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FORMATION OF ROAD CADASTRAL DATA BASED ON MODERN GEOINFORMATION TECHNOLOGIES

https://doi.org/10.5281/zenodo.18031977

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ABSTRACT.*This article examines the formation and management of automobile road cadastral data based on modern geoinformation technologies. The study emphasizes the growing importance of Geographic Information Systems (GIS), digital mapping, remote sensing, GPS, and automated monitoring technologies in improving the efficiency, safety, and sustainability of road infrastructure. Special attention is given to the integration of cadastral data for road planning, placement, monitoring, and management processes under conditions of rapid urbanization and increasing transport demand.*

The research highlights the role of GIS in visualizing road networks, analyzing traffic flows, identifying accident-prone areas, and supporting decision-making in infrastructure development. The article also analyzes the importance of continuously updating cadastral databases using real-time data, artificial intelligence, and automated systems to ensure the accuracy and reliability of information. Furthermore, international experience in road cadastral management is reviewed, and practical recommendations are proposed for the development of an effective and sustainable road infrastructure system in Uzbekistan.

The findings demonstrate that the integrated application of modern geoinformation technologies significantly enhances the operational efficiency of road management, reduces traffic risks, optimizes resource utilization, and supports environmentally sustainable development.

KEYWORDS. *Geographic Information Systems (GIS), road cadastre, automobile roads, digital mapping, transport infrastructure, remote sensing, GPS technologies, road management, sustainable development.*

The location of automobile roads and their effective management is currently one of the key elements of the transport system of any country. This process is of particular importance in conditions of increasing urbanization, accelerated economic activity, and rapid development of modern technologies. Although road planning was previously based on relatively simple approaches, today this field has become significantly

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more complex and encompasses close interrelations with many other sectors.

In recent years, information technologies have been widely introduced to improve the efficiency of road management. Geographic Information Systems (GIS) enable the visualization of road and infrastructure data in cartographic form and provide significant support in planning and monitoring traffic flows. For instance, GIS makes it possible to obtain information on traffic density, congestion, accidents, and other road-related events. Based on this data, effective traffic management and planning can be achieved. GIS technologies allow national and municipal authorities to plan road networks more efficiently and to evaluate existing and proposed projects. In addition, specialized software tools are used to assess the efficiency of existing infrastructure along specific routes.

The main advantage of GIS technologies lies in the ability to collect detailed and accurate information about each geographic object and to analyze it comprehensively. In road placement, GIS enables the integration of various factors such as natural conditions, socio-economic characteristics of the area, environmental factors, and transport demand. By presenting all these parameters in a single system and analyzing them collectively, it becomes possible to select the most optimal solution. This process helps identify the most suitable areas for road construction, save necessary resources, ensure environmental safety, and develop economically viable options.

Environmental and social issues also play a crucial role in the road design process. This includes environmental protection, reduction of air pollution, and preservation of green areas. At the same time, road infrastructure must be aimed at ensuring human safety. From an urban planning perspective, the proximity of roads to residential areas and the availability of pedestrian sidewalks and bicycle lanes are important factors in improving the quality of life of the population. Taking these elements into account in road projects helps ensure public interests and infrastructure sustainability.

The creation and application of information databases are essential prerequisites for effective road management. These databases include data on vehicle movement, traffic accidents, road conditions, and many other parameters. Through such databases, it is possible to monitor the current state of roads, analyze accident statistics, and observe traffic flows. The collected data plays a significant role in infrastructure planning and road optimization.

The combined application of these principles and modern technologies significantly enhances the efficiency of road planning and management. As a result, the stability of transport systems improves, traffic accidents decrease, resource efficiency increases, and environmental protection efforts are

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strengthened. Planning and managing roads based on modern approaches is one of the key factors in strengthening the national economy, improving public welfare, and increasing the level of urbanization. In this context, international transport corridors, global road networks, and the placement of logistics centers are also of particular importance in increasing the efficiency of road systems. Although this sector involves certain complexities, modern technologies and innovative approaches enable its further development and advancement to a higher level in the future.

One of the most important aspects of road planning and management is the road placement process. Proper placement of road networks not only ensures efficient vehicle movement but also positively affects overall economic development, tourism, trade, and service sectors. This multi-stage process begins with a thorough analysis of the social and economic potential of territories. When developing a placement plan, existing road networks, their capacity, population density, and proximity to centers of economic activity are taken into account. For example, in densely populated areas, it is essential to accurately assess the demand for roads and related infrastructure. Accordingly, roads are planned to meet economic and social needs.

