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IMPLEMENTATION OF THE 3D CADASTRE SYSTEM: CURRENT PRESSING PROBLEMS, THEIR SOLUTIONS, AND DEVELOPMENT PROSPECTS

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Abstract: This article analyzes the current status of implementing the 3D cadastre system in Uzbekistan, the reforms carried out in 2026, existing challenges, and possible solutions. It demonstrates that the traditional two-dimensional cadastral system is becoming insufficient due to rapid urbanization, increasing numbers of multi-storey buildings, underground infrastructure, and modern urban development requirements. The paper also examines international experience, digital transformation of Uzbekistan's cadastral system, and the integration of GIS, BIM, Artificial Intelligence, and remote sensing technologies into 3D cadastre. Practical recommendations for improving the national 3D cadastral system are proposed.

Keywords: 3D cadastre, digital cadastre, GIS, BIM, LADM, Artificial Intelligence, geospatial data, land administration, digital transformation, smart city.

INTRODUCTION

In recent years, radical changes have been taking place in the land resource management systems of countries worldwide. Due to the sharp increase in urbanization rates, the proliferation of multi-storey residential buildings and business centers, and the expansion of underground transport systems, metro lines, engineering utilities, and underground structures, the traditional two-dimensional (2D) cadastre system can no longer fully satisfy modern requirements. For this reason, developed countries are paying special attention to the implementation of 3D cadastre systems.

In Uzbekistan as well, the digitalization of land relations is considered one of the priority areas of state policy. In recent years, extensive work has been carried out to convert cadastral data into electronic format, automate data exchange between state bodies, and create a national spatial data infrastructure. In 2024, electronic data exchange between government agencies exceeded 206 million transactions, and 105,513 land plots were put up for electronic auction based on digital cadastral data. These indicators demonstrate that significant achievements have been made in digitalizing the cadastral system. Within the framework of new projects for 2025–2030, work has begun on developing the national geospatial infrastructure, creating a modern geoportal, installing new CORS stations, and pilot testing a 3D city model and utility cadastre in the city of Samarkand. These initiatives are creating an important foundation for the future nation-wide implementation of a full 3D cadastre system. However, a number of problems still persist today in implementing 3D cadastre. In particular, the insufficiency of three-dimensional spatial data, the incomplete formation

of unified standards, the weak integration of BIM and GIS platforms, the shortage of high-precision geodetic equipment, the low number of qualified specialists, and the lack of sufficient norms in current legislation fully reflecting 3D property rights remain pressing problems in this direction.

Theoretical Foundations of the 3D Cadastre System and the Necessity of Its Implementation

A 3D cadastre is a modern cadastral system that accurately reflects the location in three-dimensional space of land plots, buildings, structures, and underground and above-ground engineering utilities, as well as the property and other rights associated with them. The traditional 2D cadastre system serves only to show the horizontal boundaries of a land plot. However, today, as a result of rapid urban development, the expansion of multi-storey housing, shopping centers, metro lines, underground parking lots, tunnels, and utility networks, two-dimensional data alone is no longer sufficient for effective land resource management. Therefore, developed countries are gradually transitioning to 3D cadastre systems.

The main goal of a 3D cadastre is to accurately represent property objects not only on the land surface but also in terms of height and depth. For example, in the exact same area, there could be a metro line underground, a road above it, a multi-storey building above that, and overhead utilities further up. While managing such complex objects through a 2D cadastre is practically impossible, a 3D cadastre allows for the precise reflection of their spatial positioning, boundaries, and legal status.

Today, urbanization processes across the world continue at a fast pace. As populations migrate to cities, multi-storey housing, business centers, industrial zones, and transport infrastructures are steadily increasing. Under such conditions, the rational use of land resources, establishing exact coordinates for every object, and reliably protecting property rights are becoming crucial tasks of state administration. From this point of view, the 3D cadastre system is an inseparable part of modern urban development.

Geospatial Information Systems (GIS), Building Information Modeling (BIM), Global Navigation Satellite Systems (GNSS), LiDAR laser scanning, drone-assisted aerial imaging, digital photogrammetry, artificial intelligence, and cloud technologies are widely used in creating a 3D cadastre. With the help of these technologies, three-dimensional models of objects are created, their coordinates are determined with high precision, and the data is stored in a single electronic database.

