MANAGING TRAFFIC SAFETY PROGRESS

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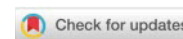
Abstract: Managing road traffic is not an easy task at all. Namely, the field of traffic management itself tends to improve traffic management systems, with the aim of increasing safety and reducing the number of traffic accidents. The aim of this paper is to identify the key factors that can improve traffic safety in the Republic of Serbia, i.e. the key factors that the traffic management system should focus on. For this reason, a survey was conducted that included 148 respondents (traffic inspectors and professors of traffic subjects). Factor analysis was applied to identify key factors. The analysis itself showed that traffic safety on the roads of the Republic of Serbia depends on the quality of infrastructure and training of traffic participants, legal regulations and their application, implementation of technical innovations in driving, as well as international cooperation between traffic inspectors.

Keywords: management, traffic, safety, traffic accidents.
Field: Management

1. INTRODUCTION

Traffic management refers to the management of various aspects of the traffic system, with the aim of ensuring efficiency, traffic safety, and traffic sustainability. The process of managing these activities is particularly complex, due to the fact that the number of cars increases from year to year. For this reason, people who specialize in these areas are constantly developing new systems to increase efficiency in traffic management (Andjelković et al., 2018).

Also, researchers in this field constantly strive to identify key areas, that is, aspects, through which the traffic management system can be improved.

Infrastructure, i.e. the condition of road networks, is extremely important for improving the efficiency and safety of traffic. (Zemlin et al., 2021; Saxena & Kumar-Yadav, 2023) For this reason, it is necessary to constantly work on the improvement of this network, in order to make driving easier and thus reduce the number of traffic accidents. Also, continuous education of traffic participants, as well as strict legal regulations can have a positive impact on reducing the number of traffic accidents. (Al-Tit et al., 2020; Molovčáková et al., 2021; Wang et al., 2019)

Certainly, modern technology has penetrated the core of all human activities, so that traffic does not remain immune. From year to year, smart systems are developed that can improve the efficiency and safety of traffic. (Pawłowicz et al., 2020; Ranka, 2020) Numerous experts in this field evaluate these systems as an opportunity to significantly reduce the number of traffic accidents in the future.

Also, the work of traffic inspectors is extremely important, in order to reduce the number of road accidents, it is necessary for inspectors from different countries to cooperate and exchange knowledge. (Bakhtari Aghdam et al, 2020)

2. METODOLOGY AND MATERIALS

Based on existing research by authors who dealt with the field of traffic safety and whose research results have already been mentioned, and with the purpose of investigating the importance of certain factors for traffic safety management, a survey was conducted in the period from October to November 2023. The very goal of the survey was to provide data, based on the answers of traffic inspectors and professors of colleges and universities in the field of traffic (who teach traffic subjects), which will enable the identification of typical factors that can increase traffic safety and reduce the number of traffic accidents. Respondents, in this particular case traffic inspectors, were offered 25 statements, which they evaluated on a Likert scale from 1 to 5, that is, I absolutely disagree to I absolutely agree.

The data were collected from the respondents electronically (e-mail), as well as by a personal visit of the inspector, after which the collected data were combined and entered into the SPSS software

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package for their processing. Data were collected by 148 respondents and all were included in further analysis. In addition to the evaluations of the statements about traffic safety, the respondents also gave answers about gender, age, and the number of years of performing tasks related to traffic and traffic safety.

After the respondents' answers were entered into the SPSS software package, a factor analysis was conducted. In addition to the arithmetic mean, standard deviations, the Bartlett test and the KMO test were used during data processing. After the key factors were determined, the Varimax method was applied, as well as regression analysis, in order to finally apply ANOVA, with the aim of showing whether the derived factors have statistical significance, similarly (Andjelković et al., 2018).

3. RESULTS AND DISCUSSION

As can be seen on the basis of table 1, out of the total number of respondents, i.e. 148 of them, the majority are men. Namely, their participation amounts to 103 respondents, or 69.6%, while the participation of women in this survey is 30.4%. When it comes to the age structure, the largest number of respondents are between 41-50 years old and 51-60 years old.

