MAIN PROBLEMS ARISING IN ENSURING THE EFFECTIVE MOVEMENT OF SPECIAL VEHICLES AND THEIR INNOVATIVE SOLUTIONS

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Abstract. This article presents an analysis of current problems arising in the organization of efficient movement of special vehicles. Disproportionate urban infrastructure, traffic congestion and traffic complexity on central roads, shortcomings in the system of prioritizing special traffic, as well as existing shortcomings and problems in the use of old types of management and communication facilities will be studied. At the same time, the article shows ways to solve these problems through innovative technologies - smart transport systems, GPS monitoring, artificial intelligence, and autonomous vehicles. The importance of introducing modern technologies and control methods to increase the efficiency of special vehicles is emphasized.

Keywords: special vehicles, infrastructure, traffic light, intelligent systems, traffic safety, road culture**.**

Annotatsiya. Ushbu maqolada maxsus transport vositalarining samarali harakatlanishini tashkil etishda yuzaga keladigan dolzarb muammolar tahlili keltirilgan. Nomutanosib shahar infratuzilmasi, Markaziy yo'llarda tirbandlik va transportning murakkabligi, maxsus transport vositalariga ustuvor ahamiyat berish tizimidagi kamchiliklar, shuningdek, eski turdagi boshqaruv va aloqa vositalaridan foydalanishdagi mavjud kamchiliklar va muammolar o'rganiladi. Shu bilan birga, maqolada ushbu muammolarni innovatsion texnologiyalar - aqlli transport tizimlari, GPS monitoringi, sun'iy intellekt va avtonom transport vositalari orqali hal qilish yo'llari ko'rsatilgan. Maxsus transport vositalarining samaradorligini oshirish uchun zamonaviy texnologiyalar va boshqarish usullarini joriy etish muhimligi ta'kidlangan.

Kalit so'zlar: maxsus transport vositalari, infratuzilma, svetofor, aqlli tizimlar, yo'l harakati xavfsizligi, yo'l madaniyati.

Аннотация. В данной статье представлен анализ актуальных проблем, возникающих при организации эффективного движения спецтранспорта. Будут изучены непропорциональная городская инфраструктура, транспортные заторы и сложность движения на центральных дорогах, недостатки в системе приоритизации специальных перевозок, а также существующие недостатки и проблемы в использовании старых типов средств управления и связи. В то же время в статье показаны пути решения

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этих проблем с помощью инновационных технологий - интеллектуальных транспортных систем, GPS-мониторинга, искусственного интеллекта и автономных транспортных средств. Подчеркивается важность внедрения современных технологий и методов управления для повышения эффективности специальных транспортных средств.

Ключевые слова: специальные транспортные средства, инфраструктура, светофор, интеллектуальные системы, безопасность дорожного движения, культура дорожного движения.

Introduction

In the context of the rapid development of modern urban infrastructure and the rapid increase in the number of vehicles, the effective organization of the movement of special vehicles is one of the pressing issues of today. The promptness of emergency medical services, fire safety, and law enforcement plays an important role not only in preserving human life and health, but also in ensuring an atmosphere of security and trust in society [1].

Nevertheless, at present, there are a number of problems in ensuring the priority of the movement of special vehicles on central roads. In particular, such factors as traffic jams, the disproportion of road infrastructure to the number of cars in urban conditions, the obsolescence of transport management systems and the improper functioning of priority signs, and the culture of the population and drivers limit their speed [2].

Methodology. Special vehicles are types of transport that are specially equipped for performing certain tasks and are at the disposal of state services and certain organizations. They are distinguished by their importance in ensuring public safety, providing medical assistance, extinguishing fires, maintaining law and order, utilities, and other emergencies [3-5].

The city of Andijann has been rapidly developing in recent years as one of the important administrative, industrial, and transit centers of Uzbekistan. Population growth, increased road transport, and infrastructure changes are putting significant pressure on the city's internal transport system. In particular, there are a number of problems in ensuring the effective movement of special vehicles, such as ambulances, fire safety, and police [6].

