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FORECASTING THE PROSPECTIVE VOLUME OF CARGO TRANSPORTATION FOR THE DEVELOPMENT OF THE TRANSPORT NETWORK

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Abstract:

Objective. The content of the article is mainly concerned with solving the problem of efficient distribution of cargo flows in the transport network and their optimal development in accordance with the growth (dynamics) of traffic volumes, taking into account the throughput of the road. For this, methods for generating initial data and determining their reliability are presented. As an example, predictive calculations of an increase in the volume of cargo transportation in the Surkhandarya region were performed using the time series method and an analysis was presented.

Methods. Statistical analysis, economic forecasting, dynamic series methods, and least squares methods were used widely in the article.

Results. The distribution of flows in the regional transport network and their development in accordance with the perspective of the dynamics of flows is an important task. In solving this problem, the perspective flow is the main source of information. The article presents the flow forecast at the site, its prognostic equations are determined, the indicators achieved by the time series method and the results of the forecast are compared, and a conclusion is made about its reliability.

Conclusion. Really achieved indicators and predicted results are compared and a conclusion is made about their reliability. For example, for 2021, the maximum value of the time series forecast is 80801.6, the minimum value is 74867.6, and the actually achieved indicator is 73779.7. Therefore, the values obtained for the calculation can be called reliable, given that they do not have a big difference.

Keywords: transport, transport network, transport capacity, prediction (prognosis), dynamic series.

Introduction. Modernization and further development of production, technical renewal and diversification require the widespread introduction of innovative technologies. It is known that the modernization and further development of production requires the expansion and improvement of the efficiency of the transport infrastructure - all elements of the network of railway and road transport, respectively, technical and technological means of transport.

Transport network and the size of traffic (transportation) are the primary data in solving the issues of effective distribution of existing and prospective flows in the transport network and their optimal development, they are reflected in the existing distribution of productive forces. The volume of transportation, that is, the transportation plan based on the volumes of production and consumption of various goods at specific points, can be set in the form of a transportation matrix.

Methods. Statistical analysis, economic forecasting, dynamic series methods, and least squares methods were used widely in the article.

Results. The traffic volume is the initial information for the distribution of flows in the transport network and their further development. The article presents general methods for predicting the intensity of traffic on public roads and the urban transport network and concludes that they are reliable [1].

Transport forecasting methods are used as an instrument in the assessment of future loading of transport types and their elements. On the example of the container cargo turnover of Russian seaports, the calculation forecast of the studied indicators with the forecast of industry experts was analyzed using the dynamic series method [2].

The issues of network development based on the distribution of transport flows in the transport network were reflected in the research works of a number of scientists, including I. Kabashkin, 2015, V.I. Zhukov, S.V. Kopylov, 2015, Mouna Mnif, Sadok Bouamama, 2017.

A general assessment of the level of transport provision of the region was made according to the forecast data of the average length of transport roads per 1000 sq.km of area and 1000 inhabitants [3].

In order to effectively absorb future transport flows in the transport modes, the transport multi-network of the region was formed and the transport flows were distributed in the network. "Narrow" sections of the transport network were identified and recommendations for their development were developed [4, 5, 6, 7].

Discussions. When solving the problem of distribution of load flows in an extended network, the transport network and transport dimensions are consider as initial information. Therefore, it is very important to determine the dimensions of the future transport. Transportation dimensions, that is, the volume of production and consumption of various cargoes at specific points, or the transportation plan for the volume of all cargoes, can be given in the form of a transportation matrix, where the data is displayed for each shipping and receiving points of the network [8].

Prospective inter-node correspondences are given in the form of a transportation matrix. In the transport network, the load flows are brought to the traffic flow and the speed of movement for this network is determined.

Traffic speed prediction is based on gravity modeling, with separatemodelingfor freight and passenger traffic. The following formula for shipping [9]:

$$N = \frac{Q_c}{275 q_{o'r} K_{yuk} K_n}, \quad (1)$$

where is the predicted movement speed;

Q_c – the available volume of cargo transportation;

$q_{o'r}$ – the average carrying capacity of the vehicle in use;

K_{yuk} – load capacity utilization factor;

For passenger transport, the capacity of buses is assumed instead of carrying capacity in this formula.

It is known that economic forecasting is used to assess the future development strategy of the industry. This situation makes it possible to develop recommendations for effective management of production. Based on the determination of the economic perspective, the initial data will be able to justify the organization of the management of the transportation process and increase productivity. A table was created based on the data on the volume of cargo transportation within the region (2010-2021) (Table 1). The dynamic range method is mainly used as part of determining the long-term perspective in shipping. This method is based on determining the target using data indicators of the past time. The increase in the volume of cargo transportation in the period 2010-2030 of the researched area was calculated based on mean square values (Fig. 1).

