Method of Analysis of the Reasons and Consequences of Traffic Accidents in Uzbekistan Cities

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ABSTRACT

The article is devoted to the problems in the analysis of road safety in the cities of Uzbekistan, specifically addressing issues with the occurrence of traffic accidents and the analysis of their statistics. The purpose of the article is to study the relationship between violations of traffic rules and the occurrence of traffic accidents in Uzbekistan. This study used the statistical method of correlation analysis and revealed a linear correlation between factors such as the number of traffic violations – the number of traffic accidents; the number of traffic violations – the number of fatalities from traffic accidents; the number of traffic violations – the number injured by traffic accidents; the number of traffic violations – the number of traffic accidents with economic damage. To determine the degree of correlation between the number of violations of traffic rules, the number of road traffic accidents and their consequences, the authors used the coefficient of determination. The results of the study showed that the number of traffic violations is negatively correlated with the number and consequences of traffic accidents. The authors argue that the methodology for registering a traffic accident in Uzbekistan requires modification and that a traffic accident is affected not only by violations of the rules of the road for drivers but also by other factors, such as the design of elements of the road traffic network.

1. INTRODUCTION

The number of road traffic deaths continues to climb, reaching 1.35 million worldwide a year. The rates of road traffic deaths relative to the size of the world's population have stabilized in recent years, but 93% of the world's fatalities on roads occur in low- and middle-income countries, even though these countries have only approximately 60% of the world's vehicles. Road traffic accidents cost most countries 3% of their gross domestic product. More than half of all road traffic deaths are among vulnerable road users: pedestrians, cyclists, and motorcyclists. The data presented in "The Global Status Report on Road Safety 2018" of the World Health Organization show that progress has been achieved in important areas such as legislation, vehicle standards and improving access to post-crash care [1, 2].

The statistics show that an increasing number of traffic accidents is one of the initial problems for all countries. This is particularly true for those countries in which economies are developing progressively, called developing countries, such as Uzbekistan. The population of Uzbekistan is more than 34 mln [3, 4]. and the length of its road network is 184,783 km, of which public roads represent 42,530 km, internal local roads represent 71,324 km, and city streets and roads represent 69,229 km. Public roads are the main highways in this country [5, 6].

According to the Pulitzer Center on Crisis Reporting, Uzbekistan has the lowest rates of road mortality among the countries of the region; for every 100,000 people, there are 11.32 deaths, and losses from road accidents represent 2.8% of GDP; although this is one of the lowest indicators, according to experts, the losses from traffic accidents represent substantial amounts [7].

The study of the causes, circumstances and conditions of traffic accidents plays a critical role in the development of measures for the prevention of such accidents in road transport [8, 9]. Any accident results not only from not observing a traffic rule but also from deviations from the optimal conditions for the driver–car–road–pedestrian–environment system.

2. MATERIAL ANALYSIS

Violation of the traffic rules of the road is dangerous because there is a relationship between the number of violations and the number of traffic accidents, as shown by a number of studies by foreign scientists such as Zhan et al. [10, 11], who studied the risk factors associated with traffic violations and the seriousness of accidents in China. Harrington and McBride [12] studied traffic violations by sex, type, and age in California, USA. Pesic et al. [13] studied the possibility of improving road safety based on an analysis of a database on traffic violations in Serbia. Rimmö and Åberg [14] examined the issue of traffic rule violations and Swedish drivers' errors. Azemsha et al. [15] analysed the data of traffic

accidents and their causes in the city of Gomel. Ayuso et al. [16] studied the effect of traffic violations on the cost of accidents with victims in Spain. Yusupov [17] conducted a multivariate analysis of traffic violations by drivers of vehicles in Tajikistan. Ilyina et al. [18] analysed the accident rate and the reasons for drivers violating traffic rules in the Penza region. Elliott et al. [19] studied the issues of errors and irregularities regarding the risk of motorcyclist accidents. Mesken et al. [20] examined the issue of interpersonal impairment, speeding and their relationship with traffic accidents in Finland; Parker et al. [21] investigated driving errors, traffic violations and their participation in traffic accidents. Liu et al. [22] claim that the penalty point strategy exhibits deterrent and binding effects; however, the penalty fine strategy does not show the expected effects where can subsequently reduce traffic accidents.

