

UDC 656.11 (075.8)

DOI 10.52167/1609-1817-2024-133-4-16-23

A.M. Zhandarbekova<sup>1</sup>, K.A. Murzabekova<sup>2</sup>✉

<sup>1</sup>S. Seifullin Kazakh Agro-Technical Research University, Astana, Kazakhstan

<sup>2</sup>Almaty Management University, Almaty, Kazakhstan

E-mail: mkaken@mail.ru

## THE STATE OF TRAFFIC SAFETY IN ALMATY

**Abstract.** Road safety issues have obtained relevance today, both globally and nationally. The fight against accidents in large cities has great economic value, and the matter is of national importance. One of the criteria affecting road safety and increasing the capacity of the road network is population growth and the level of motorization. During the period under review, the city of Almaty witnessed a significant increase both in terms of population growth and the number of registered passenger cars of individual owners.

This paper examines the possibility of assessing the state of road safety in Almaty by risk factors. This study analyzed data on 44,559 road traffic accidents with injuries for the period of 2014–2023.

**Keywords.** Almaty city, population, level of motorization, road traffic accidents, traffic safety risk, public health risk.

### Introduction.

*Relevance.* The problem of ensuring road safety (RS) has been and always remains relevant in all countries [1-4]. Population growth and the number of vehicles is predictors (means for predicting) of road traffic accidents (RTA) and the severity of their consequences [5]. Over the past decades, Almaty has witnessed significant growth both in terms of population growth and vehicle registration (VR). In this regard, currently, the traffic intensity on the road network of Almaty does not correspond to its capacity.

The situation with accident rates in cities is aggravated by such trends as the ever-increasing mobility of the population and increasing levels of motorization [6]. Almaty is characterized by continuous growth in population and registered passenger cars among individual owners [7]. Despite the measures taken and the downward trend in the total number of road accidents, mortality statistics from road accidents in Almaty still indicate the existence of a problem [8].

One of the ways to prevent road accidents is to predict them [9-13], which requires a detailed understanding of the characteristics of road accidents and a formal assessment of the influence of factors on the state of traffic safety. Many tools allow you to monitor the level of safety and limit dangers in road traffic. To apply these methods, it is necessary to have information about the scale of the existing RS problem, which is ensured by the constant study and analysis of statistical indicators, as well as the planning of appropriate measures aimed at correcting the situation and achieving planned indicators within the framework of strategic documents [4].

The main purpose of this article is to assess the state of RS in Almaty by risk factors: traffic safety risk, and public health risk.

Research materials and methods: Statistical data from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan [7], The Committee on Legal Statistics and Special Records of the Office of the Prosecutor General of the Republic of Kazakhstan [8].

Methods of statistical data processing and methods of traffic safety assessment have been applied.

### Materials and methods.

Over the last decade (2014-2023), the population of Almaty has increased by more than 32%, and the number of passenger cars registered with individual owners has increased by almost 10% and exceeded 500 thousand units. (table 1) [7]. According to the latest data from the Bureau of National Statistics, by the end of 2023, the population of Almaty was 2,228,515. In this study, these indicators are used as a predictor (means for predicting) of road accidents and the severity of their consequences.

In general, during the period under review, despite the increase in the number of registered passenger cars among individual owners in Almaty, the level of motorization shows a decrease, which is associated with population growth (table 1). The peak level of motorization occurred in 2014, i.e. 293 cars per 1000 people, in 2023 this figure was 207 cars.

