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Research on Wireless Network Transmission and Building Information Model Technologies

Feng Qiao
Luoyang Institute of Science and Technology, China

ABSTRACT

In the construction management, it is possible to transmit large amounts of information in real-time during manufacturing, which can aid in the organization and administration of building materials. Through sampling survey and sand table simulation, the management of building materials based on BIM (Building Information Model) is compared with the traditional management method and the management method combining BIM with wireless network communication, so as to better understand the management method for building materials. This study evaluates the purchase, storage and quality of materials during the construction stage, and the differences in material management between different technical methods at different stages of the project development. According to the results, the average inventory turnover rate of the BIM-based management approach is six times higher than that of conventional management method, while the latter is four times higher. On the other hand, combining BIM with wireless network communication can produce better effects.

KEYWORDS

Building information model, building material management, wireless network, construction industry

As the world's most populous construction market, China builds approximately 2 billion square meters of building space annually. However, the construction industry in China faces many challenges, including long cycles, high costs, and a lack of environmental protection. In order to address these challenges, it is necessary to update and upgrade the construction industry to achieve sustainable development. Data sharing plays a crucial role in industry progress and technological advancement, and the application of wireless communication technology provides real-time and accurate data for industrial production control, which has revitalized the construction material management industry. Wireless communication technology has advantages such as adaptability, speed, and reliability, and it is an important form of wireless access. In addition to transmitting space and time, it can also transmit data, images, and audio. In modern industrial automation, Wireless Local Area Network (WLAN) is considered an important factor since it enhances communication and data processing capabilities between industrial equipment. On the other hand, the application of Building Information Modeling (BIM) technology can help avoid common problems in construction, such as errors, omissions, collision structures, and defects. However, in the Chinese construction industry, the implementation of BIM technology is still plagued by issues such as lack of industry recognition and technical standards. In response to this issue, we propose a comprehensive management model for construction projects, aimed at improving the seamless interaction between BIM technology and construction, and studying a new architecture for integrated management of assembly building projects from a new

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classification perspective. This article will explore how to apply BIM integrated management to the construction industry and provide relevant suggestions to promote the development and progress of China's construction industry.

The contribution of the study are as follows:

1. To conduct a building test, a sand table simulation method is used in this paper.
2. This method is compared to traditional methods of managing materials, and wireless communication is used in conjunction with BIM technology to compare the differences between the two approaches.
3. The best logistics management strategy and the best construction techniques can be identified by comparing different construction approaches.
4. BIM integrates information from several disciplines to produce in-depth digital representations that are controlled on an open cloud platform for real-time collaboration.

LITERATURE REVIEW

In the context of Chinese construction, Stober and Raguz-Lucic (2024) came up with an integrated management model for building projects. The goal of facility operation and maintenance is to save energy, increase the building's lifespan, improve the satisfaction of facility users, and reduce the structure's operating expenses. This means that all the information about the facility needs to be gathered and kept in one place (Cepa et al., 2023). Home decorating design tools can help domestic clothing companies better compete in the construction of economies of scale by utilizing BIM technology's advantages in the market. The theory is that a BIM-based design system can overcome the problems of suitable design techniques and centralized control of corporate resources which have plagued the traditional design sector of decoration (Omrany et al., 2023).

BIM technology has been recognized as a strategic tool for architects, engineers, constructors, and real estate asset managers to optimize the design, construction, management, operation, maintenance, and use of buildings. Wang et al. (2024) emphasize the importance of evaluating the benefits of BIM beyond just ROI, considering intangible benefits and indirect costs. Yu et al. (2024) propose a BIM-based facility maintenance management system for maintenance staff during the operation and maintenance phase. Cespedes-Cubides and Jradi (2024) highlight the need for cloud-based BIM technology to manage building sustainability using big data, aiming to enhance environmental sustainability over building life cycles. Hauer et al. (2024) identify three stages where project performance can be improved using BIM: pre-construction, construction, and maintenance and operation phases. Rajasoundaran et al. (2024) suggest the application of BIM technology in tunnel engineering in China, focusing on design optimization, construction standards, and operation maintenance. Piras et al. (2024) review recent publications on BIM-enabled facilities operation and maintenance, emphasizing the potential of BIM to transform O&M by providing a digitalized 3D environment for facility managers. Devasenapathy et al. (2024) introduce the development of a bridge management system based on BIM technology, leveraging its visualization and informatization capabilities. Yap et al. (2024) propose a BIM-LCA approach to estimate greenhouse gas emissions of large-scale public buildings, highlighting the importance of the operation and maintenance stage in reducing GGE throughout the building's life cycle. Bellini et al. (2024) advocate for the establishment and application of an intelligent city building information model based on BIM technology, emphasizing its suitability for intelligent management in construction projects in the context of smart cities.

Keeping their design resources up to date helps clothing companies to establish long-term intangible assets that help domestic fashion design and decoration organizations compete in today's global marketplace (Sakr & Sadhu, 2023). It is now possible to design a 3D interior utilizing BIM technology. However, current research does not contain anything practical and relevant (Chen et al., 2023). Construction projects have been changed by BIM technology, and it is now being used by 25 people, according to the Building Intelligence Alliance of America (Tan et al., 2023). The construction management sector is the best technology for promoting BIM, according to architects, owners, contractors, property management companies, and construction monitoring organizations (Tan.Y et al., 2023). An alternative suggestion is to create a new BIM technology consulting firm that would integrate traditional technology innovation with a contemporary approach to social development while also expanding the scope of the existing supervision company's operation. There is no existing study on this topic. Hence, this study focuses on analyzing BIM technology in building operation and maintenance (Datta et al., 2023).

RELATED MATERIALS AND METHODS

Overview of BIM Technology

An entirely new data technology, BIM, is being used in the construction industry (Soundararajan et al., 2023). Connected construction projects can be guided by information technology. It is possible for technicians to comprehend all forms of building data correctly and devise effective mitigation plans using this method. Cutting down on building time and increasing production efficiency reduces expenses. There are several advantages to using BIM technology.

