Preliminary study on the integration control platform of construction waste based on "BIM+GIS" technology

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Abstract. In recent years, the output of construction waste in China has been increasing. 70% of more than 600 large and medium-sized cities in China are surrounded by waste, of which the contribution rate of construction waste reaches 40%. Compared with some developed countries, China lacks real-time monitoring and intelligent control of the whole process of construction waste. In this paper, the popular "BIM + GIS" technology is introduced into the field of construction waste supervision. Based on this technology, a real-time monitoring and intelligent management and control information management platform for construction waste is established, so as to achieve accurate management and control of construction waste.

1 Introduction

According to statistics, the total amount of construction waste produced in recent years in China is about 15.5 billion tons to 24 billion tons. The huge amount of construction waste disposal is a challenge^[1] faces in urban management. Construction waste occupies a lot of land resources, affects air quality, pollutes water area, destroys city appearance and environmental health, and has potential safety hazards. Therefore, the research of construction waste precise control technology system has important practical significance^[2].

2 "BIM + GIS" and construction waste

2.1 Overview of "BIM + GIS"

BIM, namely "building information model", is an information model that can integrate engineering information, process and resources in different stages of the whole life cycle of the project, and can be easily used by all parties involved in the project^[3]. Through 3D digital technology to simulate the real information of the building, it can provide a mutually coordinated and internally consistent information model for engineering design and construction^[4]. The model is a digital representation of the physical and functional characteristics of a facility. Building information model is a new tool for architecture, engineering and civil engineering, which is based on the information data of construction projects, builds the building model, and simulates the real information of buildings through digital information simulation. It has five characteristics

of visualization, coordination, simulation, optimization and printability^[5].

Geographic Information System (GIS) is a technical system which collects, stores, manages, calculates, analyzes, displays and describes the geographic distribution data in the whole or part of the earth's surface (including atmosphere) space with the support of computer hardware and software systems. As an important tool, technology and discipline to acquire, process, manage and analyze geospatial data, GIS has been widely concerned and developed rapidly in recent years^[6]. From the perspective of technology and application, GIS is a tool, method and technology to solve spatial problems. From the perspective of discipline, GIS is a discipline developed on the basis of geography, cartography, surveying and computer science, with an independent discipline system. From the perspective of function, GIS has the acquisition, storage, display, editing, processing, analysis, output and response of spatial data. From the perspective of systematology, GIS has certain structure and function and is a complete system. GIS is a comprehensive subject, which combines Geography with cartography, remote sensing and computer science. It has been widely used in different fields. It is a computer system for inputting, storing, querying, analyzing and displaying geographic data^[7].

2.2 "BIM + GIS" promotes precise control of construction waste

BIM is the carrier of building internal spatial layout and related management information, while GIS can display the overall layout of the city and integrate BIM model

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with GIS platform, which not only represents the equal display of BIM model in GIS, but also brings a lot of engineering construction information to the GIS map, providing accurate positioning and information for future construction waste supervision and treatment personnel complete and high simulation BIM construction waste visualized operation and maintenance management and emergency response service^[8]. Authorized personnel can overview the geographical location of the source and disposal sites of construction waste, query the type and output of the building, review the real-time monitoring image of the construction waste disposal site, view the traceability information of recycled products of construction waste, intuitively understand the construction waste information generated by the whole city or a single building, at the same time, they can also supervise and manage the subsequent cleaning, transportation and disposal of the construction waste online^[9].

"BIM + GIS" is a professional application system. The system is based on BIM + GIS platform for application development, which is used to manage urban buildings and underground facilities with a certain type of standard form, including topology information and asset information, covering multi-dimensional dynamic spatial information such as surface, ground and underground. The system meets the management and application requirements of the construction waste supervision department. To provide real-time monitoring and optimal allocation and transportation decision-making scheme for the construction waste clearing and transportation unit, early warning of various possible accidents and decision support for accident handling, so as to achieve the goal of strengthening facility management and creating a good internal environment for accurate control of construction waste^[10].

3 Research content

3.1 Research and development of BIM + GIS integration and intelligent collaborative platform

(1) Theoretical research and model construction of BIM based decision management system for the whole process of construction waste including: site investigation, research the construction waste classification system, research on the prediction theory of construction waste production based on BIM, research and formulate a theoretical system for construction waste disposal, research on the decision-making model of construction waste disposal based on the above theoretical content.

