Development of a Model for Monitoring and Analysis of Road Traffic Using an Algorithm for Neural Networks

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Abstract

An accident in road transport causes enormous material and moral damage both to society as a whole and to individual citizens. Ensuring road safety (ERS) is an integral part of the national tasks of ensuring personal security, solving demographic, social and economic problems, as well as improving the quality of life and promoting the development of regions.

Development of a model for representing the dependence and influence of the identified factors and road parameters on the potential number of traffic violations.

The results of this study can be used both by the traffic police in the process of developing measures to reduce accidents in road sections, and by specialized private organizations to decide on the installation of a photo-video fixation complex by analyzing its potential effectiveness in a certain section of the road.

Keywords: accident, traffic police, measures, promoting, analyzing.

INTRODUCTION

An accident in road transport causes enormous material and moral damage both to society as a whole and to individual citizens. From year to year in the Jordan more than 500 people die and get injured as a result of traffic accidents. Ensuring road safety (ERS) is an integral part of the national tasks of ensuring personal security, solving demographic, social and economic problems, as well as improving the quality of life and promoting the development of regions [1].

RELEVANCE OF THE SELECTED TOPIC AND THE SIGNIFICANCE OF THIS SCIENTIFIC RESEARCH

Relevance of the selected topic and the significance of this scientific research is confirmed by the content of these regulatory documents. In particular, among the tasks approved in the passport of the National Project "Safe and high-quality roads" contains the following items:

"Development of a methodology for redistributing the locations of cameras for photo-video recording of violations of traffic rules" with a deadline of 10/01/19, as well as a sequential annual (until 2024) increase in the number of stationary cameras for photo-video recording on roads of various values up to 211% from the base amount.

THE PURPOSE OF THIS RESEARCH WORK

The purpose of this research work is to assess the impact of various features of the road on the number of violations and to search for criteria for determining the places with the greatest number of violations and highlighting these criteria, taking into account the influence factors on the number of violations.

SCIENTIFIC NOVELTY

As part of this work, a study was conducted of the influence of various factors on the number of administrative offenses in the field of traffic. The statistics of offenses and traffic accidents in the Russian Federation and the Penza region were analyzed on the basis of [2] and [3]. In accordance with this and the diagram from [4], the most significant factors were identified:. As part of this work, a study was conducted of the influence of various factors on the number of administrative offenses in the field of traffic. The statistics of offenses and traffic accidents in the Russian Federation and the Penza region were analyzed on the basis of [2] and [3]. In accordance with this and the diagram from [4], the most significant factors were identified:

- traffic intensity;
- characteristics of the visibility of the road (slopes, turns);
- condition of the road surface;
- marking availability;
- width and number of stripes;
- additional speed limits on this section;
- weather;
- time of day and seasonality;
- remoteness from the settlement;
- destination of the road (federal / local)
- the presence of a dividing strip.

To visualize the phenomenon under study, a model was developed (Figure 1), which is a directed graph G = (V, E),