An example of a non-operational item being simulated in BIM technology is the simulation of a building. As part of the design process, BIM can be used to test visual components like emergency evacuation and energy efficiency as well as heat conduction and sunshine. As part of the construction and bidding process, 4D simulations are performed to identify the best construction strategy. For example, a free evacuation or earthquake escape simulation can be simulated in the operation stage using a 4D or 5D simulation experiment (three-dimensional model cost control).

In the construction industry, coordination is the most important topic (Luo et al., 2023). Identifying the causes and solutions to construction problems requires a conference of relevant employees, which must be scheduled. Then, the right construction improvements must be implemented. However, a coordinated solution has a time lag. Poor coordination may be the outcome of designers failing to communicate properly during the project design phase. Since the building designs are varied, there may be a dispute between the structural beam and pipeline layout in HVAC as well as other specializations. A common challenge in daily construction is as follows: Using the BIM building data model, several disciplines can work together to solve early collision issues, develop and supply coordination data, and so on. Using the coordination features of BIM technology helps not only with the design of the elevator shaft but also with the design of its free compartment and subsurface drainage systems.

As a construction worker, a strong ability to visualize is essential (Yap et al., 2024). Building plans must be examined by a professional to determine the true structure of the data expressed in each component (Cao et al., 2023). This data is merely represented with lines in the drawing. Even the simplest of things can stoke the fires of imagination. As architectural forms get more complex and better modeling becomes more ubiquitous, what can be imagined by the human brain alone will no longer be sufficient (Sadhu et al., 2023). In this way, outmoded line-type components are shown as three-dimensional physical images using BIM (Dala Pegorara Souto et al., 2023). Bar data rather than component data is often used in building sector design representations by professional production teams. There is no input or contact with identical components. BIM visualization has a lot of interaction and feedback between components. A BIM model shows every step of the process. Additionally, this data can be used for reporting purposes and to make the project operation, planning, and construction process more transparent and straightforward (Lorincz et al., 2023).

Alongside the increasing reliance on digital technology, we need to focus on addressing potential vulnerabilities and adopting mitigation strategies (Yang & Zhang, 2023). Here are some important measures to address the challenges:

- Information security and privacy protection: Strengthen network security awareness, adopt effective encryption measures, access control, and identity verification mechanisms to ensure the security of data transmission and storage processes. At the same time, comply with relevant laws and regulations to protect user privacy from infringement.
- Data quality and accuracy: Ensure the accuracy and completeness of data, establish a sound data management process and quality control mechanism, and avoid decision-making errors caused by data errors.
- Emergency response and disaster recovery: Develop comprehensive emergency response plans and disaster recovery mechanisms, timely and effectively handle emergency situations such as data leaks and system failures, and minimize losses.
- Technological updates and talent cultivation: Continuously track technological development trends, update systems and tools in a timely manner, cultivate talents with professional knowledge and skills in digital technology, and maintain the organization's competitiveness in digital transformation.
- Compliance and Regulatory Compliance: Comply with relevant regulations and standards, cooperate with regulatory agencies for compliance review, reduce the risk of violations, and ensure the legitimate and compliant use of digital technology.

In summary, addressing the vulnerabilities in digital technology and developing mitigation strategies requires comprehensive measures from multiple aspects to ensure the smooth progress of the digital process and maximize the role of digital technology in improving efficiency and innovation.

Building Operation and Management

Block construction is a good analogy to describe the construction process. This type of structure allows for manufacturing, assembly, function modernization, and design diversification. Innovative building techniques save energy and resources while also being environmentally friendly. However, this type of building must ensure that each component of the building assembly is functioning properly during the construction process to ensure that the safety and quality of buildings are met. Figure 1 illustrates the construction process of a structure.

This is based on the three elements of modernization: industrialization, informatization, and standardization techniques of building. To put it simply, buildings are built with "integration" at their core. The building life cycle may be effectively controlled and managed by using BIM technology, which can improve the efficiency of prefabrication manufacturing, construction, and layout. The building assembly process is shown in Figure 1. Four aspects influence building construction. They are as follows:

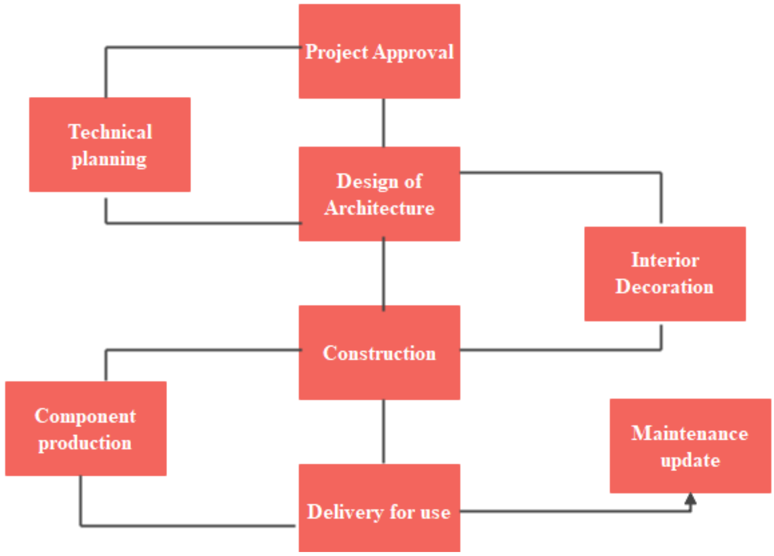
Management Factor

Management responsibilities for construction companies must be prioritized, and the current managerial approach is enough. To ensure successful management level improvement and satisfy site construction needs, management professionals must work with the existing situation to enhance and formulate the management plan and adapt the management strategy to operational conditions. An in-depth assessment of the facility will reveal the need for better training for those in charge of running it. As a result, managers will be unable to implement new ideas, preventing them from achieving their true worth and purpose. Unless a strong management system and faultless construction principles are included, there will not an accurate foundation for managerial work.

Personal Factor

An effective building project can be ensured if personnel and construction equipment are appropriately regulated. Consequently, the construction unit is responsible for closely supervising and regulating construction employees and equipment. To guarantee that the building's overall quality is

Figure 1. Building Assembly Process



significantly improved even though construction machines and employees are different from the way they were originally designed, the project manager must oversee the current condition of construction. To get the most out of these machines' advantageous properties, operators must strictly adhere to all applicable laws and regulations when operating various machines and elevating apparatus.

