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The choice of transport for freight and passenger traffic in the region, using econometric and fuzzy modeling

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Abstract

A method of decision-making based on fuzzy set theory and econometric modeling, is proposed. This technique allows you to make an informed choice of mode of transport for freight and passenger traffic in the region.

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Keywords: fuzzy set theory: analysis of transportation systems; econometric modeling.

1. The course of the study

Transport plays a leading role in the economy of any region. In this paper we propose a method of decision-making based on fuzzy set theory (Zadeh, 1965). This technique allows you to make an informed choice of mode of transport for freight and passenger traffic on the basis of preliminary analysis of the main characteristics of vehicles in the region. The method was tested for the Rostov region of the Russian Federation.

The novelty of our approach lies in the combination of econometric methods and the method of Maximin convolution of fuzzy set theory. To analyze the choice of mode of transport for freight transport is considered the main types of transport in the region: rail, road, inland waterway shipping. For passenger transport the main types of transport local traffic in the region are: bus, tram and trolleybus. The problem in question, the types of transportation

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alternatives are identified in the future, a_1, a_2, a_3 respectively, of which choice is the best.

We consider the choice of mode of transport for freight in the region using the following criteria:

- F_1 – freight turnover by types of transport (million ton-km);
- F_2 –transportation (dispatch) of goods by type of transport (thousand tons);
- F_3– the operational length of Railways for General use (km);
- F_4 –the density of the transport network of General use (km of track per 1,000 sq km area);
- F_5 – the number of road traffic accidents (units).

Based on the values of these criteria for 2006-2014, we analyze the dynamics of relevant indicators, building their trendy models (ROSSTAT, 2011-2014).We will carry out the construction of trend models of the major indicators of freight transportation in Rostov with the use of software.

We introduce the notation:

- QA –the freight turnover of road transport (million ton-km);
- QGD – rail transport freight turnover (million ton-km);
- QW – the turnover of navigable mode of transport (million ton-km);
- GGD – transportation (dispatch) of cargos by railway transport (thousand tons);
- GAW - transportation (dispatch) of cargos by road transport (thousand tonnes);
- GWS - transportation (dispatch) of cargo in navigable form of transport (thousand tons);
- LGD – the operational length of Railways of General use railway transport (km);
- LAW – the operational length of Railways for General use by road transport (km);
- LWS – the operational length of Railways for General use on navigable mind transport (km);
- SGD – the density of the transport network of General use for rail transportation (km of track per 1,000 sq km area;
- SAW – the density of the transport network of General use for road transport (km of track per 1,000 sq km area);
- SWS – the density of the network messages for common use for navigable mode of transport (km of track per 1,000 sq km area);
- AAW – the number of road accidents for road transport (in units);
- t – time (years).

Note that the metric density of network messages for common use by type of transport (according to the statistical collections of the Federal state statistics service for 2011, 2012, 2013, 2014) on rail transport has not changed and amounted to the value of 18.2 km. Water shipping meant transport in 2006 – 2008 the density of the network messages for common use amounted to the value of 11 km, and from 2009 to 2014, the value of 9.9 km per 1,000 sq km territory. Therefore, it was constructed the equation of the trend model the density of the transport network of General use only for road transport.

In addition, data on the number of accidents for rail and inland shipping transport modes do not exist in the statistical compilations of Federal state statistics service for 2011, 2012, 2013, 2014. Therefore, in this work, we constructed the equation of the trend model the number of accidents only for road transport.

Considering the different models on the basis of econometric analysis, we selected the following models:

$$QA = 626,1071 + 513,6429 \cdot t,\ R^2 = 0,96\ ; \tag{1}$$

$$QGD = 27392 + 17969.6 \cdot t - 10044,98 \cdot t^2 + 2442,662 \cdot t^3 - 270,7136 \cdot t^4 + 11,20288 \cdot t^5,\ R^2 = 0,97\ ; \tag{2}$$

$$QW = 8263,223 - 4370,505 \cdot \sin\left(\frac{t}{2}\right),\ R^2 = 0,93\ ; \tag{3}$$

$$GGD = 82,693 \cdot t^5 - 1907,8 \cdot t^4 + 16058 \cdot t^3 - 59693 \cdot t^2 + 93364 \cdot t - 22839,\ R^2 = 0,73\ ; \tag{4}$$