3. ANALYSIS METHOD

We have analysed data from the official database of violations of traffic rules of the Ministry of Internal Affairs of the Republic of Uzbekistan. For the period from 2016 to 2019, approximately 17 million traffic violations were noted. It was found that not all data from the traffic violations database can be used to improve road safety.

Therefore, it is necessary to analyse and determine which data on offences are valid or relevant for further analysis and the determination of measures. Relevant data are those that can be used for analysis, to directly or indirectly draw conclusions, and to help propose appropriate measures to improve road safety.

To determine relationships or interdependencies, statistical methods such as the regression analysis of traffic accidents and other indicators of road safety (traffic accidents and their consequences) and other known methods for the analysis of road safety can be used, depending on the specific data being analysed.

The types of data regarding violations of traffic rules are highlighted as follows:

(1). Information related to the offender: name and surname, gender, date and place of birth, address, identification number, as well as other identification data that determine and accurately identify the offender.

(2). Data associated with the place of the offence: the place, road, road sections, intersection, address with house number, etc.

(3). Data relating to the time the crime was committed: the year, month, day of the week and hour at the crime was committed.

(4). Data related to the crime committed: type of crime or legal qualification of the crime and resulting punishment.

(5). Other data - identification of the offence, information about the patrol officer who registered the offence at the police station.

To more accurately determine the relationship between the number of traffic violations and the number and consequences of traffic accidents, a correlation analysis was carried out for 14 regions of Uzbekistan.

4. RESEARCH RESULTS

According to the General Directorate of Road Traffic Safety of the Ministry of Internal Affairs of the Republic of Uzbekistan, on average, 2.0 thousand people die every year on highways [23]. Although in the republic over the past 10 years, the average number of vehicles has increased by 58% and the population by 16%, the total length of roads has increased by only 4.0 thousand km, or 2.1%.

The total number of accidents and victims in the Republic of Uzbekistan are shown in Figure 1 and Figure 2.

General statistics show that in recent years, traffic accidents and the number of injuries has been decreasing in Uzbekistan. However, experts believe that the actual situation is worse than shown by the statistics. If pay attention the number of traffic accidents in Figure 2 was the highest in 1990 and 1991, after which the number dropped sharply. This is due to the fact that in 1991 Uzbekistan became an independent country and since this year the methods of providing data on traffic accidents have changed and today this data is not available in the public domain even in Global status report on road safety of World Health Organization. And the data provided by the official authorities does not show the whole situation on the roads. When analysing road accidents by region, it can be seen that the situation has been improving over the years in Tashkent city and in the Tashkent region. However, in the Surkhandarya, Samarkand, Jizzakh, Bukhara, Namangan and Navoi regions, the number of accidents has held steady or increased (Figure 3). One of the reasons for the sharp decrease in traffic accidents in Tashkent is explained by the 2017 installation of photo and video recording systems at 115 intersections of the city, accompanied by a mechanism for imposing fines on drivers for violating the rules of the road. This technique is used by a number of foreign countries to prevent violation of traffic rules and, as a consequence, reduce traffic accidents [25-28].
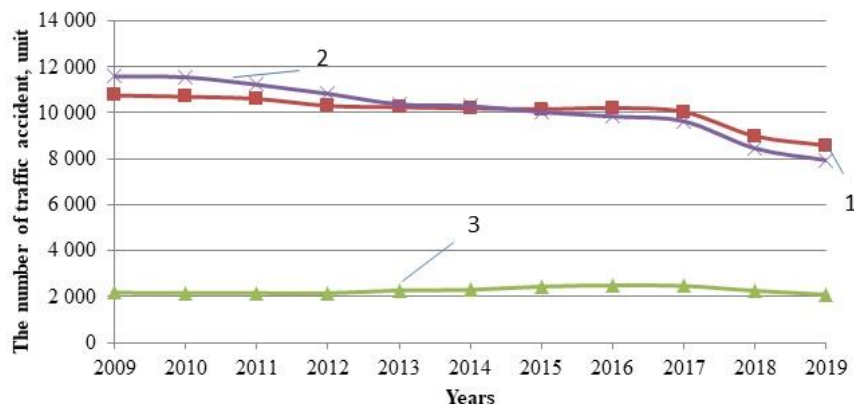