Material Factor

Materials have a part in the construction of structures since the components used in the building's construction must be created. Components must either fulfill particular requirements or be used without being tested or checked to assure the proper operation of buildings. Several factors could affect its performance; therefore, we must pay particular attention to them. To determine the quality of the materials before the building begins, it is necessary to designate a specific individual to do a specific evaluation.

Process Factor

Problems such as slurry leakage and formwork displacement are typically caused by process difficulties during the construction and manufacturing of buildings. As a result, before beginning the pour, the bolts utilized in the formwork installation must be tightened to the proper tightness. The formwork bolts must be tightened if they haven't previously. There will be visible shifts in the concrete's position if the interlayer thickness isn't tightly managed. Alternatively, the slurry layer will get thinner, enabling huge amounts of air to reach the junction surface, which will lead to varied heights.

Equation 1 is the formula for calculating the design value of shear bearing (García-Pereira et al., 2020) capacity:

$$v = 0.59 a_b X + 0.80n \tag{1}$$

Equation 2 is used to determine the horizontal joint of a shear wall.

$$v = 0.59 a_b X + 0.60n \tag{2}$$

The shear bearing capacity of the horizontal joint at the bottom of a precast column is computed using Equation 3:

$$v = 0.59n + 1.66X\,\overline{a_k a_y} \tag{3}$$

Equation 4 is used while the building is under strained:

$$v = 0.039\,a_k A_k + 0.0299\,a_k A_i + 1.61\,A_z \overline{a_k a_y} \tag{4}$$

To determine whether or not a building has a sustainable design, Equation 5 is used:

$$v = 0.039\,a_k A_k + 0.0299\,a_k A_d + 1.61\,A_z \overline{a_k a_y} \tag{5}$$

Material Management

Material management is the process through which businesses plan, organize, regulate, and save resources in their production and operations. Not only can it facilitate wireless communication across the many sections of the company, but it can also keep track of all of the company's resources, ensuring that the company runs smoothly at all times. Material management includes purchasing, determining the product's origin, and modifying materials. Automated MRP system growth, professional department management, and just-in-time supply chain management are all examples of the evolution from manual growth to MRP system informatization and automation. Equations 6, 7, and 8 demonstrate these processes:

$$M = M_{11} M_{12} \ldots\ldots\ldots M_{1x} \tag{6}$$

$$M = M_{21} M_{22} \ldots\ldots\ldots M_{2x} \tag{7}$$

$$M = M_{n1} M_{n2} \ldots\ldots\ldots M_{nx} \tag{8}$$

Let M1, M2, Mn be Original Variables. Let H1, H2, Hu (u<x) be New Variables. Then Equations 9 and 10 explain the linear relationship between the original and new variables:

$$H_1 = d11M1 + d12M2 + \ldots\ldots\ldots\ d1xMx \tag{9}$$

$$H_m = dm1M1 + dm2M2 + \ldots\ldots\ldots\ dmxMx \tag{10}$$

Assessment of Principal Components (PCA) is an attempt to determine how much of an impact the primary variable, *x*-1, has on each principal component, M1, and standardize data samples in this way (see Equations 11, 12, and 13):

$$M_{ij} = \frac{M_{ij} - \overline{M_j}}{s_j - 2} \tag{11}$$

$$M_j = \frac{1}{n}\sum_{1}^{n} M_{ij} \tag{12}$$

$$s_j = \frac{1}{n}\sum_{1}^{n} M_{ij} - \overline{M_j} \tag{13}$$

This approach yields the rate of cumulative variance contribution (rk) of the first factors as follows in Equation 14 and 15:

$$r_k = \sum_{i=1}^{k} \frac{H\,s^2}{\mu_{ix}} \tag{14}$$

where i-ith factor on the ith sample. The X-factor value:

$$T_{ij} = r_k(16)\Big(E_{j1} X_{ji} + E_{j2} X_{j2} + \ldots E_{jx} X_{jx} \tag{15}$$

The total sum value is calculated as follows in Equation 16:

$$V_{i=} r_k(17)\Big(E_{j1} X_{ji} + E_{j2} X_{j2} + \ldots E_{jx} X_{jx} \tag{16}$$

where Mj1 is the coefficient factor between the jth factor and xth original value.

Proposed System

Subjects

Sand table simulation is utilized to conduct structure testing in this article. The entire process of constructing a single building relies on BIM technology. Buildings 2 and 3 are being constructed simultaneously. The construction of one structure is based solely on traditional methods, as there is no auxiliary technology present. Factors to consider included the location of the two buildings and the quantity of staff employed in each. The control group communicates with the other group using BIM and wireless connection.

Figure 2 illustrates the most important aspects of the technology proposed plan. Profit is the most important link in the chain because it is the ultimate purpose of an enterprise to maximize its worth. The profit can be maximized at a specific price if the minimum cost is included. An organization's goal in effective material management is to eliminate waste and maximize material efficiency by ensuring that the demands of its many departments can be met on time, with suitable quality and price, and by utilizing the most effective and efficient procedure possible. The primary focus of this work is on the differences in material management between the two structures.

Procedural Steps

This can be split down into three distinct steps: the planning stage, the production stage, and the building stage. Even though there are no material challenges during the design phase, material management is handled primarily at the production and construction stages. At the time of production stage, aspects like the transportation mode, procurement batch, frequency, and selecting suppliers arise. The vendors used in this paper's sand table simulation experiment are the same as in the previous experiment, but the unit price and transportation costs vary depending on the different purchase volumes. The number of inventory rotations influence whether or not a given purchase quantity is considered acceptable to the customer.

To put it another way, inventory management is more efficient when the amount of money available for purchase is greater. The smaller the scrap rate, the finer the material quality. A process is more wasteful when surplus resources are left over after raw materials have been produced or used.