Table 1 – Dynamics of population growth and the number of cars in Almaty for 2014-2023

Years	Population change in Almaty, thousands	Growth/Reduction, %	Availability of passenger cars in Almaty, thousand units	Growth/Reduction, %	Provision of passenger cars, car/1000 people.	Growth/Reduction, %
2014	1642334	8,93	475700	-3,76	293	-11,48
2015	1703482	3,72	432700	-9,04	259	-11,60
2016	1751308	2,81	425100	-1,76	246	-5,02
2017	1801993	2,89	428500	0,80	241	-2,03
2018	1854656	2,92	437000	1,98	239	-0,83
2019	1916822	3,35	436500	-0,11	231	-3,35
2020	1977011	3,14	433400	-0,71	223	-3,46
2021	2101485	6,30	428 848	-1,05	214	-4,04
2022	2161695	2,87	448238	4,52	207	-3,27
2023	2228515	3,09	524364	16,98	235	13,67

Source: Source: compiled based on data [7]

The growth in population and passenger cars causes several problems associated with an increase in load on the street and road network (SRN). Increasing traffic congestion, high density, and intensity of vehicle traffic reduce the efficiency of the functioning of road networks, and as a result contribute to the likelihood of an increase in the number of accidents [12, 13].

A comparative analysis of changes in the distribution of road accidents at the study site shows that over the past ten years, more than 44 thousand road accidents occurred, in which 1332 people died and 52,000 thousand people were injured (Figure 1) [8].

The dynamics of the number of accidents and road traffic deaths in Almaty has a wave-like character, from 2014 to 2020. there is a decrease in their number, and then from 2020 to 2023. - growth (Figure 1).

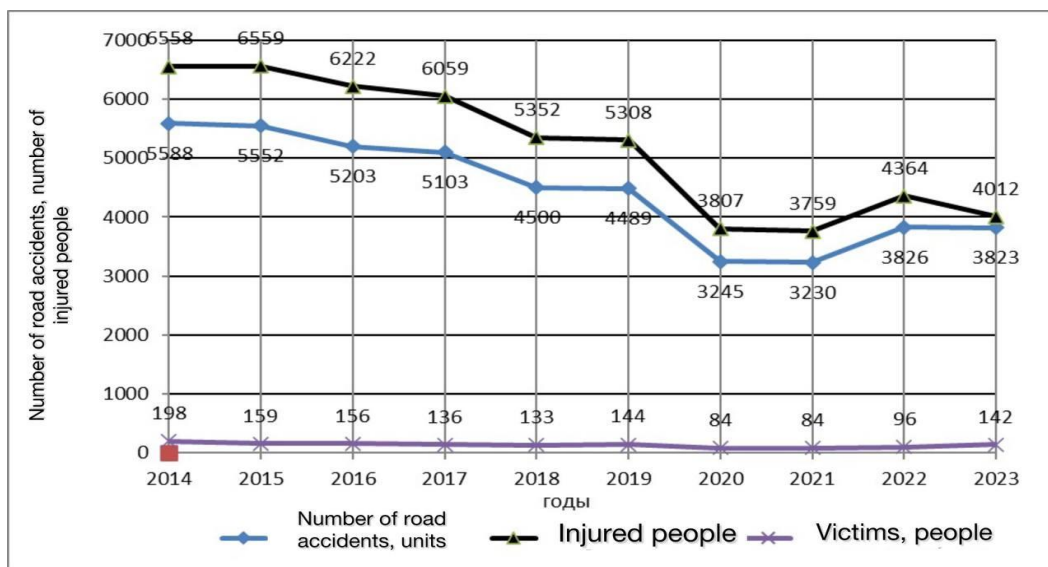


Figure 1 - Dynamics of changes in road safety indicators in Almaty (2014–2023 гг.)

Source: compiled based on data [8]

### Results.

The decrease in the number of RTA (road traffic accidents) in 2019 and 2020 can be explained by traffic restrictions during the pandemic. It should also be noted that the experience of using “Sergek” since 2019 on the Almaty traffic network has shown its effectiveness [14]. If in 2019 144 people died in road accidents, in 2020 this figure dropped to 84 people [8].

