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IMPROVING ROAD TRAFFIC SAFETY IN UZBEKISTAN THROUGH INNOVATIVE TECHNOLOGIES AND INTELLIGENT TRANSPORT SYSTEMS

Turaboev Holmurod Rustamjon ugli
Senior teacher, Andijon state technical institute,
E-mail: holmurodturaboyev@gmail.com

Abstract: Road traffic accidents (RTAs) remain one of the most significant public safety challenges in the Republic of Uzbekistan, causing substantial human and socio-economic losses. According to official statistics, 5,895 road traffic accidents were recorded between January and September 2025, resulting in 1,303 fatalities and 4,592 injuries. A considerable proportion of these accidents led to fatal or severe consequences, highlighting the need for more effective road safety interventions. This study examines the major factors contributing to road traffic accidents in Uzbekistan and evaluates contemporary approaches to improving road safety. Particular attention is given to the application of advanced vehicle safety technologies, Intelligent Transportation Systems (ITS), automated traffic enforcement, and international best practices aimed at reducing accident frequency and severity. The study also emphasizes the importance of integrating technological innovation, modern road infrastructure, effective legal frameworks, and responsible driver behavior into a comprehensive road safety strategy. The findings suggest that adopting evidence-based policies and internationally recognized road safety practices can significantly contribute to reducing road traffic accidents, protecting human life, and improving the overall safety and sustainability of the national transportation system.

Keywords words and phrases: Road traffic accidents; Road safety; Traffic safety; Intelligent Transportation Systems (ITS); Vehicle safety technologies; Automatic Emergency Braking (AEB); Lane Departure Warning (LDW); Traffic Sign Recognition (TSR); Road infrastructure; GIS-based accident analysis; Vision Zero; Speed management; Traffic law enforcement; Uzbekistan.

Introduction

A substantial proportion of road traffic accidents (RTAs) in the Republic of Uzbekistan occur within or in the vicinity of populated areas, where the majority of traffic-related fatalities and injuries are also concentrated. This trend has intensified scholarly interest in the analysis of accident patterns in urban environments. Identifying the factors contributing to RTAs, understanding their underlying causes, and developing effective preventive strategies are therefore of critical importance for improving road safety.

In recent years, the Government of Uzbekistan has implemented a range of legislative, organizational, and infrastructural measures aimed at reducing the incidence of road traffic accidents. Despite these efforts, the overall effectiveness of these interventions remains limited, as the number of accidents and their consequences continue to represent a significant public safety concern. A considerable proportion of drivers still fail to comply with traffic regulations, thereby increasing the likelihood of traffic collisions.

In response to this situation, some researchers and policy experts have advocated for stricter penalties for traffic violations. However, international experience suggests that increasing the severity of punishment alone is insufficient to achieve sustainable improvements in road safety. Long-term reductions in accident rates require the development of a strong traffic safety culture, enhanced legal awareness among all road users, and consistent compliance with traffic regulations [1].

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The current statistical evidence further supports this conclusion. According to the Road Traffic Safety Service of the Public Security Department of the Ministry of Internal Affairs of the Republic of Uzbekistan, 51.4% of all registered road traffic accidents are attributed to subjective factors, primarily resulting from drivers' non-compliance with traffic regulations. Between January and September 2025, a total of 5,895 road traffic accidents were officially recorded, resulting in 1,303 fatalities and 4,592 injuries. Analytical studies indicate that one of the principal causes of the increasing number of RTAs is the limited deterrent effect of the existing legal framework and the insufficient certainty of punishment for traffic violations.

These findings demonstrate that improving road traffic safety requires a comprehensive approach extending beyond engineering and infrastructural measures. Although road design improvements and modern traffic management systems are essential components of road safety policy, they should be complemented by more effective legal and institutional mechanisms. In particular, the existing system of administrative liability for traffic violations does not provide a sufficiently strong deterrent effect, preventive enforcement remains inadequate, and systematic risk-based approaches to violation prevention have not yet been fully institutionalized. Consequently, irresponsible driving behavior continues to be a major contributing factor to road traffic accidents.