Index of Assessment

The acquisition, storage, and quality control of construction materials can be broken down into three categories. Purchasing efficiency and capital utilization can be gauged by looking at the rate at which inventory is turned over. Equation 17 is the Taylor series expansion motion nonlinear partial differential equation used to derive the monitoring theory:

$$\frac{x^2 Q}{x t^2} = y_0^2\left[1 + \frac{r''}{r'}\frac{xu}{xz} + \ldots\right]\frac{x^2 Q}{x z^2} \tag{17}$$

The relationship of the elastic constants of nonlinear parameters includes the following Equation 18:

$$\gamma_2 = -\frac{r''}{2r''} \tag{18}$$

The variation Equation 19 and solution equation 20 are as follows:

$$\frac{x^2 Q}{x t^2} = y_0^2\left[1 - 2_{\gamma 2}\frac{xu}{xz} + \ldots\right]\frac{x^2 Q}{x z^2} \tag{19}$$

$$Q = Q_1 \cos(qx - rz) - \frac{1}{4}\gamma_2 q^2 Q_2 x\sin 2\left(qx - rz\right) \tag{20}$$

RESULT AND DISCUSSION

The Variance Between the Traditional and BIM Methods

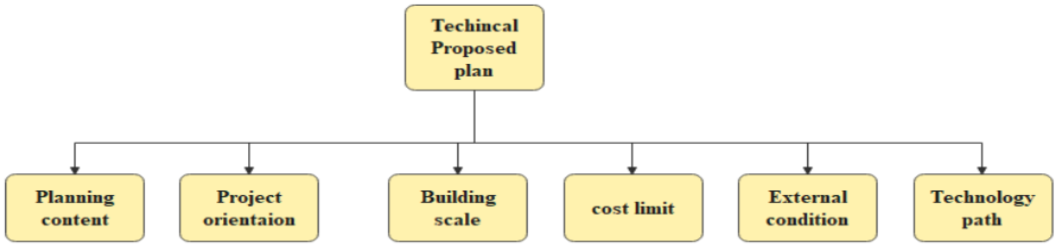
Inventory Turnover Times Comparison

The number of times a business has sold and restocked its inventory over a certain period is known as the inventory turnover ratio. A company's ability to maximize its financial resources while still meeting the needs of its customers is measured by inventory turnover. There may be fewer materials available for collection if inventory turnover is high, and expenditures will rise as a result.

As seen in Table 1, BIM management solutions have higher material turnover times compared to traditional building operation and management approaches. Building operation and management approaches that rely on purchasing staff's ability to see exactly what each production section requires at any one time do not have this capability.

As shown in Figures 3 and 4, the BIM-based assembly building operation and management strategy have an average inventory turnover time of six compared to the conventional method's four at this stage. While both methodologies have their merits, the gap between them narrows as the project progresses. It takes three times as long to turn a building around using BIM technology compared to the conventional method. Inventory turnover for BIM and wireless communication was seven times higher during the building phase than it was during the BIM assembly phase.

Figure 2. Technical Proposed Plan



Comparison of Transport Cost

When using a building materials management system based on BIM technology and wireless communication, inventory turnover times are extremely fast, which contributes to the growing problem of rising transportation costs in the construction sector. As transportation durations lengthen and the cost of transportation fuel rises, the loss of fixed assets like materials and automobiles also increases. On the one hand, transportation costs are rising as are the costs of transporting people. The amount of cash discount or commercial discount that is offered will, on the other hand, increase in proportion to the volume of each transaction. As a result, in this particular instance, the conventional way can indirectly cut the total cost. Costs associated with transportation are expenses that service providers for transportation internally bear. The particular transportation expenses associated with each route are listed in Table 2 below.

According to Figure 5, the cost of employing BIM technology to manage building materials is higher than the cost of creating the same project using an old procedure. It is more than three times faster to manage the transportation of building materials using BIM technology compared to the old way. Transport times increase dramatically when wireless and wired communication is combined. In terms of transportation expenses, BIM trumps the old method.

Storage Difference Between Two Technologies

Comparison of Warehouse Occupancy

The storage facility's capacity goes hand in hand with its cost. Construction expenses can be reduced by lowering the leasing fees of a warehouse if it is not being utilized to its full capacity. As a result of the high speed at which materials are turned over in the BIM-based building operation and management system, the warehouse has a lower occupancy rate.

Table 3 compares the occupancy rates of construction warehouses using the two techniques. The building materials management system based on BIM technology has a lower warehouse occupancy rate than the conventional approach, and the combined effect of BIM and wireless communication is superior to the conventional approach.

An Analogy of the Entire Amount of Material Purchased Compared to the Amount of Surplus Useless Material

There would certainly be a surplus of materials throughout construction. It gets more expensive as there are more leftovers. Table 4 compares the two building methods' surplus waste materials to the overall amount of materials purchased. In the building material management method based on BIM technology and wireless communication, the proportion of surplus useless materials in the warehouse is 6% and 3% of the total purchased materials, whereas in the standard approach, the proportion is 4% and 2% of the total purchased materials (see Figure 6 and Figure 7). The primary purpose of a warehouse is to keep items or products before transporting them to another place.

Table 1. Assembly Difference

*	Construction Stage	Production Stage
BIM Assembly	7	4
Control Group	5	3
Traditional Assembly	8	5

The Difference in Quality of Material

Similarly, quality control of raw materials is a key phase in the material management process. We put the purchased building materials through their paces under two different technological scenarios, and we used the sampling survey method to assess the failure rate of all of the supplies. The use of BIM technology is prevalent during the architectural design phase. To generate the information database, parametric design and 3D modeling are used in conjunction with each other. The majority of the data is supplied as a database. The BIM model creation process includes standard development, design creation, and design implementation. Among the parameters for each graphic unit in the model are size, kind, and substance. To truly grasp a BIM model's worth and benefits, one must first understand the qualities that influence all component models. If a component parameter is altered, it will be possible to delete omissions and mistakes from drawings as well as information discrepancies. The key benefit of BIM technology is its ability to foster collaborative management and information technologies. The combination of both BIM and wireless communication design models from several disciplines on a single platform enables cross-disciplinary collaboration. Table 5 shows the findings of the sampling survey.

Table 5 shows that the building material management approach based on BIM technology and wireless communication has a material failure rate of 2%, while the standard technique has a rate of 5%. The price includes the cost of materials that are discarded throughout the usage of the product. As far as it is feasible, material management should avoid scraping. From 2015 to 2019, we compared the production costs of the same facility under various management styles, as illustrated in Figure 8.