Figure 1. Statistics for traffic accidents in the Republic of Uzbekistan for the period 2009-2011
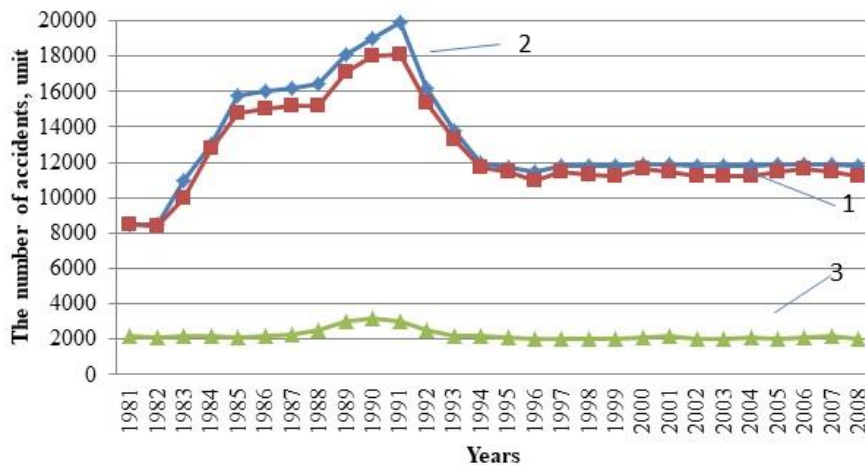
Figure 2. Information about traffic accidents on roads in the Republic of Uzbekistan for the period 1980 ÷ 2010 [23, 24]:
1– the total number of accidents; 2– the number of victims in accidents;
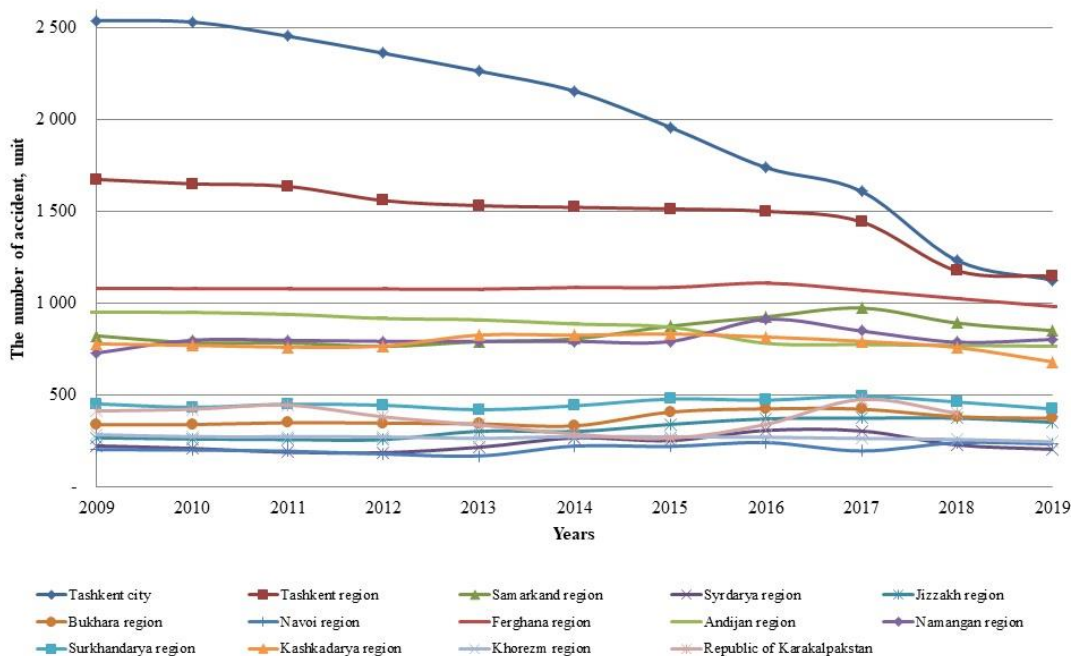3– the number of deaths in traffic accidents

