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THE ROLE OF ACCIDENT ANALYSIS IN ROAD SAFETY MANAGEMENT: CASE STUDY NEAMT COUNTY

Ciprian-Sorin VLAD, Iulia-Ioana MIRCEA, Eugen ROSCA, Larisa IVASCU, Ben-Oni ARDELEAN

Abstract: *The growing number of road accidents in Romania, combined with European pressure for a 25% reduction in road deaths by 2025 and a 50% reduction by 2030, underlines the importance of rigorous road safety management. Understanding the factors identified at local, regional and national level, as well as mitigating the specifics of accidents, is imperative for planning an appropriate strategy to control and reduce fatalities. This study aims to analyze the risk factors of road accidents in Neamt County, Romania, using statistical data obtained from the Romanian Police by applying the Haddon Matrix analysis framework. The present research analyzed 4444 accidents recorded in the period 2015-2020 in Neamt county, which were correlated with factors attributed to human factors, such as alcohol consumption, disregard of safety rules, mobile phone use, inexperience of drivers, and external factors, such as lack of road markings, inadequate road signage and lighting, meteorological aspects.*
Key words: *road safety management, safety performance indicators, management, sustainability, traffic accidents, decision-making, accident analysis.*

1. INTRODUCTION

The Annual Report published by the General Inspectorate of the Romanian Police on the Road Safety Bulletin shows there are 1.35 million people killed every year in road accidents [13]. In recent decades, the European Union has seen continuous and considerable improvements in road safety, which has led to the establishment of the strategic framework for the implementation of Vision Zero, i.e. zero road deaths by 2050[12].

The Romanian government has committed to this objective under its National Recovery and Resilience Plan, creating the National Road Safety Strategy for 2022-2030. In connection with this objective, Romania aims for a 50% reduction in the number of deaths and seriously injured people in road accidents by 2030 compared to 2019 [14].

Based on the analysis of the outdated, insufficient and substandard road infrastructure, the risky behavior demonstrated by the users of this infrastructure, the outdated vehicle fleet and the delay in post-accident interventions due to the inadequate road network, the poor management of road safety is the most important factor behind Romania's unfavorable results in terms of traffic accidents.

The objective of continuous improvement of road safety implies, according to the parameters identified by the central administration, an efficient management approach to road safety, focused on the identification and understanding of the particularities, correlations and interdependencies of the constituent elements of the road system, as well as the promotion of attitudinal benchmarks and references for safe, preventive and responsible behavior of participants in traffic [14].

The main objective of the research is to develop a conceptual model aiming to improve road safety management through the analysis of 4444 accidents in Neamt county (Romania), over a period of six years. Following the application of the Haddon matrix, the research led to the identification of prevention strategies required for the reduction of accidents.

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2. LITERATURE REVIEW

Road safety management is defined as a sector of government activity, optimized to reduce accidents occurring on the road and the number of fatalities resulting in these accidents. Road safety management performance indicators are met based on the results of measures and programs implemented towards the prevention and reduction of accidents, injuries and fatalities [4].

Models of good practice in this type of management systems are considered crucial in literature, based on the applicability of road safety outcomes for effective injury reduction. To replicate these good practice examples, several prerequisites, a structure and an institutional framework for road safety are needed to support the essential processes and policy development tasks [3].

Several studies [16, 2] rank the evaluation of safety measures as the lowest among the components of road safety management systems, providing examples of good practice from only a few European countries that have integrated this evaluation as a routine activity and have a dedicated budget for it. In order to improve management, the authors of the studies recommend predictive tools, known as crash prediction models, which can be used to analyze potential safety problems and estimate the effects to remedy them.

Ian Johnston [6], analyzing the nations with the lowest rates of road fatalities, noted an administrative tendency to identify problems, to develop improvement strategies based on data collection and an institutional responsibility to implement the necessary countermeasures.

Another approach to road safety management is proposed by Jamroz [5] through the risk management method. The author identifies this tool, considering the complexity of the road safety management process, and designates as an imperative objective of road safety management the application of specific procedures that allows us to identify road risks in a systematic way, assess the risks for traffic participants and eliminates or mitigates them in relation to injuries, deaths and related financial burdens.