Figure 9 illustrates that, during the building stage, the rate of material scrap is larger than during the manufacturing stage. When it comes to fabricated building materials management, the scrap rate of a BIM-based fabricated building material management strategy is always lower than that of a traditional process, and the shred cost of the control group is also less. This example shows how BIM and wireless networking can work together to produce good outcomes.

The PDR, which is seen in Figure 10, is the proportion of packets successfully received by a destination node to packets transmitted. The PLR, which is the inverse of the PDR, is the proportion of packets that are lost to those that are transmitted. Equation 21 is used to calculate the PDR.

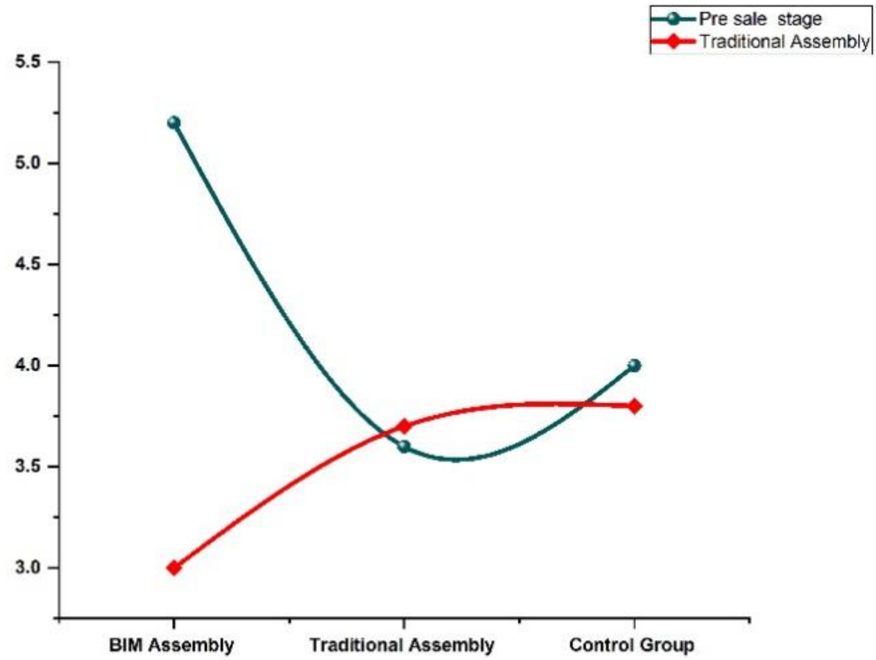
$$\mathrm{PDR}(\%) = \frac{\mathrm{P}_{\mathrm{Received}} \times 100}{\sum_{i=1}^{n} \mathrm{P}_{\mathrm{Generated}}} \tag{21}$$

The RSSI, shown in Figure 11, is a measurement of the strength of a received radio signal. It is expressed as a negative number in dBm (decibel-milliwatt) units; a higher number indicates better wireless transmission quality. In general, an RSSI number between 50 and 0 dBm indicates a strong signal; a value below 80 indicates attenuation, and a value below 100 indicates full disconnection.

Analysis of Practical Applications

Due to the continuous progress of technology and the rapid development of the construction industry, wireless communication technology and Building Information Modeling (BIM) technology are gradually becoming important engines for promoting the transformation and upgrading of

Figure 3. Comparing Both Method's Inventory Turnover Times



the construction industry. This article aims to explore the application of these two cutting-edge technologies in the field of construction, analyze their impact on the accuracy of construction experiments, industrial production efficiency, and logistics management, and reveal their profound significance for the development of the construction industry. Specifically, the research significance of this article includes the following points:

1. Promoting innovative development in the construction industry: By combining wireless communication and BIM technology, the accuracy of building experiments can be improved, promoting the development of the construction industry towards digitalization and intelligence and promoting innovation and enhancement in the construction industry.
2. Improving industrial production efficiency: Research has pointed out the importance of wireless communication technology in industrial production control. By applying these technologies, industrial production efficiency can be improved, production processes optimized, costs reduced, and enterprise competitiveness enhanced.
3. Improving logistics management and construction technology: This article studies the application of wireless communication and BIM technology in logistics management and construction technology, providing new ideas and methods for improving logistics management and optimizing construction processes in the construction industry, which helps to improve engineering quality and efficiency.
4. Promoting sustainable development: As one of the world's largest construction markets, China's construction industry faces challenges such as long cycles, high costs, and environmental protection. By updating and upgrading the construction industry and emphasizing the importance of data sharing, sustainable development of the construction industry can be promoted, achieving a combination of economic benefits and environmental friendliness.

Table 2. Transportation Cost Comparison

	BIM technology	Control group	Conventional Method
Unit price per purchase	5.4	5.3	6.4
Transportation times	16	13	15

Overall, the research findings of this article contribute to expanding the development perspective of the construction industry, leading the direction of technological innovation in the industry, improving the digital level and management efficiency of the construction industry, and providing reference and inspiration for the sustainable development of China's construction industry.

When applying wireless communication technology in buildings, there are some network security and data privacy issues that need to be taken seriously and effectively managed to ensure the security of building systems and the protection of user privacy. These network security issues include:

1. Unauthorized access: Unauthorized users may enter building systems through wireless communication networks, leading to information leakage or system attacks.
2. Data theft: Hackers may steal sensitive data transmitted through the network, such as building layouts, security system information, and more.
3. Denial of Service (DoS) attack: Attackers may use wireless networks to conduct DoS attacks, causing building systems to malfunction.

