to 179 and 54 million rubles in 2013, respectively. Return on assets furniture company amounted to 4.18% (0.0418/year) in 2013, and revenue – 4360 million rubles [9]. Then, the total given expenses of the furniture companies for the maintenance of a stock of furniture products will be 266.2 million rubles:

# 0.0418 (258 + 536) + 179 + 54 = 266.2,

and the share of these costs in the revenue will be equal to 6.1%:

# $266.2\frac{100}{4360} = 6.1.$

Share costs and reduced to an annual dimension cost of capital in revenue is a conditional indicator, because the revenue – of current income, and expenses and capital costs – the given expenses.

Reduced to an annual dimension on the basis of the profitability index of capital and current assets invested in the maintenance of a stock furniture company in the amount of 33.2 million rubles (0,0418(258+536)) – this loss of profits from the use of capital is not in furniture production, and the maintenance of a stocks.

There is another method of calculating lost profits (income) from the use of capital and current assets is not in production and physical distribution of furniture products based on bank interest rates. In this case, the use of capital in the physical distribution does not yield interest income from placing funds in the bank.

The share of the given expenses in revenue furniture company "Shatura" on functions and processes of the physical distribution shown in table 1.

| Tabl | e 1. | The s | hare o | of the g | given | expenses   | functions |
|------|------|-------|--------|----------|-------|------------|-----------|
| and  | proc | esses | of the | physic   | al di | stribution |           |

| Functions and<br>processes                                   | Share of reve-<br>nues,% | Accumulated<br>share,% | Directions of optimization   |
|--|--------------------------|------------------------|--|
| 1. Maintenance<br>of a stock of fin-<br>ished products       | 6.1                      | 6.1                    | Optimizing inventory according to crite-<br>ria of maximum turnover, minimum<br>maintenance costs                            |
| 2. Consumer ser-<br>vices                                    | 4.2                      | 10.3                   | Optimization service to criterion of min-<br>imum time for processing and fulfilling<br>orders                               |
| 3. Warehouse<br>management fin-<br>ished products            | 3.9                      | 14.2                   | Optimization of warehouse processes to<br>criterion of a minimum of time on opera-<br>tions                                  |
| 4. Transporting<br>finished products                         | 3.8                      | 18.0                   | Optimization of the routes to criterion of<br>minimum transport expenses   |
| 5. Receivables   | 1.2                      | 19.2                   | Optimization of the debt to criterion of<br>the importance of consumers  |
| 6. Forecasting<br>demand and sup-<br>ply planning            | 1.0                      | 20.2                   | Optimization of distribution to criteria of<br>maximum revenue, profit and the mini-<br>mum delivery time                    |
| 7. Accounting<br>and inventory<br>control, supply,<br>return | 0.9                      | 21.1                   | Optimal choice of information technolo-<br>gies of registration and control to criteri-<br>on of minimum time for procedures |
| 8. Manage ser-<br>vice providers<br>and infrastructure       | 0.8                      | 21.9                   | Optimization of the alternative cost of<br>services and investments in logistics in-<br>frastructure                         |

As follows from the presented data, the highest proportion of the cost of a furniture company from its total expenditure on physical distribution accounts for the following control functions and processes: the maintenance of stocks of finished products in stock furniture company (6.1%), service, wholesale and retail consumers (4.2%), management of a warehouse of finished products (3.9%) and transportation (delivery) to consumers (of 3.8%). Such a high share of expenditure requires the development of measures for their absolute and/or relative reduction based on the optimization of the distribution processes on the set criteria of optimality [12]. Main directions of optimizing individual distribution processes and possible criteria for making optimal logistics solutions are also presented in Table 1.

Territorial demand for production of the furniture company is a share of the total market demand in the same territorial borders. By author's estimates this share in Samara city of Russian Federation approximately 4.3% of the total market demand. Demand for production of the furniture company data market prices in line with its proposal. Market demand stochastically distributed on branded salons furniture company in accordance with their offer. If the sample of furniture products selected by the buyer on the company's website and its online shop, in the salon of furniture is not present, then it is search the buyer in other outlets, that is, the demand for furniture products from individual company salons is determined only by its proposal with the existing alternatives satisfaction. The analysis of parameters of physical distribution company "Shatura" conducted by commodity group of furniture for kitchens supplied in the Samara in the address nine private salons furniture according to 2013. The main parameters of physical distribution of furniture for kitchens are presented in table 2.

