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DETERMINATION OF THE OPTIMAL TYPE OF TRANSPORT FOR TRANSPORTING GOODS ALONG THE ROUTE BAKU (AZERBAIJAN) - SHANGHAI (CHINA) USING THE METHOD OF EXPERT ASSESSMENTS

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Abstract. The main task of transport logistics is the rationalization of the transportation of material resources. The solution to this problem is to choose the type of transport for transporting certain goods, as well as building an optimal route model. In this article we will consider the method of expert assessments, on the basis of which it is possible to determine the most suitable method of transportation.

Keywords. Transport, cargo transportation, types of transport, quality criteria, method of expert assessments, transport problem.

ОПРЕДЕЛЕНИЕ ОПТИМАЛЬНОГО ВИДА ТРАНСПОРТА ДЛЯ ПЕРЕВОЗКИ ГРУЗОВ ПО МАРШРУТУ БАКУ (АЗЕРБАЙДЖАН) - ШАНХАЙ (КИТАЙ) МЕТОДОМ ЭКСПЕРТНЫХ ОЦЕНОК

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Аннотация. Основной задачей транспортной логистики является рационализация транспортировки материальных ресурсов. Решением этой проблемы является выбор вида транспорта для перевозки определенных грузов, а также создание оптимальной модели маршрута. В этой статье мы рассмотрим метод экспертной оценки, с помощью которого вы сможете определить наиболее подходящий способ транспортировки.

Ключевые слова. Транспорт, грузоперевозки, виды транспорта, критерии качества, метод экспертной оценки, транспортная проблема.

БАКУ (ӘЗІРБАЙЖАН) - ШАНХАЙ (ҚЫТАЙ) БАҒЫТЫ БОЙЫНША ЖҮКТЕРДІ ТАСЫМАЛДАУ ҮШІН КӨЛІКТІҢ ОҢТАЙЛЫ ТҮРІН САРАПТАМАЛЫҚ БАҒАЛАУ ӘДІСІМЕН АЙҚЫНДАУ

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Аңдатпа. Көлік логистикасының негізгі міндеті материалдық ресурстарды тасымалдауды ұтымды ету болып табылады. Бұл мәселенің шешімі-белгілі бір жүктерді тасымалдау үшін көлік түрін таңдау, сонымен қатар маршруттың оңтайлы моделін құру. Бұл мақалада біз тасымалдаудың ең қолайлы әдісін анықтауға болатын сараптамалық бағалау әдісін қарастырамыз.

Түйін сөздер. Көлік, жүк тасымалы, көлік түрлері, сапа критерийлері, сараптамалық бағалау әдісі, көлік мәселесі.

Today, the economy of any state is inextricably linked with the development of the transport sector. Countries are making efforts to ensure the quality of freight and passenger transportation on all types of transport: ports and airports are being built, railways and roads are being laid, modern technologies and services are being introduced to facilitate the transportation process.

Every year, tens of billions of tons of cargo are transported around the world; transport companies compete with each other to attract more customers and improve the level of services provided. The goal of any carrier is to deliver goods “just in time”, with the least amount of time and resources. It is to satisfy this request that the problem arises of the optimal choice of mode of transport and construction of a route for the transportation process.

In total, there are five main modes of transport through which goods are transported: road, rail, air, water and pipeline. Each of them has its own advantages and disadvantages, taking into account which the customer/shipper chooses the method of transporting his cargo.

For example, the main advantages of road transport are that it has great maneuverability and speed, and is also the only one who always delivers “door to door”. At the same time, it cannot be called ideal; road transport has a high cost, is often suitable for transporting goods over short distances, and largely depends on weather conditions and the quality of roads.

Rail transport copes well with the transportation of large cargo, as it has a large carrying capacity. A significant advantage is also that it does not depend on weather conditions, is universal (transportation of passengers and a large range of cargo), and also has a relatively low cost. But there are also negative aspects of this type of transport, of which we can note the high capital intensity and limited geography of communication routes.

Air transport is rightfully considered the “youngest” and fastest-growing mode of transport. The ability to deliver passengers and cargo to hard-to-reach areas, speed and comfort can only be overcome by the high cost of transportation and investment, and weather dependence.