Figure 4. Variations in Assembly Modes

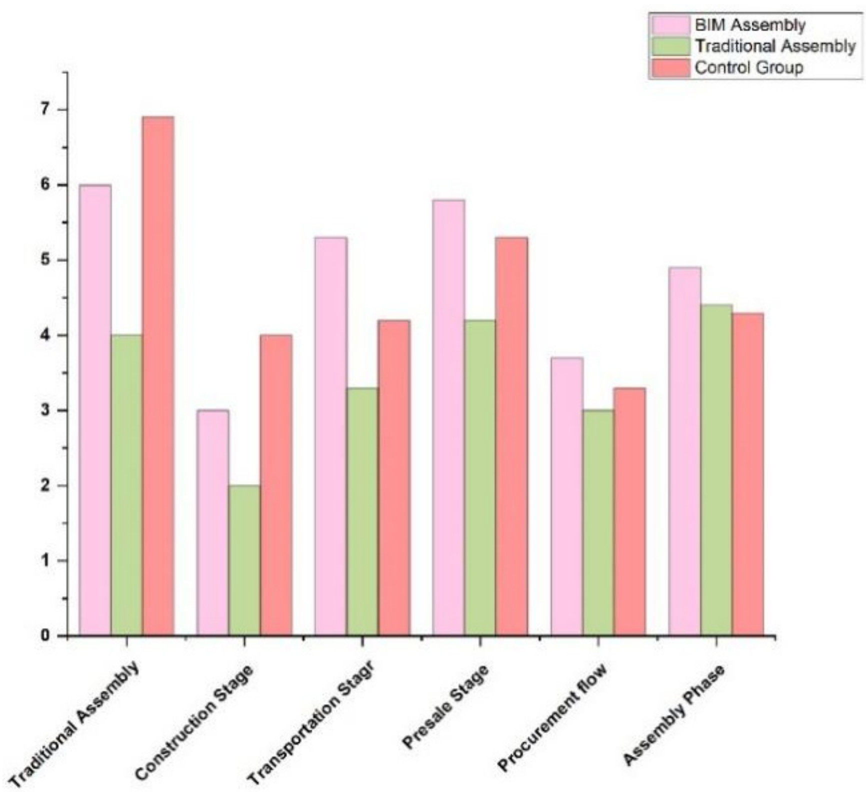


Table 3. Comparing the Construction Warehouse Occupancy Rates of the two Approaches

	Construction Stage	Production Stage
Control group	79	66
BIM Technology	65	43
Traditional Assembly	87	45

Data privacy issues include:

1. Personal privacy leakage: Sensors and monitoring devices in building systems may collect user personal information, such as location data, behavioral habits, and more, which may leak user privacy.
2. Sensitive data leakage: The building system may contain sensitive commercial secrets or design information, and once leaked, it will have a serious impact on the building project.
3. Data consistency: Data may be tampered with during transmission, posing a threat to the accuracy and integrity of information and affecting the normal operation of building systems.

To address these issues, the construction industry can take the following measures:

1. Strengthening network security measures: adopting technologies such as encrypted communication, access control, and firewalls to protect wireless network security.

Figure 5. Building Management Technique is Compared to the Traditional Method

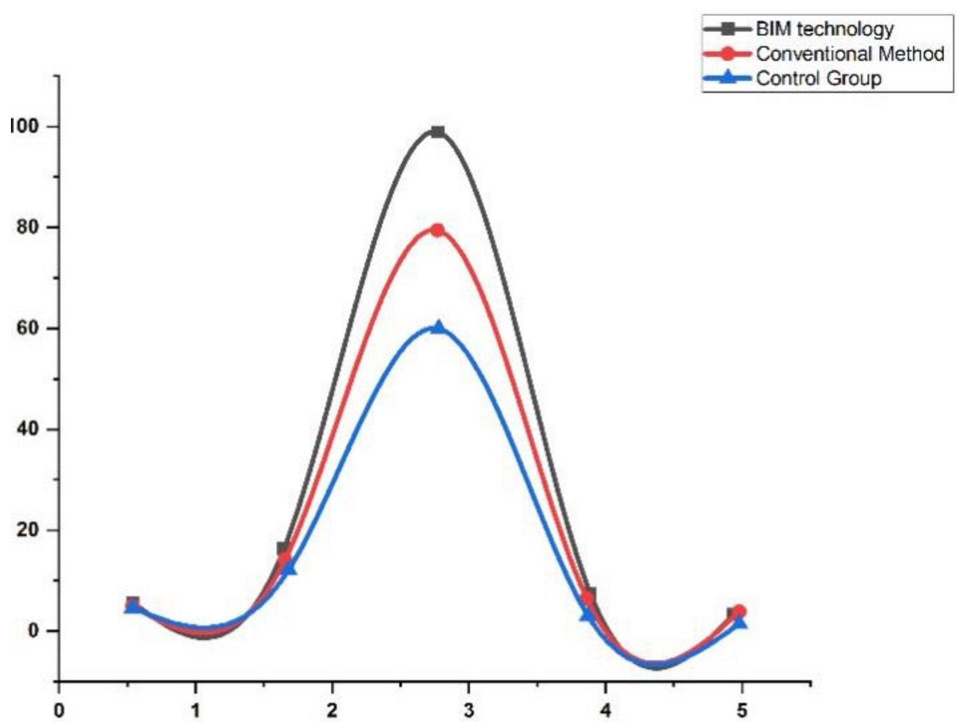
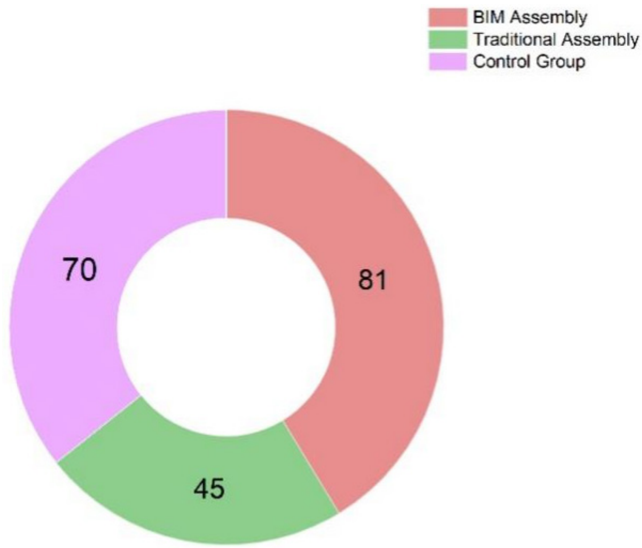


Figure 6. Rate of Warehouse Accumulation in Percentage



2. Data encryption: Encrypt the transmitted data to ensure that it is not stolen or tampered with during transmission.
3. Permission management: Establish a strict permission management mechanism to control permissions for different users and avoid unauthorized access.

