IMPROVING THE EFFICIENCY OF ROAD TRAFFIC CONTROL

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Abstract: The article considers a solution to the problem of road traffic safety control. The principles of creating an expert system, its functioning, peculiarities and merits are described. The "driver-vehicle-road-environment" subsystem as an object of an expert system is briefly described.

Key words: Expert system, road safety, road accident, human error, motor vehicle safety, road.

In September 2015, Heads of State and Government who gathered at the UN General Assembly adopted the historical Agenda for Sustainable Development [1]. The document reflects a new task of halving the number of deaths and injuries from road traffic crashes by 2020. The adoption of the task with respect to road injuries means the recognition of substantial research data on measures facilitating the reduction of these injuries. There is considerable data on effective measures on road safety enhancement, and the countries where these measures are successfully implemented are facing a corresponding reduction of deaths resulting from road traffic crashes. Global implementation of these measures will provide a huge potential for lowering future costs and saving people's lives.

In order to reduce injuries and accidents, the Federal Targeted Program "Road safety improvement in 2013-2020" has been implemented in Russia since 2013 [2]. The program's effectiveness is guaranteed by applying the program-based method as the basis for state control in the sphere of road safety enhancement through the adoption and further implementation of the Program, because it will make it possible to:

Establish unified goals and objectives on road safety enhancement up to 2020;

Build up a system of priority measures on road safety enhancement which would influence the causes of accidents reasonably and systematically;

Improve the control efficiency in the sphere of road safety enhancement on the federal, regional and local levels, as well as in the sphere of interdepartmental interaction and coordination of federal executive bodies, the bodies of executive authority of the subjects of the Russian Federation and local self-government bodies;

Focus the state resources on implementing measures in accordance with the priority goals and objectives in the sphere of road safety enhancement;

Apply the result-oriented budgeting principles.

However, according to the leading researchers of Saint Petersburg State University of Architecture and Civil Engineering S.A. Yevtyukov, P.K. Kravchenko and the authors V.N. Burkov, V.D. Kondratyev and A.V. Shchepkin [3], at the moment the state policy in the sphere of road safety enhancement is only being formed and is characterized by a lack of cooperation and an insufficient coordination among public authorities, which leads to general discord and incoordination. Hence the conclusion on the necessity to significantly strengthen control in the sphere of road safety. The authors believe that in the country as a whole the road safety enhancement problem is solved by raising control efficiency, with functions being redistributed from the federal center to the regional and local levels.

An effective way of reducing the number of accidents is the application of the systemic approach to the problem of road safety control, which requires a joint effort of several sectors (transport, police, health care, education, mass media). The agreement and correlation of economic and socio-natural potentials should be regarded as an object for research and analysis. It is common practice to analyze road accidents by applying the "driver-vehicle-road-environment" system. Therefore, it is suggested to regard the "driver-vehicle-road-environment" (DVRE) subsystem as an element of the socio-natural-economic system (SNES) comprising the social, ecological and economic components [4].

The DVRE subsystem is a complex dynamic system including the combination of elements "person", "motor vehicle", "road", all functioning in a certain environment [5, p. 16]. Road safety is guaranteed by the quality of these elements.

The motor vehicle's influence on road safety is determined by its safety. Motor vehicle safety is secured in legislation at the production stage and is controlled throughout its operation. That is why the number of road accidents due to the vehicle's failure or faults of its safety is traditionally quite low. Storing information about such road accidents will make it possible both to improve the motor vehicle safety system requirements and the contents of tool control over the state of these systems during their operation.

Human error is thought to be the major factor causing road accidents. The driver is both the most significant and the most unstable element of the DVRE system. By their nature, people are unstable, changeable, poorly predictable, due to which the problem of evaluating the stability of this element's functioning is complicated by its ambiguity. In the suggested system, the driver is the only control element without which the system cannot function [6, p. 13].

The driver's behavior is of peculiar importance in cities in conditions of high intensity and non-uniformity of traffic and higher driver error significance. In this case, the driver's behavior is reflected in breaking traffic rules prior to road accidents. The impact of this or that traffic violation is impossible to evaluate quantitatively because of road users' subjectivity, which, in

its turn, leads to ambiguity. Indeed, a complex system, where people play a most active part, is characterized by the so-called incompatibility principle: "in order to obtain significant conclusions as to the behavior of a complex system, it is necessary to abandon the high standards of precision and rigor which are characteristic of relatively simple systems and to analyze it with approaches which are approximate in their nature" [7, p. 10].

Researches show that "frequently, a person's behavior is more effectively influenced by improving road traffic conditions than by training or by police control" [8, p. 54]. This stresses the relevance of the safety level provided by a road.

