Research Article

Application of BIM Technology in Data Collection of Large-Scale Engineering Intelligent Construction

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Received 14 June 2022; Revised 2 July 2022; Accepted 12 July 2022; Published 31 July 2022

Academic Editor: Balakrishnan Nagaraj

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In order to solve the problem of data collection of intelligent construction of large-scale projects, the author proposes the application of BIM technology in the collection of intelligent construction data of large-scale projects; this method proposes to take advantage of the technical advantages of BIM; starting from the needs of the commercial complex operation and management stage, a BIM-based commercial complex operation management model is established, and the application content of this model to improve the efficiency of commercial complex operation and management is studied. The experimental results show that according to the design conditions and the depth of BIM application, the standard elements and variable factors can be divided into 70% and 30%, respectively. Conclusion. BIM can realize the refinement, intelligence, and quality of commercial complex operation.

1. Introduction

Under the background of the new normal of China’s social and economic development, the main contradiction in Chinese society in the new era has been transformed into the contradiction between the people’s ever-growing needs for a better life and unbalanced and insufficient development. Residents have put forward higher demands for various business formats such as material consumption, commercial shopping experience, health and wellness, education, and training, and commercial complexes are the carriers that carry these complex functions. Commercial complexes are social places with rich formats, complete functions, and fashionable atmosphere; therefore, the design of commercial complexes is becoming more and more difficult, and it is difficult for general design methods and technologies to meet the design needs. Since the introduction of BIM technology in China, it has achieved great development in various fields, and its application in the design stage of commercial complexes has become more common, but the application value of BIM technology still has a lot of room for improvement. In the application of BIM technology in the field of engineering, the application value of BIM technology in construction management, operation and maintenance, project cost, etc., is generally recognized, there are few researches on the application value in the design stage of commercial complexes, and there is insufficient understanding of the application value generated; it is not conducive to promoting the in-depth application of BIM technology in commercial complex projects. Therefore, fully understanding and attaching importance to the application value of BIM technology in the design stage of commercial complexes are urgent problems needed to be solved in the current industry.

2. Literature Review

Zhang et al. said that BIM (Building Information Modeling) technology is emerging in the construction industry in China and abroad today, and it has become more and more popular and has been highly praised by many scholars and architects [1]. Sheng said that the idea of BIM began to take shape in the 1970s, and since then, BIM technology has been continuously developed in practical construction and theoretical applications and supplemented and defined in more detail [2]. Pan et al. said that in the definition given by Wikipedia, it is pointed out that the purpose of BIM technology is to establish and manage the functions of engineering construction projects and the process of digitizing, visualizing,
and visualizing physical characteristics [3]. Perera et al. said that multiple forms of model information have become an important resource platform for sharing data and information in the process of project construction and are deeply embedded in the entire life cycle of the project (including project planning, design, construction, operation, and maintenance stages) [4]. Gao et al. said that the various information generated by the continuous deepening and refinement of the BIM model in the project also changes continuously and closely, and finally, the information is closely related [5]. Wu et al. said that the building simulation technology in BIM technology is a multidimensional model information integration technology based on traditional CAD technology in recent years [6]. Guo and Hu said that all parties involved in the project can obtain project information in the digital virtual model established by BIM technology [7]. Borkowski and Wyszomirski said that it has also achieved a high degree of integration of scattered information in the past, which is an important feature of BIM technology that is different from other technologies, the infrastructure of the technology is the model, the relevant information is its soul, the software platform is the tool, the content is its focus, and management is the key [8]. Rwanyiziri et al. said that it provides support for the technology and method of decision-making, design, construction, and operation in the whole life cycle of complex construction projects [9]. Malila and others said that the construction industry informatization based on BIM technology breaks the gap between management and technology; the project safety, quality, progress, cost, and performance that were in a state of separation in the past can be centralized, facilitating management, ensuring project efficiency, improving project quality, reducing risks, and improving industry efficiency and profits [10]. It can be seen from the foregoing that BIM is not only a technology but also a concept and an idea at a higher level. BIM technology realizes information integration, management, interaction, real-time update, and changes in the construction of complex projects, provide more abundant and accurate information exchange and sharing for different participants in the whole life cycle of engineering construction, and improve the level and efficiency of project management in construction projects, as shown in Figure 1.

3. Methods

The numerical simulation of PyroSim software is calculated based on grids; all objects in the simulation must be divided into cells; after the BIM model is imported, according to the specific parameters of the actual model, it is simplified to a grid cube of $80.4 \times 48 \times 15.3 = 59045.76$ m$^3$, the grid size is set to $0.5 \times 0.5 \times 0.5$, and the total number of grids is 472360. The corresponding grid parameters are shown in Table 1.