To achieve digital transformation in the construction industry, we need more innovative thinking and the application of cutting-edge technologies. Therefore, in this article, we will explore key areas for the future development of the construction industry and propose relevant research recommendations to promote sustainable development and efficiency improvement in the construction industry:

1. Application of Sensor Technology: We aim to strengthen research on the application of sensor technology in the construction field, and explore the wider application of sensors in building operation and maintenance, in order to achieve real-time monitoring, analysis, and management of data.
2. Artificial intelligence and big data: By combining artificial intelligence and big data technology, we can tap into the potential of data in the construction industry, providing more intelligent solutions for building material management, production process optimization, and efficiency improvement.
3. Virtual reality and augmented reality technology: This involves further research on the application of virtual reality (VR) and augmented reality (AR) technology in architectural design, construction, and maintenance, to improve the visualization and interactivity of building projects.
4. Digital twin technology: This involves exploring the application of digital twin technology in the field of architecture, achieving precise monitoring and prediction of building operation status through real-time data interaction between digital models and actual buildings.
5. Ecological architecture and sustainable development: One should pay attention to the concept of ecological architecture and sustainable development, combine technological innovation with environmental protection concepts, and promote the development of the construction industry towards a greener and more sustainable direction.

Table 4. On-The-Spot Verification of the Qualified Rate of Materials

	Cost stage	Production stage
BIM and wireless communication Assembly	6	4
Traditional Assembly	2	8

Table 5. Failure Rate for Both Methods

	Conventional method	BIM and wireless communication Method
Size of sample	100	100
Total failure rate (%)	3	6
No. of failures	3	6

By continuously exploring the application of cutting-edge technology and combining it with the actual needs of the construction industry, we can promote the digital transformation of the construction industry, improve production efficiency, reduce costs, and promote sustainable development of the industry.

Figure 7. Comparing Two Methods for the Occupancy Period

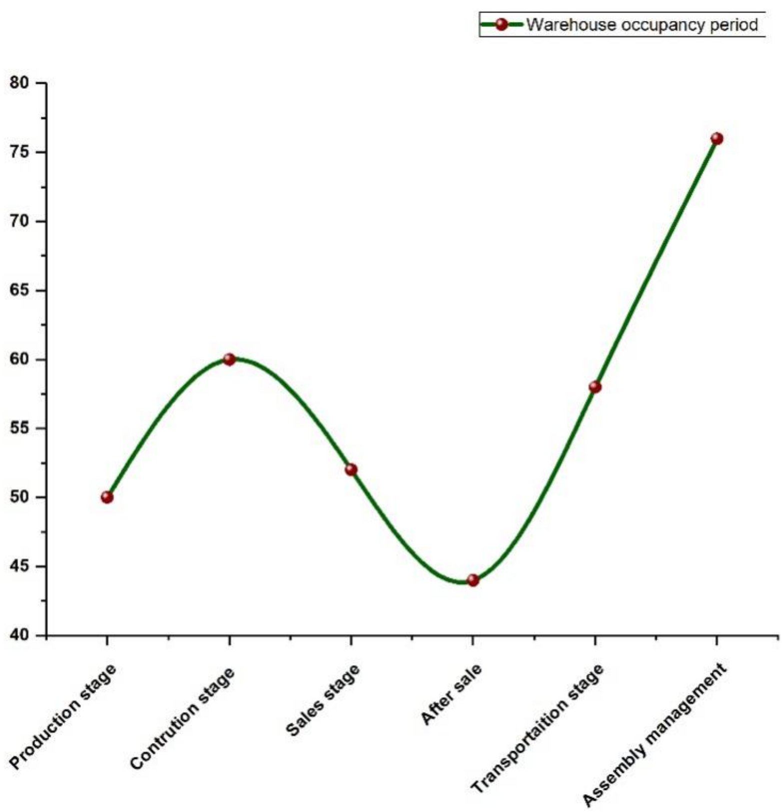


Figure 8. Modification in Cost

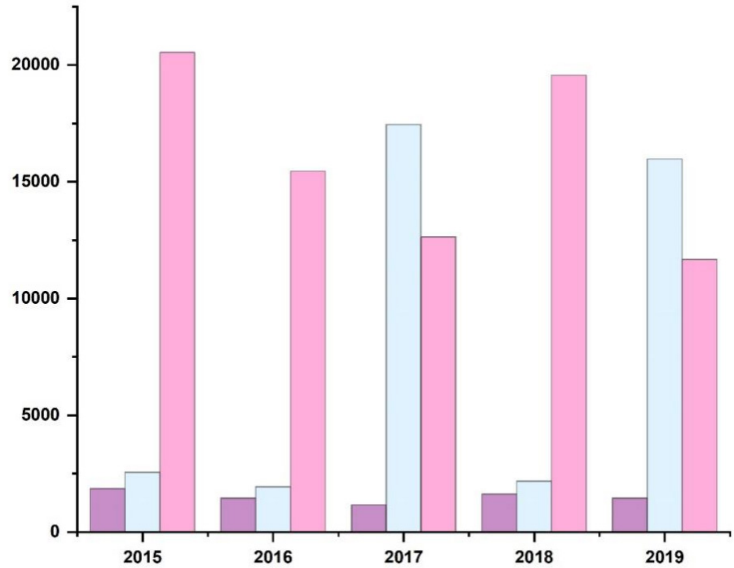
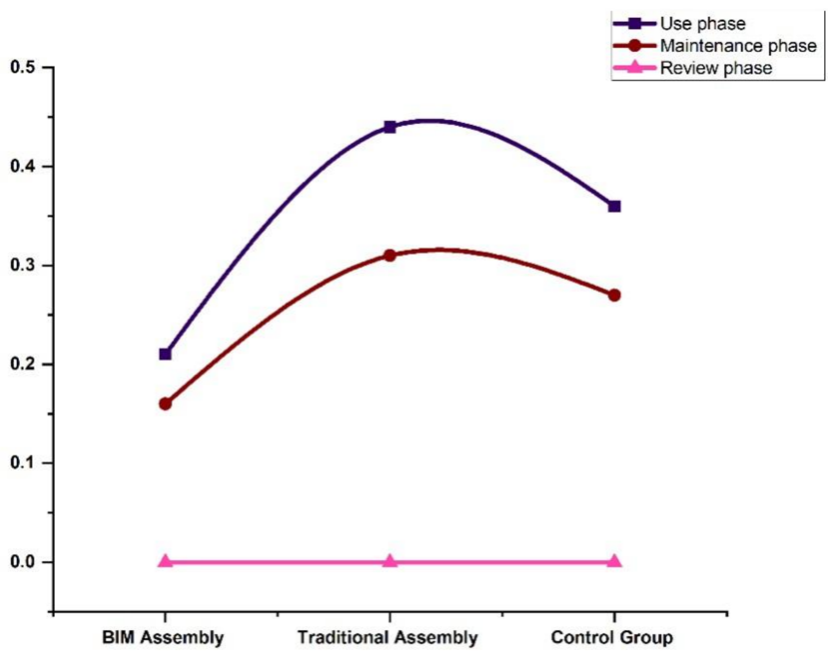