An effective road safety management involves a strategy of sharing responsibility, both between road users and among road designers and operators. Driver training and testing institutions, prevention campaigns conducted by the private sector or by authorities are also contributing factors that need to be monitored. Academic studies [17-21] demonstrate that socio-economic cost issues do not have a major role in the developing road safety strategies, so poor management is not justified in the context of lack of funds. Data and statistics on road safety are vital and highly relevant for the management of road safety. In terms of collecting and thoroughly researching the information underlying road accidents, international reporting of results can lead to statistical comparisons that can generate examples of best practice to mitigate identified phenomena [10].

Among the simplest methods of road safety management, the literature identifies the guarantee of quality road infrastructure conditions, an effective legislative and sanctioning framework, and measures to continuously educate road users [1, 11, 15].

At the same time, horizontal road markings are considered essential and are recognized as one of the most cost-effective means of increasing road safety. Their quality and durability play a role in the safety of all traffic participants, pedestrians, cyclists and drivers [9]. Evaluation of road infrastructure to ensure appropriate markings, systematic verification of markings through a road safety audit, road safety inspection for maintenance are fundamental preliminary steps in providing the road safety management the ability to ensure that safety parameters are prioritized and that solutions to reduce accident rates are identified [7].

The development of road safety management has focused, over the years, in four directions: on the driver and his intervention, considering that the most relevant factor in road accidents is the human factor, on the intervention at the level of determinants, on achieving results through best practice examples and on measures to protect the infrastructure and the road users (post-accident care, risk management, speed management etc.) [8, 19-22].

3. RESEARCH METHODOLOGY

This research methodology consists in processing primary data obtained from the Romanian Police, aiming to determine the factors involved in causing accidents in Neamt County (Romania), in the period 2015-2020. Thus, we requested the situation of accidents over a period of 6 consecutive years and the reporting of determining factors, such as: time of occurrence of the accident, road category, road markings, light conditions, road grip, number and type of injuries of persons involved in the accident. The resulting sample includes 4444 correlations, for the processing of which we used the Statistical Package for the Social Sciences to establish a descriptive analysis, and we applied Haddon's matrix as a qualitative analytical research tool to obtain the conceptual model necessary to improve road safety management.

4. DISCUSSION AND RESULTS

4.1. Analysis of the statistical data. Interpretations and debates

Like other previous studies, the present research highlights the importance of horizontal road markings, as nearly half of the accidents analyzed were caused by their absence. The importance of strengthening the sanctioning legislation is reconfirmed in the present study considering the accident contributory factors attributed to the road administrator. However, although in Romania the legislation is completely restrictive in relation to the consumption of alcohol behind the wheel, compared to other European examples of good practice, the present research identifies a significant percentage of accidents caused by the consumption of substances when driving, which demonstrates more the importance of education and awareness campaigns among the Romanian population.

Statistics on accidents occurred in the period 2015-2020 in Neamt county (Romania) were officially requested from the Romanian Police and were correlated with the following parameters: category of road on which the accident occurred, existence of road markings, visibility conditions, driving impaired by alcohol, driver's age group in relation to the category of victims, age of driving license, road grip at the time of the accident and others.

In relation to the age of the driver responsible, according to Table 1, most accidents were caused by people in the 25-44 age group, leading to 1.469 accidents, which resulted in 104 fatalities and 1.874 injuries.

Analyzing the statistical data related to the age of the driving license, according to Table 2, accidents in Neamt county (Romania) were mainly caused by novice drivers, recording 1416 accidents resulting in 96 fatalities and 1705 injuries, compared to 609 accidents with 41 fatalities and 864 injuries where the driver had a driving license of 6-10 years and 489 accidents caused by people with a driving license exceeding 11 years, resulting in 31 fatalities and 634 injuries.

Following this descriptive analysis, we applied a bivariate analysis of accidents according to road category and the existence of road markings (Table 3).

