Varazdin Development and Entrepreneurship Agency
in cooperation with
Azerbaijan State University of Economics (UNEC)
University North
Faculty of Management University of Warsaw
Faculty of Law, Economics and Social Sciences Sale - Mohammed V University in Rabat

Economic and Social Development

37th International Scientific Conference on Economic and Social Development –
"Socio Economic Problems of Sustainable Development"

Book of Proceedings

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OPTIMIZATION OF QUALITY MANAGEMENT OF CARGO TRANSPORTATION

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ABSTRACT

The method of calculation of basic parameters of cargo transportation has been analyzed. An optimal model of quality management has been developed. An equation of full economic costs has been formed for the logistics chain. The possibilities of carrying out optimal management of cargo transportation have been studied. It was determined that optimization parameters such as the capacity of the warehouse, the transport capacity of the vehicle, the efficiency of lifting vehicles can be taken. The main parameter of the logistics chain is justification for the minimization of the cost of economic integration costs. The issue of improving the production structure of transport enterprises has been solved to optimize quality management. It has been shown that the range of technical means that provide freight traffic is dynamic interacting and has a certain hierarchical structure. The system approach has confirmed that the system has an invariant structure. It has been established that optimization of the logistics chain must first be achieved by optimizing its structure, ie proportional development of its elements, rational union, and perfect harmonization of key parameters. It has been established that the multidimensionality and diversity of indicators and parameters characterizing the work of technical facilities make it difficult to select effective methods and tools for their calculation. It has been shown that the methodological basis of the optimization of the quality of transportations can be generated by the use of production power, which is an integral indicator of the potential for load capacity over a single period of time.

Keywords*: economic cost, logistics, management, quality, transportation*

1. INTRODUCTION

Resulting from the socio-economic needs of modern society organic integration of transport with production and consumption has led to the conversion of transport into a indivisible unit of the integrated "production-transport-distribution" system {1}. In the open market and the decentralized management of production, transportation and distribution of goods, this system consists of a set of horizontally interconnected objects {2}. From this point of view, the object of optimization is a combination of all technical means involved in the delivery process of cargoes and realizing the objectives of logistics on the basis of relevant technological processes and operations. Investigate the simplest logistics chain. Let's propose that the gravel is delivered from the production site to the consumer point. The commodity producer is Khanbulakchay gravel plant, the consumer of the product (cargo) Akkord OJSC. The amount of gravel ordered to be delivered within 100 days is 5,000 tons. First of all, characterize the requirements for safe delivery, protection and storage of material flow and cargo. The crushed stone belongs to bulk cargoes, transported by open vehicles and stored in open warehouses. There is no need for additional measures to exclude damage of cargo during its loading to vessels, wagons and cars. We suppose the hourly productivity is 70t per hour for loading and 58t per hour for unloading. Let’s characterize the technology of gravel transportation and the route of movement from the production site to the consumer site. Let's assume that the gravel plant has a railroad on a freight yard. The first operation here is the loading of the crushed stone from the consumer's open warehouse to wagons with the help of a conveyor belt. Let's say that the railcars full of gravel are transported by rail to Lankaran station and further to the existing railway line. The gravel is unloaded at the open warehouse in the port.

Gravel is stored in the warehouse until the ships are loaded. The gravel is loaded to ships and shipped to Baku. Let us suppose that the length of the waterway is 413 km. A gravel is emptied by floating crane to an open warehouse in Baku Alat Sea Port. The gravel is transported to the consumer's warehouse by dump trucks.

2. CHAPTER 1

The required logistic operations, tools and their parameters are presented in Table 1.

Table 1: Required logistics operations, tools and their parameters

Operations	Tools	Parameters
Storage at the production site	Open storehouse	Capacity, t
Loading	Conveyor transporter	Loading capacity, t
Railway transportation	Flatcar	Productivity, t/hour
Unloading at the port's warehouse	Greifer harbor crane	Productivity, t/hour
Storage at the port's warehouse	Open warehouse	Capacity, t
Loading to ships	Greifer harbor crane	Productivity, t/hour
Railway transportation	Dry cargo ship	Loading capacity, t
Unloading	Greifer floating crane	Productivity, t/hour
Storage	Open warehouse	Capacity, t
Loading to dump truck	Excavator crane	Productivity, t/hour
Transportation by truck	Dump truck	Loading capacity, t

Thus, delivery of crushed stone consists of four operations: storage, loading, transportation and unloading {3}. The following equipment is used to carry out these operations: open warehouse, conveyor transporter, harbor crane, floating crane, excavator crane, flat railcar, dry cargo tanks, dump truck. The following optimization parameters could be taken: the capacity of the warehouse, the loading capacity of the vehicles (railcar, ship, truck, etc.), the productivity (or loading capacity) of lifting vehicles and so on.

3. CHAPTER 2

Basic methods of parameters' calculation. All economic costs or integrated costs can be taken as the key parameters of the logistics chain (load capacity Q, t, productivity P, t/hr, capacity E,t) optimization criteria. Integral costs Z - both current costs E and unused capabilities of the specific capital. Integrated costs are as follows:

$$Z = E + k\rho/100 \,, \qquad (1)$$

Where K - the equity used, man;
ρ - average rate of return of capital,%.

