

# Analysis of factors affecting the severity of car accidents in the Akmola region of Kazakhstan

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**Abstract.** The article presents the results of the analysis of statistical data on the number of victims of traffic accidents on the roads of Kazakhstan over the past five years, an analysis of the causes of road accidents is carried out, conclusions are drawn on the distribution of participants in road accidents depending on driving experience. An analysis of the condition of vehicles has been carried out, which makes it possible to predict a further increase in the number of victims. The purpose of the study was to identify the main factors that affect the number of dead participants in road accidents. As a result of research, it was determined that the main factor of severe consequences is the low level of training of drivers to make the right decision in stressful situations on the road. Additional factors are the unsatisfactory condition of roads in the Akmola region and a large number of vehicles that have a service life of more than twenty years and are not equipped with modern safety equipment.

## 1 Introduction

The volume of cargo and passenger transportation by cars and buses is growing at a faster pace than by other modes of transport. Road transport is characterized by great flexibility, meeting the demand for the transportation of goods of various types and volumes, changing routes and delivery points. Thanks to these qualities, road transport plays an increasingly important role in the development of the economy of all countries.

However, along with the positive role that road transport plays in the development of the country's economy, there are also negative factors directly related to the process of motorization. These include environmental pollution, urban planning problems associated with the allocation of urban spaces for the movement and parking of vehicles, the growing shortage of petroleum products, etc.

Among the most negative factors of the process of motorization are road accidents and their consequences, characterized by loss of life, material damage from damage to vehicles, cargo, road or other structures, payment of disability and temporary disability benefits, etc. Material damage from road accidents, in countries with developed motorization reaches 10% of annual national income. For Kazakhstan, this figure is more than 13% (<https://ffins.kz/>).

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Road traffic accidents are among the top ten causes of total mortality in the world. More people die in road accidents than from AIDS and tuberculosis.

The aim of the study is to find the main factors that directly affect the death rate on the roads of the Akmola region of Kazakhstan. After solving this goal, it will be possible to really develop a strategy to eliminate or reduce the identified factors, which means to maintain the number of able-bodied population and reduce the damage and losses of Kazakhstan's tax product.

## **2 Material and methods**

The authors used the following methods in this study: statistical, economic-mathematical, comparative and analytical methods, as well as search work on the Internet. The theoretical and methodological basis of the study was the analysis of statistical data for the last ten years in the Akmola region. The classification of accidents was carried out in accordance with the age of the drivers involved in the accident, gender and driving experience.

In addition, samples were made from statistical data on the number of driving schools in the region. The ranking of driver training courses was carried out by the availability of simulator training, by the number of practical driving lessons. The analysis of the frequency of getting into an accident of drivers with different levels of training is carried out. the method of Reuben Jacob Smid was used. A British statistician and transport researcher proposed in 1949 a theory according to which there is an assumed rule of thumb that an increase in traffic volume (an increase in the number of vehicle registrations) leads to an increase in the number of deaths per capita, but a decrease in the number of deaths per vehicle.

The paper analyzed the causes of accidents on the highways of the world and Kazakhstan and, in particular, the causes of accidents in the Akmola region were considered in detail.

## **3 Theory**

The reason for the decrease in the population in a number of countries is the death rate from car accidents. Statistics on deaths in road accidents are maintained by the World Health Organization (WHO) (World Health Organization).

Sufficiently accessible data can always be seen in the "Global Status Report on Road Safety" ("Global Status Report on Road Safety"). The indicator used in this case is the average mortality rate per 100 thousand people per year. This method of calculation allows you to abstract from the absolute number of people in the country and accidents.

The systematization of data on mortality in road accidents is carried out by the World Bank, which publishes these data in the report Mortality caused by road traffic injury (per 100,000 people).

According to WHO, more than 1.35 million people die on the world's roads every year. From

20 to 50 million people receive non-fatal injuries, many of which lead to disability, and economically these are severe consequences for both the family and the state.

These losses are associated with the cost of treatment, as well as with the lost productivity of those who died or became disabled due to injuries, as well as their family members who need time off from work or study to care for relatives who have been injured. Road accidents cost most countries 3% of their gross domestic product.

