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Applications of BIM in Information Technology: A Review

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Abstract: ***To promote intelligent development in the construction sector and enhance construction management efficiency, the concept of smart development has been integrated into the planning of smart cities. A crucial aspect of smart city projects is developing a 3D digital city model. The integration of GIS and BIM technology is vital for achieving this, supporting the creation and analysis of dynamic smart cities. Using AR technology, we can recreate real-world scenes in virtual reality to provide customers with a more "immersive" experience. This article explores the diverse applications of GIS-BIM integration technology, focusing on construction schedule management, site material handling, and worker safety. Additionally, it delves into the application trends of GIS-BIM integration technology, global wide area network, Internet of Things (IoT), virtual reality, and other emerging technologies in integrated building construction management, promoting intelligent and visually enhanced management through GIS-BIM technology. This paper addresses safety management considering the entire project life cycle, setting a benchmark to elevate safety standards comprehensively in construction projects.***
Keywords: BIM, GIS, AR Technology, Construction Technology, IoT, VR, World Wide Web

I. INTRODUCTION

The planning, research, design, construction, and operation phases in building projects are highly dynamic processes. A growing and innovative trend in construction management involves the integration of Building Information Modeling (BIM) with Geographic Information System (GIS) technology. GIS specializes in low-density geographical information data covering a broader range, while BIM is centered on high-density spatial data of the built environment within a smaller scope. Integrating GIS and BIM provides a more detailed and comprehensive dataset, particularly in integrated human environmental activity spaces. Therefore, GIS-BIM integration technology is well-suited to cater to the varying demands throughout the building's life cycle in most urban areas, facilitating its application in engineering practice.

BIM technology significantly contributes to enhancing construction safety. However, a notable drawback of BIM in real project management lies in the manual input of engineering information, lack of feedback from the surrounding environment, construction technology, and other factors. It struggles to seamlessly connect with the project's actual environment and construction progress, resulting in insufficient feedback regarding on-site conditions. Consequently, there's an urgent need for a system that can bridge the model with practical implementation. Only through such integration can we enhance building project management effectively.

II. BIM AND INFORMATION INTEGRATED TECHNOLOGY SUMMARY

A. Development Status of GIS and BIM Integration Technology

BIM involves creating a digital 3D model using project data to visualize a structure's details. On the other hand, GIS technology, a cutting-edge mapping technique, is extensively used in construction. It effectively manages environmental information in building projects using computer software and hardware. GIS development enables intricate geographical analysis and 3D spatial inquiry, aiding decision-making across various sectors. Combining GIS with databases and statistical analysis allows for effective visual presentation on maps. A crucial aspect of smart city projects is developing a 3D digital city model. The integration of GIS and BIM technology is vital for achieving this, supporting the creation and analysis of dynamic smart cities. However, challenges such as data volume, format compatibility, coordinate system uniformity, and standardized specifications persist.

Researchers, both domestically and internationally, are actively exploring solutions to address these challenges, paving the way for widespread adoption and advancements in technology and research.

Nagel and others proposed switching from a KML visual model to a BIM using CityGML. Amir Ebrahimi and the team suggested using a data model to merge BIM with GIS. Liu Xin and the team established a data model for this integration in their study. Ruiyang Guo studied the SUPERMAP secondary development platform, focusing on the BIM model's integration with GIS. They explored various aspects like user interface, asset grouping, spatial analysis, and more. Zhang Wensheng and team delved into BIM-

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to-3DGIS integration technology, applying it to railway bridge construction. Cheng Fangyuan and team investigated integrated GIS/BIM digital management for highway tunnels, applying it successfully in tunnel engineering using Tongji University's infrastructure Smart Service System (iS3).

B. Functions of GIS-BIM Integration Technology

GIS and BIM technologies each have their strengths and weaknesses. Combining them is beneficial as they provide complementary information, creating a powerful and efficient tool for engineering. The main goal is to enhance engineering practice, making it more convenient and seamless.