Table 1 Description of sample

Demographic characteristics	Frequency	%
Gender	148	100
Male	103	69,6
Female	45	30.4
Age	148	100
Until 30	8	5.41
31-40	22	14.86
41-50	60	40.54
51-60	42	28.38
61 and more	20	13.51
Years of experience in traffic-related jobs	148	100
Up to 10	18	12.16
11-15	69	46.62
16-20	36	24.32
21-25	14	9.46
26 and more	11	7.43

Source: Authors

The data from the table show that as many as 60 respondents are between 41-50 years old, and they make up 40.54% of the entire sample. The least respondents are under 30 years of age, and their participation in the total number of respondents is 5.41%, that is, in absolute terms, 8 respondents. When it comes to the experience of respondents in jobs related to traffic, traffic management, and traffic safety, it can be seen from Table 1 that most respondents have between 11 and 15 years of experience, that is, 46.62% of them. The least are those who have more than 26 years of experience in these jobs, that is, 7.43% of them, that is, in absolute terms, 11 respondents.

Table No. 2 shows descriptive statistics and standard deviation for all 25 statements that respondents evaluated regarding traffic safety and traffic safety management.

Table 2. Descriptive statistic

Statement	Aritmetic mean	Sandard deviation
1. Implementation of advanced solutions for monitoring and analyzing driving performance can improve traffic safety	4,14	0,699
2. Strengthening cooperation between traffic inspectors between countries can improve traffic safety	4,07	0,878
3. Pointing out traffic rules in educational radio broadcasts can increase traffic safety	4,01	0,782
4. Information sharing between traffic authorities from different countries can improve responses to security challenges	4,11	0,733
5. Organization of social marketing campaigns on traffic safety can have a positive effect on driver awareness	3,99	1,022
6. Mandatory education for pedestrians about traffic regulations is necessary	4,01	1,072
7. Scientists in Serbia must deal more with the topic of traffic safety	4,06	0,969
8. Organizing training through television shows can reduce the number of traffic accidents	3,92	1,001
9. The system of traffic signs and signaling on the roads must be improved	3,91	0,968
10. In secondary schools, more attention should be paid to traffic education	4,01	1,069
11. Texts about traffic safety in newspapers can reduce the number of traffic accidents	3,61	1,016
12. It is necessary to constantly take care of the quality of signs and signaling on the roads	3,81	0,989
13. It is necessary to improve the road infrastructure in order to reduce the number of traffic accidents	4,03	1,015
14. Continuously solving the problem of potholes on the roads can reduce the number of accidents	4,05	0,799
15. Mandatory education on traffic regulations for drivers is necessary	3,86	0,899
16. It is necessary to clearly define and control the working hours of truck drivers	4,41	0,691
17. It is necessary to punish drivers more severely for violating traffic regulations	4,39	0,771
18. It is necessary to increase the penalties for those who knowingly endanger traffic safety	4,21	0,791
19. The introduction of advanced systems in driver's vehicles can lead to a reduction in the risk of traffic accidents	4,45	0,791
20. The development and application of a system for detecting the alcoholic state of drivers can reduce the number of traffic accidents	3,96	1,116
21. The development and implementation of fatigue detection systems can reduce the number of traffic accidents	3,99	0,969
22. The introduction of smart systems in cars, which have an impact on the insurance premium paid, can have a positive effect on the reduction of traffic accidents	4,02	0,862
23. It is necessary to ensure adequate application of defined legal regulations	4,34	0,731
24. Joint trainings at the international level can improve the work of traffic inspectors and increase the level of traffic safety	4,05	0,771
25. It is necessary to improve traffic safety in the Republic of Serbia	4,11	1,061

Source: Authors

As table number 2 shows, statement 16, which refers to the control of working hours of drivers of off-road vehicles, was rated the best. The respondents rated statement number 11 the worst, which refers to raising the awareness of drivers through newspaper articles on traffic safety. In the following, a factor analysis will be carried out, in order to reduce the large number of factors and to group the statements into a certain number of factors. In order to be sure that we can apply factor analysis, the following table shows the results of the Kaiser-Masiel-Olkin and Barthelet tests.