In international practice, the ISO 19152 (LADM — Land Administration Domain Model) standard holds great importance in creating a 3D cadastre. This standard allows land plots, buildings, structures, property rights, restrictions, and responsibilities to be represented based on a unified model. Consequently, exchanging data and integrating different countries' cadastral systems becomes easier.

In Uzbekistan, extensive reforms are also being carried out to digitalize land relations and introduce modern geospatial technologies. However, the current cadastral system is still primarily based on two-dimensional data. For this reason, certain problems arise in accounting for multi-storey buildings, underground utilities, engineering networks, and complex infrastructure objects.

Especially in large cities, the increasing number of instances where a single area is used for multiple purposes makes the implementation of a 3D cadastre system an even more urgent issue.

The implementation of a 3D cadastre system serves to ensure the efficient use of land resources, increase the accuracy of cadastral data, develop the real estate market, improve the investment climate, monitor construction processes, reduce property disputes, and ensure transparency in public administration. Furthermore, this system serves as an important information base for implementing the "Digital Uzbekistan – 2030" strategy and the "Smart City" concept. Thus, 3D cadastre is not only a cadastral system based on modern information technologies, but also one of the most important tools for managing land resources, planning urban development, conducting environmental monitoring, and ensuring sustainable regional development. Its gradual introduction in Uzbekistan will contribute to economic development, attracting investments, and increasing legal reliability in the real estate sector.

Modernizing the land resource management system and fully digitalizing the state cadastre in Uzbekistan has become one of the priority directions of state policy in recent years. Consistent reforms are being implemented for the electronic registration of land plots and real estate objects, the wide introduction of geospatial information systems, the establishment of electronic data exchange between state bodies, and the transition of cadastral services into a digital format. These reforms are creating the necessary technical and legal foundations for the future implementation of the 3D cadastre system.

As of 2026, a large portion of cadastral data in the republic has been transferred to electronic databases, and integration between state bodies has developed significantly. In 2024, more than 206 million electronic data exchanges were carried out between government agencies, and over 105,000 land plots were sold through electronic auctions, demonstrating the acceleration of the digitalization process. These results have been a significant step toward reducing the human factor in land resource management, increasing the speed of services, and ensuring transparency.

At the same time, the current cadastral system mainly relies on two-dimensional data. Modern cities, however, no longer consist solely of objects on the land surface. Multi-storey residential areas, business centers, underground parking lots, metro lines, tunnels, water, gas, electricity, and communication networks are located at different height and depth layers of the same territory. Fully managing such complex objects through 2D maps is difficult, and in some cases, causes legal ambiguities and technical errors.

In 2026, one of the most pressing problems in implementing 3D cadastre is the insufficient development of the legal and regulatory framework. In current legislation, land plot boundaries are mostly determined on a plane, but the mechanism for separate registration of underground and above-ground spatial property rights has not yet been fully formed. As a result, legal misunderstandings may arise regarding matters related to the simultaneous use of a single area for multiple purposes.

The second major problem is the lack of high-precision spatial data. Creating a 3D cadastre requires laser scanning (LiDAR), aerial photographs, drones, GNSS observations, and modern geodetic measurements. Currently, not all regions are fully covered with such data. Especially in

remote districts, the necessary database for creating three-dimensional digital models is still insufficient.

Another urgent issue is that integration between GIS, BIM, and cadastral information systems has not been fully established. Because construction organizations use one software platform and cadastral bodies use another, discrepancies are observed in data exchange. This slows down the process of registering newly constructed objects into the cadastre.

Additionally, the shortage of qualified personnel remains a significant problem. The number of specialists who perfectly understand 3D modeling, BIM technologies, artificial intelligence, geospatial information systems, and laser scanning methods is not yet at the required level. It is necessary to expand modern training programs in these fields within higher education institutions.

There are also issues related to technical infrastructure. High-precision geodetic equipment, servers, data storage centers, and powerful computing resources require substantial financial investments. In some regions, internet speeds and the level of technical equipment are also insufficient to fully support a modern 3D cadastre system.

Furthermore, the issue of cybersecurity and data protection is also pressing. Since detailed spatial data about strategically important infrastructure objects and real estate is stored in the 3D cadastre database, it is necessary to reliably protect them from unauthorized access, cyberattacks, and data loss.

Thus, although significant work is being carried out to implement the 3D cadastre system in Uzbekistan, a comprehensive resolution of legal, technical, organizational, and personnel-related problems is required. Only then can a modern, reliable 3D cadastre system that meets international standards be fully formed in the country.