In recent decades, the role of technology in road planning and management has increased significantly. The development of information technologies and artificial intelligence has brought a fundamental transformation to the efficiency of transport systems. GIS enables fast and accurate analysis of road locations and their characteristics. Through continuous monitoring and analysis of traffic parameters, this technology helps optimize transport infrastructure. For instance, accident-prone areas can be identified using GIS, and safety measures can be enhanced. Another important feature of GIS is real-time data updating, which allows continuous monitoring of road conditions and timely implementation of maintenance or reconstruction measures.

The cadastral system serves as the primary source of information for identifying the overall map and technical condition of main roads. Its main function is to collect detailed data on road width, length, pavement type, interconnections between road networks, traffic flows, and safety elements. The road infrastructure database supports government authorities in planning, constructing new roads, or expanding existing ones. Cadastral data enables the development of infrastructure strategies and facilitates the attraction of private sector and international partners to infrastructure projects.

Modern technologies play a key role in forming cadastral systems. GIS allows road infrastructure to be represented on digital maps and enables comprehensive analysis. The use of GIS software facilitates accurate data acquisition, analysis, and application in infrastructure planning. In addition, cadastral data can

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be generated using modern drones and GPS technologies, which provide high-precision data collection and real-time updates. Satellite data and 3D scanning technologies contribute to ensuring the accuracy and relevance of cadastral information. Managing road infrastructure based on digital mapping technologies not only improves transport efficiency but also enhances the economic feasibility of planned projects.

Continuous updating of cadastral data is essential in managing internal highways due to the dynamic nature of transport infrastructure. Artificial intelligence and automated monitoring systems are implemented to maintain data relevance and enable real-time observation. Surveillance cameras and sensors monitor traffic flow changes, infrastructure defects, maintenance needs, and accident statistics. The collected data is automatically integrated into the cadastral database, facilitating timely and informed decision-making.

GIS plays a significant role in mapping road networks and aggregating statistical data. It enables analysis of various infrastructure parameters such as road width, length, surrounding area characteristics, and congestion levels. Real-time GIS operation allows continuous updating and monitoring of infrastructure data, enabling authorities to better control traffic flow. Additionally, GIS-based maps, diagrams, and analytical reports provide clear and accessible information to decision-makers, thereby improving overall management efficiency.

Digital mapping technologies also occupy a special place in forming cadastral data. They ensure high accuracy in road network representation and support planning or expansion projects. Data obtained from satellites, drones, and GPS systems provides real-time insights into congestion levels and pavement conditions, allowing prompt resolution of infrastructure issues. Automated monitoring systems further optimize cadastral updates and maintenance processes.

Continuous updating of the cadastral system is crucial for road placement and management. Data on infrastructure changes, new construction, traffic flow variations, and accidents must be regularly integrated into the cadastral database. Effective implementation requires close cooperation between government agencies, local authorities, transport organizations, and construction companies. The involvement of skilled specialists and continuous professional development is also essential. A systematic and continuously updated cadastral system enables better assessment of infrastructure conditions and future development prospects.

International experience in managing cadastral systems is of great importance. In the United States, road management is based on cooperation between the public and private sectors, with transparent and open data access. Japan utilizes advanced technologies such

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as artificial intelligence and digital management systems to ensure infrastructure safety and efficiency. European countries, including Norway and Sweden, emphasize environmental sustainability by continuously monitoring ecological indicators and developing environmentally safe strategies.

Therefore, by learning from international experience, implementing modern technologies, ensuring environmental safety, and improving infrastructure management, Uzbekistan can develop a highly advanced road infrastructure system. Strong cooperation between the public and private sectors, transparent data management, and continuous monitoring through modern systems are essential to modernizing the national transport system and enhancing the efficiency of internal highways.

CONCLUSION

The study confirms that the formation and effective management of road cadastral data using modern geoinformation technologies is a critical factor in the sustainable development of transport infrastructure. The application of GIS, digital mapping, remote sensing, and automated monitoring systems enables accurate data collection, real-time analysis, and informed decision-making in road planning and management processes.

The results show that an up-to-date and well-structured cadastral system improves traffic safety, optimizes infrastructure maintenance, reduces economic costs, and minimizes environmental impacts. Continuous updating of cadastral data through advanced technologies and inter-institutional cooperation is essential for ensuring the reliability and relevance of road information.

Based on international experience and current technological trends, it can be concluded that the widespread implementation of modern geoinformation technologies in Uzbekistan’s road sector will contribute to the modernization of the national transport system, strengthen economic development, and enhance the overall quality and efficiency of internal and international road networks.

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