Accordingly, drawing upon the best practices adopted in developed countries, greater emphasis should be placed on preventive rather than exclusively punitive measures. Administrative sanctions should be proportionate to the severity of traffic violations while ensuring the certainty and consistency of their enforcement. Furthermore, the large-scale deployment of intelligent transportation systems (ITS), including automated photo and video enforcement technologies, artificial intelligence-based traffic monitoring platforms, and digital law-enforcement mechanisms, can substantially reduce the influence of the human factor, improve compliance with traffic regulations, and ultimately contribute to a sustainable reduction in road traffic accidents and their associated social and economic costs.

Methodology. The speed limit for motor vehicles in urban areas and populated settlements of the Republic of Uzbekistan has recently been reduced from 70 km/h to 60 km/h. This regulatory measure was introduced in response to the continuous increase in road traffic accidents (RTAs) reported across the country, many of which result in fatalities. Reports published by national media frequently highlight the growing number of serious traffic accidents, reflecting increasing public concern regarding road safety, the quality of transport infrastructure, and the level of road safety awareness among the population, particularly children and young people.

Previous studies have consistently demonstrated a strong relationship between vehicle speed and both the probability and severity of road traffic accidents. A 1% increase in the average travel speed is associated with approximately a 4% increase in the risk of fatal crashes and a 3% increase in the risk of serious injury crashes. Likewise, the fatality risk for pedestrians rises substantially with increasing vehicle speed. For example, the probability of pedestrian death following a collision at 65 km/h is approximately 4.5 times higher than at 50 km/h. Furthermore, in side-impact collisions occurring at 65 km/h, the probability of fatal injury to drivers and passengers reaches approximately 85%.

Conversely, reducing the average vehicle speed by only 5% can decrease the number of fatal road traffic accidents by nearly 30%. The underlying reason is that higher travel speeds require significantly longer stopping distances, thereby reducing the driver's available reaction time and increasing the likelihood of collisions. Under dry pavement conditions, a vehicle travelling at 70 km/h covers approximately 18–20 m during the driver's perception–reaction time, while the total stopping distance is approximately 47 m. In addition to speed, several other factors influence crash occurrence and severity, including alcohol consumption, roadway geometry and pavement condition, traffic

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density, and adverse weather conditions. Therefore, improving road safety requires not only the implementation of appropriate speed-limit regulations but also effective enforcement, scientifically based roadway design, and the adoption of modern vehicle safety technologies [2].

This study adopts a comprehensive analytical approach to investigate the factors contributing to road traffic accidents and to evaluate preventive measures. Accident causation is examined through the analysis of traffic characteristics, roadway infrastructure, and environmental conditions. Geographic Information System (GIS) technologies are employed to identify accident hotspots by mapping the spatial distribution of road traffic accidents and analyzing their frequency. The identification of high-risk locations provides a scientific basis for evaluating existing road infrastructure, optimizing traffic control devices, and implementing targeted engineering interventions. Similar GIS-based approaches have been successfully applied in many developed countries to identify hazardous road sections and develop evidence-based countermeasures for improving road safety. Applying these methods in Uzbekistan is expected to facilitate the identification of accident-prone locations and support the implementation of effective measures to reduce future road traffic accidents [3].

Results and Discussion. According to reports published by the World Health Organization (WHO), the safety and mobility of pedestrians can be significantly improved through the provision of dedicated pedestrian infrastructure, including sidewalks, signalized crossings, and curb ramps. The reports further recommend the installation of speed limit signs and designated Safe School Zone signs within a 100-meter radius of schools to enhance the safety of children. These measures are considered essential components of sustainable urban transport systems and play a critical role in reducing pedestrian injuries and fatalities.

The WHO also reports that, between 2019 and 2021, several countries allocated between 1% and 5% of their Gross Domestic Product (GDP) to transport infrastructure development. Such investment provides a substantial opportunity to develop multimodal transport systems and infrastructure that ensure the safety of all road users. Furthermore, investments in pedestrian infrastructure contribute not only to reducing the number of road traffic accidents but also to increasing physical activity, decreasing environmental pollution, and improving the overall quality of urban life. Infrastructure designed specifically for vulnerable road users—including children, older adults, and persons with disabilities—such as accessible sidewalks, well-illuminated pedestrian crossings, and digital warning systems, has been shown to significantly enhance road safety.