Out of a total of 4.444 accidents registered in Neamt county (Romania)between 2015 and 2020, 1.555 accidents occurred on county and rural roads and more than 50% of them occurred in the absence of road markings. Analyzing the visibility conditions in relation to the existence of road markings, we applied a descriptive analysis, according to Table 5, which shows that out of a total of 4.444 accidents in the period 2015-2020 in Neamt County (Romania), 1.196 occurred in conditions of non-existent markings. At the same time, more than half of the accidents occurred in normal visibility conditions and only 428 accidents may have had external causes attributable to the road administrator (lack or failure of lighting systems).

Table 1

Age group of the responsible driver.

2015-2020	Accidents	Deceased	Injured
18-24 years old	615	57	695
25-44 years old	1469	104	1874
45-64 years old	1094	56	1350
>65 years old	420	32	499

Table 2

Validity of the driver's driving license.

Validity of the driving license	Accidents	Deceased	Injured
0-5 years old	1416	96	1705
6-10 years old	609	41	864
>11 years old	489	31	634

Table 3

Relationship analysis of the classification of roads and the existence of road markings.

Road classification * road marks Crosstabulation			
	Road marks		Total
	No road marks	Road marks	
National road	79	1446	1525
Local road	230	1134	1364
County road	380	400	780
Rural road	507	268	775
Total	1196	3248	4444

Table 4

Relationship analysis of the classification of roads and the existence of road marks depending on the year.

Year	Road marks	Road classification	Total	%
2015	No road marks	National road	15500	2.2
		Local road	35500	5.2
		County road	93500	13.6
		Rural road	82500	12
	Road marks	National road	218500	31.7
		Local road	164500	23.9
		County road	56500	8.2
		Rural road	22500	3.3
2016	No road marks	National road	14500	1.8
		Local road	24500	3.1
		County road	73500	9.3
		Rural road	96500	12.2
	Road marks	National road	256500	32.5
		Local road	229500	29.1
		County road	55500	7
		Rural road	38500	4.9
2017	No road marks	National road	18500	2.3
		Local road	46500	5.9
		County road	65500	8.3
		Rural road	94500	12
	Road marks	National road	251500	31.8
		Local road	209500	26.5
		County road	57500	7.3
		Rural road	46500	5.9
2018	No road marks	National road	13500	1.7
		Local road	40500	5.1
		County road	56500	7.1
		Rural road	90500	11.4
	Road marks	National road	257500	32.5
		Local road	209500	26.4
		County road	77500	9.8
		Rural road	47500	6
2019	No road marks	National road	14500	1.9
		Local road	54500	7.1
		County road	39500	5.1
		Rural road	79500	10.3
	Road marks	National road	257500	33.4
		Local road	176500	22.9
		County road	79500	10.3
		Rural road	68500	8.9
2020	No road marks	National road	5500	0.9
		Local road	31500	4.9
		County road	54500	8.6
		Rural road	66500	10.4
	Road marks	National road	207500	32.6
		Local road	147500	23.2
		County road	76500	12
		Rural road	47500	7.5

Table 5

The relationship between visibility and the existence of road marks.

Visibility	No road marks	Road marks	Total
No street lightning	107	226	333
Daylight	763	1958	2721
Cloudy	107	417	524
At dawn	11	41	52
Working street lightning	149	497	646
Non-functional street lightning	40	55	95
Blinding sun	19	54	73
Total	1196	3248	4444

Given the fact that more than half of the accidents occurred in perfect visibility conditions, we correlated the number of accidents with the detection of alcohol or drugs on the driver, according to Table 6, resulting in the fact that in Neamt County (Romania), about 10% of accidents in the period 2015-2020 had a concurrent or main cause the consumption of prohibited substances.

Regarding the other accident determinants, according to Table 7 we can see that a significant number of accidents, more than 30% are caused by the failure to give priority to traffic participants, 12.74% of accidents were caused by cyclists, 1.68% of accidents were caused by falling asleep at the wheel and 4.17% were due to the use of the phone while driving. Maneuvering without proper insurance accounted for about 7% of the causes of accidents, improper distance between vehicles caused more than 12% of accidents and erratic speed was the cause of 18.27% of road accidents.