The main hotbeds of accidents occur in the central part (business part) of Almaty, which shows the relationship between the number of accidents and traffic density (Figure 2). The influence of the main transit highways on the distribution of road accidents in peripheral and central areas is noticeable. On main streets with heavy traffic (for example, Raiymbek Ave., Tolebi St.), the frequency of accidents is much higher and exceeds the accident rate on adjacent city streets.

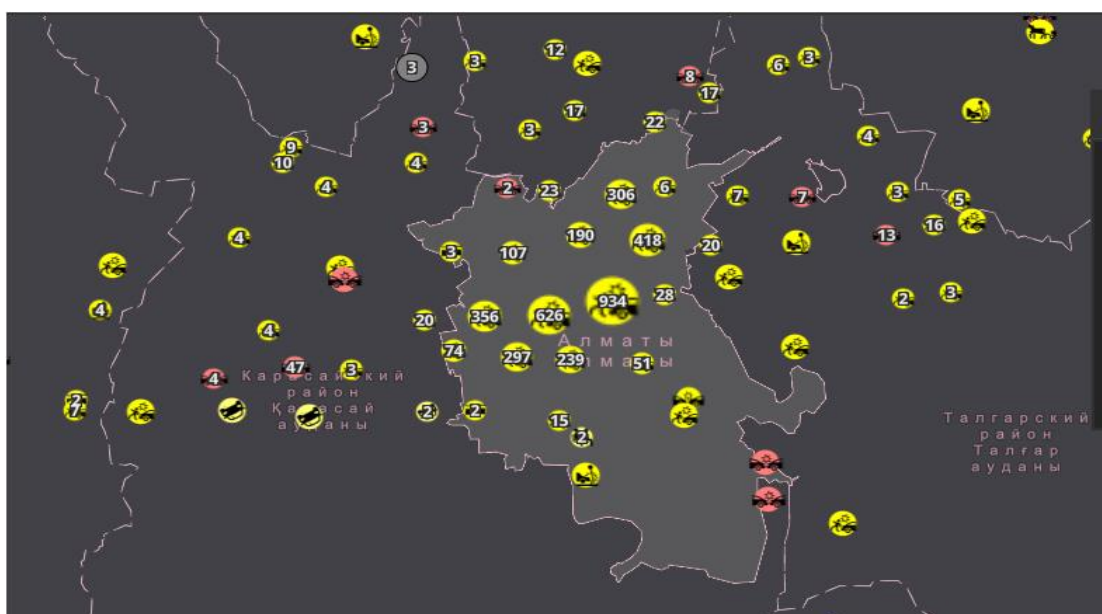


Figure 2 – Accident map (main focus of road accidents) in Almaty: situation for 2023

Source: Source: compiled based on data [8]