Figure 3. The number of traffic accidents in the regions of Uzbekistan

Table 1. Statistical data on types of accidents in the Republic of Uzbekistan

Years	Collision			Rollover			Hit a standing vehicle		
	Total traffic accidents	Died	Injured	Total traffic accidents	Died	Injured	Total traffic accidents	Died	Injured
2019	2373	616	2662	408	138	407	133	40	134
2018	2354	664	2797	423	183	404	117	35	115
2017	2228	616	2483	494	198	483	109	29	108
2016	2242	642	2500	504	212	478	120	31	129
2015	4232	1124	4752	833	314	817	184	61	178
2014	4206	1193	4892	808	357	795	179	53	171

Years	Hit an obstacle			Hit a pedestrian			Hit a cyclist		
	Total traffic accidents	Died	Injured	Total traffic accidents	Died	Injured	Total traffic accidents	Died	Injured
2019	440	146	452	4305	929	3530	729	191	563
2018	423	149	442	4852	1035	4042	682	176	531
2017	359	134	339	4096	824	3417	1044	236	850
2016	380	113	374	4207	877	3509	979	248	777
2015	759	246	749	7815	1723	6336	1472	384	1128
2014	761	269	775	8453	1810	6959	1417	353	1121

Years	Hit a horse-drawn transport			Hitting an animal			Another type of traffic accident
	Total traffic accidents	Died	Injured	Total traffic accidents	Died	Injured	
2019	36	5	34	8	4	6	85
2018	40	5	40	4	1	4	95
2017	27	4	26	7	4	5	86
2016	34	4	37	3	0	3	87
2015	72	11	70	16	8	12	153
2014	75	13	70	6	1	7	158

A detailed analysis of the types of accidents showed that over the past 6 years, the highest percentage is for pedestrian collisions, followed by vehicle collisions and then by collisions with cyclists. The figure shows that in 2019, 929 people were killed in accidents involving a pedestrian; 616 people in accidents involving vehicle collisions; and 191 people in accidents involving a cyclist (Table 1). Table 2 shows the approximate share of traffic violations by type.

In the Republic of Uzbekistan in recent years, traffic violations have sharply increased (Figure 4). This can be explained by the use of photo and video recording systems, which increased ability to identify violations of the rules of the road and to determine the violator. In 2019, there were 4,881,457 traffic violations, while those violations revealed by the computerized control system amounted to 1,227,844, representing a 25% increase in cited traffic violations (Table 3 and Figure 5).

Figure 5. Statistics on traffic violations identified, 2019

Table 3. The share of traffic violations by causes in the Republic of Uzbekistan, 2019