where V is a finite set of vertices: N, F1, F2, F3, F4, F5, F6, F7, F8, F9, F10, F11, F12 where the vertex N is the number of violations on the site for a period of time, and the vertices F1-F12 correspond to previously selected factors.
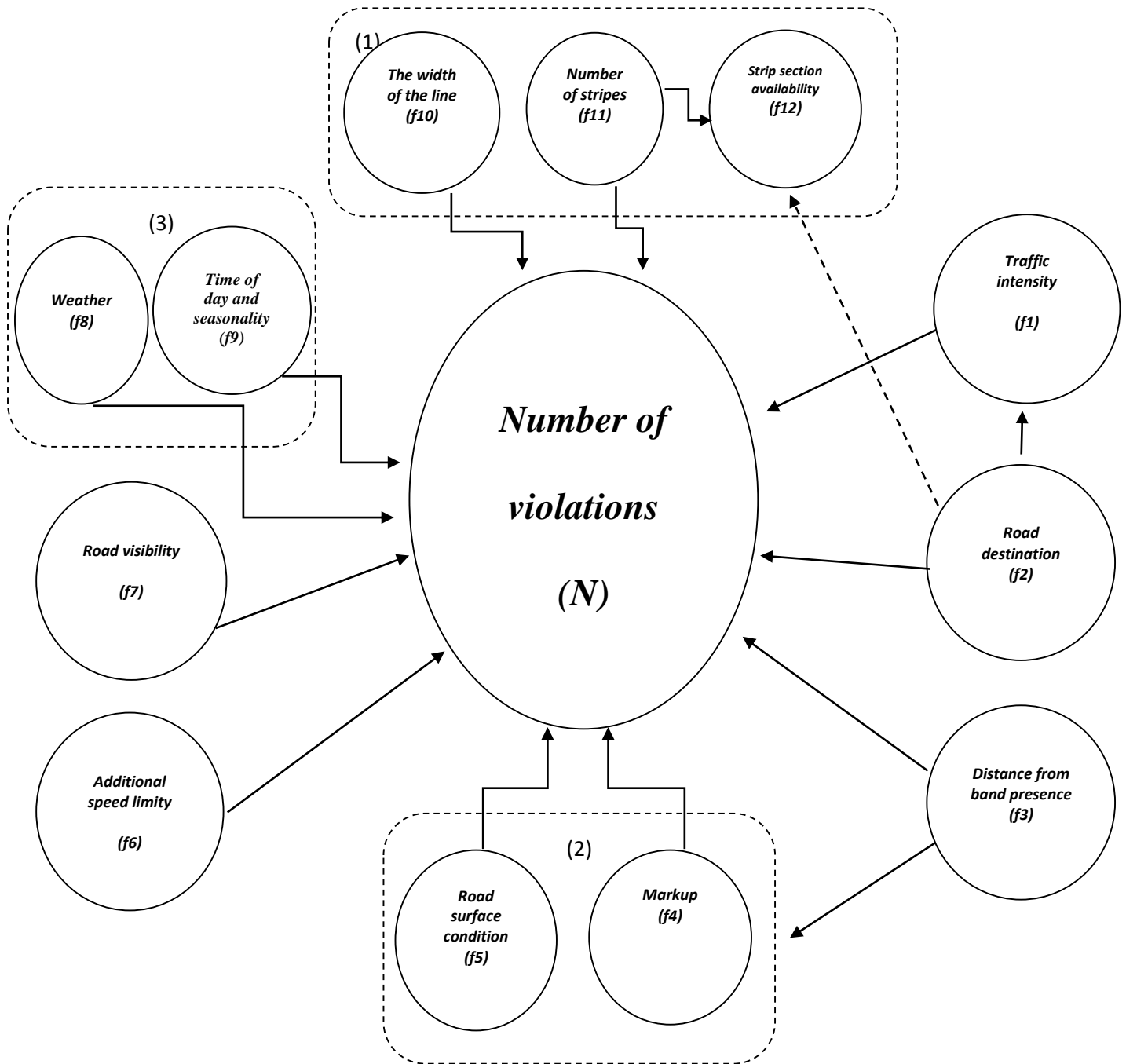

Figure 1. A graph model of the studied dependence

The arcs in the graph display the relationship of the influence of factors F1-F8 on the number of violations.

Dotted rectangles on the model highlight groups of factors similar in nature. The factors of the first group can be characterized as the geometric parameters of the road, set at the stage of designing the road section or in the process of its

subsequent repair or expansion. The second group of factors can be arbitrarily combined by the concept of "pavement characteristics", which can change over time due to external influences. We call the group of factors of the third group "weather-time". These are factors of random external influences that are in no way dependent on the person.

Dotted arcs indicate the possible effects of factors on each other, both on individual parameters and on selected groups as a whole.

We will consider the problem of choosing the final input parameters of the model from the point of view of solving the problem of determining the potentially effective location of the complex of automatic photo-video recording of violations. Then, at this stage, we can say about the inappropriateness of taking into account the factors of the weather-time group. This is due to the fact that the fixation systems work constantly, and do not turn off depending on the time of day or weather conditions, and the weather phenomena themselves are more probabilistic in nature and cannot be specified as an input parameter for forecasting. Also, within the framework of this work, the factors "Remoteness from the settlement" and "Additional speed limits" were also decided to be excluded from the final set and left for consideration as part of further additional research and improvements to expand and improve the model of this subject area.

Then, more than 2 million data from a number of photo-video recording complexes in the Penza region were analyzed and samples were prepared based on these data.

As components of the final model, in the framework of the current work, factors from the model in Figure 1 were selected, with the exception of the above. Their empirical estimates were mapped and assigned numerical coefficients.