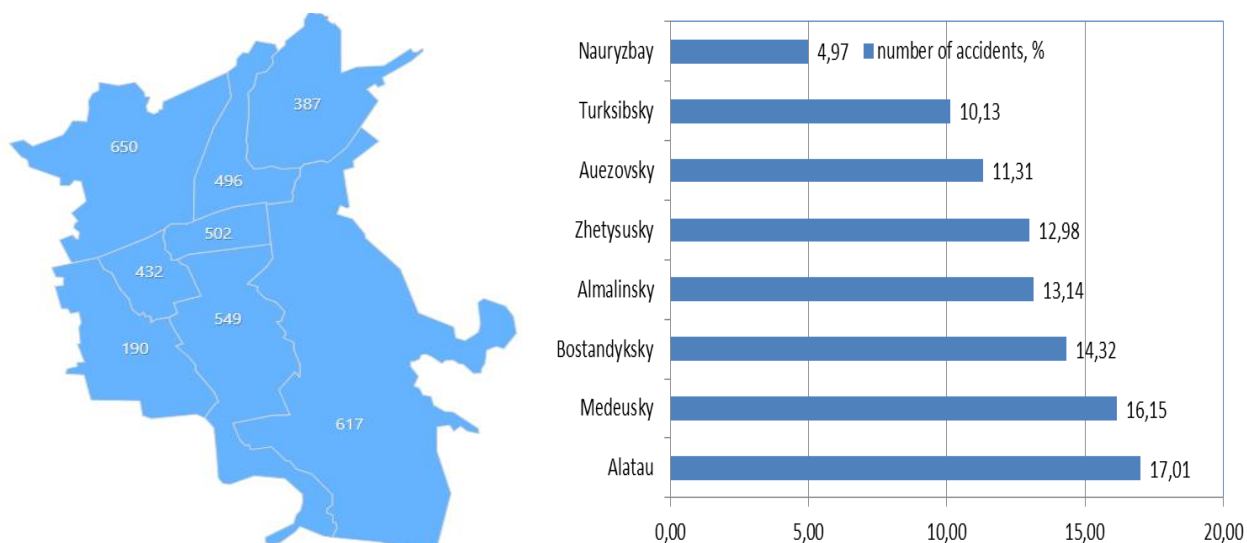


Figure 3 Distribution of road accidents by districts of Almaty for 2023  
 Source: Source: compiled based on data [8]

Consideration of the causes of accidents, contributing factors and other issues that are often not taken into account helps identify methods to further reduce the number and severity of accidents [15].

According to various studies on road accidents, several factors influence these accidents. International organizations recommend using the number of fatalities per 100 thousand population and the number of fatalities per 10 thousand vehicles for accident analysis. These indicators are called indicators of social and transport risks [16]. Risk factors are caused if their relationship with accidents can be changed by implementing one or more road safety measures that influence the risk factors [17].

When assessing the state of road safety, it is advisable to use parameters of statistical causes, such as risk factors, which allow you to determine the likelihood of an accident or injury. However, they should not be understood as necessary or sufficient for the occurrence of incidents.

In the course of this study, it was proposed to assess traffic safety according to the methodology given in [12] according to two parameters:

1) Traffic safety risk (TSR) is defined as the expected number of incidents, that is, the average number of incidents per unit of time that will ultimately occur under constant traffic intensity and conditions.

$$risk\_TSR = \frac{RTA(average\_number)}{units\_of\_time} \quad (1)$$

2) The public health risk is associated with the number of road traffic casualties and is defined as the number of casualties per 100,000 inhabitants per year:

$$risk\_of\_public\_health = \frac{The\_number\_of\_victims(injured)per\_year}{100000\_residents} \quad (2)$$

Due to the varying severity of the consequences of road accidents, for the comparative assessment and analysis of various road accidents, the accident severity coefficient ( $k_c$ ), defined as the ratio of the number of deaths to the number of injured over a certain period of time, is used:

$$k_c = \frac{\sum n_d}{\sum n_w} \quad (3)$$

The number of injured and killed in road accidents is a consequence of the increase in traffic intensity [12]. This indicator is general because it is the final link in a chain of causes, but health risk is a more general measure of risk than BD risk because it takes into account the volume of movement of the population.

The data in Table 2 shows the results of assessing the state of traffic safety in Almaty.

Table 2 - Analysis of road safety indicators in Almaty

Years	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Number of accidents, units	5588	5552	5203	5103	4500	4489	3245	3230	3826	3823
Number of victims, people	6756	6 718	6 378	6 195	5 485	5 469	3 891	3 843	4 460	4 154
injured	6558	6 559	6 222	6 059	5 352	5 308	3 807	3 759	4 364	4 012
perished	198	159	156	136	133	144	84	84	96	142
Road accidents per 100,000 population	345	332	311	287	246	238	167	161	179	172
Random change in the number of accidents, %	1,34	1,34	1,39	1,40	1,49	1,49	1,76	1,76	1,62	1,62
Database risk	15,309	15,210	14,254	13,980	12,328	12,298	8,890	8,849	10,482	10,473
Public health risk	0,0655	0,0655	0,0622	0,0605	0,0535	0,0530	0,0380	0,0375	0,0436	0,0401
Accident severity coefficient	0,03	0,02	0,03	0,02	0,02	0,03	0,02	0,02	0,02	0,04

Source: Source: compiled based on data [8]

When analyzing road accidents, a distinction is made between systematic and random road accidents [9]. It is known that systematic changes in the number of accidents are more important than random changes. Accidental accidents are influenced by the following reasons: climatic conditions, the psychophysical state of the driver, and malfunction of technical means of regulating traffic control. Systematic changes in the number of accidents are influenced by traffic volume and risk factors.