Reason for traffic violation	Quantity, pcs.	%
Failure to comply with road signs and road markings	2383182	48.82
Not using seat belts	1526803	31.28
Traffic violations by pedestrians	354658	7.27
Lack of documents	198018	4.06
Failure to comply with the speed limit	136334	2.79
Parking in the wrong place (3.27 sign)	63327	1.30
Ignoring traffic signals	61989	1.27
Lack of insurance	55426	1.14
Drunk driving	28098	0.58
Using a cell phone while driving	25037	0.51
Installation of sound and lighting equipment	9911	0.20
Window tinting	9219	0.19
Non-compliance with the requirements of the traffic police	7217	0.15
Refusal to take a blood alcohol test	5595	0.11
Oncoming traffic, creating a state of emergency	4530	0.09
Railroad crossing violation	4344	0.09
Use of defective vehicles	2390	0.05
Violation of cargo transportation rules	1330	0.03
Freight and passenger transportation without a license	1082	0.02
Group movement	1031	0.02
Monitor (display) installation in the vehicle	846	0.02
Damage to traffic control equipment	741	0.02
Permission to drive drunk drivers	263	0.01
Using a car for personal gain	86	0.002
Total	4881 457	100

Table 2. Percentage of traffic violations by type [29]

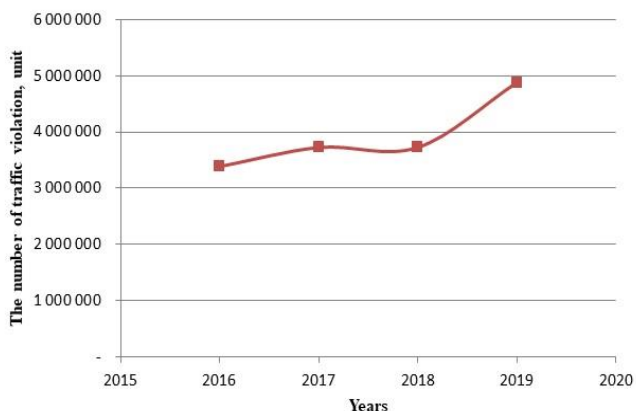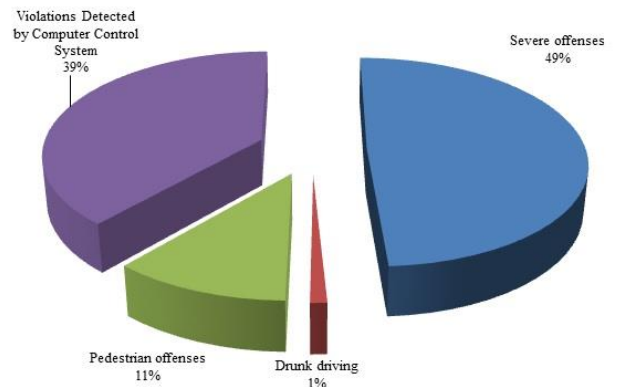| Type of traffic violation	%
Crossroads Violation	15.8
Driving technically faulty vehicle	15.6
Failure to overtake	12.0
Failure to comply with traffic signs	7.5
Over speed limit	7.2
Violation of the rules for parking, stopping or starting	6.5
Driving on the left side of the road	3.5
Use of cars for personal gain	2.5
Driving while intoxicated	2.0
Violation of the rules for using lighting devices	1.6
Violation of passenger transportation rules	1.1
Violation of the rules for passage of railway crossings	0.6
Blinding headlights despite an oncoming car	0.5
Violation of cargo transportation rules	0.4
Violation of the rules for towing vehicles	0.2
Other traffic violations	23
Total	100

Figure 4. Traffic violation statistics

When comparing traffic violations (1970 and 2019), there is a large difference in types. Of course, there are a number of

"modern" violations of traffic rules that did not exist in 1970 and thus cannot be compared like using a cell phone while driving, installing a monitor (display), lack of insurance and not using seat belts. However, there are also standard violations of traffic rules, and the influence of traffic police efforts to ensure road safety can be observed. Table 4 presents a comparison of the number of traffic rules and the number of violations for ten violation types. Currently, an acute question persists regarding the "Failure to comply with road signs and road markings" by drivers and pedestrians, where the number reaches 48.8% and 7.7%, respectively.