Table 3. Results of the Kaiser-Meyer-Olkin and Bartlett test

Kaiser-Meyer-Olkin test	0.897
Bartlett test	2898.995
Df	269
Sig.	.000

Source: Authors

Based on the results from the table, that is, the conducted tests, it can be concluded that it is possible to apply factor analysis with the aim of grouping factors. After rotating all the factors, using the Kaiser's criterion, it was determined that all the statements that the respondents evaluated, that is, the factors, can be grouped into four factors. These four factors explain 67.611% of the variance, which is shown in table 4. After the most significant components were determined using factor analysis, their

rotation was performed. It was done using the Varimax method, and only those factor components with factor weights that are statistically significant (>0.05) were selected.

Table 4 Analysis of the most important components

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1.	11.629	48.980	48.980	11.629	48.980	48.980	7.411	31.441	31.441
2.	1.894	7.871	56.851	1.894	7.871	56.851	3.589	14.112	45.553
3.	1.511	6.269	63.120	1.511	6.269	63.120	2.796	11.899	57.452
4.	1.101	4.491	67.611	1.101	4.491	67.611	2.2976	10.159	67.611
5.	0.939	3.899	71.510						
6.	0.768	3.308	74.818						
7.	0.694	3.046	77.864						
8.	0.631	2.662	80.526						
9.	0.591	2.398	82.924						
10.	0.482	1.957	84.881						
11.	0.426	1.801	86.682						
12.	0.409	1.722	88.404						
13.	0.392	1.569	89.973						
14.	0.341	1.423	91.396						
15.	0.309	1.298	92.694						
16.	0.271	1.131	93.825						
17.	0.249	1.038	94.863						
18.	0.231	0.946	95.809						
19.	0.215	0.921	96.730						
20.	0.198	0.852	97.582						
21.	0.169	0.731	98.313						
22.	0.151	0.626	98.939						
23.	0.131	0.554	99.493						
24.	0.118	0.507	100.000						

Source: Authors

Table 5 shows the matrix after factor rotation. As the table itself shows, the first factor related to infrastructural and educational activities was assigned 12 statements, where the lowest factor weight is 0.581 (greater than 0.5). 4 statements were added to the second factor related to technical innovations and their application. Three statements are attached to the third factor, which refers to the necessity of improving legal regulations, while two statements are attached to the fourth factor, and it refers to international cooperation and its contribution to the improvement of traffic safety, based on the reduction of the number of road accidents. Defining these four factors creates a basis for applying regression analysis and determining whether these factors influence the dependent variable, i.e. 25 findings from table 2. The results of the applied regression analysis show that all four factors have an impact on the dependent variable and the results obtained are statistically significant. As the table itself shows, the coefficient of determination, which shows how much the variability of the dependent variables, explains the independent variable in this case is 0.481.

Table 5. Results of Varimax method

	Components			
	1	2	3	4
The system of traffic signs and signaling on the roads must be improved	0,808			
It is necessary to constantly take care of the quality of signs and signaling on the roads	0,799			
It is necessary to improve the road infrastructure in order to reduce the number of traffic accidents	0,785			
Mandatory education on traffic regulations for drivers is necessary	0,779			
Organizing training through television shows can reduce the number of traffic accidents	0,774			
Mandatory education for pedestrians about traffic regulations is necessary	0,771			
Texts about traffic safety in newspapers can reduce the number of traffic accidents	0,719			
Organization of social marketing campaigns on traffic safety can have a positive effect on driver awareness	0,711			
Pointing out traffic rules in educational radio broadcasts can increase traffic safety	0,701			
Continuously solving the problem of potholes on the roads can reduce the number of accidents	0,619			
In secondary schools, more attention should be paid to traffic education	0,602			
Scientists in Serbia must deal more with the topic of traffic safety	0,581			
The introduction of advanced systems in driver's vehicles can lead to a reduction in the risk of traffic accidents		0,839		
The development and implementation of fatigue detection systems can reduce the number of traffic accidents		0,799		
The development and application of a system for detecting the alcoholic state of drivers can reduce the number of traffic accidents		0,765		
The introduction of smart systems in cars, which have an impact on the insurance premium paid, can have a positive effect on the reduction of traffic accidents		0,597		
Implementation of advanced solutions for monitoring and analyzing driving performance can improve traffic safety				
It is necessary to punish drivers more severely for violating traffic regulations			0,841	
It is necessary to clearly define and control the working hours of truck drivers			0,799	
It is necessary to increase the penalties for those who knowingly endanger traffic safety			0,554	
It is necessary to ensure adequate application of defined legal regulations				
Strengthening cooperation between traffic inspectors between countries can improve traffic safety				0,819
Information sharing between traffic authorities from different countries can improve responses to security challenges				0,624
Joint trainings at the international level can improve the work of traffic inspectors and increase the level of traffic safety				