The random variation in the number of accidents can be calculated based on the total number of accidents (Table 2). This means that the random change in the number of accidents is calculated as a percentage of the total number of accidents, and it will be smaller the higher the number. For example: for road accidents in 2014:  $\sqrt{3823} \approx 62$ , that is 1,62%.

To accurately determine accidental accidents, it is necessary to apply probability analysis methods and take into account the area of accidental changes in the accident, which is determined by a confidence interval with probability  $P=0.96$  or 96% and is from 3823 to 3824.62 accidents in 2023.

Based on the selected parameters of the TR (traffic safety) evaluation for Almaty, the risk values for traffic safety and public health during the period under review were calculated. For example, for 2023 this was:

$$risk\_TSR = \frac{3823}{365} = 10,473;$$

$$risk\_of\_public\_health = \frac{4012}{100000} = 0,0401.$$

Thus, the values necessary for an objective assessment of the state of traffic safety in Almaty were obtained.

### **Discussion.**

Based on the selected indicators, the risk of road traffic accidents and the risk of consequences for public health for the city of Almaty were calculated. It has been established that there is no close connection between the social risk indicator and the level of motorization, measured by the number of cars per 1000 inhabitants. This makes it possible to assess the presence of other factors influencing the indicator under consideration. In addition, an increase in the value of risk parameters indicates an increase in the intensity of traffic flow and traffic conditions that do not correspond to it.

It should be taken into account that the state of road safety is associated with the risk of medical organizations (failure to provide timely medical assistance to victims of road accidents, the admission of persons with medical contraindications or restrictions to driving a vehicle to participate in traffic) and the risk of educational organizations (training candidates for the positions of drivers of mechanical vehicles).

It is known that any analysis of the causes of road accidents must include a list of measures to ensure road safety that could be implemented. Considering that the traffic intensity on the main streets is maximum for Almaty, it can be assumed that the transfer of transit traffic flows to them will improve the level of traffic safety. In addition, obviously, the better design and maintenance of streets (avenues) is a prerequisite for reducing accidents.

In the course of this study, without pretending to be complete, an attempt was made to show the steps necessary for an objective assessment of the state of road safety in Almaty. It has been demonstrated that the functional relationship between road accidents and critical situations is the topic of many modern studies and should be used in assessing the state of road safety.

### **Conclusions.**

This article discusses the possibilities of assessing risks for road users. The conducted analytical study of the state of the road safety system in Almaty is the starting point for subsequent work in this direction, which will allow stakeholders, primarily specialists, and experts, to obtain high-quality and reliable information about the main indicators characterizing the state of safety of road users. Based on reliable data on road accidents, it is possible to solve the problem of developing effective measures aimed at improving traffic conditions on the road network of Almaty.

## **REFERENCES**

- [1] Global Plan for the Decade of Action for RS 2021-2030 20 October 2021 Available at: <https://www.who.int/publications/m/item/global-plan-for-the-decade-of-action-for-road-safety-2021-2030> (accessed on 15 February 2024).
- [2] EU road safety policy framework 2021-2030 Next steps towards ‘Vision Zero’. Available at: <https://www.krbrd.gov.pl/wp-content/uploads/2022/05/EU-Road-Safety-Policy-Framework-2021-2030.pdf> (accessed on 15 February 2024).
- [3] <https://www.who.int/>

