Pindus Journal of Culture, Literature, and ELT
ISSN: 2792 – 1883 | Volume 2 No. 12
https://literature.academicjournal.io

STATISTICAL MODEL OF OPERATIONAL COSTS INDICATORS IN THE INTELLIGENT TRANSPORT SYSTEM OF JSC " UZBEKISTAN TEMIR YULLARI»

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Annotation: The development strategy of JSC "Uzbekiston Temir Yullari" in the conditions of digitalization of the economy of the Republic of Uzbekistan determines the need for the formation of an intelligent transport system in JSC "Uzbekistan Temir Yullari". The intelligent transport system will provide continuous monitoring to analyze the main operational indicators. The paper proposes a statistical model of JSC "Uzbekiston Temir Yullari" performance.

Keywords: intelligent transportation system, transportation activities, rail transport, JSC "Uzbekiston Temir Yullari", the statistical model.

1. Introduction. In the Republic of Uzbekistan, large-scale work is being carried out to organize an effective transport system that meets the needs of the economy and the population in transport services by all means of transport. Currently, the spatial connectivity of all regions of the country has been ensured, structural reforms have been carried out in the field of passenger and cargo road and air transport, and conditions have been created for active and effective integration into the global transport space.

At the same time, the transport system of Uzbekistan must solve a number of serious problems that reduce the efficiency of its activities. This will require serious institutional changes aimed at improving the country's transport policy, ensuring a sharp increase in the quality and volume of passenger and cargo transportation, reducing their cost to consumers, increasing the volume of cargo transit through Uzbekistan and forming a competitive market for transport and logistics services, improving the level of safety, environmental friendliness and innovation of all types of transport. In our opinion, the digitalization of the economy of the Republic of Uzbekistan determines the need for the formation of an intelligent transport system in JSC "Uzbekiston Temir Yullari".

In order to further improve the transport system of Uzbekistan, provide affordable and high-quality transport services for businesses and the public, and increase the competitiveness of the country's transport sector, it is necessary to actively introduce innovations, intelligent transport systems, and advanced information and communication technologies into the transport sector. The results of statistical digital data related to freight transport primarily characterize the efficiency of freight work on railway transport. The applied results of the research, based on the data of the digital economy, are considered in this article.

2. Review. Intelligent transport systems use economic, statistical and mathematical methods as the main research methods, and a mathematical model of the object or process under study is constructed. The paper uses as primary digital data - operational indicators that determine the quality of cargo work of JSC "Uzbekiston Temir Yullari" and builds a mathematical model of the dynamics of operational indicators.

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3. Analysis and methodology. The issues of model building operational performance of the railway system was investigated Wroblewski I. P., Basharina, O. Yu., Bazilevsky, M. P., Noskov S. I., and more others.

In the works of these authors, this evidence-based conclusions about the need to build a regression model for the dynamics of performance indicators of railway transport.

In our research, based on the research of the above-mentioned authors, we offer our own methodological approach to the development of an appropriate mathematical model of an intelligent transport system. We define the effective indexes - highlight weekend performance (group Y). the control factors (group X); and characteristics reflecting the state of the "external environment", in which operational regulation at the local level (group Z). Performance indicators that determine the quality and specificity of freight transportation JSC "Uzbekiston Temir Yullari" presented in the table 1

Table 1. Performance indicators of the model

Name of cargo performance indicators	**Designation in the constructed model**
Operational performance	
Cargo turnover (million tons km);	Y_1
Locomotive capacity (tn km);	Y_2
Local speed (km / h);	Y_3
Average weight of a freight train (t)	Y_4 -
Idle time of a local car (hour);	Y_5
Idle time at the technical station (hour);	Y_6
Loading (thousand tons).	Y_7
Driving factors	
Receiving loaded wagons	X_1
Receiving empty wagons	X_2
Dynamic load (t /km);	X_3
Transfer via junctions (trains);	X_4
Average daily mileage of the locomotive (km);	X_5
Operating fleet of locomotives (pcs.)	X_6
Technical speed (km / h);	X_7
Static load (t / car);	X_8
Average train composition (cars);	X_9
Idle under one cargo operation (hour)	X_{10}
Unloading (car);	X_{11}
Working fleet of road cars (cars);	X_{12}
Freight car turnover (day);	X_{13}
The declared volume of traffic (ths. T);	X_{14}
Availability of a fleet of cars (thousand units).	X_{15}

*As shown in table 1, the two groups of indicators include operational and control factors.