The construction process of engineering projects has the characteristics of large volume, long construction period and many participants, complex construction process, and difficult management. Especially for large-scale key engineering projects, the construction schedule time requirements are urgent, and the construction schedule management is under great pressure [11]. Schedule, cost, and quality are the three most important goals in the process of engineering project management; the three goals must be balanced organically; the blind pursuit of progress will inevitably affect the balance of project quality and cost. Therefore, schedule management directly determines whether the project objectives can be achieved. For project progress management, its purpose is to formulate a schedule based on scientific methods and reasonable forecasts after systematically analyzing the project objectives, work tasks, and work logical relationships and duration. In order to ensure that each stage of the project can achieve the predetermined progress target and ensure the effective realization of the overall project schedule, it is necessary to plan, adjust, and analyze the progress of each management stage in the whole life cycle of the project. In the process of project implementation, in order to achieve the project goal, it is necessary to constantly find out the schedule deviation, analyze the cause of the deviation problem, and formulate corrective measures; through the implementation of corrective measures, the project can be completed on time and reduce the schedule deviation. Project schedule management includes the formulation of schedules and control of schedules. The project progress management process is shown in Figure 2.

The S-curve comparison method is a function diagram of the relationship between the completed engineering quantity and the construction period and calculates the actual cumulative completed engineering quantity and the change curve of the construction period during the implementation of the project; the same coordinate system is also drawn for comparative analysis. Because the resource input in the early and late stages of project implementation is usually less and the midterm investment is larger, the corresponding cumulative completed engineering volume is also the same, and the change curve is similar to the English letter “S” [12-13], as shown in Figure 3.

The application of BIM technology requires the support of BIM software, and the project management capability can be improved through software collaboration; the application of BIM technology in progress management requires the coordination and cooperation of many BIM software; construction projects include many types of design disciplines, difficulty, and high technical requirements; BIM technology has many application points in the whole project, so it is difficult to realize the effective application of BIM technology by a single software; even if the technology application of the whole process of BIM can be completed, its application effect and professional level are relatively low [14]. Therefore, BIM software is aimed at various majors, and the user needs of each participant are classified more carefully, which is also a reflection of the higher user experience and better application effect. At present, the main application software of BIM technology in the global market has the following types, as shown in Table 2.

The guiding ideology of the flow model theory in the construction production TFV theory refers to eliminating waste, shortening the construction period, reducing unnecessary construction procedures, and optimizing construction steps, thereby improving construction efficiency. In the
Figure 1: Application of BIM technology in data collection of large-scale engineering intelligent construction.

Table 1: Grid parameter table.

| Axis | Minimum | Maximum value | Number of grids |
|------|---------|---------------|-----------------|
| X    | -24     | 24            | 96              |
| Y    | -40.2   | 40.2          | 161             |
| Z    | 0       | 15.3          | 31              |

According to the image, the functional relationship can be obtained as follows: the functional relationship of the linear functional relationship is shown in

\[ c_i^D = a_i t_i + b_i, \] (1)

which is shown in

\[ a_i = \frac{C_i^n - C_i^l}{t_i^n - t_i^l}, \]
\[ b_i = \frac{C_i^n t_i^l - C_i^l t_i^n}{t_i^n - t_i^l}, \] (2)

where \( C_i^D \) is the direct cost of work \( i \); \( t_i \) is the duration of work \( i \); \( t_i^n, t_i^l \) are the minimum duration and normal duration of work \( i \), respectively; and \( C_i^l \) and \( C_i^n \) represent the direct cost of work under the shortest duration and the normal duration, respectively.

The functional relationship of the nonlinear functional relationship is shown in

\[ C_i^D = a_i t_i^2 + b_i + C_i^l, \] (3)
which is shown in

\[ a_i = \frac{C^n_i - C^l_i}{(t^n_i)^2 - (t^l_i)^2}, \]

\[ b_i = \frac{C^n_i (t^l_i)^2 - C^l_i (t^n_i)^2}{(t^n_i)^3 - (t^l_i)^3}. \]  

\[
\text{(4)}
\]

The indirect cost is proportional to the construction period. This situation also causes the relationship between the total cost and the construction period as shown in the figure, which is a curve relationship of decreasing first and then increasing. Then, the total cost must have a minimum point, which is the optimal point to be determined in the process of duration-cost optimization. It can be seen from the figure that the total cost curve has an extreme point (Ts, Cs), at which time the corresponding cost is the lowest, and the corresponding construction period is the most reasonable. The relationship between the total project cost and the duration function is shown in

\[ TC = DC + IC = \sum C^D_i + \Delta C^I T. \]  

\[
\text{(5)}
\]