| The number of sets of<br>kitchen in the cargo<br>unit, pieces | The number of delivered<br>cargo units in the year,<br>units | Average transportation costs<br>on cargo unit, thousand rubles | Transport costs on one<br>complete set of kitchens,<br>thousand rubles |
|---|--|--|--|
| 1   | 4  | 5.0  | 5.00   |
| 2   | 12   | 5.3  | 2.65   |
| 3   | 16   | 5.6  | 1.87   |
| 4   | 40   | 6.0  | 1.50   |
| 5   | 14   | 6.4  | 1.28   |
| 6   | 8  | 6.7  | 1.12   |
| 7   | 2  | 7.0  | 1.00   |

| <b>Fable 2. Parameters of p</b> | physical distribution |
|---------------------------------|-----------------------|
|---------------------------------|-----------------------|

To test the hypothesis normal law distribution of the number of delivered furniture packages in the cargo unit as random variables was carried out on the basis of calculations mathematicalstatistical characteristics:

- A – matrix of frequencies;

- ORIGIN – the number of the first element;

- i – random value;

- m<sub>i</sub> frequency of the i-th random value;
- M mean (average);
- D dispersion;
- $\sqrt{D}$  standard deviation;
- V variation coefficient.



Figure 1. The graph of a random variable distributed according to the normal law

Schedule probability density (dnorm) confirms the hypothesis of normal distribution (figure 1).

Physical distribution of furniture for kitchens of the "Shatura" company is characterized by average of sets of the furniture, equal 4 pieces, and variation coefficient -33.8%. Whether these parameters of physical distribution of furniture for kitchens are optimum?

The author developed economicmathematical model of optimization of physical distribution of furniture for kitchens-branded salons company "Shatura". This model defines the following optimal parameters of the distribution process furniture company: optimal value of the stock of furniture, best party supplies, frequency and interval of the delivery of the furniture.

Total cost of the furniture companies have two main components: transport expenses on delivery of furniture in the own sales network and maintenance of stocks in furniture stores.

Formulation of the problem of optimization of physical distribution of furniture production was carried out by commodity group of furniture for kitchens economy class average price 19.3 thousand rubles per set according to the "Shatura" for 2013.

Transportation expenses the company "Shatura" in the year depending on two factors: the number of delivered furniture sets for kitchens in the cargo unit and number of cargo units per year. Economic-mathematical dependence of the transport costs from the number of sets of furniture for kitchens in the cargo unit is:

$$f(x) = \frac{4.759}{x^{1.004}} + 0.273,$$

- f(x) – transport costs, thousand rubles/set;

x – number of kits supplied at a time, pieces. Mathematical-statistical characteristics of regression equations:

- index of correlation - 0.996, the determination coefficient - 0.991;

- approximation error -0.3%;

- regression equation significantly, as the Fcriterion for degrees of freedom (2.5) equal 330.3 that more of its valued (99.3).

Graph of transport expenses on delivery of one set of furniture from the number of simultaneously supplied sets presented in figure 2.



Figure 2. Regression f(x) and empirical (y) the dependence of the transport costs from the number of sets of furniture

Transport expenses on delivery of an equal number of sets of furniture for kitchens were assumed to be the same for each of the nine salons furniture "Shatura" within the territory of Samara, as their actual discrepancy was not more than 2%.

Proposal of furniture for kitchens every branded salon in terms of the stochastic distribution of demand is 24 pieces /year. Then, the annual transport costs of the company w(x) for any salon furniture, taking into account both factors will be:

$$w(x) = \left(\frac{4.759}{x^{1.004}} + 0.273\right)\frac{24}{x}$$

Maintenance of a stock of furniture includes expenses of storage (salaries for sales staff, rent, utilities and other expenses) and current assets reserves, reduced to an annual dimension.

A current assets in the stocks, given to annual dimension on the basis of an interest rate of bank (15% or 0.15) which depends on number of sets of furniture in stocks, is defined by calculations:

- entering price of one standard set of furniture for kitchens – 16.9 thousand rubles;

- current assets depending on number of sets of furniture in stocks, are normalized in average size (0.5\*16.9).