The leader in cargo transportation is considered to be water (sea and river) mode of transport, which accounts for 80% of the total turnover. Its main advantages are low cost, large carrying capacity and relative straightness of transportation routes. Disadvantages: the lowest speed, dependence on natural conditions, high cost of building ships and ports. [1]

At the same time, having revealed all the advantages and disadvantages of mainline modes of transport, we can say that when choosing a transportation method, it is difficult to rely only on them. Each shipper has his own additional requests, these may be delivery speed, transportation cost, cargo safety and much more.

Often, when choosing the optimal mode of transport, different assessment methods are used to obtain the greatest benefit. One of these is the method of expert assessments.

The method of expert assessments is part of the broad field of decision-making theory, and expert assessment itself is a procedure for obtaining an assessment of a problem based on the opinions of specialists (experts) for the purpose of subsequent decision-making (choice). [2]

Let's consider this method using the example of a specific transport problem.

The carrier is faced with the task of organizing the transportation of 5 tons of cargo along the route Baku (Azerbaijan) - Shanghai (China). The difficulty lies in determining the optimal method of transportation, namely in choosing a type of transport that, according to its criteria, would meet all

the customer's standards. Five experts of different qualifications are involved in solving the problem, who, in turn, propose the following assessment method.

The following initial data is specified:

Number of experts: 5.

Types of transport: road, air, rail, sea.

Criteria: safety of cargo, speed of delivery, cost of transportation, reliability of delivery, availability of transportation.

Rating scale: 0-3 – "unsatisfactory";
4-5 – "satisfactory";
6-8 – "good";
9-10 – "excellent".

This method consists of experts determining assessments for all quality criteria for all possible modes of transport, drawing generalized assessments and determining the most profitable type of transportation.

Let's look at all the steps step by step.

Step 1: designation of quantities.

Table 1. Initial data

Expert №	Criteria and their indicators				
	safety	speed	cost	reliability	availability
1	Z_{11}	Z_{12}	Z_{13}	Z_{14}	Z_{15}
2	Z_{21}	Z_{22}	Z_{23}	Z_{24}	Z_{25}
3	Z_{31}	Z_{32}	Z_{33}	Z_{34}	Z_{35}
4	Z_{41}	Z_{42}	Z_{43}	Z_{44}	Z_{45}
5	Z_{51}	Z_{52}	Z_{53}	Z_{54}	Z_{55}

Where Z_{ij} – expert assessment;

i – expert number;

j – number of the specified criterion.

Action 2: experts evaluate various indicators of transportation quality (cargo safety, delivery speed, transportation cost, delivery reliability, transportation availability) for specific types of transport (road, air, rail, sea).

Action 3: summarizing the ratings given, based on the opinions of five experts, according to the following formula:

$$Z'_{ij} = \frac{1}{n} \times \sum_{j=1}^{n} Z_{ij}, \text{ where}$$

Z'_{ij} - generalized assessment given by experts;

n – number of ratings for a specific criterion;

i – expert number;

j – number of the specified criterion;

Z_{ij} – initial expert assessment.

So, for example, the final assessment for road transport according to the criterion of cargo safety will be calculated as follows:

$$\frac{1}{5} \times \sum_{j=1}^{5} 5 + 9 + 7 + 6 + 4 = 6{,}2 \sim 6$$

All subsequent final assessments for all quality indicators for all modes of transport are calculated in the above manner.

Table 2. Expert assessments for road transport

Expert №	Criteria and their indicators				
	safety	speed	cost	reliability	availability
1	5	7	5	7	9
2	9	5	4	5	10
3	7	9	2	8	8
4	6	8	6	9	9
5	4	6	4	5	9
Total	6	7	4	7	9

Table 3. Expert assessments for air transport

Expert №	Criteria and their indicators				
	safety	speed	cost	reliability	availability
1	9	10	5	8	4
2	8	9	3	5	3
3	9	10	4	7	7
4	7	10	7	4	8
5	5	10	4	9	5
Total	8	10	5	7	5

Table 4. Expert assessments for railway transport

Expert №	Criteria and their indicators				
	safety	speed	cost	reliability	availability
1	4	6	6	6	8
2	7	5	7	5	6
3	3	9	5	8	9
4	8	7	9	4	5
5	5	8	7	4	7
Total	5	7	7	5	7

Table 5. Expert assessments for maritime transport

Expert №	Criteria and their indicators				
	safety	speed	cost	reliability	availability
1	4	3	9	3	4
2	3	2	8	4	3
3	6	4	10	2	4
4	5	3	8	4	2
5	4	5	9	3	1
Total	4	3	9	3	3

Action 4: after determining the final estimates, a generalized table is constructed, which takes into account all types of transport and uses the values obtained in action 3. At the same time, all the obtained estimates are separately summarized:

a) each individual type of transport;

b) each individual quality indicator.