Among them, TC is the total cost of the project; \( C^D_i \) is the direct cost of \( i \) work; \( \Delta C^I \) is the indirect cost rate; in general, it is approximated that the indirect cost rate and the work duration have a linear function relationship, which is a fixed value; \( T \) is the construction period; \( i \) work direct cost rate \( \Delta C^D_i \) is shown in

\[ \Delta C^D_i = \frac{C^n_i - C^l_i}{t^n_i - t^l_i}. \]  

\[
\text{(6)}
\]

Therefore, the total cost rate \( \Delta TC_i \) of \( i \) work can be obtained as shown in

\[ \Delta TC_i = \Delta C^D_i + \Delta C^I_i. \]  

\[
\text{(7)}
\]

Therefore, when \( \Delta TC_i < 0 \), the total cost is proportional to the construction period. When \( \Delta TC_i > 0 \), the total cost is inversely proportional to the construction period. The construction period of engineering projects is long, and the amount of capital investment is large; the flow of funds is not a one-time payment, but a multistage and multipoint flow, which also causes the project cost to pass over time during the construction process; additional value-added charges will apply. Excluding the consideration of inflation, the value of the same amount of money invested at the moment is greater than the value generated by the investment in the future, because the current funds can be invested immediately and bring benefits. It can be seen that the passage of time will add a certain value to the funds, this part of the value for the owner of the funds becomes a benefit,
and this part of the value for the borrower of the funds becomes a cost. Therefore, it can be seen that due to the particularity of engineering projects, the time value of funds accounts for a large proportion of the total cost of engineering projects, and it is also a part that cannot be ignored in progress management. The traditional static duration-cost optimization only considers the amount of capital (the inflow and outflow of capital), while ignoring the time value of capital; with the more refined development of the construction industry, enterprises have stricter requirements for schedule management costs. To maximize the benefits, the time value of money has become the focus of the research on duration-cost optimization. It is also a hot spot for scholars in the research of progress optimization in recent years. In the process of cost payment for engineering projects, the most common form is multiple payments, and the flow of funds occurs at multiple points in time, rather than at a certain point in time. This also creates the time value of money. The time value of capital is considered in the optimization of construction costs, and the net present value is usually used as the optimization index. The calculation principle of net present value takes the time value of funds into consideration reasonably, its economic significance is clear, and the evaluation standard is easy to determine. Its formula is shown in

$$NPV = \sum_{t=0}^{n} \left( CI - CO \right)_t (1 + i)^{-t},$$  

where NPV is the net present value, CI is cash inflow, CO is cash outflow, \( (CI - CO)_t \) is the net cash flow in year \( t \), \( (1 + i)^{-t} \) is the present value coefficient of one-time payment, \( i \) is the benchmark rate of return, and \( n \) is the plan calculation period. The NPV indicator takes into account the time value of money and fully considers the capital status of the whole project cycle, the meaning of funds is clear, the calculation is accurate, and it is easy to analyze. When dynamically optimizing the cost of construction period 1 in the construction phase of a project, the schedule plan is usually prepared in units of days, which is the same as the interest-bearing period and conforms to the calculation method of continuous compound interest. In the process of dynamic optimization of construction period and cost, the essence is to reasonably arrange the relationship between construction activities and cost and time schedule, so as to achieve the goal of the lowest cost and the best construction period. The main idea of particle swarm optimization is to simulate the group behavior of birds foraging and a group of birds randomly searching for things in a limited area and by constantly updating the distance and speed between the bird and the food, until the food is found. In the particle swarm algorithm, the optimized fitness function is first defined, and each particle can be regarded as a bird; during the optimization process, the particles search and fly in the multidimensional space at a certain speed; according to the dynamics of the group, the flight speed and position are dynamically adjusted and updated, and the optimization is continued until the optimal fitness value is found. In the PSO algorithm, each particle represents a solution to the optimization problem, and the fitness function is used to check whether the particle meets the requirements. The particle moves in the solution space with a certain speed and trajectory direction; its motion direction and position are determined by the velocity variable. The optimal solution is achieved by continuously searching for particles that replace the optimal position. When the particle reaches the new motion position, it will first compare with the optimal