[4] Ibraev, K., Ibraev, A., Kapskij, D., Kot, E., Rubinskij, A., Bogdanovich, S. Analiz sostoyaniya bezopasnosti dorozhnogo dvizheniya v Respublike Kazakhstan Nauka i Tekhnika Tom 18, № 6 (2019). Available at: <https://doi.org/10.21122/2227-1031-2019-18-6-482-489>. Available at: <https://doi.org/10.21122/2227-1031-2019-18-6-482-489>

[5] Analysis of road traffic crashes in the State of Qatar. International Journal of Injury Control and Safety Promotion 26(2):1-9 May 2019/ Available at: <https://www.tandfonline.com/doi/pdf/10.1080/17457300.2019.1620289>

[6] Ibraev, K., Ibraev, A., Kapskij and others Analiz sostoyaniya bezopasnosti dorozhnogo dvizheniya v Respublike Kazakhstan Nauka i Tekhnika Tom 18, № 6 (2019). Available at: <https://doi.org/10.21122/2227-1031-2019-18-6-482-489> Available at: <https://doi.org/10.52167/1609-1817-2022-121-2-126-132>

[7] <https://stat.gov.kz> (accessed on 10 January 2024).

[8] <https://www.gov.kz/memleket/entities/pravstat?lang=ru> (accessed on 18 January 2024).

[9] Smeed's law and the role of hospitals in modeling traffic accidents and fatalities in Japan YT Lu, M Fukushima - Asia-Pacific Journal of Regional Science, 2019 – Springer Asia-Pacific Journal of Regional Science (2019) 3:319–332. Available at: <https://doi.org/10.1007/s41685-018-0097-x>

[10] Khasawneh, M.A., Al-Omari, A.A. and Ganam, B. “Forecasting traffic accidents in Jordan using regression techniques” Jordan Journal of Civil Engineering, Volume 12, No. 4, 2018. Available at: <https://www.researchgate.net/publication/322977386>

[11] Modeling road traffic fatalities in India: Smeed's law, time invariance and regional specificity RV Ponnaluri - IATSS research, 2012 – Elsevier. Available at: <https://daneshyari.com/article/preview/1104624.pdf>

[12] Reshetnikov E.B., Abramova L.S., Chernobaev N.S., Shirin V.V. Analiz organizatsii dorozhnogo dvizheniya v central'noj chasti goroda Khar'kova. Available at: <https://cyberleninka.ru/article/n/analiz-organizatsii-dorozhnogo-dvizheniya-v-tsentralnoy-chasti-goroda-harkova>

[13] Zhandarbekova A.M., Murzabekova K.A. Astana қаласының зһол қозғалысы қауіпсіздігінің зһағдајын талдау ҚазККА Хабаршысы № 1 (124), 2023. Available at: <https://doi.org/10.52167/1609-1817-2023-124-1-128-135>

[14] Vse, chto vy khoteli znat' o «SergeK». Available at: <https://bluescreen.kz/vsio-chto-vy-khotieli-znat-o-sierghiek-no-stiesnialis-sprosit> (accessed on 10 March 2024).

[15] Ataev P.G., Geller R.M., Lipatkin D.V. Metodika analiza dorozhno-transportnykh proisshestvij s postradavshimi na primere Sankt-Peterburga/ «Transport Rossijskoj Federacii» № 5 (84) 2019. Available at: <file:///C:/Users/Asus-pc/Downloads/metodika-analiza-dorozhno-transportnyh-proisshestvij-s-postradavshi>

[16] Nataliia Semchenko, Oleksii Stepanov, Olha Kholodova, and Maryna Buhaiova “Research of the world trend of risks accident rate” Cite as: AIP Conference Proceedings 2439, 020020 (2021). Available at: <https://doi.org/10.1063/5.0068455>