C. Development of Construction Technology

The technology used in architectural engineering projects has evolved from 2D CAD to 3D BIM and then to spatial GIS and BIM technology. Traditional software like AutoCAD primarily focuses on two-dimensional visual design.

D. AR Technology

New human-computer interaction technology called Augmented Reality (AR) superimposes computer-generated virtual items, sceneries, video, music, animation, and prompt messages onto the virtual environment. With the aid of information, the actual world and virtual world are combined via Augmented Reality (AR) technology. It is a high-level human-computer interface with the fundamental qualities of conceptualization and interactivity thanks to hybrid technologies. Using AR technology, we can recreate real-world scenes in virtual reality to provide customers with a more "immersive" experience. In the virtual world, we can transcend time, space, and other objectives. Viewing both the virtual and actual data simultaneously will improve the user's understanding of the virtual model.

III. APPLICATIONS OF BIM IN INFORMATION TECHNOLOGY

A. Construction Schedule Management

The construction schedule significantly impacts the speed, cost, and quality of a building project. It sets the start and end times for each task, influencing the project's duration. Various factors, such as time, location, technology, management, and resources, influence the construction schedule.

B. Objectives of Site Material Management

Site material management involves handling, usage, disposal, and trash collection after materials are delivered. It's a coordinated process crucial for predictable project outcomes, cost-efficiency, improved productivity, quality, and safety. GIS and BIM integration optimize material stacking, handling routes, and quantities through data analysis. It ensures equitable resource allocation for uninterrupted construction progress. This technology also assesses climatic and environmental factors to ensure material safety, enhancing project predictability, reducing costs, and promoting a safer work environment. GIS-BIM technology employs dynamic supervisory tools to enhance construction safety, efficiently mitigating safety risks and improving overall project safety.

C. Safety Technology Disclosure and Safety Training

We can utilize BIM technology before construction to develop construction safety measurements and evaluate various information data in the construction information model. We can optimize and perfect the safety index system using feedback obtained from simulated construction. The construction organization scheme is strongly linked to the construction safety index. We can achieve real-time and effective construction site monitoring in this manner. Managers may more intuitively and efficiently convey project parameters, technical quality criteria, construction safety, and other critical information when combined with AR technology. The operating method, safety risk points, and sites with possible safety hazards must be disclosed by management and construction staff.

D. Identifying Hazards and Safety Alerts

Ensuring safety throughout construction stages involves spotting potential hazards during project development. Utilizing BIM for 4D simulation in safety management aids this process by integrating data from a 3D model and construction progress. The 4D model fosters stronger connections among team members. Combining a 4D building model with a construction plan allows efficient resource allocation and reduces material usage, enhancing safety and organization during construction. Additionally, augmented reality (AR) technology helps workers perceive dangers and take appropriate rescue actions, preventing misunderstandings.

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E. Feedback and Security Exploration

A BIM model offers a virtual representation of real buildings. Integrating BIM and AR technologies lets us create a virtual construction site, enabling participants to fully engage in emergency drills tailored to their roles. During these drills, employees can effectively meet emergency exercise requirements by perceiving their surroundings. BIM visually identifies hazards in the model. Operation data collected throughout the construction process is documented and sent to the BIM database upon project completion. This forms a security-related database, providing a strong foundation for future safety initiatives.

IV. THE COMBINATION OF GIS AND BIM TECHNOLOGY AND OTHER INFORMATION TECHNOLOGY IS APPLIED IN CONSTRUCTION MANAGEMENT

A. GIS-BIM and World Wide Web (Web)

In traditional construction methods, exchanging management information among construction teams is slow and ineffective. Combining GIS & BIM with WEB technology can integrate all construction process data, coordinate information management, and enable real-time data visualization. By collectively using GIS and BIM+WEB technologies, the construction process can be efficiently managed, aiming for effective use and sharing of construction process information. BIM-GIS+WEB technology can simulate the feasibility plan before construction, aiding in making optimal decisions. It also helps in efficient infrastructure and amenity management, reducing resource waste, ensuring quality control, and ultimately enhancing residents' quality of life.

