Scenarious modeling and justification of perspective intensity of motion of transport flow

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Abstract. The article discusses the problematic aspects of justifying a project. Such issues include the formation of a sound system of indicators for assessing the effectiveness of the project solution, which has a special impact on the level of investment attractiveness of the project as a whole. The problem of assessing the effectiveness of the project, of its social and budgetary attractiveness for the region has not only not lost its relevance, but has also been transformed into of the most important conditions for ensuring effective management of all spheres of the region. The article poses the classical task of making decisions on the results of assessing the social and budgetary efficiency of the project for the region in a matrix format with an evaluation utility function. The principal distinguishing feature of the results of the study are schemes of manipulation in the evaluation activity associated with the selection of groups of optimality criteria. The article presents the results of scenario-variant studies on the substantiation of the significance of modeling, specifies the features and limitations in applying the statistical apparatus in constructing long-term forecasts for the development of the region and studying the intensity traffic flow.

1. Introduction

The basis of the road economy of the Russian Federation is a network of motor roads with a total length of more than 900 thousand km, according to [1-3], including federal and territorial public roads that are in federal ownership and property of the constituent entities of the Russian Federation, as well as departmental roads. Automobile roads are the most important link in the transport infrastructure, without which no branch of the economy can function efficiently in the market. The efficiency of the use of road transport and road safety depend on the complexity of the road network and its quality.Automobile roads create the conditions for satisfying the ever growing needs of the entire economy in transportation by road. The intensity of traffic on the roads continuously and uncontrollably increases, which makes it necessary to build and reconstruct roads in a very remote perspective. However, the length of motorways of the corresponding technical level [4] is estimated only by the first tens of thousands of kilometers, so the problem of the state and creation of a modern network of highways remains one of the most urgent for Russia. For the stable development of the road industry in Russia, three components are needed: financing, innovation, quality control. The constant inflow of large investments is fundamental. In this connection, according to Gazprombank "... from March 16, 2016 the government intends to raise the tariff for the use of federal routes from today's 1.53 rubles.for 1 km to 3.06 rubles"[5].

The road industry is also affected by the weakening of the national currency, which raises prices for machinery used in construction; there are problems with technical re-equipment, as a significant part of construction equipment is bought abroad. In the opinion of the authors of the article, the problem of choosing an adequate statistical apparatus in assessing the intensity of the functioning of the road economy remains very topical.The purpose of this study was long-term forecasting of the investment attractiveness of the development of the road infrastructure of the Tyumen region. The object of the study was the methods of long-term forecasting of traffic intensity on highways. The subject of the study is a section of the road between Nefteyugansk and Surgut 39-49 km in the Tyumen Region located within the West Siberian Plain and belonging to the regions of the Urals Federal District.

2. Literature Review

Calculation of the existing and forecasting of the prospective intensity of traffic on the roads is "in determining the likely number of vehicles traveling between the pairs of corresponding populated areas of the territory in question, the correspondence between which are significant. At the same time, the forecasting of traffic intensity is reduced to the formation of flows of an existing or prospective fleet of vehicles on the corresponding network of highways of the territory under consideration "[5].

Currently, most of the available forecasting methods are adapted to the features of the forecast for traffic intensity on highways. There are methods designed to predict traffic intensity on individual, specific roads, and on the road network. In this case, the forecast methods are based on the account of various factors, which, according to the authors [6-17], have a significant effect on the traffic intensity.

3. Theoretical model

In order to provide methodological support to the investor and road construction organizations in the process of forecasting the traffic on the roads, of developing targeted programs, justifying the size of investments and engineering projects for the construction, reconstruction and repair of highways, use the following sources [18-22]. A guide to traffic intensity forecasting on highways was developed by GIPRODORNII OJSC in terms of forecasting the traffic intensity on public roads and NIPI of territorial development and transport infrastructure in terms of forecasting the traffic on the city's road network, as well as in the suburbs of large cities at an estimation of intensity of movement of the motor transport leaving with recreational purposes.

This Handbook is intended for calculating the current and forecasting of the expected average annual daily traffic intensity for the corresponding long-term period on the sections of the public highway network, on the urban road network (UDS), in the suburbs of large cities when assessing the traffic intensity of motor vehicles traveling with recreational purposes , as well as the average speed of movement of vehicles, the volume of freight and passenger traffic on the network of highways of general interest in the planning of road works, the development of programs for the development and improvement of the network of highways of different levels, the rationale for investing in individual roads and structures on them. The manual allows you to calculate the "chess" of correspondence between individual settlements, areas and territories.