In the city of Andijan, there is no single digital system for coordinating the movement of special vehicles. Emergency medical services, the Ministry of Emergency Situations, and other services independently determine their routes, but their real-time coordination with traffic authorities is insufficient. This, if necessary, limits speed and maneuverability. If we dwell on the existing problems in ensuring the effective movement of special vehicles in the city of Andijan:

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There is no single digital system for coordinating the movement of special vehicles in the city of Andijan. Emergency medical services, the Ministry of Emergency Situations, and other services independently determine their routes, but their real-time coordination with traffic authorities is insufficient. This limits speed and maneuverability when necessary [7].

In addition, the current rules establishing a special priority for the preschool education system (for example, the automatic "green wave" at the traffic light) are practically not applied or are rarely applied [8].

Problems with the road infrastructure of the city of Andijan. The main streets in the center of the city of Andijan are currently narrowed on both sides and are not sufficiently convenient for traffic flow. Many roads do not have dedicated lanes for special vehicles.

In some intersections, traffic lights still operate on outdated equipment, most of which do not have real-time control or automatic adjustment. Especially during wedding ceremonies, public events, or in areas adjacent to markets, traffic congestion will increase.

Driver behavior and traffic jams. The culture of giving way to special vehicles among road users in Andijan is insufficiently formed. Many drivers do not follow the rules of yielding or do not take into account the approach of an emergency vehicle. This is especially noticeable during periods of high traffic congestion, at night, and in areas with poorly lit streets.

In addition, incorrect parking , especially near markets, significantly slows down MTV movement.

Technological shortage. Transport monitoring systems based on IoT and GPS have not yet been widely implemented in Andijan. There is no integrated information system for determining the location of ambulances or fire services vehicles within the city in real time. This prevents other services and drivers from anticipating their approach.

Also, until now, the traffic light system and traffic management have not been integrated with AI technologies. This significantly reduces the ability to manage traffic flow in real time.

Table 1

Country comparison chart for adverse effects of special vehicle delays

State	Average delay time	Number of deaths	Severe complications (in percent)	Comment on the negative consequences of delay

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USA	8-12 minutes	More than 2,100 deaths per year	13.2% traffic accidents	For every 1 minute of delayed action, the patient's chances of survival are reduced, with more than 2,100 deaths recorded annually (CDC, 2023).
Russia	15-20 minutes	More than 4,500 emergency deaths	18% emergency situations	The response time in the regions in most cases is 15-20 minutes, which increases mortality and severe complications (Rosstat, 2023).
Turkey	10-14 minutes	More than 1,300 deaths per year	11% due to ambulance delays	The percentage of deaths and complications due to ambulance delays is high, especially in rural areas (Ministry of Health of Turkey, 2023).
Germany	7-10 minutes	800-1,000 average annual deaths	Complications due to 9% delay	Europe has a developed medical system, but delays are associated with mortality and complications (Robert Koch Institute, 2023).

To reduce the negative consequences of the above-mentioned problems, world experience, in particular, the experience of developed countries, the USA, Singapore, Germany, Turkey, and Russia, shows that modern technologies, clear legal mechanisms, automated control systems, and the legal culture of the population are of decisive importance in ensuring the effective movement of special vehicles. For example, in Singapore, emergency services have the ability to control the movement of each special vehicle through a "smart traffic management system" and a "real-time coordination center." In Germany, traffic delays are minimized using methods such as "Notfallspur" (emergency lane). As a result of

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these approaches, the average arrival time of special vehicles in these countries is about 6-8 minutes, which corresponds to the standards established by the World Health Organization.

In conclusion, it can be said that ensuring the effective movement of special vehicles in the city of Andijan is a pressing and vital problem. This problem is closely related not only to infrastructural shortcomings in the urban transport system, but also to management, cultural, and technological deficiencies. It has been observed and proven in numerous experiments that delays in the movement of special vehicles can be fatal to human life in such conditions as cardiac arrest, bleeding, stroke, and trauma. According to the World Health Organization (WHO), a 1-minute delay in emergency situations reduces the patient's chances of survival by 7-11%. This fact requires considering the minimization of delays not just as a transportation issue, but as a problem of medical and social security.

