A Simulation Model of an Expert Analysis System of Road Accidents

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A Simulation Model of an Expert Analysis System of Road Accidents

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Abstract. In the article, a simulation model of functioning of an expert analysis system of road accidents is described. The model allows to estimate the load of experts (specialists) and the system on the whole. The model is presented as an enlarged block diagram with the description of all incoming items connecting the system resources, tasks that need to be solved, and the application outflow. The model algorithm allows estimating the state of the expert analysis system of the road accident mechanism in changeable conditions (when the number of service channels or the number and nomenclature of incoming applications are changed). The model use allows making reasonable management decisions aimed to improve the system functioning.

1. Introduction
Automobile transport has a row of advantages when compared to other types of transport which is the reason of its rapid development and wide application [1]. But it also has significant disadvantages, one of which is a relatively high accident rate. To decrease the number of road accidents, it is necessary to carry out a high-quality and comprehensive investigation that will allow to define the reasons of their occurrence and the guilty party.

To determine the reasons of an accident occurrence and the guilty party, an auto technical expertise is carried out with the help of highly qualified personnel, or experts, who have a certain level of knowledge in car operation, criminalistics, and other spheres. They can estimate the degree of involvement in the incident and the damage caused to both the individual and society as a whole [2].

In the meantime, it takes long to process applications for examination because of the high accident rate and the lack of staff. That is regularly criticized by the investigative body, State road safety inspection, Prosecutor's office and court. [3]. The carried out analysis shows that the normative documents contain no scientifically grounded system of quality indicators of expert organization activity. There is only an indicator nomenclature used to estimate the activity in comparison to the previous periods. In this connection, it is necessary to note the research relevance aimed to determine the regularities of the expert system functioning and to develop measures for its improvement.

2. Research method
Auto expertise is massive due to the accident regularity. Applications for expertise are incoming in random time intervals, that is why the expert system can be represented as a queueing system, where experts are request flow service channels [4]. As in any queueing system, there is an incoming request flow that turns into a queue over time, and the queue slows down the processing time of each separate application. That is why the task of decreasing the time of carrying out an expertise of one request is...
relevant in conditions when an incoming flow is constantly changing due to various factors (figure 1). The budget of an expert organization should be considered as a limitation.

To estimate the processing time of an application for expertise appointed by one of the authorities (court, State road safety inspection, Prosecutor's office or inquiry), it is necessary to determine the outcome flow. That flow depends on the number of service channels (experts) and intensity of application processing.

The number of channels is formed on the basis of the incoming flow, while the processing intensity depends on each channel capacity and qualification of each service channel (expert). The qualification of each service channel is the level of preparation of each separate service channel. It includes the expert’s experience estimated by the seniority, rank, and position in the system.

The incoming flow is determined by the number of accidents that occurred in the area of the system responsibility. The accident number depends on the number of cars in the considered region, movement conditions, and operational rate. The number of cars depends directly on the number of citizens of the territory and motorization level.

Under the current legislation, expertise (research) production is possible both in cases of administrative and criminal offenses. The test materials can be used to carry out a research in a form of a certificate from an expert (specialist). A research is not assigned according to specific criteria, but at a request or need of the body that decided that it is necessary (figure 2).

![Diagram of Application Processing Time](image)

**Figure 1.** Forming of an application service time.

This approach does not track the processes of receipt, distribution, and execution of applications. It is therefore not clear what should be changed in the process to improve the functioning efficiency of the expert service system. To eliminate this drawback, an algorithm of the expert analysis system
functioning of the road accident mechanism is developed, which includes the blocks presented in figure 3.

Figure 2. The system structure of application appointment for expertise.

Figure 3. The algorithm of the expert analysis system functioning of road accidents.
The model work starts with the initial data input: \( N_{\text{Exp}} \) – number of service channels; \( K_N \) – coefficient of application receipt irregularity; \( N_P \) – time corresponding to the maximum intensity of applications receipt; \( K_V \) – variation coefficient of the number of incoming applications per time unit; \( N_{\text{Del}} \) – average number of applications incoming during a year; \( Z_{\text{Exp}} \) – workload of an expert at the beginning of a year.

Each channel represents an expert (a staff member of an expert service) who has certain skills due to their experience, age and mastery in the implementation of applications (expertise). Channel bandwidth varies. Because of various reasons, all expertise cases can not be complete by the end of the year, that is why a part of applications from the previous period (year) stay incomplete.

Based on the data input, the model generates an incoming application flow for a day for each type of the study. Applications come into the service channel, provided that it is free, and if it is not, the application is queued for service. After the request has taken its place in the service channel, the execution time of each received request is generated. If the application is executed, it enters the case output flow for each type of the research separately. If it is not, the application stays in the system.

The output data are the average time of an application stay in the system, the average load of a service channel, the average system load, the average time of an application stay in the queue, and the average application execution time in the system. These indicators are calculated in general and for each type of the research separately. Absolute and relative bandwidth is also calculated.

3. Results

The developed model allows calculating the functioning expenses and optimizing the expert analysis system of road accident mechanism.

A number of regularities are obtained using the software product created on the basis of this algorithm. One of them is presented in figure 4.

![Figure 4](image-url)

**Figure 4.** The dependence of applications in queue number on service channels number.

The results obtained with the use of the model were compared to the actual performance indicators of the considered system. The adequacy of the simulation model was evaluated by Fisher's criterion. The calculations showed that the dispersion ratio exceeds the table value of the Fisher test at 0.95 probability. The average approximation error does not exceed 13 %. That indicates the adequacy of the developed model.

4. Inference

The model algorithm allows to assess the state of the expert analysis system of the road accident mechanism in changing conditions (when the number of service channels or the number and nomenclature of incoming applications are changed). The use of the model allows making reasonable management decisions aimed to improve the system functioning.
5. References

[1] Zakharov N S and Boyrkina E F 2011 Regularities in the formation of the number of cars on the city's road network Tyumen. TSOGU 161 p