### Table 2: BIM technology software.

| Software classification                 | Name          | Professional use                  | Priority |
|----------------------------------------|---------------|----------------------------------|----------|
| BIM core modeling software             | Revit         | Building, structure, electromechanical | High     |
|                                        | Rhino+GH     | Building, structure, electromechanical | High     |
|                                        | ArchiCAD     | Architecture                      | Middle   |
| File sharing and collaboration software | Vault         | Collaboration platform            | High     |
|                                        | Navisworks   | Collaboration platform            | High     |
|                                        | ProjectWise  | Collaboration platform            | High     |
| Analyzing software                     | Vasari        | Green analysis                    | High     |
|                                        | PKPM          | Structural analysis               | High     |

![Figure 4: Duration-direct cost linear function diagram.](image-url)
position that it has experienced; if the comparison result is better, it needs to be compared with the global optimal position, and finally, the optimal solution is obtained. The position and velocity update of the particle will be achieved by the following formula as shown in

\[ v_{id}^{t+1} = v_{id}^{t} + c_1 r_1 (p_{id}^{t} - x_{id}^{t}) + c_2 r_2 (p_{gd}^{t} - x_{id}^{t}), \]

\[ x_{id}^{t+1} = x_{id}^{t} + v_{id}^{t+1}. \]

In the formula, \( r_1, r_2 \) is a random number, and its value range is \((0, 1)\); \( c_1, c_2 \) is the learning factor, usually \( c_1 = c_2 = 2 \). Among them, particles realize the update of speed and position through three parts, \( v_{id}^{t} \) is the particle “memory” part, \( p_{id}^{t} - x_{id}^{t} \) is the “cognitive” part, and \( p_{gd}^{t} - x_{id}^{t} \) is the “social” part; through mutual cooperation and comparison, the particles update the optimal position of the entire search global scope, indicating information sharing and mutual cooperation between particles.