In addition, the experience of developed countries demonstrates the effectiveness of implementing road safety policies based on the Vision Zero concept, which aims to eliminate fatalities and serious injuries resulting from road traffic accidents. Within this framework, advanced technologies such as intelligent traffic signal control, automated speed enforcement cameras, and artificial intelligence (AI)-based traffic management systems have become essential components of modern transport infrastructure.

These findings indicate that the implementation of comprehensive pedestrian safety measures, together with advanced technological solutions, constitutes an integral element of effective road safety management and contributes to long-term social and economic sustainability [4].

The WHO further emphasizes that a substantial proportion of road traffic accidents is associated with deficiencies in road infrastructure. Consequently, improving roadway design and integrating intelligent transport technologies should be considered fundamental strategies for enhancing traffic safety.

In recent years, the automotive industry has introduced numerous advanced technologies aimed at improving road safety and preventing road traffic accidents. From the development of autonomous

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vehicles to sophisticated collision avoidance systems, modern vehicles have evolved into intelligent transportation platforms capable of actively protecting drivers, passengers, and vulnerable road users.

One of the most widely implemented safety technologies is the Automatic Emergency Braking (AEB) system. This technology utilizes cameras, radar, and other sensors to detect obstacles ahead of the vehicle. When the driver fails to respond appropriately to an imminent collision, the system automatically applies the brakes, thereby substantially reducing the likelihood and severity of crashes.

Another important innovation is the Lane Departure Warning (LDW) system. Using cameras and onboard sensors, this system continuously monitors the vehicle's position within the traffic lane and warns the driver if the vehicle unintentionally deviates from its lane. The technology is particularly effective in situations involving driver fatigue or distraction and has proven successful in preventing lane-departure-related crashes.

Furthermore, Traffic Sign Recognition (TSR) technology has become increasingly common in modern vehicles. Through the integration of cameras and image-processing software, TSR systems automatically identify and interpret traffic signs, providing drivers with real-time information regarding speed limits, prohibitions, and other traffic regulations. By improving drivers' awareness of road rules and assisting compliance with traffic regulations, these systems contribute significantly to reducing the risk of road traffic accidents [5].

Conclusion. Despite the rapid development and implementation of advanced vehicle safety technologies, the primary responsibility for ensuring road traffic safety continues to rest with the driver. Although modern technological solutions can effectively prevent or mitigate certain hazardous situations, they cannot replace careful driving, sound judgment, and responsible driving behavior.

Overall, contemporary accident prevention technologies represent a significant advancement in vehicle safety. Systems such as intelligent driver assistance technologies, automated emergency braking, lane departure warning, and traffic sign recognition have demonstrated considerable potential for reducing crash frequency and severity, thereby saving human lives. Nevertheless, drivers must be aware of the capabilities and limitations of these technologies and continue to play an active role in maintaining road safety.

In parallel with technological progress, it is essential to modernize the road infrastructure of the Republic of Uzbekistan in accordance with internationally recognized standards and best engineering practices. The adoption of globally accepted road design methodologies and the rapid implementation of innovative infrastructure solutions will facilitate the development of a safer, more efficient, and sustainable transportation system.

Furthermore, ensuring road traffic safety requires a balanced integration of technological innovations and human factors. Improving drivers' knowledge, professional competence, and sense of responsibility, together with promoting a strong culture of compliance with traffic regulations, should remain a national priority alongside technological advancement. Continuous public awareness campaigns, the introduction of modern driver education programs, and the enhancement of driver training and retraining systems are expected to make a substantial contribution to reducing road traffic accidents.

In addition, the gradual implementation of digital technologies, Intelligent Transportation Systems (ITS), automated traffic management, and real-time monitoring systems should be prioritized in the development of the national road transport infrastructure. Roads, intersections, and pedestrian facilities designed in accordance with international standards can provide a safer and more accessible environment for all categories of road users.

In conclusion, the findings of this study indicate that a comprehensive road safety strategy integrating advanced technologies, high-quality transport infrastructure, effective legal and

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institutional frameworks, and a strong culture of responsible driving offers the most sustainable approach to reducing road traffic accidents in Uzbekistan. The adoption of international best practices, supported by evidence-based transport policies and intelligent transportation technologies, will contribute significantly to protecting human life and improving the overall safety and efficiency of the national road transport system.

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