When planning the construction and reconstruction of public roads, this manual provides an opportunity to assess the expected traffic intensity on highways long before the work is completed without detailed economic studies in the collection of data on the volumes of freight and passenger traffic.Depending on the approach to predicting traffic intensity, the methods used can be divided into three groups: extrapolation methods; balance methods (Program-Target Planning Method, Financial-value method, etc.); Model (factor) methods (stochastic and deterministic models).Extrapolation methods are the simplest and most accessible for economic entities that need objective predictions. They are based on the condition of maintaining the current trends in the intensity of movement in time. The most widespread among them was the method of direct extrapolation, in which the forecasting of the intensity of motion is carried out on the basis of the establishment of the existing intensity, which increases in accordance with the tendency of its change revealed over several previous years, which

makes it possible to realize the possibilities of the scenario approach in the process of selecting the most adequate mathematical function by the analyzed information on the dynamics of a given evaluation object. In practice, the method of selection of functions is widely applicable in view of the availability of appropriate functionality of software products for business planning (Business-Pro, Project Expert, Business-analyst, etc.), Microsoft Office (EXCEL) and IBM SPSS Statistics 20.

The method consists in the sequential application of various mathematical functions for a number of quantitative data for a sufficiently long period of observation and an estimation of their adequacy-approximation by means of calculating and comparing statistical and mathematical parameters, for example, such as variance of approximation, variation (relative error of counting), consistency criteria and etc.This method allows you to build trends for the medium and long-term prospects. The disadvantages of the method include its limited capabilities in anticipating seasonal and cyclical fluctuations, which are most typical for the finished products of road construction enterprises, and therefore the method was supplemented with the functionality of the Moving Average (EMA) method - the exponential moving average model and the index method for estimating seasonality and cyclicity:

4. Results of approbation

Summarizing the results of the iterations and modeling the prospective intensity of the traffic flow, and also examining the current state of investment activity in the region in the framework of the implementation of concepts and programs of federal and regional significance, we come to the conclusion that the most probable option should be the variant developed using the Moving Average Method by the exponential function with the cyclicality index (SLMA) taken into account (Table 1, Project 3, Table 2).

Table 1. Average annual values of the current and future traffic flow along the road section on the section of the Nefteyugansk-Surgut airport - Surgut 39-52 km, in the units given per day.

Period	Project 1. The period of the history of 2006-2015.					Project 2. The period of the history of 2012-2015.				
	The intensity of the movement of cars, led.eda.avto / sut.					The intensity of the movement of cars, led.eda.avto / sut.				
	Method of smoothing with seasonality, SLMA	Mean value method, MA				Method of exponential smoothing taking into account the cyclicity, SLMA	Mean value method, MA			
		Scenario №1	Scenario №2	Scenario №3	Optimum value		Scenario №1	Scenario №2	Scenario №3	Optimum value
2025	35765	44452	36530	90550	36787	31449	52093	46651	78397	33241
2030	41897	54207	47122	176441	44173	27716	63140	59332	139803	31068
Scenario and criteria for assessing the significance of the scenario	optimistic	unlikely	unlikely	excluded	Optimistic scenario when improving the macro environment	**The most probabilistic scenario**	excluded	excluded	excluded	optimistic scenario with macro-environment stabilization
Variations of the approximation,% *	*20,970*	*2,340*	*4,146*	*2,973*		*1,794*	*3,219*	*3,532*	*3,386*	

According to the calculations, the demand for movement on a given site will grow less than one and a half times - from 23.5 thousand units. In 2015 to 32.3 thousand units. in 2038. Thus, the prospective traffic intensity of the 39-52 km section of the Nefteyugansk-Surgut airport in the units given per day will be- by 2020, 22 thousand units / day, by 2038 32.3 thousand units / day. The main share, namely from 60% to 68% (in the calculation physical units are applied) will fall on cars. The

share of cargo vehicles is projected at the level of 23-32%. The main share among trucks will take motor vehicles of 4 classes with a carrying capacity of more than 5 tons (10-13%).The summary of the forecasts made in Table 2 allows us to distinguish the range of max / min values of the average annual calculated values of the prospective traffic trafficintensity or a given section:

- in the case of preservation of socio-economic indicators achieved in the period from 2010-2015 in the long-term perspective, the economy of the country and the region should be guided by the traffic intensity in the range from 32321 to 39489 priv.eda.avto / sut. as of 2038 (Project 2);
- in case of improvement of the geopolitical situation, with restoration of intensity of social and economic development of the region and its investment attractiveness, we come to the perspective intensity of the traffic flow in the range from 51709 to 55991 priv.ed.avto / sut. as of 2038 (Project 1).

