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The Assessment Model for Economic Efficiency of Traffic Safety Improvements

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Abstract

Traffic safety improvement activities demand considerable financial resources which are not accessible in today's economic conditions; therefore, attraction of investments into projects associated with traffic safety improvements has great importance today.
Elaboration of scientific measures associated with improvement of traffic safety/road traffic organization in current conditions demands not only economic studies aiming to define their efficiency but also financial estimates allowing to determine potential investors.
This paper presents a mathematic model elaborated to determine expedient investor's shares and probable profits which may be earned from projects associated with improvements of road traffic safety.

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Keywords: Traffic safety, improvement of road traffic organization, economic efficiency, financial resources, investors, profit.

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1. Introduction

Recent years have been characterized by steady tendency for road accidents (RA) rate increase both at highways and within street and road networks of cities inflicting considerable damage to national economy. The said trend is particularly characteristic for large cities.

Currently the economic situation is characterized by limited financial resources, all traffic safety improvement measures are being planned and implemented mainly in RA concentration areas.

Traffic safety improvement activities demand considerable financial resources which are not accessible in today's economic conditions; therefore, attraction of investments into projects associated with traffic safety improvements has great importance today.

Elaboration of scientific measures associated with improvement of traffic safety/road traffic organization in current conditions demands not only economic studies aiming to define their efficiency but also financial estimates allowing to determine potential investors [State Committee for Construction RF, Ministry of Economy RF, Ministry of Finance RF, State Committee for Industry RF (1994)].

This paper presents a mathematic model elaborated to determine expedient investor’s shares and probable profits which may be earned from projects associated with improvements of road traffic safety.

2. Main Text

Steady increase of road accident rate (RA rate) may be explained by a number of factors:

- increase of road traffic intensity (caused by relative stabilization of national economy) with almost unchanged throughput of street and road networks;
- presence of non-eliminated (in due time) defects of (i) road surfaces and road shoulders, (ii) road traffic organization facilities and (iii) engineering equipment (for roads and town streets) enabling road traffic safety improvement;
- poor level of roads and town streets technical maintenance;
- absence of properly equipped crosswalks (in appropriate places) resulting in sudden appearance of pedestrians within the roadways;
- absence of (or defective) proper engineering equipment on railway-crossings;
- insufficient financing of traffic safety improvement activities;
- other unfavorable factors [Konovalova (2013)].

These factors not only aggravate RA rate but also generate RA concentration areas where influence of aforementioned factors has longtime character.

In today's economic situation characterized by limited financial resources all traffic safety improvement measures are being planned and implemented mainly in RA concentration areas. Before the year 2015 RA concentration areas in RF were detected in compliance with [Federal Road Service (1998)], while today they are assigned in compliance with [Federal Road Agency (2009)]. According to RA rate analysis performed with reference to data gathered during the years 2014 & 2015 (Krasnodar and Sochi) modification undertaken in RA analysis and record regulations resulted in actual decrease of RA concentration areas by 32–37 %. At that, quantitative RA rate indices for the same period increased by 3–5 %.

Selection of priority measures targeting (i) elimination of RA concentration areas and (ii) improvement of traffic safety is performed, as a rule, in accordance with [Federal Road Transport Agency (2009)]. Methods of assessment of traffic safety improvement measures in RA concentration areas presented in [Federal Road Transport Agency (2009)] is based on RA evaluation from costs viewpoint which accidents will probably not occur upon safety measures implementation.

Elimination of RA concentration areas is the principal part of federal, regional and local programs targeting traffic safety improvement elaborated on the basis of [State Duma (1995)] and aiming to completely resolve the problem of RA rate reduction.

Decision to implement traffic safety improvement measures and a need to determine their efficiency is caused by the necessity to make account to numerous factors, which differ between each other in features, orientation and intensity of influence. In such conditions, one of prerequisites for efficient solution consists in systematic approach employment. Such approach allows (i) revealing interrelationships between object under investigation and environment (ii) discover its integrity and (iii) select efficient problem solution strategy. In order to properly investigate issues associated with (i) traffic safety improvement measures and (ii) determination of their efficiency it is expedient to make use of system entitled “Road Conditions-Traffic Stream-Environment” [Konovalova and Zarovnaja (2011)].