(2) Demand analysis and design the system's function. Preliminarily designed the functional modules of the construction waste integrated management system based on BIM+GIS: construction waste information management, BIM model application and system management. The construction waste information management module includes the management of various information in the construction waste disposal process. Among them, the realization of the production forecast

and disposal decision-making functions depends on the research theory in (1). The construction waste information management module and the BIM application module are mainly aimed at the users of all parties involved in the project. After the users register and log in, they can manage and apply the project information through BIM model application and other functional modules. The specific functional module of system is shown in figure 1.

(3) Database selection and design. The plan is to use MySQL database as the main storage and Redis as the cache database. Use Redis where high performance is needed and MySQL where high performance is not needed, to speed up access. Research and design the entity relationships of the system, design E-R diagrams, and design specific data tables.

(4) Function design of BIM information integrated management system platform software development By providing a unified API (Application Programming Interface), users can directly program IFC data, avoid dealing with the complex entity relationship of IFC Standard, and develop programs according to professional application requirements^[11].

(5) Provide model view display and BIM software application function for BIM information integrated management system platform. Users can directly browse the information model, select different information model display options, view the components that make up the information model and obtain the relevant properties of the components, and then through the professional software to carry out various performance simulation analysis of the building information model, complete the data exchange and sharing between the various disciplines, and realize the collaborative work between the project participants.

Fig. 1. BIM+GIS information integrated management system

(6) The application of GIS technology in the construction waste management platform. In order to

realize the visual management of construction sites and construction waste disposal sites in the city, it is planned to use open source GIS services such as ArcGIS to draw dynamic spatial location distribution maps.

3.2 Based on the integration of BIM + GIS and real-time monitoring technology of the whole process of construction waste, a platform for real-time monitoring and intelligent management and control of the whole process of construction waste is built

(1) Real time monitoring and intelligent control platform for the whole process of construction waste.

Integrate the construction waste management system based on BIM+GIS to realize the intelligent comprehensive management of the whole process of construction waste from generation, transportation, disposal, recycling to the application of recycled products. The platform integrates construction waste generation source characteristics information, transportation supervision and distribution information, stacking, landfill, final disposal information and resource recovery information, and comprehensively uses technologies of The Internet of Things (IOT) and Artificial Intelligence (AI) to realize the path tracking and intelligent identification of transportation vehicles, safety monitoring and warning of the construction environment, etc.

(2) Related theory and technology research.

In order to truly realize intelligent management, in addition to the BIM-based accurate prediction model and construction waste disposal decision-making model mentioned above, it is necessary to study rapid identification technology based on remote sensing data, vehicle identification technology based on surveillance video, and construction waste transportation vehicles. Path planning algorithm, environmental risk assessment technology, etc.

(3) System development and integration.

Research the development of the platform, the general agreement in the integration process, the integration interface form of each subsystem, the communication protocol with the monitoring equipment, as well as the call interface, data dictionary library, data format, data collection frequency, data output form and frequency, coding method, data encryption and verification method, etc., and formulate the construction of the real-time monitoring and intelligent control platform for the whole process of construction waste Standard, guide platform integration^[12]. The system is planned to adopt microservice architecture. Each microservice can be developed independently, with low coupling between services, free choice of languages and tools, and easy expansion of requirements. The system architecture diagram of the preliminary design is shown in Figure2.

(4) Real time monitoring and intelligent control platform project demonstration of the whole process of construction waste.

In the project demonstration project, organize training and promotion application, in the promotion and application stage, constantly improve the integrated platform function, keep close to the user's use habits, and become an effective tool for precise management and control of construction waste.

Fig. 2. System architecture of real-time monitoring and intelligent control platform for the whole process of construction waste

3.3 Based on the integration of BIM + GIS and real-time monitoring technology of the whole process of construction waste, a platform for digital city construction waste comprehensive management platform is built

The construction of digital urban management system can realize the integration of system, location, function, resource, information and location resources, integrate the existing urban emergency management, electronic video monitoring, mayor's hotline and other systems and functions, share video, data and services, and directly integrate the decentralized construction of computer room to the municipal emergency linkage center, and build the information exchange hub. "Unified supervision" refers to the establishment of an independent digital city management and supervision center to effectively supervise the city's urban management. The digital urban management information system is to divide the city into several management grids by digitizing the urban management objects, taking 1km² as a unit; in view of the particularity of the management of three links (generation, transportation, consumption and disposal) of urban construction waste disposal, the division principles of the grid, components and events of the three links are determined respectively^[13].