Table 1

The volume of cargo transportation by year in Surkhandarya region, thousand tons (2010-2021)

Indicators	Years 2010	2011	2012	2013	2014	2015
Cargo volume, thousand tons	22 134,9	25 366,3	28 662,8	32 204,0	41 660,9	50 769,5
Indicators	Years 2016	2017	2018	2019	2020	2021
Cargo volume, thousand tons	57 618,1	58 857,6	61104,9	69 080,9	72 227,2	73 779,7
Indicator	Years 2022	2023	2024	2025	2026	2027
Prospective cargo volume, thousand tons	82994	88462	93486	97226	97952	98214
Indicator	Years 2028		2029		2030	
Prospective cargo volume, thousand tons	100430		107977		112277	

A transportation checkerboard of resources is created, reflecting the existing or planned transportation volumes for each type of cargo. It allows to determine the cargo turnover of transport companies.

It is desirable to compare several natural indicators with the dynamic series method. Another important requirement is the need to establish a logical relationship when selecting the rows to be compared. A detailed clarification of such series allows to reflect the functional dependence of the investigated indicators and, in turn, to determine their correlation.

Figure 1. Shipping volume, thousand tons

In simple cases, the problem is reduced to an equation in the form of a linear relationship [9].

$$y = a_0 + a_1 t, \qquad (2)$$

where the carrying capacity; constant value; coefficient; account period.

a_0, a_1 parameters are determined by the method of least squares [9].

We will carry out calculations to forecast the growth of freight traffic in the studied area. First, we form a dynamic series and the first three graphs in Table 2 are filled (Table 2).

Table 2

Initial data for determining the parameters of the equation

Years	Time in years, t	Cargo volume, thousand tons	t^2	ty_t	y_t^2	$a_1 t$	$\bar{y}_t$	$y_t - \bar{y} = \varepsilon_t$	ε_t^2
2010	1	22 134,9	1	22135	489953798	5159,8	21076,8	0,2	0,1
2011	2	25 366,3	4	50733	2573796703	10319,6	26236,6	-870,3	757 422,1
2012	3	28 662,8	9	85988	7394004935	15479,4	31396,4	-2 733,6	7 472 569,0
2013	4	32 204,0	16	128816	16593561856	20639,2	36556,2	-4 352,2	18 941 644,8
2014	5	41 660,9	25	208305	43390764720	25799	41716	-55,1	3 036,0
2015	6	50 769,5	36	304617	92791516689	30958,8	46875,8	3 893,7	15 160 899,7
2016	7	57 618,1	49	403327	162672426933	36118,6	52035,6	5 582,5	31 164 306,3
2017	8	58 857,6	64	470861	221709892977	41278,4	57195,4	1 662,2	2 762 908,8
2018	9	61 104,9	81	549944	302438513125	46438,2	62355,2	-1 250,3	1 563 250,1
2019	10	69 080,9	100	690809	477217074481	51598	67515	1 565,9	2 452 042,8
2020	11	72 227,2	121	794499	631228978801	56757,8	72674,8	-447,6	200 345,8
2021	12	73 779,7	144	885356	783855955021	61917,6	77834,6	-4 054,9	16 442 214,0

$y = a_0 + a_1 t$ a straight line graph is constructed (Fig. 2).

In order to determine the parameter values of the approximation equation by the method of least squares, the necessary calculation is performed and Table 3 is filled.

The correlation coefficient is calculated by the following formula:

$$r = \frac{n\sum ty_t - \sum y_t \sum t}{\sqrt{n\sum t^2 - (\sum t)^2}\sqrt{n\sum y^2 - (\sum y)^2}} = 0{,}978 \qquad (3)$$

The correlation coefficient showed that there is a strong relationship between the researched factors.

The parameter values of the equation are determined by the following formula:

$$a_1 = \frac{n\sum ty_t - \sum y_t \sum t}{n\sum t^2 - (\sum t)^2} = 5159{,}8, \qquad (4)$$

$$a_0 = \frac{\sum y_t - a_1 \sum t}{n} = 15917 \qquad (5)$$

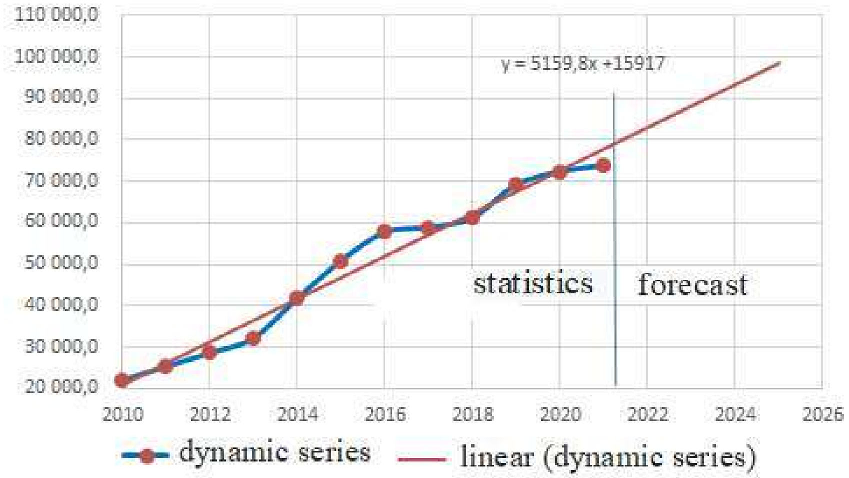

Figure 2. The growth of cargo transportation (2010-2025)

The mean squared error is defined as:

$$\sigma = \sqrt{\frac{\sum (y_t - \bar{y}_t)^2}{n-p}} = 2967, \tag{6}$$

$n-$ number of dynamic series equations; $p-$ the order of the equation representing the trend.