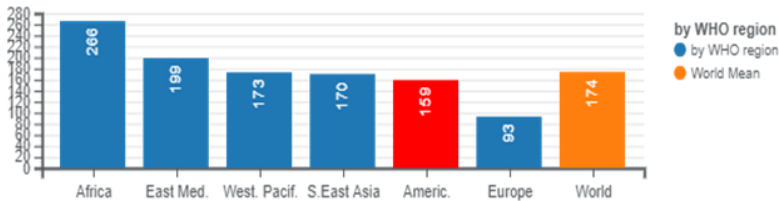
More than 90% of deaths due to road traffic injuries occur in low- and middle-income countries. It is believed that the risk of death on the roads is three times higher in low-income countries than in more developed countries. According to WHO, more than 3 million people

are killed or injured on roads around the world every year. At the same time, analysts predict that by 2030 the number of victims will grow to 3.6 million people annually.

Most injuries and deaths were recorded in India. There are 220 accidents per 1 million inhabitants of the country. There are also high accident rates in China (180 accidents) and the USA (114 accidents). This significantly exceeds the statistics in other countries [1].

The safest roads are considered to be in Norway. There are only 20 accidents per 1 million inhabitants of the country. There are also low accident rates in Sweden (25 accidents), Japan (25 accidents) and the UK (30 accidents).

Figure 1 shows a diagram of mortality in road accidents by region per million inhabitants.



**Fig. 1.** Mortality rate Global start of the Decade of Action for Road Safety 2011-2021 - World Health Organization (WHO).

If we talk about Kazakhstan, out of 136 countries in the world by the level of motorization, Kazakhstan ranks 67th. The number of vehicles in Kazakhstan is no more than 200 per thousand people, for comparison, in Russia this figure is 309. The highest level belongs to San Marino – 1263 and the lowest in Somalia and Bangladesh, where there are only 2 cars per 1000 people.

Automobile transport in Kazakhstan is developing rapidly, but it is hampered by the backwardness of the infrastructure, the technical condition of the automobile fleet, the insufficient readiness of the industry to function in conditions of international competition and at the level of international requirements for the organization of transportation.

The total volume of transport financing, which is 1.5% of GDP in Kazakhstan, is much lower than in countries with similar territorial characteristics. Actively developing countries invest up to 4-7% of GDP in the transport sector (according to <https://gurk.kz/news/ministerstvo-vnutrennih-del-provelo-seminar-soveshhanie-po-voprosam-obespecheniya-bezopasnosti-dorozhnogo-dvizheniya>).

Among other problems of Kazakhstan's motor transport, it should be noted the problems of staffing the industry:

- shortage of qualified personnel (within the management of the industry and individual carriers, lagging implementation of marketing and logistics; insufficient intersectoral coordination and intensification of international cooperation);
- disadvantages of licensing the activities of automobile carriers;
- weak pre-trip control of the driver's staff and rules for loading buses and cars;
- low qualification and transport discipline of drivers (due to the low quality of training in driving schools over the past 10 years). As a result, Kazakhstan's road traffic safety indicators do not correspond to the world level.

At the same time, an analysis of the state of accidents in road transport shows that the level of road traffic injuries in the country continues to remain at a high level.

For proper planning and organization of measures to improve road safety, it is important to identify the main factors contributing to the occurrence of accidents.

Often, the prevention of an accident depends on the driver, how attentive he is under unfavorable road conditions, etc. In order to prevent accidents and reduce the severity of their consequences, a number of organizational and legal measures are being implemented in the country. Ensuring road safety is one of the main priorities of the work of the Ministry of

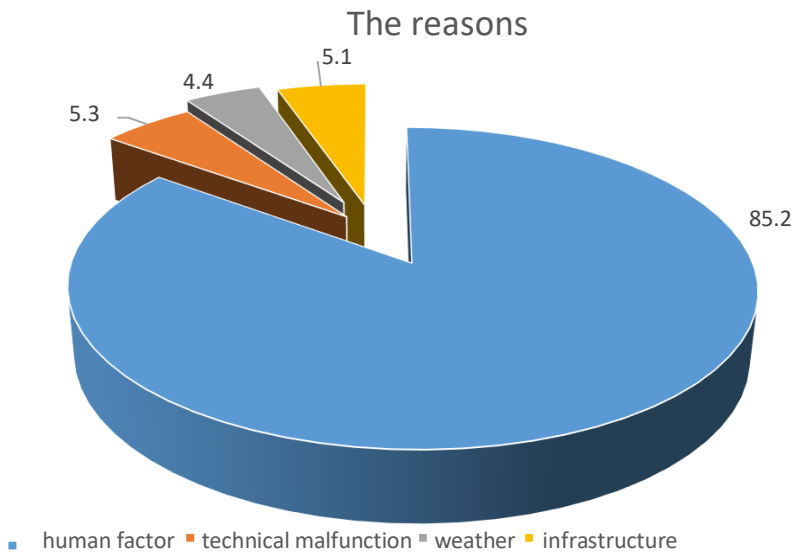
Internal Affairs of the Republic of Kazakhstan. Taking into account the growth of motorization of the population (4.3 million vehicles are already in operation in the country today), the number of road accidents is also growing [2].