At present, the method based on road accident statistic analysis, the accident rate method, and the safety factor method are used to evaluate road traffic safety [9, p. 6]. The methods of finding dangerous road sections on the basis of road accident statistics are used to evaluate road safety on the existing roads with complete and reliable information available on road accidents over a period of not less than 3-5 years. When the data is not available or when it is necessary to evaluate design decisions in constructing new roads or reconstructing the existing ones, the accident rate method is used which is based on the analysis and summary of road accident statistics. The safety factor method is based on the analysis of speed-time charts for road traffic. These methods make it possible to evaluate how geometric features of the road, condition of the road surface, traffic density influence road safety. However, the information obtained in applying these methods does not provide for direct decisions, instead it requires additional research, which does not make it possible to use the methods for operating control over road safety.

Artificial intelligence methods are being increasingly used for solving problems in complex systems. Expert systems are among the most developed directions of artificial intelligence. They are complex software applications aimed at storing knowledge on a certain sphere and manipulating knowledge in order to solve problems of their domain [10, p. 60].

Expert systems are used in solving complex practical tasks; in the quality and effectiveness of decision-making, expert systems match the decisions of human experts, they can be explained to the user on the qualitative level and can enrich their knowledge [11, p. 9]. These opportunities dictate the need for the Road Safety Expert System (RSES) (Figure 1).

The RSES includes the following components: 1) the knowledge base with regulatory documentation, expert evaluation and scientific research as its foundation; 2) the database accumulating the outside information, including the information on road accidents; 3) the solver (controlling component) determining the necessary actions on road safety control by using the knowledge base and the database; 4) the explanatory component explaining the decision-making process; 5) the interface connecting the user and the expert as parts of a single information environment with the RSES; 6) the component of knowledge acquisition through the dialog with the expert.

The informal character of the problems being solved in designing expert systems implies

the use of the "rapid prototype" principle. It means that at the initial stage an expert system prototype is created to meet two opposite requirements: on the one hand, it is to solve typical problems, on the other hand, its development effort must be quite insignificant. The means of speeding up the design process are generally called tools [11, p.13]. As the knowledge grows, the prototype can reach the state of successful problem-solving.
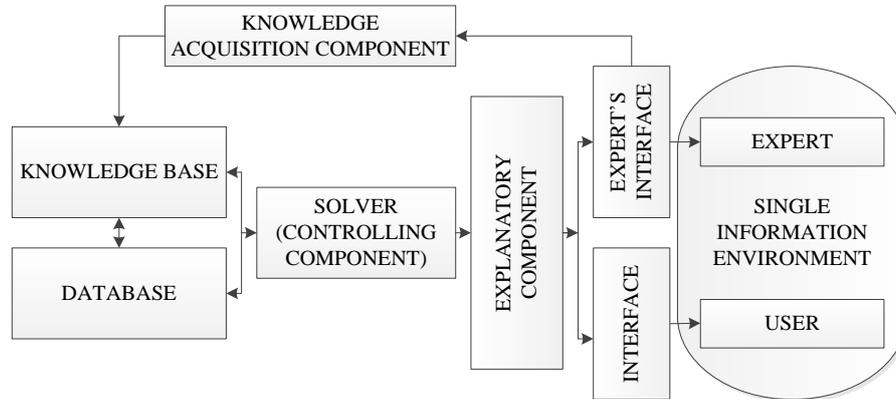
Figure 1. A generalized road safety expert control system diagram.

The main task of the RSES is to search for decisions on road safety improvement. The RSES is intended to provide counseling on field-specific issues in decision-making in the sphere of road safety in order to enhance and widen its users' professional capabilities.

Peculiar features of the RSES are:

1. Expert examination can be conducted in one specific field only.

2. The expert system explains the course of solving a problem (reasoning chain) in a way which is clear to the user (they may ask how and why this particular solution was obtained and get a clear answer).

3. The output results are qualitative, not quantitative (numerical).

4. The system is modular, which allows the extension of the knowledge base.

The RSES merits are:

1. Storage and extension of experience and knowledge of highly skilled specialists.

2. The opportunity to solve practical tasks.

3. The efficiency of decisions made by the expert system which match the decisions made by a human expert.

4. "Transparency", i.e. the opportunity to explain the causes and mechanisms of decision-making.

5. The ability to enrich and to correct knowledge during the dialog with the expert.

6. Availability for solving road safety control problems at any level.

7. Applicability as a training program.

8. Effective performance.

The RSES formation and maintenance is based, on the one hand, on scientific research in the field of road safety and, on the other hand, on the opportunities of organizations working with government institutions responsible for road safety. The task of leading universities should be to generate and accumulate scientific researches in the sphere of road safety and to provide their objective evaluation.

CONCLUSIONS

The development and implementation of the road safety expert system will make it possible to solve the following problems: to form decisions at all levels of road safety control with account of their peculiarities and state; to monitor the efficiency of the decisions and, if necessary, correct and improve them; to provide rapid and wide implementation of new road safety control methods. The data required for the preparatory stage (expert evaluation and its results' processing) can be reused. The statistics stored in the Road Safety Expert System database will provide for the timely evaluation of the road safety level.

The RSES application in road safety control is an effective way of reaching the main goal: to reduce the number of deaths, to lower road injuries and accidents.

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