Specific economic expenses of a single transport product Z can be found as follows:

$$Z = S + k\rho/100 \,, \qquad (2)$$

where S is the cost of transport product, man / ton (man / tkm);
K - special capital ratio of transport product falling on special capital, man / ton (man / tkm).

Let's formulate the equation of full economic costs for the logistics chain described above:

$$Z = Z_1 + Z_2 + Z_3 + Z_4,$$

here, - full economic costs in the transportation, loading, unloading and storage operations, respectively.

It should be noted that the parameters of the automobile and railway transport technics are determined by the type of load. However, we have to look at the full economic costs of transporting cargoes on the railroad. In this case, we can define the integral costs of shipping a G ship with a ship:

$$\begin{aligned} Z &= Z_{don} \cdot t_d + Z_{yük} \cdot t_{yük} + Z_{boş} \cdot t_{boş} + Z_{sax} \cdot t_{sax} \\ &= Z_q \cdot t_q + Z_d \cdot t_d + Z_i \cdot t_i + Z_{b.d.} \cdot t_{b.d.} + Z_{sax} \cdot t_{sax.} \end{aligned} \quad , \qquad (3)$$

where - $Z_{don}, Z_{yük}, Z_{boş}, Z_{sax}$ economic costs, man/hour, in transportation, loading, unloading and storage accordingly;

Z_q, Z_{bd} - economic expenses, man / hour, during departure and leisure according to the fleet;

Z_i, Z_{bd} - economic expenses, man / hour, for keeping the mechanisms in operation and during idle time;

t_d, t_u, t_b, t_{sax} transportation, loading, unloading and storage period, hours;

t_i, t_{bd} - the time during which the mechanisms for the handling of a ship's (one train) burden are at work and vacancy.

We can write based on obvious dependencies without having detailed technical and technological operations:

$$t_q = l / U,$$
$$t_i = t_d = G / P,$$
$$t_{bd} = 24G / G_{gün} - G / P,$$
$$t_{sax} = 24G / G_{gün}.$$

The latter seems to be that the logging operation, such as the load storage parameters, is tightly closed with the load parameter $Q = G / P$, ie the capacity of the warehouse is $E = f(Q)$ and can be removed from the range of the inputs. Then this equation looks as follows:

$$\begin{aligned} &Z = Z_q l / U + (Z_d + Z_i) \sum G / P + Z_d \sum \\ &(24G / G_{gün} - G / P) + Z_{sax} \cdot 24G / P \end{aligned} \quad , \qquad (4)$$

Here, l - length of sea transportation route, km;
U - speed of the vessel, km / h;
P - productivity of cargo works, t / h;

$G_{gün} = G_y / t_{i.d.}$ daily load input, t / hr; here $t_{id} - G_y$ is the business cycle of the fleet to deliver a thousand tons of cargo, hours.
For similar calculations, the speed of the ship (train) can be expressed by the following empirical dependence:

$$U = a \cdot Q^b \qquad (5)$$

It is logical to assume that mechanization costs may be proportionate to the productivity of those vehicles,

$$Z_i = Z_i \cdot P, \quad Z_{bd} = Z_{bd} \cdot P,$$

Here, Z_i, Z_{bd} - are special costs for mechanization, man.

It is necessary to take into account the scale effect of the fleet maintenance costs (the lower the cost per ton, the greater the load capacity), ie:

$$Z = Z_0 \left(\frac{Q}{Q_0} \right)^d \quad , \qquad (6)$$

here Q_0, Z_0 - the ability to ship, tone, and a selected vessel (train) - current costs for maintaining the prototype, t / h.

Cost of storage can be found as follows:

$$Z_{sax} = Z_{sax} \cdot G_{sax} .$$

Let us assume that the maximum amount of cargo storage at the port of departure is $G_{\max} = G$, at the destination port is $G_{\max} = G_h (1 - t_e / T)$. In this case, the average storage capacity of ships can be found in the range of ships:

$$G_{sax} = G \lfloor 1 - t_e / T - G_{gün} / (24P) \rfloor / 2 .$$

Go to the definition of special expenses. (5) by dividing the equation on the ship (train) by the amount of load $G = \rho' Q$ and making certain transformation:

$$Z = A / Q^{l+b+d} + BQ^d / P + CP + FQ / P + H, \qquad (7)$$
$$F = Z_{xo} l / (\rho' a Q_0);$$
$$B = Z_{do} (1 + k) / Q_o^d;$$
$$C = 24 \sum Z_{bd} / G_{gün};$$
$$D = 24 \rho' \lfloor Z_{sax(yük)} / 2 + Z_{sax(boş)} (1 - t_e / (2T)) \rfloor G_{gün};$$

$$F = Z_{sax(boş)} \rho' / 2$$
$$H = \sum (Z_i - Z_{bd}),$$

where K is a coefficient characterizing the ratio of productivity in load handling and loading, $K \leq 1$).