ISSN 2792-1883 (online), Published in Vol: 2 No: 12 for the month of Dec-2022

To study the dependence of the cargo turnover indicator on various factors-signs, as the analysis showed, it is optimal to use dynamics series. The dependence of the indicators was studied by us for 2011-2020. As the initial data, we used the data of the statistical reports of JSC "Uzbekiston Temir Yullari" on the volume and quality indicators of cargo turnover, grouped as arguments-factors in Table 1. To obtain an economic model of the forecasting process under the EXEL program on the PC, calculations were performed and the corresponding results were obtained.

The mathematical problem is formulated as follows: it is required to find a functional expression of the relationship between the phenomenon and the factors that determine them, i.e., the search for a function:

$$Y = f(F1, F2,\ldots, Fn) \quad (1)$$

where:

f- is the function of the relationship of indicators;

F1,F2,..., Fn-factor indicators.

4. Results. The most important effective factor affecting the level of costs is the cargo turnover indicator. It is he who makes it possible to identify the factors-signs, so that it is possible to quickly respond to the changing working conditions of JSC "Uzbekiston Temir Yullari".

The main functions considered by us in the selection of the analytical expression were calculated by the types of connection: logarithmic power, rectilinear, hyperbolic, and the equation of the models of interdependence is compiled for the enlarged indicators [2-5].

The most reliable predictive figures are obtained when selecting a relationship based on the multiple correlation coefficients, the F value, and the approximation error in % for the rectilinear type of relationship. The logical analysis made it possible to link the volume and financial indicators and determine the form of communication.

As an example of the calculation of a one-factor model, the data of attributes-factors that affect the volume of cargo turnover-are taken. The initial data is presented in table 2.

Table 2. Source data for building a single-factor model

Years	Operating turnover, mln.tons.km	Operating fleet of locomotives, freight movement,lok	locomotive Productivity, million tons.km/lok
2011	21016,6	97,6	215,33
2012	21076,1	104,0	202,66
2013	19820,4	96,3	205,82
2014	18175,5	82,9	219,25
2015	17895,6	80,6	222,03
2016	17697,6	89,7	197,3
2017	18765,1	88,9	211,08
2018	19245,9	87,1	220,96
2019	19983,9	86,2	231,83
2020	21418,8	88,2	242,84

*Source: Statistical reports of JSC "Uzbekiston Temir Yullari»

The characteristics of one-factor models of the dependence of financial indicators on the volume of products produced are presented in Table 3.

An equation corresponding to a higher value of the coefficient of determination is used if it does not contradict the economic meaning. In the case of a slight improvement in the model with a non-linear

ISSN 2792-1883 (online), Published in Vol: 2 No: 12 for the month of Dec-2022

form, preference is given to the simplest and most convenient in calculations.

Table 3. Models of the dependence of the performance of the locomotive and the available fleet on the operational cargo turnover

Contact form	Coefficient of determination	Regression equation
Linear	0,78	У = 848,72 * X + 16490,64
Logarithmic	0,36	У = 397,63 ln(x) – $3*10^{-6}$
The 2nd degree polynomial	0,817	У=0,0039* x^2-27,98* x +16490,64
Power function	0,44	У = 0,0142 * $x^{1,1897}$

*Source: author's calculations

The possibility of using multivariate analysis is determined by the values of the paired correlation coefficients. If the values of the paired correlation coefficients are more than 0.8-0.85, multivariate analysis is not possible due to the multicollinearity of the factors.

The results of the matrix analysis show that the following factors are multicollinear:

- Operational cargo turnover million tons-km;
- Average daily mileage of the locomotive, km / day.

To solve the multiple regression equation from two multicollinear factors, the one with the greatest relationship to the resulting feature is taken.

The main indicator with which the freight turnover is linked is the operating fleet of locomotives and the performance of one locomotive [6, p. 93].

At the third stage, the model is constructed taking into account the selected features-factors. Based on the obtained equations of models of the relationship of the studied indicators, we made a forecast of the operational cargo turnover of JSC "Uzbekiston Temir Yullari" for 2021-2022, shown in Table 5.

Table 5. Calculated forecast indicators of the correlation model

Years	Operational cargo turnover, million ton-km	Operating fleet of locomotives (forecast), loc	Static load of the car	Locomotive productivity, million tons.km
2021	25826,58	92,8	50,1	269,16
2022	26675,31	95,7	50,5	269,87

*Source: author's calculations

The results of the calculations are clearly shown in Table 6 and Figure 1.