Table 1

Calculation of freight volume forecasting equations

Years	Time	$\bar{y} = a_0 + a_1 t$	$\bar{y} + \sigma_{\varepsilon t} = y, \max$	$\bar{y} - \sigma_{\varepsilon t} = y, \min$
2022	13	82994,4	85962	80026,4
2023	14	88154,2	91122,2	85456,2
2024	15	93314	96282	90616
2025	16	98473,8	101441,8	95775,8

The calculations obtained in the table are compared with the volume of actual cargo transportation.

Table 4

Comparison of actual achieved indicators and forecast results, thousand tons

Year	Forecasting by dynamic series method		Real achieved indicators
	Max	Min	
2018	65322,2	59388,2	61 104,9
2019	70482	64548	69 080,9
2020	75641,8	69707,8	72 227,2
2021	80801,6	74867,6	73 779,7

The transport network of the region is also the initial data for solving the problem of distribution of promising cargo flows in the network. Therefore, a ground transport multi-network of the Surkhandarya region was built [5].

The task of optimizing cargo in the network is reduced to the issue of creating the best system of roads. In this case, it will be more convenient to distribute the cargo to the next senders and recipients along the arc of these roads from one point to all other points.

The task is set as follows. It is required to determine the traffic density in each arc along with the approximate distribution of the load flow in the network in the shortest possible time. In this case, the following criteria must be met [6].

$$F = \sum_{ij}^{m} C_{ij} \cdot G_{ij} \text{ ёки } F = \sum_{st} C_{st} \cdot X_{st} \to \min$$

The idea of this method is as follows: a tree of the most profitable paths is built, the throughput of the most profitable path is determined $\mu(S,...i,j...t)$ $d_{st} = \min d_{ij}$.

A value is superimposed on the arcs of the path, taking into account the previously laid transportations. At the same time, the capacity of the track arcs is reduced by the value X_{st} . At full saturation, the last arc is excluded from further consideration. The issue of optimal distribution and development of the promising cargo flow of the region in the transport network is being solved.

Conclusion. To determine the distribution of flows in the transport network and plans for their future development, the choice of the method of forecasting the flows formed in the network and their determination is a very complex issue. Quick and high-quality determination of the future volume of transport helps the designer to develop more accurate plans for the development of the transport network.

The calculation results presented in the table do not have much difference from the values of real achieved indicators. Therefore, the method presented in the article allows to more accurately determine the dimensions of future transportation and ensures the reliability of the values obtained for the next calculation. Therefore, based on the distribution of flows in the transport network across the region, it becomes possible to identify "narrow" sections of the transport network and obtain plans for their development in accordance with the prospective growth of flows, as well as spend capital funds aimed at building roads in a targeted manner.

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CONTROL OF STATIC AND DYNAMIC MODES OF ASYNCHRONOUS MOTOR OF FODDER GRINDING DEVICES

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Abstract:

Objective. The article covers the ways of achieving energy savings by controlling the speed of asynchronous electric motors in a frequency method. Frequency control is economical because it increases the efficiency and reduces power loss by adjusting the speed of the asynchronous motor.

Methods. One of these methods is the method of controlling the speed of the asynchronous motor of feed crushers using a frequency converter. Start and control of the crushers is carried out using a frequency converter, which is set between the automatic and asynchronous motor and is controlled by the rotational frequency of the induction motor, which in addition leads to energy savings. In this case, the start and control of the asynchronous motor of feed crushers is carried out using a frequency converter.

Results. Asynchronous motors of feed crushers, the speed of which is adjustable by changing the frequency, along with saving the energy in static modes, saves the energy in dynamic modes as well. When starting the asynchronous motor of feed crushers without direct mains voltage, the starting current is 5-10 times higher than the rated stator current, which leads to an increase in power dissipation in the stator winding, if the inertia torque of the asynchronous motor and working mechanisms is large it lasts a very long time. As a result, the stator coil insulation heats up above the allowable temperature and the insulation fails.

Conclusion. As a conclusion, we can say that the frequency control of asynchronous motor in the operation of the asynchronous electric motor of feed crushers used in agricultural enterprises is economical, because the frequency converter allows the adjustment of the speed of the asynchronous motor and increase of the power coefficient of the electric drive.

Keywords: energy saving, electric drive, frequency converter, optimal control, energy criteria, operating mechanisms, energy efficiency, control systems, efficiency factor, power factor.

Introduction. As we know, today the agricultural sector in Republic is improving and developing rapidly. The asynchronous motor of feed grinding devices currently used in agriculture can be operated in several ways. For example, when we use feed grinding devices, used in agriculture, to grind corn seeds, very large current

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