In January, May 2022, 5.2 thousand road accidents were registered in the Republic of Kazakhstan. People were killed or injured in them, which is 11.2 percent more compared to the same period last year.

Compared to the same period last year, the death toll increased by 11.7%.

The reasons for the accident are the low transport discipline of drivers associated with speeding, driving into the oncoming lane and passing intersections. Also, a key element of influence on road safety is the condition and infrastructure of highways (according to News - Accident statistics in summaries. <https://www.ktk.kz/ru/news/video/2022/07/04/216845>). Every year in Kazakhstan, according to statistics, there are more than 18 thousand road accidents and about 2.5 thousand Kazakhstanis die in them. The most difficult is the post-accident result, when people lose their ability to work and become disabled [3-4].

The simplest classification of the causes of an accident is shown in Figure 2



**Fig. 2.** The main causes of road accidents.

There are five main causes of accidents caused by the driver, according to the latest data:

- 1 – violation of the speed limit, while accidents occur on roads with good coverage;
- exit to the oncoming lane, but here it is necessary to clarify that this is due to poor lighting on country roads and due to the poor condition of Kazakhstani roads;
- non-compliance with the distance and aggressive driving, more than 15% of accidents are associated with sudden braking, speed changes or as a result of lane changes and U-turns;
- bad weather conditions, a large number of drivers have no experience of driving in difficult conditions, 13% of accidents are registered during rain or snowfall;
- drunk driving, the Ministry of Internal Affairs of the Republic of Kazakhstan reported that 3% of the total number of accidents were caused by drunk drivers, almost 26 thousand drivers were deprived of their rights for drunk driving in 2021.

If the cause of the accident is the emergency condition of the road, then in Kazakhstan the total length of highways is 128 thousand km, of which 97.1 thousand km are public roads, including 23.5 thousand km of republican significance, 73.6 thousand km belong to the local network. Paved roads make up only 32.8% of the total road network. More than 80% of the

republican highways in their technical condition do not meet the needs of the economy. In the world ranking on the condition of roads, Kazakhstan is on the 113th place [5].

The condition of the vehicle is also a problematic issue of road transport structures in Kazakhstan. The Republican fleet of motor vehicles (MV) has about 2686.7 thousand passenger cars, about 397.6 thousand freight MV and 94 thousand buses. There are over 110 international and 115 inter-regional passenger routes for the organization of regular communication [6].

The rapid increase in the provision of passenger cars to the population of Kazakhstan, which has occurred over the past decade, is a sign of an increase in living standards. However, the increase in the MV fleet in large cities of Kazakhstan, especially in Astana, has led to the onset of a transport crisis, when daily movement around the city in traffic jams leads to significant loss of time, stress for drivers and passengers. However, the main consequence is a significant deterioration of the environmental situation in large cities, especially in the city of Almaty, which is fraught with an increase in the morbidity of the population, a decrease in life expectancy, a deterioration in the efficiency of labor and economic activity and other serious consequences [7].

Table 1. provides information on the terms of operation of the MV fleet in Kazakhstan. It can be seen from the data that the vast majority of all types of MV have a service life of 1.5-2 times or more exceeding the regulatory period of compliance with Euro-3. Moreover, the trend is still observed in the direction of a further increase in car wear.