(1) Division principle of grid, component and event

In the process of construction waste source generation, the grid is divided into urban area as the unit; the components are divided into the red line map of the construction project as the unit; the event management is mainly for the approval and coordination of construction waste disposal. For the construction waste transportation link, the grid is divided into urban area as a unit; the components are divided into transportation enterprises as

a unit; the event management mainly monitors and manages the spilling, omission and illegal spoil in the process of construction waste transportation.

In the process of construction waste absorption and disposal, the grid is divided into urban area as a unit; the components are divided into construction waste absorption yard as a unit; the event management mainly focuses on the monitoring of the unauthorized establishment of waste disposal site, the emergency of waste soil landslide and the supervision of temporary waste disposal yard.

(2) Information exchange mechanism of grid, component and event management.

The integration of grid, component and event management information includes three blocks: the approval information of disposal Emission Declaration, the information of vehicle transportation market and the information of coordination, absorption and disposal

1) The information exchange mechanism between the application procedures of the construction in progress department and the application and approval of the construction waste disposal and discharge is conducive to the approval and supervision of the construction waste discharge amount and disposal plan during the construction of the construction project;

2) The communication mechanism of vehicle information, construction waste transportation administrative license information and administrative law enforcement information of public security and transportation departments is conducive to the monitoring and joint law enforcement management of construction waste transportation license approval, spilling omission and illegal waste soil in the transportation process;

3) The information exchange mechanism between land ownership information of land department and urban construction planning information of planning department and construction waste adjustment, absorption and disposal information is conducive to the reasonable establishment of temporary disposal site and the management of illegal spoil.

(3) Operation and management mechanism of construction waste management system.

Digital construction waste management needs both technical support and mechanism guarantee. According to the current management practice of urban construction waste in each city, the management measures such as the implementation measures of digital urban construction waste management, the standards and time limit of construction waste management events and components disposal, and the management and disposal process of digital urban construction waste are formulated. Based on above-mentioned management measures, establish a working mechanism of "unified acceptance at the municipal level, coordinated command of the city and departments, and disposal of problems by relevant units".

4 Prediction and analysis of platform effectiveness

4.1 Preparation of unified specifications and standards

In the process of building the "BIM + GIS" integrated platform for precise management and control of construction waste, it is necessary to establish a standardized integrated platform to ensure the unity, stability and scalability of the platform.

4.2 Research and development of BIM + GIS fusion technology platform based on Web3D

Integrate multi-source heterogeneous data into a unified platform of GIS and BIM integration, and realize the Internet visual control service of real-time monitoring data of all kinds of construction waste in the whole process with lightweight Web3D technology. In terms of function, the platform can realize virtual space display, information release, data analysis, risk assessment, early warning and prediction, emergency response, comprehensive management, statistical analysis and other functions; in terms of performance, it can ensure the stability, reliability, fast response and strong operability of the software platform; in terms of security, the software platform can prevent the leakage of important data and information and ensure the operation of the software platform Safety of the line.

4.3 Preparation of unified specifications and standards

Establish a real-time monitoring and intelligent management and control platform for the whole process of construction waste; realize the allocation and control amount accounting for more than 95% of the construction waste production. Relying on the digital urban management information system, gradually establish the urban construction waste information management platform, and take the information platform construction as the starting point to build the construction waste supply and demand information system, and improve the socialized and standardized level of the comprehensive utilization of construction waste.

5 Conclusion

Based on the "BIM + GIS" technology, the information management platform for urban construction waste is gradually established, and the information platform construction is taken as the starting point to build the construction waste supply and demand information system, so as to improve the socialized and standardized level of comprehensive utilization of construction waste. The whole process real-time monitoring and intelligent management and control platform of construction waste is oriented to service and data sharing in the design, establishing and providing comprehensive services based on the resource utilization of the construction industry, and providing standard open data interface to realize data sharing with other systems. The data of the management and control platform can be collected in multiple

dimensions, and the relationship between data can be established, and multi-dimensional data verification and analysis can be provided to realize closed-loop data management. Combined with the construction and application of digital city management platform, it provides effective support for government supervision.

The platform provides users with an information platform to improve the operation efficiency of the clearing and transportation enterprises. With the standardized process of the platform, the urban management department simultaneously establishes the source approval and the issuance of franchise qualification. Continuously promote the organic integration and co governance of government, society and enterprises. Through online business activities and market factors, enterprises form a dual effect governance ecology of self-management and government supervision.

This research is closely related to the development of social economy and society, the national ecological environment protection strategy, the people's life and health, and the environmental security. It is an urgent strategic demand of the country, and has important scientific value and social, economic and ecological benefits.

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