Correlation coefficients were obtained according to the model, which in general terms reflect the initial assumption about the significance of the selected parameters. Therefore, it was decided to supplement them with the final model by using graph arcs as weighting factors. The resulting model is presented in Figure 2.
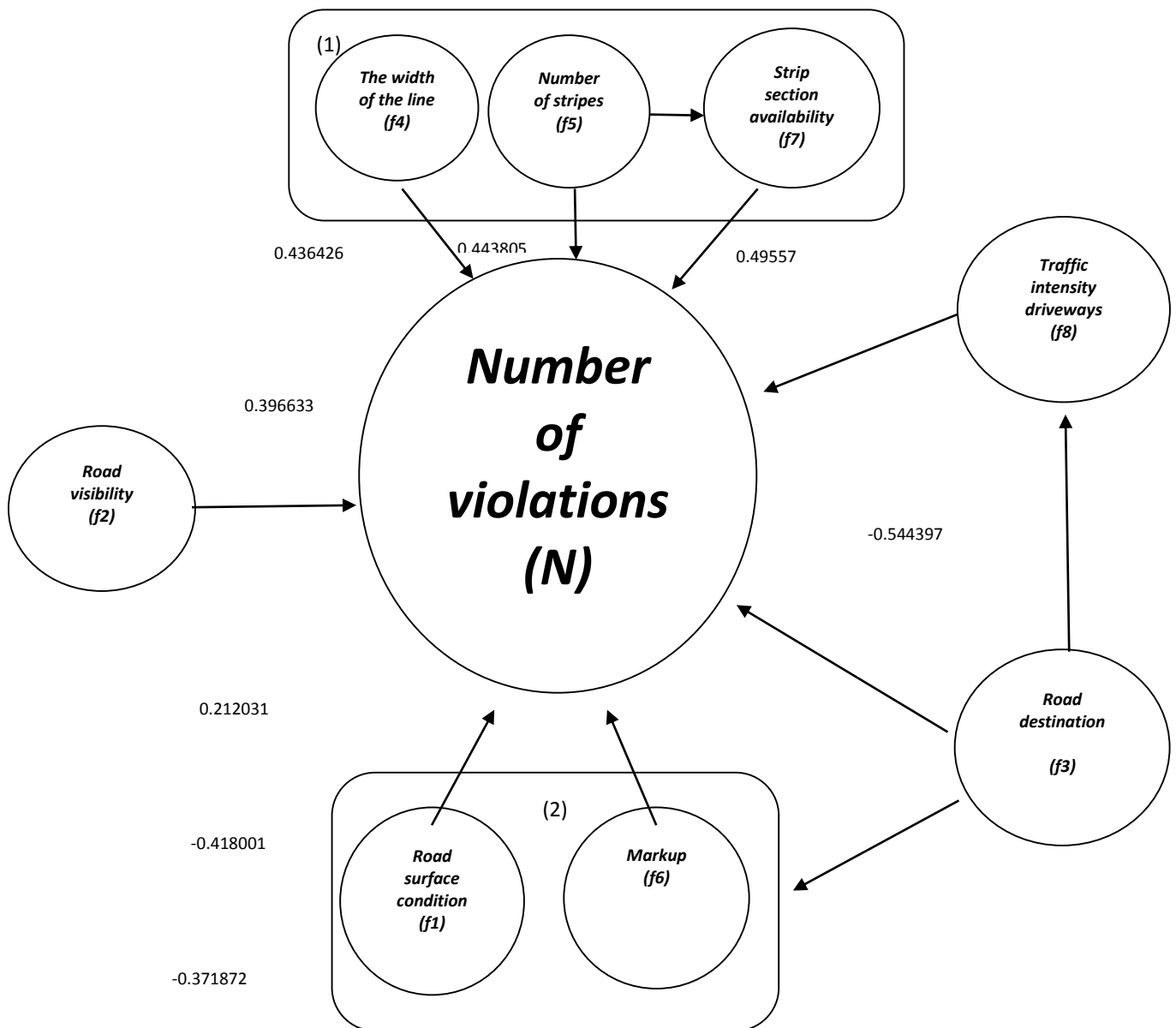

Figure 2. The resulting model

In order to get practical application of the model and based on new sets of initial data on the road to get a forecast about the potential accident of the site and the possible number of violations, several neural networks of various architectures were trained on the set of selected data in the STATISTICA Neural Networks software package and the most optimal one was displayed by dimension and performance.

Based on the analysis of the sensitivity of the NS, we can conclude that the greatest influence on the number of violations for this network is influenced by factors: the number of passes on the site (flow rate), the condition of the roadway, as well as the geometric parameters of the road (number, width of lanes and availability separation of oncoming and passing traffic lanes), which coincides with the preliminary assumption based on the analysis of data from photo-video fixation complexes.

This trained neural network is of interest from the point of view of its practical application, so with its help it is possible to predict the possible the number of violations on the site by entering the necessary parameters of the road and data on the number of driveways, and therefore, draw preliminary conclusions about the potential effectiveness of the complex of photo-video recording on this section of the road.

The results of the network in predicting the number of violations according to user input turned out to be as follows:

"Worse side" of the training value of the condition of the roadway, the expected change in the final possible number of violations downward is observed.

The resulting network can also be saved in a convenient format for future use on other data sets, for example, embedded as a module in the workstation software of a specialized employee.

The run of the test sample gave the expected correct results, therefore, the network was trained qualitatively.

RESULTS

The results of this study can be used both by the traffic police in the process of developing measures to reduce accidents in road sections, and by specialized private organizations to decide on the installation of a photo-video fixation complex by analyzing its potential effectiveness in a certain section of the road.

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