**Table 1.** Characteristics of motor vehicles (MV) of Kazakhstan by service life.

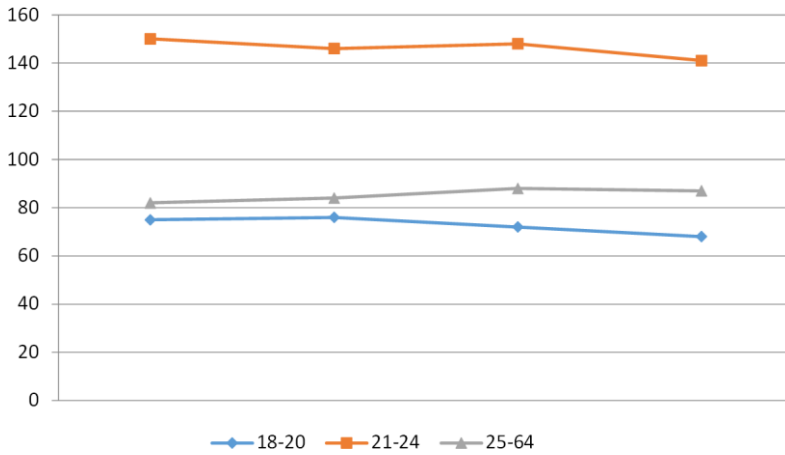
Types of MV	Separation by service life				total
	up to 2 years	from 2 to 7 years	from 7 to 12 years old	above 12 years	
passenger transport	86 086 (5%)	207 856 (12%)	420 589 (24%)	1 030 542 (59%)	1 745 073 (100%)
cargo transport	15 963 (5%)	18 716 (6%)	15 429 (5%)	261 720 (84%)	311 828 (100%)
buses	6 127 (8%)	16 733 (22%)	9 723 (13%)	42 459 (57%)	75 042 (100%)
total	108 443 (5%)	243 093 (11%)	441 768 (21%)	1 338 639 (63%)	2 131 943 (100%)

Note: compiled by the author [8]

The average age of a passenger car is approaching 19 years, as the preferential customs regime that existed in recent years has worsened the condition of the fleet of the Republic of Kazakhstan. Today, cars older than 10 years are prohibited for import, because they do not comply with the Euro-3 standard. Aging and high wear of the rolling stock of the motor vehicle fleet entails an increase in the costs of repair and operation of the MV, reduces the level of services and has a significant negative impact on the environment.

Injuries as a result of road accidents are the main cause of death of children and young people aged 5-29 years. This is confirmed by other researchers [9-11].

Men, starting from a young age, are more likely to get into an accident than women. About three quarters (73%) of all deaths due to road traffic accidents occur among young men under the age of 25, who are almost three times more likely to die in a car accident than among young women [12].



**Fig. 3.** Analysis of road accidents by death toll by age group.

Age is important to the risk of an accident, as shown in Fig.3. Statistics show that the risk of an accident is maximum in the case of driving by young (under 25 years old) and elderly drivers (over 65 years old).

Based on statistics from foreign countries, from 20 to 30% of accidents involving young drivers occur, resulting in the death of people in accordance with Figure 4. This age group represents only 10% of the population.

The high risk of an accident for a group of young drivers is primarily due to the influence of inexperience, age and gender. The risk increases even more as a result of exposure to such adverse factors as high speed, dark hours, the presence of passengers of the same age, alcohol consumption and ignoring seat belts.

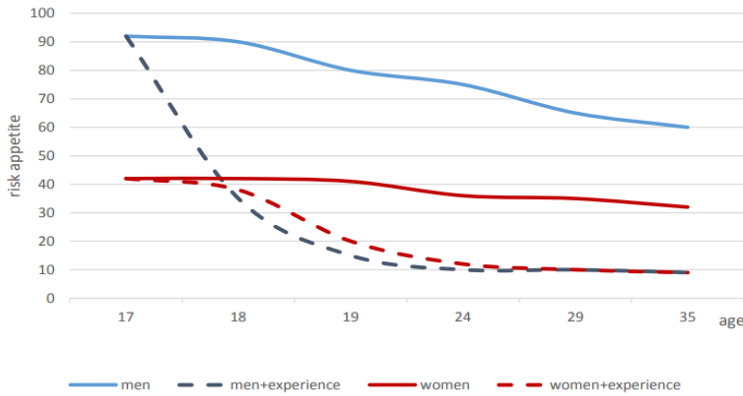


**Fig. 4.** The share of young people in the total population and in the total number of road accidents with fatalities [13].

A large proportion of accidents for elderly people is due to physiology, although the experience of an older driver is able to somewhat compensate for the decrease in his physical capabilities.

Figure 5 shows that the death rate on the road for drivers aged 18-24 is almost twice as high as for older drivers.