The registered number of violations of traffic rules due to excess speed represents 7.2% of the total number of detected violations, and the largest number of accidents is due to speeding – 48%. A similar comparison can be made for types of violations such as driving on the left-hand side of the road when overtaking (3.5 and 17%, respectively) and violations of the rules for crossing intersections (15.8 and 23%). This situation can be explained by insufficient control over the streets and roads to ensure that drivers observe traffic rules. Although similar statistics can be seen for the Republic of Uzbekistan, they are not available in publicly available resources.

An assessment of the correlation and regression relationships between the number of traffic violations and traffic accidents is shown in Figure 6-13 and Table 5-7.

Table 4. Comparative traffic violation data

№	Types of traffic violations	1970 y.	2019 y.
1	Failure to comply with the speed limit	7.2	2.79
2	Parking in the wrong place	6.5	1.30
3	Ignoring traffic signals	15.8	1.27
4	Oncoming traffic, creating a state of emergency	12	0.09
5	Railroad crossing violation	15.8	0.09
6	Use of defective vehicles	15.6	0.05
7	Violation of cargo transportation rules	0.4	0.03
8	Freight and passenger transportation without a licence	1.1	0.02
9	Using a car for personal gain	2.5	0.002
10	Drunk driving	2	0.61

Table 5. Correlation between the number of traffic violations and traffic accidents (by region)

Variable № 1	Variable №2	Linear correlation function between variable 1 and variable 2	Correlation coefficient	F test	t test
Number of traffic violations	The number of traffic accidents	y=342.6x+48238	$R^2 = 0.478$	F=50.4	t=1.20
	The number of fatalities from traffic accident	y=661.7x +16836	$R^2 = 0.085$	F=5.11	t=3.09
	The number of injured from traffic accidents	y=359.5x + 49477	$R^2 = 0.632$	F=94.1	t=1.74
	The number of accidents with economic damage	y=-5377.4x+433679	$R^2= 0.2083$	F=13.7	t=1.15

Table 6. Comparison of traffic violations and traffic accidents (by republic)

Years	Traffic violations	Traffic accident	Dead	Injured	Damage to property[1]
2016	3 385 051	10 212	2 496	9 845	8 885
2017	3 725 616	10 044	2 473	9 637	9 619
2018	4 347 824	8 990	2 262	8 458	10 951
2019	6 109 301	8 588	2 096	7 943	12 598

[1]Sources: Traffic police of the Republic of Uzbekistan and *Fund for guaranteeing payments on compulsory civil liability insurance of vehicle owners.

Table 7. Correlation between the number of traffic violations and road accidents (by republic)

| Variable № 1	Variable №2	Linear correlation function between variable 1 and variable 2	Correlation coefficient	F test	t test
Number of traffic violations	The number of traffic accidents	y = -1389x + 2E+07	$R^2 = 0.826$	F=9.53	t=4.1
	The number of fatalities from traffic accident	y = -6158x + 2E+07	$R^2 = 0.923$	F=24.2	t=6.4
	The number of injured from traffic accidents	y = -1213x + 2E+07	$R^2 = 0.843$	F=10.8	t=4.5
	The number of accidents with economic damage	y = 725.5x - 3E+06	$R^2 = 0.953$	F=41.3	t=-2.7
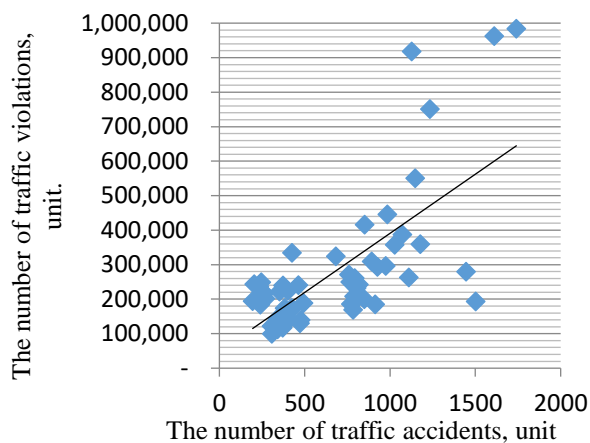
Figure 6. The relationship between traffic violations and traffic accidents
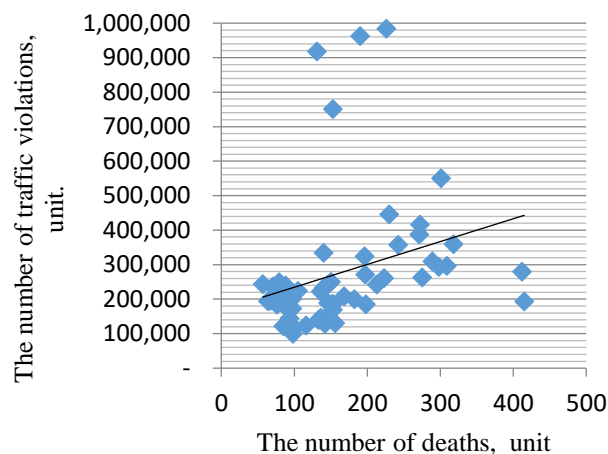