Elaboration of scientific measures associated with improvement of traffic safety/road traffic organization in current conditions demands not only economic studies aiming to define their efficiency but also financial estimates allowing determining potential investors [Konovalova and Zarovnaja (2011)].

Unlike other profit yielding measures, traffic organization and safety improvement measures are not reflected in terms of money in accountancy records although the above measures are directly or indirectly affecting the financial balance of the company (increase of transportation fuel and lubricant expenses, excessive mileage, technical maintenance and repairs etc.) [Konovalova and Parnevaya (2015)].

Income deficiency due to excessive service costs is profit which could have been gained [Konovalova and Kotenkova (2013)].

It is possible to perform calculations allowing (i) to find potential investors in projects targeting traffic safety organization improvements and (ii) to determine estimated profit which might be gained upon implementation of certain measures.

Mathematical model of expedient investor’s shares in project may be presented as follows:

$$S_{pr} = \sum_{i=1}^{n} I_j \tag{1}$$

where S_{pr} – project implementation cost, rub.;
I_j – investments to project, rub.;
n – number of investors.

Cost-to-performance ratio for capital investments in project is determined using the formula:

$$E = \frac{\sum_{j=1}^{n} E_j}{\delta \cdot \sum_{j=1}^{n} I_j} \geq E_n \tag{2}$$

where E_n – normative cost-to-performance ratio for capital investments in project;
E_j – economic effect yielded from project implementation for j–investor, rub.;
δ – coefficient of investments discounting.

$$\sum_{j=1}^{n} \eta_j \leq \frac{\sum_{j=1}^{n} E_j}{S_{pr} \cdot \delta \cdot E_n} \tag{3}$$

$$\sum_{j=1}^{n} \eta_j = 1$$

where η_j – expedient share of investments provided by j–investor.

In order to determine expediency of investments in projects associated with improvement and organization of traffic safety it is possible to make use of the following criteria:

- general criterion of expediency:

$$\sum_{i=1}^{t} P_i \geq K\left\{\left(1+\frac{r_1}{100}\right)\cdot\left(1+\frac{r_2}{100}\right)\cdot\ldots\cdot\left(1+\frac{r_i}{100}\right)-1\right\} \tag{4}$$

$$E_{pr} \geq E_n$$

where P_i – annual profit resulting from project performance, rub.;
K – scope of capital investments in project, rub.;
r_i – rate of refinancing established by RF Central Bank in i-year, %;
t – period of comparison, years;
where E_{pr} – cost-to-performance ratio for capital investments in project.

- particular criterion of expediency:

$$\sum_{i=1}^{t} d_{ij} \geq I_j\left\{\left(1+\frac{r_1}{100}\right)\cdot\left(1+\frac{r_2}{100}\right)\cdot\ldots\cdot\left(1+\frac{r_t}{100}\right)-1\right\}$$

$$\sum_{i=1}^{n} I_j = K \tag{5}$$

$$\sum_{j=1}^{n}\sum_{i=1}^{t} d_{ij} \rangle \sum_{i=1}^{t} P_i$$

where d_{ij} – profit of j–investor in i–year, rub.;

- profit gained from project production operations:

$$P = \sum_{i=1}^{m} P_i - \sum_{i=1}^{m} E_i - S \tag{6}$$

where P_i – profit from project production operations per i–revenue item, rub.;
E_i – expenses associated with exploitation or maintenance of i–revenue item, rub.;
S – scope of taxes and payments into the budget, rub.;
m – number of revenue items.

Conclusion

Using the elaborated mathematical model of expedient shares of investors in projects associated with organization and improvement of traffic safety measures it is possible to improve economic efficiency via their implementation not only in RA concentration areas but also in a single package within a certain part of street-and-road network. At that, the aforementioned part of street-and-road network may be characterized either by presence of several RA concentration areas or by no such areas as per [State Committee for Construction RF, Ministry of Economy RF, Ministry of Finance RF, State Committee for Industry RF (1994)].

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