Figure 9. Resource Scrap Cost Analysis of Two Alternative Building Techniques



CONCLUSION

The rapid development of social media technology promotes the development of wireless and wired communication modes. Wireless communication has numerous advantages over traditional communication. A wide range of communication is possible because of wireless technology. Increasing the scientific validity of building materials management has helped industrial production efficiency

Figure 10. Comparison of Packet Delivery Ratio for Proposed and Existing Methods

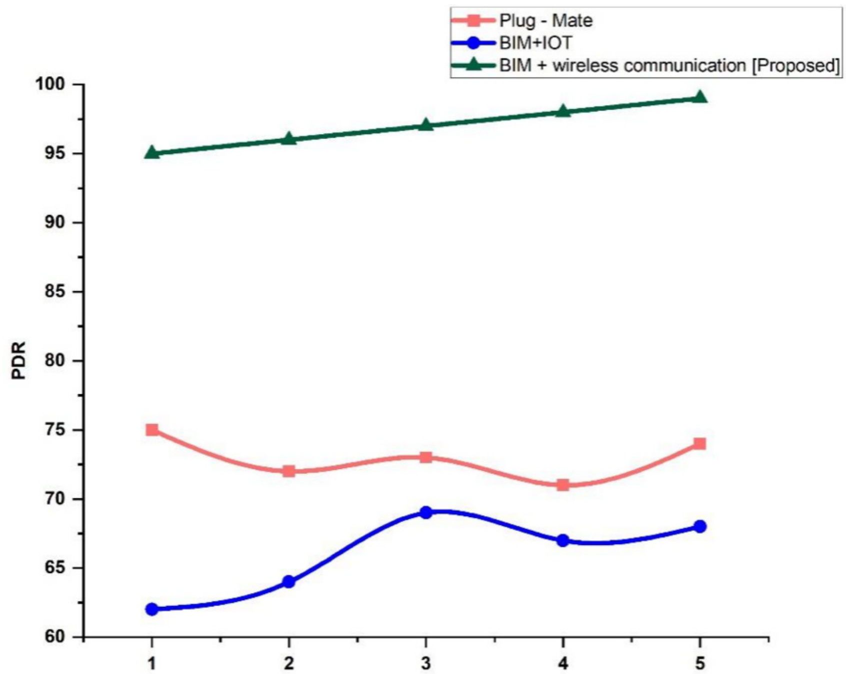
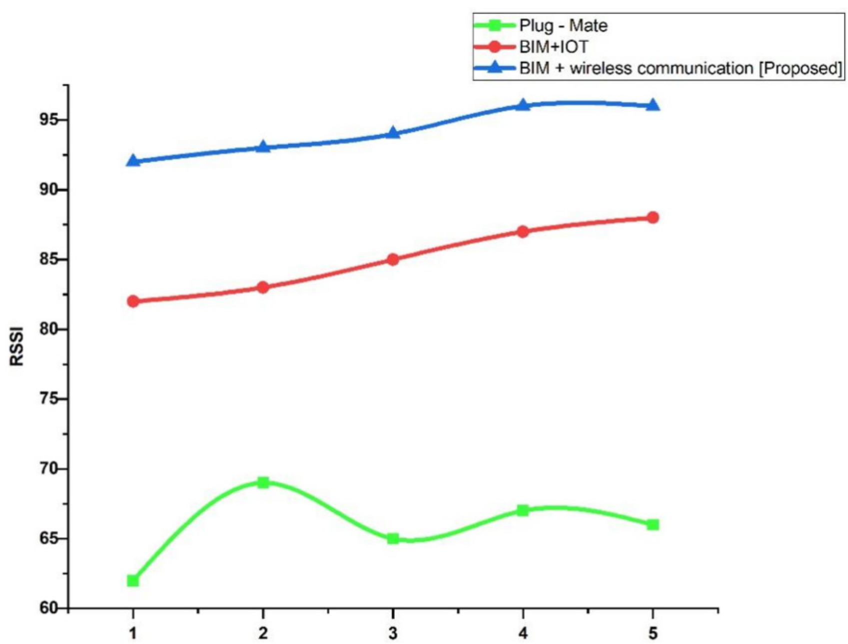


Figure 11. Comparison of Received Signal Strength in Proposed and Existing Methods



in several respects. Improvements in mobile networks can boost organizational effectiveness by increasing the quality of wireless communication and improving services for people from all walks of life. Hand-operated schedules and forklift truck operations are common in traditional methods of material management, but they require a large number of personnel and cannot be coordinated for data input, equipment operation, inspections, or detection. However, the vast majority is still purely on paper. In a typical foundry, the process sheet is easily damaged or destroyed during the transfer process, resulting in erroneous component identification. It's also difficult to enter and adjust a wide range of machining settings. It's possible that the finished product doesn't match the process flow diagram. Since all of these steps are carried out by hand, they have the potential to introduce errors and lags into the final product. In this study, the sand table model is used to carry out the architectural experiment. The present BIM technology has provided 100% accuracy when compared to the conventional method. For future research, it is recommended to implement sensor techniques for managing building operations and maintenance.

DATA AVAILABILITY

The figures and tables used to support the findings of this study are included in the article.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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CORRESPONDING AUTHOR

Correspondence should be addressed to Feng Qiao (China, arch888@lit.edu.cn)

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APPENDIX

1975年出生于河南洛阳。彼于中国西安建筑科技大学获硕士学位。现就职于洛阳科技学院土木工程学院。他的主要研究领域是建筑设计。