Figure 7. The relationship between traffic violations and deaths from traffic accidents
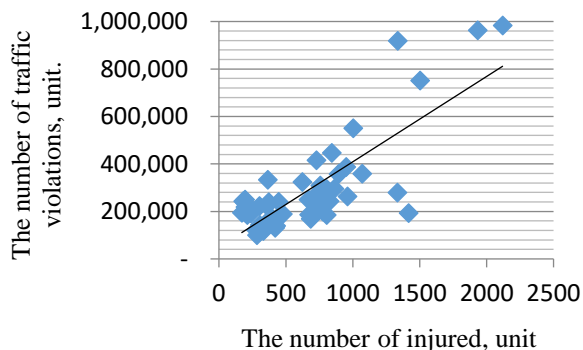
Figure 8. The relationship between traffic violations and injured from traffic accidents
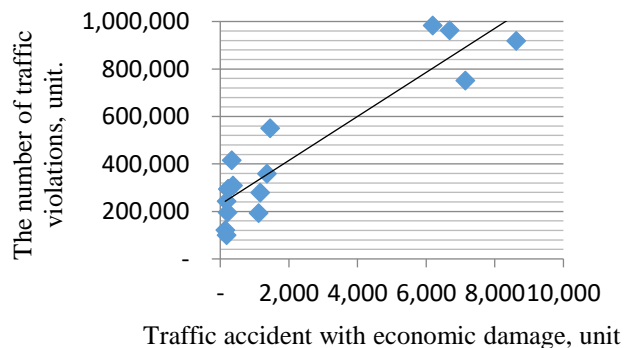

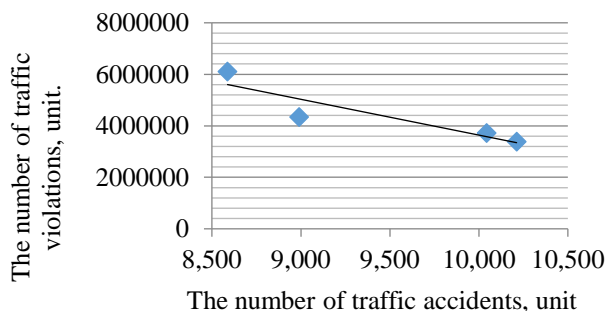**Figure 9.** The relationship between traffic violations and traffic accidents with economic damage

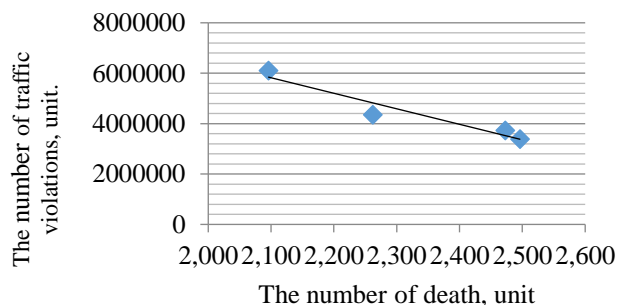**Figure 10.** The relationship between traffic violations and traffic accidents