B. GIS and BIM Technology and Internet of Things (IoT)

The Internet of Things (IoT) comprises interconnected objects for automated monitoring and data collection. Combining GIS and BIM with IoT enables real-time monitoring of equipment, material testing, environmental conditions, noise levels, dust levels, and the presence of people on the construction site. This technology senses and predicts construction workers' situations to provide early warnings and prevent safety incidents and delays. GIS-BIM+IoT technology quickly and accurately analyzes construction site data, improving worker safety, productivity, and efficiency.

C. BIM and GIS Technology and Virtual Reality (VR)

VR technology's widespread growth and maturity have expanded its application in construction engineering and related fields. GIS and BIM+VR technology support visual simulation in construction, enabling the visualization of construction progress, drawings, optimal construction routes, personnel, and on-site material needs. It monitors and evaluates building project progress, safety risks, and project quality. With GIS and BIM+VR technology, users can fully immerse themselves in 1:1 simulated reality scenarios. This allows for the assessment of project constructibility, identification of time and space conflicts, saving on material costs, and efficient allocation of workforce. To replicate the building process and prevent material waste, GIS and BIM+VR technology present the construction process clearly and allow precise quantity assessment of materials needed for each part.

D. Combination of BIM and AR (Augmented Reality)

BIM incorporates all of the building's data information. AR technology may offer data in an entirely new way, making communication between parties more convenient, efficient, and real. AR technology also includes characteristics like as virtual and real-world integration, real-time interaction, 3D tracking, and location. We can give a more complete, efficient, and scientific basis for building safety management by combining BIM with AR.

V. SUGGESTIONS

A. Promoting Standardization and Adoption of GIS-BIM Integration Technology

Due to the lack of harmonized standards and specifications for GIS and BIM integration technology, achieving consistent construction practices becomes challenging. Addressing this, our country should actively advocate for the use of GIS-BIM integration technology in construction management. Encouraging the accumulation of practical experience and enforcing policies to develop relevant standards will be essential. This concerted effort will lead to the standardized and intelligent advancement of GIS and BIM technology in construction management.

B. Fostering Research and Talent Development in GIS and BIM for Construction Management

Research concerning the utilization of GIS and BIM in construction management is notably scarce within China, and academic programs dedicated to nurturing specialized talent in this field are non-existent.

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To address this gap, our nation should enact policies that promote and support the integration of GIS and BIM in construction management. Furthermore, there's a pressing need for construction companies to define appropriate job roles in anticipation of future growth trends to meet the rising demand for skilled professionals. Universities and colleges should proactively design educational programs that cater to the evolving needs of society, fostering specialized talent in this domain.

C. Enhancing Software Compatibility and Development of Management Platforms

To facilitate the widespread application of GIS and BIM integration technology in construction management, it is vital to expedite efforts towards aligning professional software formats. Simultaneously, a robust focus on the development and widespread promotion of construction management platforms is essential. This initiative will significantly contribute to advancing the effective utilization of GIS and BIM integration technology within the construction management landscape.