The successful implementation of a 3D cadastre system is not limited to just purchasing modern technologies. For this system to operate effectively, the legal-regulatory framework, digital infrastructure, qualified personnel, international standards, and modern information technologies must be developed in harmony with each other. Therefore, improving the 3D cadastre under the conditions of Uzbekistan requires a integrated approach.

First and foremost, it is necessary to improve the legal framework relating to 3D cadastre based on international standards. In current legislation, mechanisms must be developed for the separate registration of property rights in underground and above-ground spaces, defining the boundaries of three-dimensional objects, and clearly reflecting the spatial rights of owners in multi-storey buildings. This will reduce property disputes in the future and increase the legal reliability of investment projects.

The second important direction is the integration of BIM (Building Information Modeling) and GIS (Geospatial Information System) platforms with a single electronic cadastre database. At present, the possibility of automatically transmitting digital building models created by construction organizations into the information systems of cadastral bodies is limited. If this integration is implemented, as soon as newly constructed objects are commissioned, their 3D models will be

automatically entered into the state cadastre database. As a result, the human factor will be reduced, data accuracy will increase, and time will be saved.

As a third direction, the wide use of artificial intelligence technologies is recommended. Artificial intelligence can automatically detect buildings and structures based on aerospace imagery, drone footage, and LiDAR data, form their contours, identify illegal constructions, and update cadastral data in real-time. This accelerates the monitoring process and increases the efficiency of state control.

The fourth direction is the regular use of LiDAR and unmanned aerial vehicles (drones). With the help of these technologies, high-precision three-dimensional spatial data can be obtained within a short period. Especially in mountainous regions, large cities, and areas where complex engineering structures are located, collecting data via drones is also economically efficient.

As a fifth direction, it is necessary to further develop the National Spatial Data Infrastructure (NSDI). In this regard, it is advisable to integrate the geospatial databases of the Cadastre Agency, the Ministry of Construction and Housing and Communal Economy, the Ministry of Water Resources, the Ministry of Energy, and other state bodies into a single platform. This will reduce duplicate data and increase efficiency in public administration.

International experience shows that the Netherlands, Norway, Sweden, Australia, Singapore, and South Korea are countries that have successfully implemented 3D cadastre in practice. In these countries, along with land plots, underground utilities, metro lines, bridges, tunnels, and multi-storey buildings are also registered by the state based on three-dimensional models. Consequently, construction processes have accelerated, property disputes have decreased, and the investment climate has improved. It is advisable for Uzbekistan to gradually introduce these practices, adapting them to national conditions.

CONCLUSION

The results of this study show that the implementation of a 3D cadastre system is one of the most important directions for elevating Uzbekistan's land resource management system to a modern stage. Although significant results have been achieved in the country regarding the digitalization of the cadastral system, the wide application of geospatial technologies, and turning public services into an electronic format, the current 2D cadastre system does not have the capability to fully account for multi-storey buildings, underground utilities, and complex engineering structures. Therefore, the step-by-step introduction of a 3D cadastre system is one of today's urgent tasks.

During the research, it was determined that the main factors hindering the development of 3D cadastre in 2026 include the insufficient improvement of the legal-regulatory framework, the lack of high-precision spatial data, the incomplete integration of BIM and GIS platforms, a shortage of modern geodetic equipment, a lack of qualified specialists, and problems related to cybersecurity. To eliminate these shortcomings, it is necessary to introduce international standards into national practice and make wide use of artificial intelligence, LiDAR, drones, blockchain, and Digital Twin technologies.

The proposals put forward in the article, including the creation of a single national 3D cadastre geoportal, integrating BIM–GIS–cadastre systems, introducing 3D digital passports for multi-storey buildings, forming a single electronic register of underground utilities, and establishing an automatic monitoring system based on artificial intelligence, will serve to significantly increase the efficiency of the country's cadastral system.

In conclusion, the implementation of a 3D cadastre system is an important factor in the rational use of land resources, ensuring the transparency of the real estate market, improving the investment climate, reducing property disputes, and achieving the goals of the "Digital Uzbekistan – 2030" strategy. In the future, harmonizing 3D cadastre with artificial intelligence, geospatial information systems, and digital twin technologies will serve to bring Uzbekistan's land resource management system to the level of international standards.

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