The amount for point “a” is obtained by the formula:

$$\sum_{i=1}^{n} Z'_{ij} = Z_{i1} + Z_{i2} + \cdots + Z_{in}$$, where

n – number of ratings;

i – mode of transport;

j – number of the specified criterion;

Z'_{ij} – the sum of estimates for a particular mode of transport.

So, for example, it turns out that the total sum of estimates for road transport will be: 6 + 7 + 4 + 7 + 9 = 33

The amount for point “b” is obtained by the formula:

$$\sum_{j=1}^{n} Z'_{ij} = Z_{1j} + Z_{2j} + \cdots + Z_{nj}$$, where

n – number of ratings;

i – mode of transport;

j – number of the specified criterion;

Z'_{ij} – the sum of scores for a single quality indicator.

It follows from the formula that the sum of assessments of all types of transport according to the criterion of cargo safety will be: 6 + 8 + 5 + 4 = 23

Table 6. Generalized table of ratings for all modes of transport

Kind of transport	Criteria and their indicators					
	safety	speed	cost	reliability	availability	Max
road	6	7	4	7	9	33
air	8	10	5	7	5	35
rail	5	7	7	5	7	31
sea	4	3	9	3	3	22
Min	23	27	25	22	24	

Action 5: to determine the most profitable mode of transport for the purpose of transportation, it is necessary to find the max and min values from Table 6. The max value will be the most optimal solution, and min will be the criterion that will be fundamental in the selection process.

These values are found using the following formulas:

$$\max_{j} Z_{ij} = Z_i$$

$$\min_{i} Z_{ij} = Z_j$$, where

Z_i – kind of transport;

Z_j – transportation quality criterion.

Based on the data obtained, taking into account all the estimates, we come to the conclusion that air transport would be the best option.

It is also worth noting that during the assessment we did not take into account the competence and qualifications of the experts, it follows that only by taking this factor into account we can obtain a reliable result. Therefore, we change the algorithm of actions and return to the beginning.

Action 1: determine the significance coefficient of experts based on their competence. It is found by the formula:

$$K'_j = \frac{\sum K_j}{n}$$, where

$\sum K_j$ – sum of expert assessments;

n – number of experts;

K_j' - coefficient assigned to the expert.

Table 7. Expert rating scale

Experts	Rating	Coefficient
№1 (professor)	5	5/15
№2 (assistant professor)	4	4/15
№3 (director of a logistics company)	3	3/15
№4 (logistics department employee)	2	2/15
№5 (master's student)	1	1/15
Total	15	

Action 2: next we perform actions 2-5 described above, while not forgetting that each expert is assigned its own coefficient. This means that all estimates of a particular expert are multiplied by the coefficient assigned to him. Otherwise, all actions are performed exactly:

1. determination of quality indicator estimates for all modes of transport (taking into account the coefficient of each expert);
2. finding final estimates of quality indicators for all modes of transport;
3. compilation of a summary table;
4. summing up estimates for each individual mode of transport;
5. summing up the ratings for each individual quality indicator;
6. finding the values of max and min.

Table 8. Generalized table of assessments (taking into account the coefficient) for all types of transport

Kind of transport	Criteria and their indicators					
	safety	speed	cost	reliability	availability	Max
road	1,32	1,38	0,86	1,34	1,82	6,72
air	1,62	1,94	0,9	1,3	0,98	6,74
rail	1,04	1,3	1,32	1,14	1,46	6,26
sea	0,86	0,6	1,76	0,64	0,66	4,52
Min	4,84	5,22	4,84	4,42	4,92	

Conclusions: taking into account Table 8, we can come to the conclusion that when entering the coefficient, the result did not change. Experts have determined that it is advisable to carry out transportation along the route Baku (Azerbaijan) - Shanghai (China) by air.

Results: thus, by resorting to the method of expert assessments, we can summarize that the most appropriate way is to transport 5 tons of cargo along the route Baku (Azerbaijan) - Shanghai (China) by air. It is worth noting the fact that this decision may vary depending on what criterion is decisive for the shipper. So, for example, if speed of delivery is a priority, and the cost of transportation is not important, then it would be advisable to use air transport. In the case when time is of secondary importance, and price comes to the fore, then the choice will fall on other options.

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