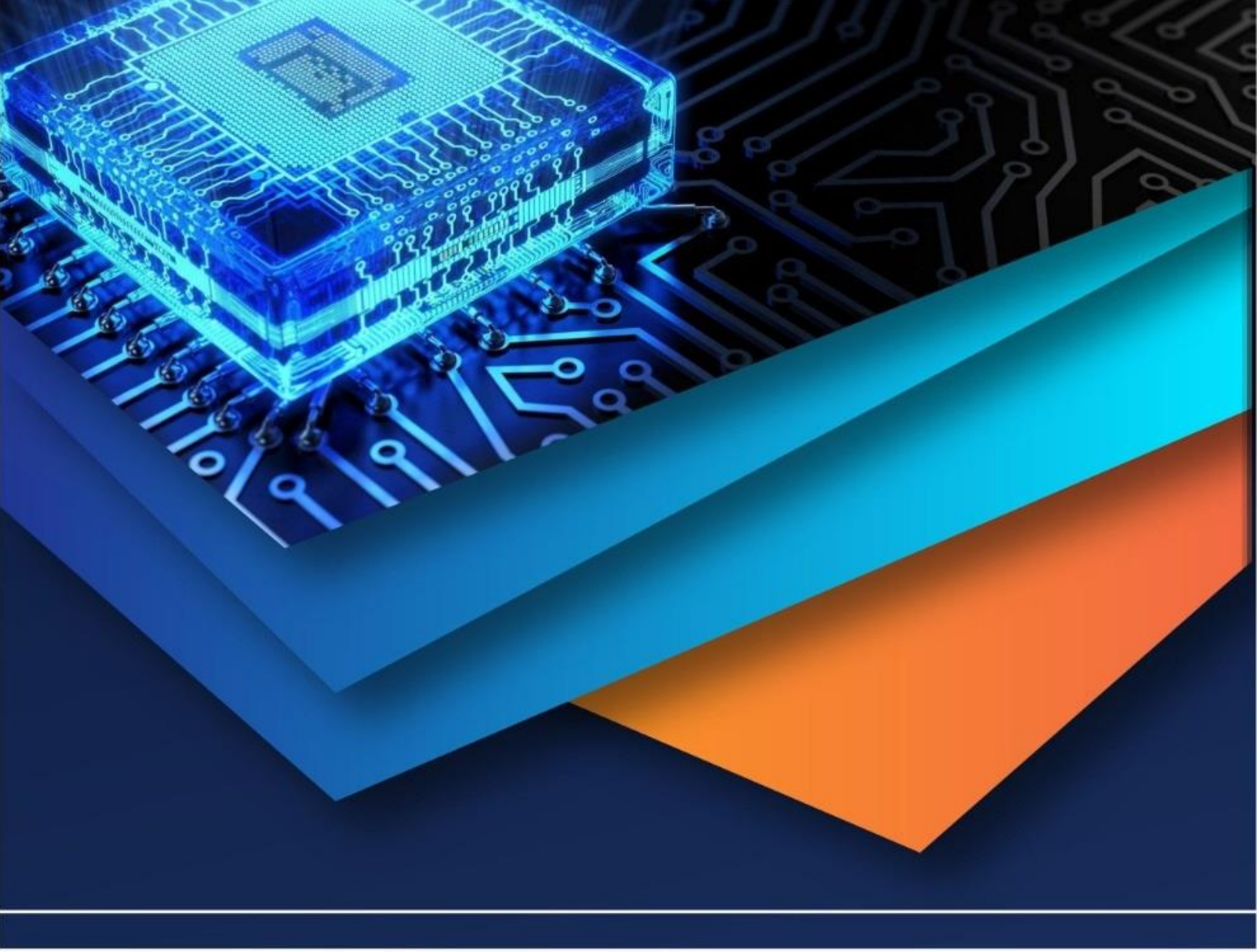
VI. CONCLUSION

Construction quality management, schedule adherence, cost efficiency, health and safety protocols, environmental performance enhancement, information handling, and inter-departmental coordination are among the crucial management domains significantly impacted by GIS and BIM technology. This study highlights several innovative advancements resulting from the integration of GIS and BIM in construction management: (1) GIS-BIM technology amplifies the informatization, automation, and overall wisdom in construction management. (2) It transforms individual building management inherent in BIM into a comprehensive system, surmounting BIM's limitation of singular building focus. (3) By integrating geographic information system data into project management, it achieves precise and detailed construction management. (4) The utilization of GIS-BIM technology yields cost savings, enhances project safety, fosters collaborative management, and facilitates seamless data exchange.

Construction safety management is an essential component of construction management. Construction safety management is challenging for the following reasons. We can easily illustrate the whole construction process by creating models using BIM and AR technologies. We will nip all types of safety threats in the bud with BIM and AR technologies, and significantly increase the safety and dependability of construction projects.

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