Source: Authors

In order to be able to accept the results of the analysis as statistically significant, an ANOVA analysis was conducted, the results of which are shown in table 7. The results of the Anova analysis show that in this particular case Sneder's F-statistic is 36.625 and is statistically significant, which confirms that the influence all four factors on the dependent variable statistically significant.

Table 6. Regression analysis

Model	The correlation coefficient (R)	Coefficient of determination (R²)	Adjusted coefficient of determination	Standard error value
1.	0.531[a]	0.279	0.263	0.874
2.	0.598[b]	0.399	0.381	0.803
3.	0.679[c]	0.412	0.401	0.699
4.	0.684[d]	0.481	0.458	0.773

Source: Authors

All the results shown in the tables clearly indicate that the previous research on the basic factors that can contribute to the improvement of the traffic safety system in the Republic of Serbia has also been confirmed, based on the research that was conducted. Namely, based on the conducted analysis, it can be clearly seen that the infrastructure and education of road users are one of the crucial factors in reducing the number of traffic accidents on the roads, as proven in their works by Zemlin et al. (2021), Saxena & Kumar-Yadav (2023), Al-Tit et al. (2020), Molovčáková et al. (2021) and Wang et al. (2019), Andjelković (2019), Andjelković et al. (2019), Andjelković et al. (2018). Also like Al-Tit et al. (2020), Molovčáková et al. (2021) and Wang et al. (2019), this paper proved that continuous education of road users is one of the key safety factors.

Table 7. ANOVA analysis

		Sum of squares	Number of degrees of freedom	Mean of square	F - statistics	Significance
1.	Regression	51.211	1	51.211	64.291	.000[a]
	Residual	135.114	146	0.787		
	Amount	186.325	147			
2.	Regression	75.981	2	37.991	62.124	.000[b]
	Residual	107.829	146	0.661		
	Amount	183.810	147			
3.	Regression	86.112	3	28.704	45.398	.000[c]
	Residual	101.981	146	0.618		
	Amount	188.093	147			
4.	Regression	89.991	4	22.498	36.625	.000[d]
	Residual	99.102	146	0.596		
	Amount	189.093	147			

Source: Authors

Also the results obtained by Pawłowicz et al. (2020)0 and Ranka (2020) were confirmed in this research. They refer to the application of modern technology with the aim of improving traffic safety. This is a topic that, among other things, will increasingly attract the attention of the scientific and professional public in the future.

International cooperation between inspectors can also contribute to the improvement of traffic safety, which is proven in this work. In this way, the results obtained by Bakhtari Aghdam et al. were confirmed. (2020).

4. CONCLUSION

The traffic safety of the participants largely depends on whether the traffic is managed in an adequate manner. Namely, traffic management is not at all a simple task and must be adapted to the conditions of the country in which it is managed. This paper identified the most significant factors that have an impact on the growth of traffic safety and the reduction of the number of traffic accidents in the Republic of Serbia. Namely, it has been proven that the education of traffic participants, the development of infrastructure, the implementation of modern systems, as well as legal regulations and international cooperation can positively influence the growth of the level of traffic safety.

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