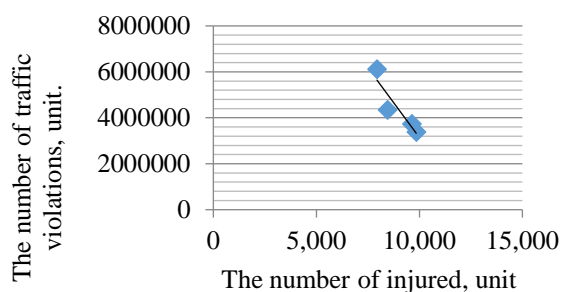**Figure 11.** The relationship between traffic violations and deaths from traffic accidents

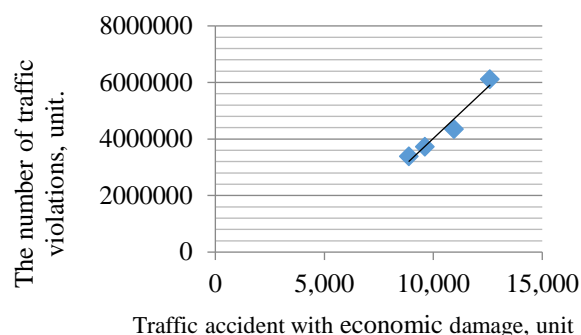**Figure 12.** The relationship between traffic violations and injured from traffic accidents

Figure 13. The relationship between traffic violations and traffic accidents with economic damage

5. DISCUSSIONS

By analysing data on the number of traffic violations and the number of traffic accidents, we concluded that during the analysed period, the number of traffic violations increased and the number of traffic accidents decreased.

In 2019, the number of traffic violations increased by 80.5% compared with 2016, while over the same period, the number of traffic accidents decreased by 19%. Many researchers studying other countries [29-31] have investigated similar trends but have drawn exactly the opposite conclusions.

Other researchers have shown that there is a connection between traffic violations and traffic accidents, which means that a decrease in the number of traffic violations will lead to a decrease in the number of traffic accidents. They then conclude that eliminating the most frequent traffic violations could lead to a significant reduction in the number of traffic accidents and their consequences.

Additionally, other studies have shown that the number of

fatal accidents and other consequences is correlated with the number of registered or detected violations of traffic rules.

6. CONCLUSIONS

To determine the degree of correlation between the number of violations of traffic rules and the number of road traffic accidents and their consequences, we used the coefficient of determination (R^2). To determine whether the correlation was positive or negative, a correlation coefficient (R) was used.

The analysis revealed the following:

(1). The number of violations of traffic rules is negatively correlated with the number and consequences of traffic accidents;

(2). The number of traffic violations has a strong negative correlation with the number of road traffic accidents and with the number of road traffic accidents with only material damage;

(3). There is a negative correlation of average strength between the number of traffic violations and the number of road traffic accidents with victims;

(4). There is a weak negative correlation between the number of traffic violations and the number of fatalities in traffic accidents;

(5). Since the coefficient of determination does not exceed 0.9, the so-called "single factor" does not exist.

The number of traffic violations is not the only factor affecting the number and consequences of traffic accidents. A relationship was found between the number of traffic rule violations detected and the consequences of accidents.

Thus, planning and development, which should provide the methodological foundations for ensuring traffic safety when designing street-road networks, is one of the most important measures that can reduce the number of violations and, consequently, improve road safety in Uzbekistan. These types of changes will incur financial costs but will save lives and provide other benefits such as increasing the speed and efficiency of road transport.

The authors recommend that the responsible authorities modernize the registration procedure, in particular switching to the electronic registration of accidents, and the analysis of their statistics.

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