MODELING TRANSPORT CULTURE OF POPULATION

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ABSTRACT

The article presents the results of a research in the field of modeling of transport culture of population, particularly based on R. Smeed's law modifications. Using experimental data analysis it was found that behavior of citizens on the roads is determined primarily by the level of motorization in the region. The proposed basic model of transport culture of population allows us to solve a number of problems associated with implementation of federal and regional programs of road safety.

Keywords: transport, road safety, transport culture of population, model, transport risk, social risk, level of motorization.

Background. *Reducing road traffic accidents has become one of national priorities. Its solution requires well-targeted (in terms of methodology and practice) engineering methods for designing road safety control systems (hereinafter – RSCS). The main difficulty is the lack of strong scales in this subject area, which leads to inadequate formalization of the problem. And first of all difficulties relate to management of social and transport risks in the region that directly intersect with the goals of a current federal targeted program to improve road safety in the country. And this defines ultimately just an actual level of national transport culture, somehow transforming in its various manifestations. Hence, actually there is an attempt to eliminate this gap.*

Objective. *The objective of the author is to presents the results of research in the field of modeling of transport culture of population, particularly using R. Smeed's law modifications.*

Methods. *The author uses general scientific methods, modeling, equation modification, statistical analysis, mathematical methods, evaluation approach.*

Results. *The algorithmic basis to solve this problem is work [4] associated with modification of R. Smeed's law. The approach involves the use of a generalized interpretation of transport (TR) and social (HR) risks:*

$$TR = k_{TR} \cdot (U_a)^{-\frac{1}{1+1/x}},\ \text{dead/100000 vehicles;} \qquad (1)$$

$$HR = k_{HR} \cdot (U_a)^{\frac{1}{1+x}},\ \text{dead/100000 inhabitants,} \qquad (2)$$

where $U_a = N/P$ is a level of motorization, vehicles/1000 people;

N is a number of registered vehicles;

P is population number;

k_i is constant, $k_{TR} = 3000$, $k_{HR} = 3$;

x is an indicator, characterizing transport culture level of population (UTC) and having (as shown by structural identification) a form $x = x_0 + \exp(a \cdot U_a)$;

a and x_o are constants, depending generally on features of transport behavior of citizens of the region.

The concept «transport culture level» is not new: it is mentioned, in particular, in works [1,2], however it has not been filled with engineering content. However certain attempts have been made [see: 5–7, 9].

Of course, structural and parametric identification of UTC model, allowing finally to solve applied tasks, is of practical interest. Its results are shown in Pic. 1. As an evidence base Russian and European statistics were used [3, 10], respectively for 2011 and 2013 years. High values of determination coefficients show compliance of obtained models with experimental data.

The identified according to experimental data model of transport culture level in the form of

$$x = x_o + \exp(a \cdot U_a) \qquad (3)$$

indicates that the mechanism of dependence of x on level of motorization U_a is described by differential equation

$$\frac{dW}{dU_a} = k \cdot W^{\gamma}, \qquad (4)$$

where $W = x - x_0$ (Pic. 2);

k and γ are constants.

Actually, dividing variables, we have when $\gamma = 1$:

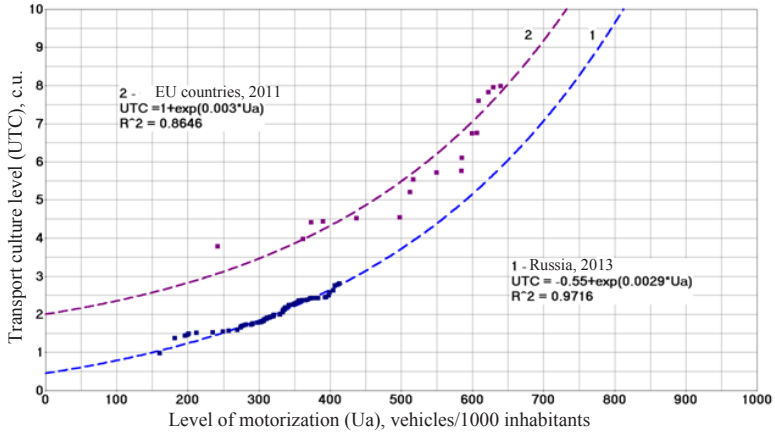
$$\frac{dW}{W} = k \cdot dU_a .$$

It gives as a result of integration:

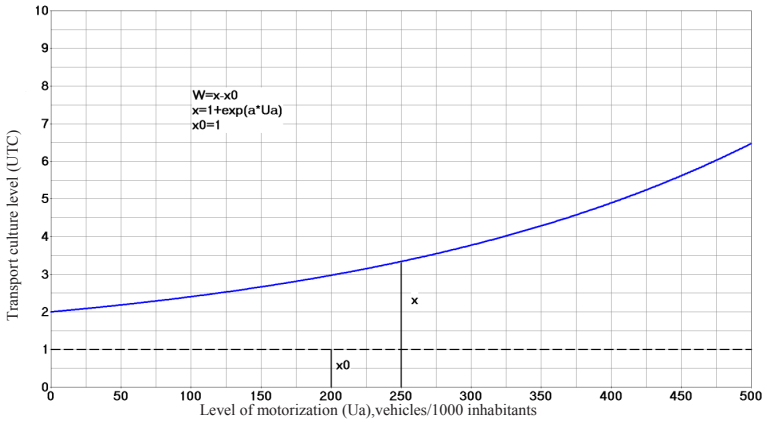
$\ln(W) = k \cdot Ua + \ln(C)$,

i.e. $W = x - x_o = C \cdot \exp(k \cdot U_a)$ (5)

or $x = x_o + C \cdot \exp(k \cdot U_a)$. (6)



Pic. 1. Identification of models of transport culture level of population UTC for countries of the European Union (2011) and regions of Russia (2013).



Pic. 2. On solving the problem of modeling transport culture level of population of countries (regions).

Assuming that at a low level of motorization (including when $U_a = 0$) classical R. Smeed's law works, when $x = 2$, we obtain for $x_0 = 1$ (see Pic. 1), the value of multiplier $C = 1$. This means that (6) completely coincides with the relation (3) when $k = a$.

Solutions of the differential equation (4) for other conditions (e.g., $\gamma \neq 1$) are still only of academic interest, and if desired, they can be found in [8].

The main message for modeling is to obtain relation (6) for a wide range of application conditions. In particular, it can be used to solve spatial-temporal problems, when the motorization level is defined by a time trend, and by direct regional data.

Conclusions. *A basic model of transport culture level of population in various countries was offered (6).*

Its software testing was performed.

Obtained research results allow us to:

1. Perform a quantitative estimate of transport culture level of population in the region (country, administrative district, city).

2. Implement monitoring of this level in the framework of multi-parameter information and analytical system.

3. Segment Russian regions by the level of transport culture level of population with the purpose of priority implementation of programs of transport safety management.

4. Perform strategic and tactical planning in management of social and transport risks.

5. Conduct a quantitative evaluation of effectiveness of programmed activities.

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