BABEȘ-BOLYAI UNIVERSITY
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PHD THESIS

GIS ANALYSIS OF ROAD ACCIDENTS IN ROMANIA 2010-2019

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Summary:

In latest decades, road accidents have been and continue to be a major global problem with huge effects on society. Along with the United States and Canada, the countries of the European Union have the lowest mortality rate from road accidents, the average for 2018 being about 49 deaths per 1 million inhabitants. However, in 2018, 25,047 people lost their lives on the roads of the European Union and over 1.3 million were seriously injured.

In Romania, road accidents are a real problem of society, with a special impact on public health, with approximately 2,000 deaths annually, which has made Romania have the highest mortality rate in the European Union in recent years. Thus, in 2018, there were 96 deaths from road accidents per 1 million inhabitants, the value being maintained in 2019. Every day 5 people die in road accidents in Romania and another 22 are seriously injured, the situation being even more dramatic due to the fact that the most affected social group is represented by young people aged between 18 and 26 years.

The main purpose of this paper is to contribute effectively to the development of solutions for preventing and combating traffic accidents, by statistical-spatial interpretation of existing data and information on this phenomenon, as well as by exposing the analysis capabilities of GIS technology in this domain.

CHAPTER I is an introductory chapter in which general information is presented on the impact of road accidents worldwide, but also the purpose and objectives of research. Starting from the purpose of the paper, the basic questions of this research were stated. "Where do road accidents occur regularly?", "When do road accidents occur?", "Why do road accidents occur?", “Who causes road accidents?” are the questions that govern the entire study and also the questions whose answers generate the main objectives of the paper.

CHAPTER II presents a detailed synthesis of the literature in which the role of mobility and road transport in the ergonomics of road accidents is highlighted, together with the role of GIS in the analysis of these events.

Chapter III describes the database and the main methods used. The database is a complex one and represents the central core of this thesis, as it’s formed by several categories of data, the most important being obviously, the road accident records for the period 2010-2019. Data on driving licenses, Romania's car fleet, demographic and economic data, data on the public road network and traffic volumes were also used.

In this paper there were used both classical methods of quantitative and qualitative statistical analysis, but also modern methods supported by GIS processing software. Thus, starting from the purpose of this paper, different statistical indicators were calculated and interpreted, that express the effect of road accidents on the Romanian population and implicitly on public health. The method of mapping these indicators was also used, not only to easily interpret the results, but also to highlight potential regional trends.

Classical methods for establishing correlation, such as regressions or correlation coefficients, were used to explain the statistical relationship between road accidents and different parameters / factors. In addition, for complex spatial analyzes, methods applied using GIS technology were used, such as the Kernel density estimation method, the SANET method (for analyzing events across a network), or the emerging hotspot method (spatio-temporal)

CHAPTER IV is dedicated to the results obtained in this thesis. A first result consisted in establishing the spatio-temporal characteristics of road accidents. In this sense, the evolution of accidents and their consequences in the period 2010-2019 was analyzed, noting that although Romania registered a decrease in the number of road events, they remained at an alarming level, placing our country on the first place in the top of European states in terms of the number of deaths in traffic accidents, reported per 1 million inhabitants. There was also a distribution of accidents by hours, days, months, concluding that most accidents occur in August, on Fridays, especially between 16:00-19:00. Also in the analysis of the spatio-temporal characteristics of road accidents there were investigated the causes, as well as a series of statistical indicators of road accident severity: Accident Rate (RA), Injury Rate (RR), Fatality Rate (RF), Hazard Rate (RH). It turned out that the main specific cause of accidents is the non-adaptation of speed to road conditions, with counties such as Constanta, Prahova, Brasov, Cluj, Iasi, Suceava, Timis and Bucharest recording the highest values of RA, RR, RF, and the counties of Satu Mare and Călărași having the highest value of RH.

The distribution of accidents by the main categories of roads highlighted first of all the fact that 82% of them occurred inside the localities, on the road networks, followed by the national roads, at the opposite pole being the highways. Although only 26% of the total number of accidents occurred on national roads, most deaths (52%) were registered here.

Another notable result was the determination of hotspots and blackspots at national and municipal level (Bucharest case study). Prior to this analysis, there were established statistical relationships between road incidents and various parameters such as fleet, number of driving licenses or traffic volume. Thus, with the help of simple linear regression and the Pearson

correlation coefficient, it turned out that there is a close statistical link between the indicators presented and road accidents, the values being directly proportional.

The identification of hotspots and blackspots is a key element in improving road safety policies. Often in literature, the two terms are used in the same sense, respectively by area with a high frequency of road accidents. In the present paper this definition is kept only for the hotspot, while blackspots are defined as an area with a high frequency of fatal road accidents. In other words, all types of road accidents were used in the hotspot identification analysis, regardless of their severity, while in the case of blackspots, only fatal accidents were used.

This paper focused on determining hotspots and blackspots by using the best known method of identifying them, namely Kernel density estimation, in two forms, two-dimensional Kernel density estimation (EDKB) and network kernel density estimation (EDKR). It has been shown that, in order to obtain results with the highest possible credibility, the two methods must be used depending on the area of interest. Thus, when we refer to a larger area (for example the entire national road network) the EDKB method is the efficient one, and when we refer to a street network of a city / municipality, it is advisable to use the EDKR method. Although hotspots and blackspots at national level (all categories of accidents), hotspots of accidents on national roads, as well as hotspots and road accidents in Bucharest have been determined in this paper, the methodology for determining them can be extrapolated to any area, smaller or larger depending on the interest (county, commune, city).

Broadly speaking, the results obtained by applying the EDKB method to all accidents at national level, indicate that hotspots are molded in the main localities and their surroundings. Consequently, by far, the largest hotspot of road accidents in Romania overlaps on the area of the Bucharest-Ilfov region. If the same method is applied, but this time using only the accidents that took place on national roads, it can be stated that the most dangerous road sectors are found on the main national roads (DN1, DN2, DN3, DN4, DN5, DN6 , DN7), in the vicinity of entering / leaving the capital, but also on other national road segments such as the one on DN2 between Focşani municipality and Râmnicu Sărat municipality or the one on DN1 between Gilău and Cluj-Napoca localities.

As it was observed in the case of Bucharest, the EDKR method has the ability to classify the road network according to the degree of danger, respectively according to the number of accidents recorded in each segment. Although no other cities / municipalities have been treated in this paper, the EDKR method can be used without problems to determine the dangerous segments of the road network of any locality, smaller or larger, provided there is a spatial database of road accidents.

A last notable result of this paper is the explanation of the social substratum of road accidents and the exposure of their socio-economic cost. In this sense, the pyramids of the social categories prone to road accidents (of people guilty of accidents) were built, as well as those prone to being victims of traffic accidents (black pyramids). The result of this analysis indicates that the most vulnerable social category in accidents is young people aged 18-23. Both the pyramids of social groups vulnerable to road accidents and the black pyramids provide important information for road safety decision-makers regarding the structuring of future measures on different categories of target audiences.

Road accident analysis is the basis for designing road safety policies. All road safety policies should have a short, medium and long term strategy, a strategy that should be developed both based on the results of the analysis of road accidents and on tangential factors such as road infrastructure, education, level of emergency medical services and post-accident treatment.