Table 6. Calculations of the correlation model of operational cargo turnover

t	*y(t)*	*(t-tcp)*	*(t-tcp)^2*	*yt - ycp t*	*(yt-ycp t)(t-tcp)*	*yp (t)*	*Et*
1	21016,6	-5,1	26,12	-660,68	3376,80	17339,37	3677,23
2	21076,1	-4,1	16,90	-601,18	2471,51	18188,09	2888,01
3	19820,4	-3,1	9,68	-1856,88	5776,95	19036,81	783,59
4	18175,5	-2,1	4,46	-3501,78	7392,64	19885,53	-1710,03
5	17895,6	-1,1	1,23	-3781,68	4201,86	20734,25	-2838,65
6	17697,6	-0,1	0,01	-3979,68	442,19	21582,98	-3885,38
7	18765,1	0,9	0,79	-2912,18	-2588,60	22431,70	-3666,60

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8	19245,9	1,9	3,57	-2431,38	-4592,60	23280,42	-4034,52
9	19983,9	2,9	8,35	19977,79	57713,61	24129,14	-4145,24
10	21418,8	3,9	15,12	-258,48	-1005,19	24977,86	-3559,06
Σ			86,23		73189,17		
The calculation of the forecast Ур *(2021 год)* = 25826,58 Ур *(2022 год)* = 26675,31							

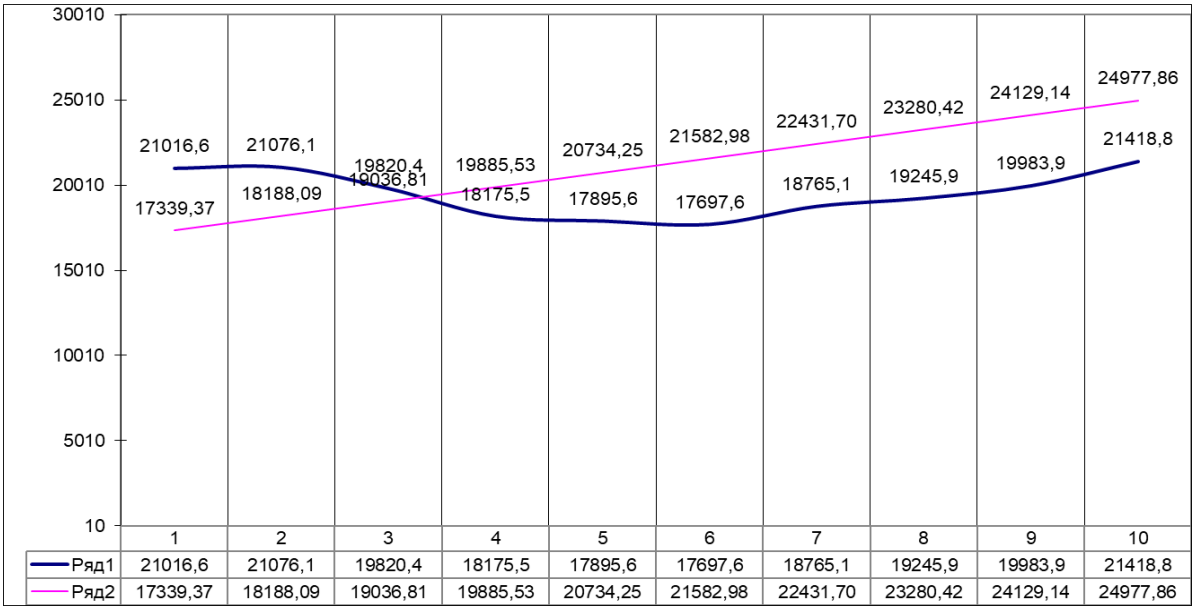

*Figure 1. Dynamics of smoothing of the indicator of operational cargo turnover according to the calculation of the model [8, p. 14]

The results of the forecast can be seen that the rate of Operating turnover of JSC "Uzbekiston Temir Yullari" on 2021-2022 years has a growth of 3.4%, the fleet of locomotives 3.1 %, statistical load of 0.8 %, the performance of the locomotive is designed according to the forecast data will increase 0.3 %.

5.Conclusion. The constructed model is an element of the intelligent transport information system of statistical accounting and will allow to generate effective and analytical data necessary for forecasting the cargo turnover of JSC "Uzbekiston Temir Yullari".

The model is nonlinear, essentially open and recursive, that is, allowing the search for a solution by successive, from equation to equation, and appropriate calculations. The process of multivariate forecasting consists in setting various values of external variables within a certain scenario and then calculating the corresponding values of internal variables using the model. In order to automate this process, the authors developed a computer version of the model.

The model can be effectively used both in the analysis of general patterns in the interaction of the selected variables, and for solving a wide range of tasks of short - and medium-term descriptive forecasting of operational performance indicators of JSC "Yzbekiston Temir Yillari". This will significantly improve the quality of management decisions made by the management of the relevant structures.

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