Table 2. Perspective traffic intensity transport flow in the sector of the city of Nefteyugansk - Surgut 39-52 km, in the units given per day for 2020-2038.

Project / Indicator	Forecasting period			
	2020	2025	2030	2038
Project 1, taking into account the coefficients of significance. An optimistic option when improving the socio-economic conditions in the country and the region. Moving Average Method with Seasonality / Repeatability (SLMA) Index: Sliding Linear Function. The level of forecast error (VAR = 2.71% per year)	29400	35765	41897	51709
Project 2, taking into account the significance factors.The most probable option is PROJECT 3. Moving average method with seasonality / cyclicality index (SLMA): sliding exponential function. Level of forecast error (VAR = 1.79% for the year).	21960	30341	33859	39489
Project 3, taking into account the coefficients of significance. An optimistic option while preserving the socio-economic conditions in the country and the region. Mean value method (MA). Level of forecast error (VAR = 3.33% per year).	23515	31449	27716	32321

5. Conclusion

The combination of these methods and approaches allowed to take into account both objective and subjective factors of traffic flows on a given section of the highway, overcome the limitations associated with the delay in providing, the incompleteness and inaccuracy of certain quantitative data, and the subjectivity of qualitative assessments in setting the probabilities for the implementation of the scenario and option.

We should especially note the priority of the scenario scenario approach in forecasting, which made it possible to single out the field of possible variants of the development of events, which allows timely pre-emptive actions and minimizes the risks and negative consequences of external forces' influence on the investor, as well as create the conditions for extracting the maximum benefits from the realization of that or other scenario.

The developed variational-scenario approaches in assessing the prospective traffic intensity of the transport approach make it possible to determine the readiness of regional executive authorities to respond to identified environmental influences and to pool resources within the municipal formation to increase the capacity of the motorway, improve its quality and create safe conditions for traffic flows along the to such a significant section of the city of Nefteyugansk-Surgut is 39-52 km.

In addition, the forecasts indicate an inevitable increase in the traffic intensity in the whole region and in particular on this section of the road, which raises the need to assess the ability of the municipal

formation to conduct systematic work and to attract external resources (Russian and foreign investments) for the implementation of reconstruction programs and / or the construction of parallel sections of roads in the framework of preventive works to create conditions for the safety of traffic and livelihoods in the Jelenia points. Of particular relevance, research data at the regional level was received due to the withdrawal of the main source of welfare and prosperity of the Tyumen region from the regional budget and the termination of compensation payments from the federal budget - the mineral extraction tax - at the turn of 2009-12.

The recommended range of traffic flow intensity at a particular section of the road has a high degree of realism and attainability in conditions of stability, certainty and prospects for the development of the region (an error in the account from 1.79% from 3.3%).And then the matter of technology, to calculate the investment attractiveness of the investment project for construction / reconstruction, or the maintenance / operation of that or a section of the highway.

The provision of reliable motor transport links contributes to the integration of industry not only within the same territory, but also with the adjacent territories of the Tyumen region and the districts, which becomes particularly relevant in the face of rising railway tariffs and within the concept of import substitution. The lack of reliable and functional transport links on the one hand reduces the possibility of importing Tyumen enterprises' products to remote areas of the autonomous regions - KhMAA and Yamal-Nenets Autonomous District, which is a deterrent to the development of these enterprises and the implementation of social programs by the executive authorities. On the other hand, it leads to a monopoly of producers because of the inability to import such products from other producers and, as a consequence, overstating the real cost of manufactured and sold products, both for industrial purposes and for public consumption. And also taking into account the practice of the last five years, in the conditions of the post-crisis period, we believe that the forecasts require further refinement and correction using correction factors calculated using the balance method for predicting the traffic flow intensity.

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