4.2. Analysis of the data by using Haddon's Matrix. Interpretations and debates

Haddon's Matrix is a brainstorming tool that combines the epidemiology triangle (host, agent, environment) and levels of prevention. This combination gives researchers a way to look at planning for injury interventions and prevention strategies by phases in time of the event. From the practical perspective, Haddon's Matrix is considered a systematic approach for risk mitigation and has been implemented successfully in different fields [23, 24].

Road accidents cause many casualties. Road accidents become a danger for less traveled areas and where the infrastructure is less well maintained. Thus, a significant number of road accidents take place in these areas and an analysis of the main causes (with their hierarchy) that led to such events is required. With the increase in population and motorized vehicles, accident scenarios are becoming more complex. Most of the study's data are collected from the annual road accident report provided by the Romanian Ministry of Transport and the Romanian Neamt Police. The collected data are classified into different sets of sub-parameters, thus managing to understand the general impact on the population and processes. As a result, the major influencing factors (human factors, vehicle factors, environmental factors related to the infrastructure and social factors) were identified and they were characterized (sub-factors) in different phases of the road events. These major factors are integrated during the study by applying the Haddon matrix. Thus, because of the applied research, the major determinants of influence for the occurrence of road accidents in Neamt county (Romania) were highlighted. The analysis provides the most affected factors in the pre-accident, during-accident and post-accident scenario, with preventive strategies at each stage.

Following the analysis of statistical data obtained from the Romanian Police, we applied the Haddon matrix, as shown in Table 8, to identify a road safety management model oriented towards appropriate solutions to reduce the number of road fatalities in Neamt County (Romania).

Table 6

Accidents due to the influence of prohibited substances.

Accidents 2015-2020	Alcoholic or narcotics	%
4444	401	9.02

Table 7

Cause of accidents between 2015-2020 in Neamț county (Romania).

Cause	%
Cyclist misconduct	12.74
Falling asleep	1.68
Phone usage	4.17
Driving without a license	2.04
Erratic driving	4.24
Failure to give priority to pedestrians	13.90
Failure to give priority to other vehicles	17.28
Non-assurance when changing direction	5.83
Non-insurance of band change	1.20

Table 8

Haddon matrix analysis of road accidents in Neamt county (Romania) and potential prevention strategies developed for accident victims in this study.

Phasis	Influencing factors	
	HUMAN FACTORS	VEHICLE FACTORS
PRECRASH	• Driver's age; • Driving under influence; • Driver's license age; • Use of mobile phones;	• Speeding vehicle; • Pedestrians or two-wheeler; • Rider's misconduct;

	• Erratic driving; • Driver attentiveness; • Inexperienced drivers;	
EVENT	• Compliance to seat belt; • Bicycle lanes; • Evacuation; • Sheltering;	• Vehicle crashworthiness; • Speed detectors; • Seatbelt sensors;
POST-CRASH	• First-aid skills; • Being able to request help;	• First aid kit; • Fire extinguisher;
PREVENTION STEPS, AS SHOWN IN THE CURRENT STUDY	• Measures to be taken to evoke the suspension of the license and seizure of the vehicle;	• Alcohol interlock devices in vehicles; • Policies encouraging public transport systems;
Phasis	**Influencing factors**	
	ENVIRONMENT FACTORS	**SOCIAL FACTORS**
PRECRASH	• No road markings; • No street lightning; • Non-functional street lightning; • Weather conditions; • Improper speed limiters; • Lack of pedestrians' facilities;	• Rush hours; • Attitudes to drink driving and speeding; • Lack of road condition maintenance; • Lack of comprehensive safety law;
EVENT	• Lack of crash barriers; • Poorly maintained roads;	
POST-CRASH	• Rapid evacuation; • Rescue facilities; • Effective emergency response.	• Public support for trauma care and rehabilitation.
PREVENTION STEPS, AS SHOWN IN THE CURRENT STUDY	• Ensuring a safe infrastructure; • Severe sanctioning measures against the road manager for inadequate infrastructure.	• Road safety campaigns; • Increased alertness for offenders during peak hours; • Road safety education in schools; • Merging of data from all the involved stakeholders of traffic safety.