Thus, we have acquired a two-dimensional equation that can be easily solved by the numerical methods of optimization, for example, the Huk-Chiv method. Let's clarify the example we are looking at. The full cost of the ship's fare on departure is $Z_{do} = 310\, man / ton$, and when it stops is $Z_{do} = 150\, man / ton$. Special expenses in the discharge port are $Z_i = 1{,}5 man / ton,$ $Z_{bd} = 1 man / ton$, in storage is $Z_{sax} = 1{,}0 man / ton$. Take the shipping ratios $\rho' = 1; K = 0{,}8$. Note that the load is consumed within 5 months (summer-autumn), ie T = 153 days. It is required to substantiate the loading and unloading of mechanization facilities at the discharge point. On the basis of processing of numerous data on dry cargo ships and trains, we accept a = 5, downwards a = 3, and for trains 3 and 2, for downhill mileage. We must take into account that the speed of the load lane is 12% -20% during the free movement. We accept empirical coefficients b = 0,2, d = 0,5.

Then,

$$A = 310 \cdot 413 / 1 \cdot 3 \cdot 1500^{\;0,5}) = 1102\ ,$$
$$B = 150\,(1 + 0{,}8) / 1500^{\;0,5} = 7\,,$$
$$C = 24 \cdot 0{,}1 \cdot (1 - 100) / (2 \cdot 153))(100 / 50000) = 3{,}23 \cdot 10^{-3}\,,$$
$$F = 0{,}1 \cdot 1 / 2 = 0{,}05\,,$$
$$H = 1{,}5 - 1 = 0{,}5\,.$$

Numerically can be summarized as follows:

$$Z = 1102 / Q^{0,7} + 7 \cdot Q^{0,5} / \rho + 0{,}048 P + 3{,}23 \cdot 10^{-3} Q - 0{,}05 Q / P + 0{,}05;$$

After calculations we've got:

$$Q_{opt} = 1177t,$$
$$P_{opt} = 61 t / saat$$

Special charges for the delivery of water by way of water will be 18mt / ton, taking into account the costs of mechanization and load maintenance at the discharge point. The equation can also be obtained sequentially with the help of individual derivatives, that is, the price of one of the variables. For this purpose, the productivity of mechanization at the level of the ship-hour norm is $P{=}Б_{yük}$ and after a number of simplifications we will have an unbalanced equation:

$$Z = A / Q^{l+b+d} + BQ / Б_{yük} / DQ - FQ / Б + 6\,. \tag{8}$$

The optimum value of loading capacity Q can be easily reached by classic method as follows:

$$Q_{opt} = \left[(1 + b + d) \cdot A \cdot Б_{yük} / (dB)\right]^{1/(1+b)}\,.$$

After certain transformations we will get:

$$Q_{opt} = (K_x \frac{Z_x Б_{yük} l}{Z_{bd} a \cdot \rho'})^{q/(l+b)} \quad , \qquad (9)$$

where K_3 is an empirical coefficient. For indirectly stored loads it is 0.2; K_3 = 0.3 for open loads.

The optimal loading capacity of sea transport for gravel transportation can be found as follows:

$$Q_{opt} = [(0,3 \cdot 310 \cdot 58 \cdot 413/(150 \cdot 3 \cdot 1))]^{1/1,2} = 1200t \ .$$

Find the characteristic of the ship to carry gravel from the book of inquiry. We choose a 942 project cargo carrier (barge or tanker etc.) with a load of 1000t.

We accept that the gravel emptying capacity is 1.6 m^3 and 5t gravity floating cranes are used. In the loading and unloading work, productivity is defined in accordance with complex mechanization and time norms:

$$P_{kom} = (588 + 286)/2 = 437\, t/növb \ .$$

This figure corresponds to the accepted productivity (438t hours). Let us determine the number of floating cranes that make up the crushed wagons and ships with the daily input and the need to master the load:

$$\begin{aligned} &G_{gün} = 50000/100 = 500 \frac{t}{gün}; \\ &n = G_{gün} / П_{gün} \end{aligned} \quad , \qquad (10)$$

here $П_{gün} = K_{el} \cdot n_n \cdot P_{kom} -$ is the capacity of shipyard in the port, t / day;

n_n - number of turns;

$K_{el} = 0,6 \div 0,8$ is plus productivity, and is a factor that takes into account the impact of technical service on auxiliary mechanisms and devices.

$$\begin{aligned} &П_{gün} =).* \cdot 3 \cdot 437 = 1049t/gün \\ &n = 500/(0,8 \cdot 3 \cdot 437) = 500/1049 = 0,48 \end{aligned} \ .$$

4. CONCLUSION

Thus, the calculation shows that a floating crane will be enough for the port. If $E_{yük} = G = 1000t$ is warehouse capacity in the port of loading, the necessary capacity of the warehouse in the port of emptying can be calculated as follows:

$$E_{boş} = G_H (1 - t_e/T) = 50.000(1 - 100/153) = 17320t \ .$$

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