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# Cybernetic Modeling in Tasks of Traffic Safety Management

Victor Kolesov [a]*, Artur Petrov [b]

*Federal State Budgetary Educational Institution of Higher Education "Tyumen Industrial University", 38 Volodarskogo Str., Tyumen, 625000, Russia*

**Abstract**

Currently, traffic safety management (TSM) can also be considered as a subject of cybernetics and, therefore, it requires a new approach based on cybernetics traditions. The objective of the article is the specific character of the cybernetic approach in the field of traffic safety management.

The article describes the cybernetic modeling of the cause-and-effect mechanism of road traffic accidents (RTA). Correlation between model parameters and TSM indicators of the 1st and 2nd level is established, their ABC analysis is conducted, which allows to define "weak" links and set priorities in the field of TSM.



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*Keywords:* cybernetic model; the link transmission rate; TSM indicators of 1st and 2nd levels; ABC analysis according to Pareto; priorities in the field of traffic safety management

## 1. Introduction

Traffic safety management (TSM) is taking features typical for large cybernetic systems, and synthesis of such systems has no prospects in the absence of a cybernetic model (CM) of the process. The concept of the CM is interpreted by Krutov, Glushko and Popov (1989) as follows: "cybernetic models are based on discovering relationships between input and output functions for a black or gray box, representing the phenomenon under study, without revealing its internal structure". The construction of such models in the field of traffic safety is, unfortunately, far from perfect.

* Corresponding author. Tel.: +0-000-000-0000 ; fax: +0-000-000-0000 .
*E-mail address:* vikolesov@yandex.ru[a*], ArtIgPetrov@yandex.ru[b]


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As a rule, the procedure for solving such problems is considered in the following sequence:

- construction of a block diagram of the process under study (identification of the cause-and-effect model of the motor transport accident rate formation);
- setting of the value for coefficients of model link transmission (path);
- setting of the value for the through path transmission coefficient (TTC).
- prioritization of process links (via ABC analysis).

The study is based on use of the rank analysis developed in the works of Kudrin (1993), Gnatyuk (2014) (and subsequently used by Kolesov and Petrov (2014[1])) to process statistical data of the State Traffic Safety Inpectorate (STSI) of the Ministry of Internal Affairs of the Russian Federation. The objective of this study is to improve the management efficiency with regard to the traffic safety on the federal level on the basis of cybernetic modeling of the cause-and-effect mechanism of road traffic accidents (RTA).

## 2. Main text

### *2.1. Analysis of the cause-and-effect model of the motor transport accident rate formation)*

The task of analysis of the cause-and-effect model (Fig. 1), consists in: (i) creation of a system of basic indicators of the process (indicators of the 1st and 2nd level), and (ii) establishment of correlation between coefficients of link transmission and these indicators.

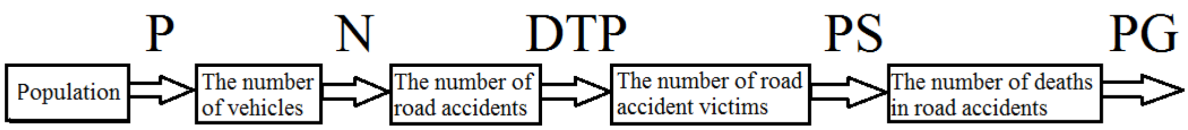


Fig. 1. Cause-and-effect model of the RTA mechanism.

The first part of the task has been considered by Kolesov and Petrov (2015[1]), and its main point is the following:

Characteristics shown in Fig. 1 — *P*, *N*, *DTP*, *PB*, and *PG* — are process indicators as they are formed on the basis of monitoring results. They are used as a basis to set target indicators (TI) of the 1st and 2nd levels.

Indicators of the 1st level (FLI) are directly generated by indicators of the technology process (*P, N, DTP, P, PG*), and indicators of the 2nd level (SLI) are formed on the basis of obtained FLIs.

Road safety indicators of the 1st level include the following ten indicators (Table 1).

Road safety indicators of the 2nd level (Table 2), as noted, are formed on the basis of traffic safety indicators of the 1st level. The Smeed's law and its modifications serve as a classic example [Kolesov (2012)].

Table 1. Road safety target indicators of the 1st level

| No. | Road safety indicators of the 1st level | Identifier | Determination algorithm |
|---|---|---|---|
| 1 | Motorization level in the country (region), vehicle/1,000 people. | $U_a$ | $U_a = N/P$ |
| 2 | Number of actual road accidents per 1,000 people, accident/1,000 people | $DTPp$ | $DTPp = DTP/P$ |
| 3 | Number of road accident victims per 1000 people, injured in accidents/1,000 people | $PSp$ | $PSp = PS/P$ |
| 4 | Number of fatalities as a result of road accidents per 100,000 people, fatalities/100,000 people | $PGp$ | $PGp = PG \cdot 100/P$ |
| 5 | Number of road accidents per 1000 vehicles, accident/1,000 vehicles | $DTPn$ | $DTPn = DTP/(N/1000)$ |
| 6 | Number of road accident victims per 1000 vehicles, injured in accidents/1,000 vehicles | $PSn$ | $PSn = PS/(N/1000)$ |