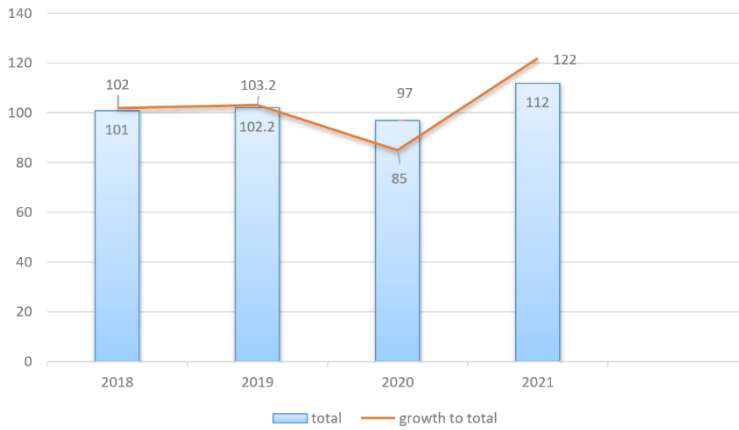
Statistics from all countries indicate a greater risk of accidents for men than for women. Women are more careful, follow the rules more accurately and therefore are less likely to get into dangerous situations. Male drivers become involved in road accidents due to excessive self- confidence and overestimation of their capabilities, and female drivers, on the contrary, due to excessive caution, indecision and underestimation of their strength [14].



**Fig. 5.** Diagram of the influence of age, experience and gender on the predisposition of drivers to risk.

The death rate as a result of road accidents for men is three or more times higher than for women [15].

The risk of an accident decreases not only with experience, but also with age. The risk of an accident for drivers who have just received a driver's license will be lower the older their age. This is probably due to the fact that the tendency to overestimate their own abilities and to underestimate the dangers in road traffic is more characteristic of young people.



Note – Ranking.kz

**Fig. 6.** Change in the growth of accidents on the roads of the Akmola region over the past 4 years.

Figure 6 shows the influence of the driver's age and driving experience on the risk of an accident. Black indicates the risk of an accident for young male and female drivers who have just received their license, taking into account their age, and red indicates the progression of the level of risk of an accident for drivers who received a driver's license at the age of 17. In other words, the black curve shows the influence of age, while the red one shows the influence of driving experience in accordance with Figure 4. The data are consistent with analyzes performed by other authors [16, 17].

A more detailed study showed that with a driver's experience of 5 years (+2 years), a second peak of accident risk is detected [18].

If the accidents of the first year are mainly caused by a lack of experience, then the increase in the risk of an accident in the fifth year has a psychological nature. By this time, the driver acquires stable professional skills, which leads to:

- To professional automatism
- To act according to the usual pattern
- To reduce attention
- To underestimate the seriousness of emerging non-standard situations and, as a result, incomplete realization of their capabilities in their resolution.

## **4 Scientific novelty and significance of the study**

The scientific novelty of the work lies in the fact that possible options for reducing accidents on highways are considered and specific recommendations are given to improve road safety: it is necessary to continue the development of vehicles and digital technologies in transport to improve road safety.

## **5 Direct results**

- The results of research and statistics show that the main reason drivers commit accidents is their lack of discipline, which is expressed in their violation of traffic rules and poor psychological preparation for driving in difficult conditions (poor visibility, night ice, strong wind or stressful situations).

- A difference was also established between the mortality from road accidents in cities and districts: in urban areas, the mortality rate is from 3 to 12 deaths per 100 thousand inhabitants, in rural areas it reaches 118 deaths per 100 thousand inhabitants. The most dangerous areas in the territory of the region are those belonging to the Eastern Group. In second place in terms of danger is the Southern Group and in third place is the Western group of districts.

- The result of processing statistical data was the conclusion that of all those killed in an accident, 74.3% die at the scene of an accident, 3.7% die during transportation, 21.9% die in medical institutions. The most likely cause of death, according to autopsies, are injuries involving several areas of the body - up to 68.4% of all cases and head injuries — up to 29.7%.

The current state of the system of teaching motor transport drivers the rules of first aid is unsatisfactory. As shown by the analysis of a survey conducted among 250 drivers (including in the Akmola region):

- lack of knowledge of first aid rules – 75% of professional drivers and 60% of amateurs;
- availability of first aid skills (artificial respiration, heart massage, proper transportation of victims, etc.) 21% of respondents.