Therefore, current assets of firm salon of furniture "Shatura" brought to annual dimension, are defined by calculation:

### $16.9 \cdot 0.15 \cdot 0.5 \cdot x = 1.27 \cdot x.$

Expenses for storage of one set of furniture for kitchens vary on furniture salons because of distinctions in a rent. So, for a rent of firm salon of furniture "Myagkoff" (a month) annual costs for storage will make 0.7 thousand rubles/m<sup>2</sup>:

#### $0.7 \cdot 24 \cdot x$

Then, the general expenses according to the maintenance of sets of furniture for kitchens as the sum of costs for storage and the given current assets will be equal in "Myagkoff" salon stocks:

#### 0.7 · 25.81. x.

This analytical dependence is shown in figure 3.



Figure 3. Expenses according to the maintenance of sets of furniture in salon

Therefore, cumulative costs of the furniture company "Shatura" F(x) of transportation of furniture for kitchens and its contents in stocks of firm salon depend on number of sets of furniture:

$$F(x) = \left(\frac{4.759}{x^{1.004}} + 0.273\right)\frac{24}{x} + 18.1x,$$

and the schedule of this dependence is shown in figure 4.



Figure 4. Dependence of cumulative expenses of the company on number of delivered sets of furniture to "Myagkoff" salon

Statement and the solution of a problem of optimization on criterion of a minimum of expenses of F(x) in the computer program:

$$F(x) = \left(\frac{4.759}{x^{1.004}} + 0.273\right)\frac{24}{x} + 18.1x,$$
  

$$1 \le x \le 7$$
  
Given  
Minimize (F, x) = 2.379  

$$F(2.379) = 65.925.$$

Then, the optimum number of sets of the furniture delivered at a time to "Myagkoff" salon, has to make 2 pieces, the minimum size of expenses of the furniture company -65.9 thousand rubles a year, the maximum stock -2 pieces, an average stock -1 piece, a delivery interval – once a month.

The computer program of calculation of optimum number of delivered furniture for kitchens in firm salons of the "Shatura" company can be used as imitating. So, at change of a rent and, respectively, costs for storage of stocks it is possible to recalculate quickly expenses and optimum party of delivery for other salons of furniture.

For example, economic-mathematical modeling of expenses of the "Shatura" company on transportation of furniture for kitchens and its contents in salon stocks to the address Tovarnaya street, 70, with a rent of 0.3 thousand rubles/sq.m a month:

$$F(x) = \left(\frac{4.759}{x^{1.004}} + 0.273\right)\frac{24}{x} + 7.7x$$
  

$$1 \le x \le 7$$
  
*Given*  
*Minimize* (F, x) = 3.185  
F(3.185) = 37.789.

and the schedule of this dependence is shown in figure 5.



Figure 5. Dependence of cumulative expenses of the company on number of delivered sets of furniture of Tovarnaya street, 70

Therefore, the optimum number of sets of furniture for kitchens has to make 3 pieces, the minimum expenses of the company -37.8 thousand rubles a year, the maximum stock -3 pieces, a delivery interval -45 days.

The effect of optimization is equal to a difference of the given expenses for physical distribution by existing and optimum options.

The choice of pulling logistic system for satisfaction of regional demand of buyers of furniture and pushing system – for satisfaction of local demand of consumers of salons of furniture allows to offer sequence of decision-making in physical distribution:

- the forecast of regional demand for furniture production of the "Shatura" company as shares from the general regional demand is carried out;

- for each firm salon of furniture on developed above economic-mathematical model the optimum volume of party of delivery of furniture production is defined;

- completing of its cargo units at manufacturer to each firm salon of furniture is carried out;

- insurance stocks in points of retails are not created as possible violations in terms of deliveries of furniture production from manufacturer are quickly eliminated on the basis of distribution of the general stocks of a distribution network.

Improvement of the offered model of optimization of physical distribution of furniture is connected with inclusion in optimization of such business processes of physical distribution, as the maintenance of stocks of finished product in a warehouse of the manufacturer and completing of cargo units, and also the account in expenses of transactional expenses, expenses on insurance and others. Besides, it is necessary to consider completing of cargo units from several types of furniture and to several salons in economic-mathematical model.

# Conclusions

1. Expenses on physical distribution occupy a considerable share in revenue of the companies. The general expenses on physical distribution include not only expenses, but also capital and current assets that demands their reduction to annual dimension.

2. The economic-mathematical model of optimization of parameters of physical distribution is based on minimization of the sum of transportation costs and expenses according to the maintenance of stocks in points of sales.

3. The solution of a problem of optimization allows to determine such optimum parameters of process of physical distribution, as the volume of party of delivery, number and a delivery interval.

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