[17] Ataev P.G., Geller R.M., Lipatkin D.V. Metodika analiza dorozhno-transportnykh proisshestvij s postradavshimi na primere Sankt-Peterburga/ «Transport Rossijskoj Federacii» № 5 (84) 2019. Available at: <https://cyberleninka.ru/article/n/institutsionalnye-novatsii-i-matem>

**Асель Жандарбекова**, т.ғ.к., аға оқытушы, С.Сейфуллин атындағы Қазақ агротехникалық зерттеу университеті, Астана, Қазақстан, [azhandarbekova@bk.ru](mailto:azhandarbekova@bk.ru)

**Кенжегуль Мурзабекова**, т.ғ.к., профессор, Алматы менеджмент университеті, Алматы, Қазақстан, [mkaken@mail.ru](mailto:mkaken@mail.ru)

## АЛМАТЫ ҚАЛАСЫНЫҢ ЖОЛ ҚОЗҒАЛЫСЫ ҚАУІПСІЗДІГІНІҢ ЖАҒДАЙЫ

**Аңдатпа.** Жол қозғалысы қауіпсіздігін қамтамасыз ету мәселелері бүгінде жаһандық және ұлттық ауқымда өзекті болып табылады. Ірі қалалардағы жазатайым оқиғалармен күрестің әлеуметтік маңызы зор мемлекеттік іс. Жол қозғалысы қауіпсіздігіне әсер ететін және жол желісінің өткізу қабілетін арттыратын шамалардың бірі халық санының өсуі мен автокөлікпен қамтылу деңгейі болып табылады. Қарастырылып отырған кезеңде Алматы қаласында халық саны бойынша да, жеке меншік иелерінің тіркелген жеңіл автокөліктерінің саны бойынша да айтарлықтай өсім байқалды.

Бұл жұмыста тәуекел факторлармен Алматы қаласындағы жол қозғалысы қауіпсіздігінің жағдайын бағалау мүмкіндігі қарастырылған. Зерттеуде 2014-2023 жылдар аралығында жарақат алған 44 559 жол-көлік оқиғасы туралы деректер талданды.

**Түйінді сөздер.** Алматы қаласы, халық саны, автокөлікпен қамтылу деңгейі, жол-көлік оқиғалары, қозғалыс қауіпсіздігі тәуекелі, халық денсаулығына тиетін зардаптардың тәуекелі.

**Асель Жандарбекова**, к.т.н., старший преподаватель Казахский агротехнический исследовательский университет имени С. Сейфуллина, Астана, Казахстан, [azhandarbekova@bk.ru](mailto:azhandarbekova@bk.ru)

**Кенжегуль Мурзабекова**, к.т.н., профессор, Алматы менеджмент университет, Алматы, Казахстан, [mkaken@mail.ru](mailto:mkaken@mail.ru)

## СОСТОЯНИЕ БЕЗОПАСНОСТИ ДОРОЖНОГО ДВИЖЕНИЯ ГОРОДА АЛМАТЫ

**Аннотация.** Вопросы обеспечения дорожной безопасности сегодня имеют актуальное значение, как в мировом, так и в национальном масштабе. Борьба с аварийностью в крупных городах имеет большую социальную значимость и является делом государственной важности. Одним из критериев, влияющих на безопасность дорожного движения, повышения пропускной способности улично-дорожной сети являются рост численности населения и уровень автомобилизации. За рассматриваемый период г. Алматы стала свидетелем значительного увеличения как с точки зрения роста населения, так и количества зарегистрированных легковых автомобилей индивидуальных владельцев.

В данной работе рассмотрена возможность оценки состояния безопасности дорожного движения в г. Алматы факторами риска. В рамках данного исследования проанализированы данные по 44559 дорожно-транспортным происшествиям с пострадавшими за период 2014–2023 гг.

**Ключевые слова.** г. Алматы, численность населения, уровень автомобилизации, дорожно-транспортные происшествия, риск безопасности движения, риск здоровья населения.

\*\*\*\*\*

Received: 15 April 2024; accepted: 30 June 2024