More than half of all drivers surveyed, 58%, are ready to actively provide first aid to victims, but improper treatment of victims leads to aggravation of injuries.

To change the current system of education, it is necessary to start learning from preschool age and make this process permanent and regular. It is necessary to teach children not only the rules of the road, but also first aid.

Based on the results of the conducted research, the following measures to improve road safety are proposed in this paper:

Arrangement of road structures:

- simple road markings;
- modernization of designated pedestrian crossings;
- pedestrian overpasses or underground pedestrian crossings;



- fencing along the roadsides;
- removal of obstacles along the roadsides;
- central dividing fence;
- installation of signs before dangerous turns;
- zonal speed limits and territorial traffic management schemes.

Visibility measures:

- road lighting;
- driving with the headlights on in the daytime.

Alcohol consumption control:

- random checks with a breathalyzer; Restrictive devices in the car:
- sound reminders to fasten your seat belt;
- chairs and seats for transporting children;
- programs for monitoring the use of seat belts.

Introduction of a differentiated system for issuing driver's licenses to young drivers:

- issuance of six-month student licenses that do not allow their owners to drive from midnight to 5 a.m., and then for one year there is a limit on the number of passengers carried in their car.

The principle of designing protective devices in a car should, first of all, assume a reduction in serious and fatal injuries.

Such technical devices as seat belts and airbags will reduce the death rate in an accident.

Currently, the installation of a GPS/GPRS tracker, a portable electronic device, is the most inexpensive and simple method of quickly notifying about an accident, and therefore calling specialized resuscitation teams to provide professional medical assistance to victims.

## **6 Discussion**

The factors determining the probability of an accident related to a person, road infrastructure and a vehicle are elements of a single road transport system, where many elements that are in relationships and connections with each other form a certain integrity [18].

The goal of a systematic approach to improving traffic safety on the road network should be to identify the diverse types of connections in the system and bring them into a single theoretical picture to understand the nature of accidents, their prediction, and hence the prevention of accidents [19].

It is the prevention of accidents that is the main professional task of the road industry, responsible for the level of accidents on road networks.

The development of modern traffic management systems based on modern communications and information technologies becomes useful for road users only in the case of unified management on the scale of the road network [20].

The development of information and communication technologies in road transport contains a huge potential for:

- improvements in traffic management;
- increasing the efficiency of transport operations;
- reduction of fuel consumption, and, consequently, reduction of harmful effects on the environment;
- improving road safety [21].

## **7 Conclusion**

The goal set in the research work has been achieved. The tasks set to achieve the goal have been solved. Road traffic injuries can be prevented. The number of injured and dead in road accidents may be reduced if the driver training system is improved:

- the formation of study groups and the development of curricula should be focused on the personal individual psychotype of the cadet;
- theoretical training should include simulator classes that bring driving skills to automatism;
- classes at the circuit should be held for all seasons and days to practice driving skills in difficult conditions;
- it should be mandatory to train drivers to provide first aid to victims and conduct regular practical training in medical institutions;
- recertification should be introduced based on the results of constant monitoring of the psychophysiological condition of the driver.

Governments need to continue regular analytical work and take measures to ensure road safety based on a holistic approach. It requires the participation of a wide range of sectors, such as transport, police, health, education, as well as measures to improve the safety of roads, vehicles and road users.

Measures aimed at improving road safety are rarely popular among citizens. Therefore, strong political will is needed to ensure support for these measures and to ensure irreversible positive results in reducing accidents.

Each driving school should have its own race track, a sufficient number of different simulators, qualified instructors and training methods in accordance with the psychophysiological type and condition of the cadet.

In addition, it is important to inform the public about the results of certain measures to improve road safety and the costs associated with their implementation.

The practical significance of the work lies in the fact that the ways of improving safety by reducing the causes and preventing a large number of accidents due to the human factor are proposed.

New trends in statistical data processing are a "Safe Systematic approach" to road traffic, it is aimed at creating an accident-free movement system for all road users. This approach takes into account the vulnerability of people to serious injuries as a result of road accidents and proceeds from the fact that the system should be designed with a tolerance for human error. The most important principles of this approach are safe roads and roadsides, safe speeds, safe vehicles and safe road users — all these aspects should be provided for the elimination of fatal accidents and the reduction of serious injuries.

Conflict of interests: The authors have no conflicts of interest with other organizations or researchers.

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