As a solution to the above-mentioned urgent problems, we can cite the following recommendations:

1. Implementation of an intelligent transport system will automate the movement, navigation routes, and priorities of special vehicles in real time.

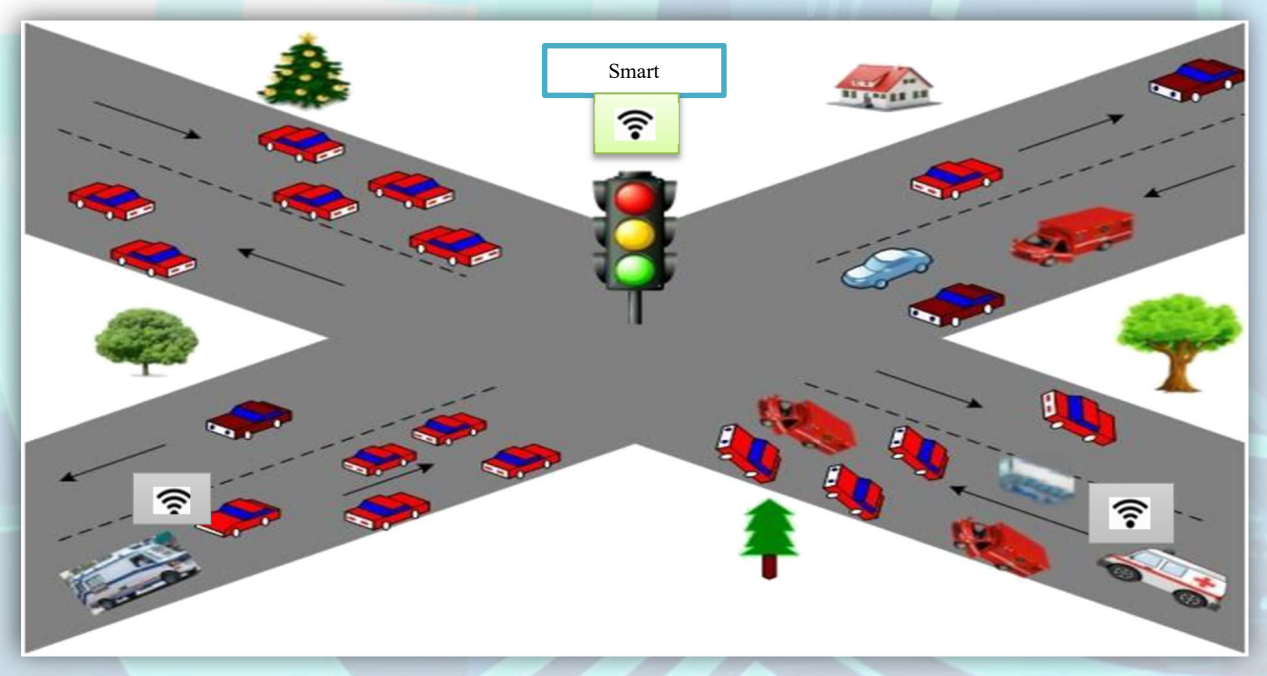


Figure 1. Intelligent transport systems in Central city of Andijan.

2. **Raising awareness and culture of the population,** the use of innovative technologies in the process of traffic flow management does not give the expected result. It is necessary to raise the culture of the movement's participants, conduct public awareness campaigns in this regard, and regularly organize special training

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sessions in educational institutions and classes included in driver training programs.

3. **Technical modernization of special vehicles**, i.e., centralization of their control and coordination by equipping them with GPS, automatic warning systems, and communication modules.

In addition, taking into account the specific urban planning features of the city of Andijan (narrow streets, historical centers, proximity of the traffic zone to the center), it is advisable to develop mobile duty stations **adapted to local conditions, alternative routes** and a system of temporary restrictions.

Conclusion. Thus, the combination of a scientifically based approach, technological integration, and legal and moral measures ensures the effective movement of special vehicles in the city of Andijan. This not only improves the quality of service but, most importantly, plays an invaluable role in preserving human life, health, and safety.

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