5. CONCLUSION

Road safety management is a complex process aimed at monitoring, coordinating and implementing all activities and processes related to traffic safety. This study analyses the general context of accident occurrence in Neamt County over a 6-year period, as well as the strategic limitations and perspectives for reducing the number of fatalities.

Although the academic literature highlights the human factor as being 95% to blame for accidents, there are several tools that can be used, either taking them from countries that have demonstrated their effective use or by developing new tools compatible with locally identified scenarios such as the high percentage of accidents caused using banned substances.

In the context in which Romanian legislation requires the road administrator to ensure appropriate markings and safe traffic conditions, the statistic of this study shows that, in the case of Neamt County, a significant transport segment is inadequate and causes accidents. This demonstrates the need for the central authorities to tighten regulations and develop effective public policies to ensure optimal traffic conditions.

Road safety education in schools, road safety campaigns carried out on a continuous basis, intensified controls and speed reduction means are a series of tools compatible with the prevention and reduction of road accidents in the

context of the statistics highlighted by the Romanian Police.

It is important to consider the period of time after the year 2020, given the European pressure to reach the target of reducing deaths by 25% by 2025.

At the same time, according to economic and social indicators, Neamt county is in the ranking of the poorest counties in Romania, which may lead to different road safety strategies, in the context of potential statistical discrepancies with other counties.

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Rolul analizei accidentelor în managementul siguranței rutiere: studiu de caz Județul Neamț

Abstract: Numărul crescut al accidentelor rutiere în România, precum și presiunea europeană de încadrare în reducerea cu 25% a numărului de morți cauzate de acestea până în anul 2025, respectiv 50% până în anul 2030, subliniază importanța unui management riguros în domeniul siguranței rutiere. O înțelegere a factorilor determinanți identificați la nivel local, regional cât și național, corelată cu diminuarea elementelor de specificitate, este imperativă pentru a planifica o strategie adecvată de control și de reducere a deceselor. Obiectivul studiului constă în evaluarea factorilor de risc ai accidentelor rutiere în județul Neamț, România, cu ajutorul datelor statistice obținute de la Poliția Română cărora li s-a aplicat cadrul de analiză aferent matricii Haddon. Cercetarea de față a analizat 4444 de accidente înregistrate între anii 2015-2020 în Județul Neamț ce au fost corelate cu aspecte ce țin de factorul uman, precum consumul de alcool, nerespectarea regulilor de siguranță, utilizarea telefonului mobil, lipsa experienței șoferului ș.a. și factori externi, precum lipsa marcajelor rutiere, semnalizarea și iluminarea necorespunzătoare, aspecte de ordin meteorologic etc. Rezultatele ne arată faptul că este necesară modificarea legislației din punct de vedere sancționator, dar și propagarea conceptului de siguranță rutieră la nivel educațional, prin instrumente specifice tuturor categoriilor de vârstă.

Ciprian-Sorin VLAD, PhD Student, Politehnica University of Timisoara, Faculty of Management in Production and Transportation, 14 Remus Str., Timisoara, Romania, ciprian-sorin.vlad@student.upt.ro
Iulia-Ioana MIRCEA, PhD Student, Politehnica University of Bucharest, Faculty of Transportation, 313 Splaiul Independenței, Bucharest, Romania, iulia_ioana.mircea@stud.trans.upb.ro
Eugen ROSCA, Prof. Dr. Eng, Politehnica University of Bucharest, Faculty of Transportation, 313 Splaiul Independenței, Bucharest, Romania, eugen.rosca@gmail.com
Larisa IVASCU, Prof. Dr. Eng. Habil, Politehnica University of Timisoara, Management Department, 14 Remus Str., Timisoara, Romania, larisa.ivascu@upt.ro
Ben-Oni Ardelean, Assoc. Prof., PhD., Baptist Theological Institute, Bucharest, Faculty of Baptist Theology, University of Bucharest, Bucharest, Romania, benardelean@gmail.com