### 4. Experiments and Analysis

The design of commercial complexes is quite different from the traditional commercial architectural design; the traditional commercial architectural design has limited functions and a single form; design work can be realized based on conventional design concepts and design methods. The emergence and further development of commercial complexes broke the rules of traditional architectural design; due to the diverse needs of commercial complexes, such as rich formats, complex structures, and rich facade shapes, higher requirements have been placed on the design. The application of BIM technology provides a variety of means for the design of commercial complexes; limited by the degree and scope of application, at present, the application of BIM technology in the design stage of commercial complexes still mostly stays in two-dimensional design, single-specialty design, and other dimensions, and the application value of BIM technology has not really been brought into play [19, 20]. With the diversified development of design methods, various drawing and modeling software emerge in an endless stream; these tools provide designers with a variety of choices to get rid of simple two-dimensional design; however, from the essence of design thinking, these tools are only auxiliary functions; design thinking is still in the two-dimensional stage; the starting point of design is still the scrutiny and thinking of the plane; when necessary, BIM modeling software is used for scrutiny, and the powerful 3D display and simulation functions of BIM technology are not fully utilized; a shift from consciousness and thinking levels to three-dimensionality is required [21]. In the design of commercial complexes, because there are many specialties involved, it is necessary to repeatedly raise funds, review, and modify each other during the design process. However, affected by the division of design majors and traditional design ideas, the design work of various majors in commercial complexes is still relatively independent, and there is no change at the level of design thinking. Although in the design of commercial complexes the drawings are combined and checked against each other according to the design progress, there are still many loopholes; in the places where there are still a lot of mistakes and omissions in the construction process according to the drawings, the value of BIM technology is small. With the update and iterative upgrading of commercial complexes, the work in the design phase of commercial complexes has become more complex, and the majors involved have increased to architecture, structure, HVAC, water supply and drainage, electrical, curtain wall, landscape, interior decoration, guide signs, weak current intelligence chemical, garage moving line, and many other specialties. With the deepening of the understanding stage of commercial complex design, the traditional single-specialty design mode is no longer applicable, and new application modes such as general design contracting and BIM general contracting have been derived; with the in-depth application of the general design contracting mode and the maturity of BIM technology, the industry is constantly exploring how BIM technology can give full play to its application value in commercial complex projects; China’s leading commercial real estate companies, Wanda, Xincheng, China Resources, Longfor, etc., are all conducting design research, development, and application exploration [22, 23]. In 2017, after completing all R&D and project pilots, Wanda Group publicly proposed for the first time to comprehensively promote the BIM general contracting model, implementing in all direct investment Wanda Plazas across the country, with the BIM model as the core to achieve the comprehensive goals of design control, plan management, cost control, and quality control. The BIM general contract management mode is a BIM-based design general contract mode, which runs through the whole life cycle of the project and has the characteristics of coordination and synchronization, management preposition, and mode unification. The BIM general contract management mode is the intelligent construction mode of Wanda commercial real estate, and it is another milestone change after the general construction contract; on the basis of the general design contract, the comprehensive introduction of BIM technology is aimed at achieving BIM as the core, improving the design efficiency and quality through the unified and coordinated management of the general design contract, and ultimately providing guarantee for the construction and operation of the project. Since the design general contracting mode will greatly increase the work content and difficulty of the general design contracting, how to effectively manage the design subcontracting from the aspects of technology and management is the key and difficult point [24]. The BIM general contracting mode has been deeply optimized on the basis of the design general contracting mode; the core point is to fully introduce the BIM model, which requires the general design contract to use the BIM model as the core, and carry out the design results of all design subcontracts through the BIM collaborative work platform and integrate and manage through information technology. In addition, in order to ensure the quality of the design, the general design contract is managed by formulating the standard contract for the general design contract, the design
task statement, and the performance assessment, and in the introduction of a third-party review mechanism, the consulting company hired by the construction unit shall review the results of the general design contract; in order to ensure compliance and rationality, with the in-depth application of BIM technology in various fields, the production factors and work efficiency improvements generated by BIM technology have been widely recognized; the BIM application model has also undergone major changes, gradually shifting to the general design contract and BIM model as the core, and the value of the general design contract, BIM model, and BIM collaboration platform will become more and more important in the design stage of commercial complexes [25, 26]. Through the analysis of the changes in the application mode of BIM technology in the design stage of commercial complexes, by consulting relevant research literature and sorting out a large number of actual project cases, it is found that the application of BIM technology in the design stage of commercial complexes has brought design processes, design thinking, and design management. For equal dimensional changes, these changes have an impact on the application value of BIM technology in the design stage of commercial complexes. According to the conventional commercial complex design process, the design can be designed according to the preliminary design conditions and standards, and the design content can be adjusted according to the in-depth and perfect design conditions; if the design conditions change significantly, it will lead to subversive modifications of the design, which will bring great trouble to the design work. Especially in the design of commercial complex projects, there are many cases where major design modifications are caused by changes in external variables such as municipal, fire protection, and civil air defense [27]. After consulting the “Wanda BIM General Contracting Operation Manual,” due to the standardization and informatization characteristics of BIM, this dilemma can be effectively improved in a sense, so the design elements are divided into two elements: standard and variable. According to the design conditions and the depth of BIM application, the standard elements and variable factors can be divided into 70% and 30%, respectively; 70% of the standards are locked in the design stage, and the rationality of the standards is strengthened; at the same time, it is necessary to maximize the controllability of 30% of the variable factors. According to traditional design conventions and thinking, the role of design is that of the designer, who realizes the owner’s design task by giving full play to his professional advantages and skills [28]. With the in-depth application of BIM technology in the design stage of commercial complexes, it will force changes in design thinking such as role perspective, service content, and resource utilization. From the perspective of role, the design often starts from the single identity of the supplier and only needs to meet the requirements of the owner’s design brief; this kind of design thinking often fails to comprehensively consider the actual needs of the owner, which leads to the emergence of the design transformation practice process, out of the way of the original design. Due to the changes in BIM design work requirements and supporting design contract modes, the design will change from the single perspective of the supplier to the multiple identities of the owner’s perspective; at the same time, it can also help the owner to achieve greater comprehensive benefits. In the application cases of BIM projects in recent years, more and more design contracts link project output value with social benefit indicators, and the role perspective of design is gradually transforming. In terms of service content, the traditional design provides a single service, and the way of thinking is straight-line thinking, and the design task can only be completed according to the requirements of the design contract and the task book. The application of BIM technology makes this single service change to in-depth service, from linear thinking to comprehensive thinking. The application of BIM technology in the design of commercial complexes has changed conventional design thinking. In the dimension of the management platform, the traditional single-item design has been transformed into a general design contractor, which has changed the situation of individual majors fighting each other; in the end, the overall design is coordinated by the general design contractor; through the combination of drawings and verification, the contradictions between majors are found, and the overall design of the design can be brought into play; the coordination function of the package is solved. For the BIM design work platform dimension, from 2D design to BIM design, traditional 2D design can only achieve design goals through simple model and shape analysis; BIM technology has powerful three-dimensional display, space analysis, node decomposition, shape simulation, and other functions, which can fully meet various design requirements. In terms of the information work platform, the traditional 2D general contract management is gradually transferred to the BIM general contract management; under the leadership of the BIM general contract, the upstream and downstream design chain of the design will be closely designed around the BIM model, and finally, the general design contractor will transform the design results of various majors into the BIM model and output the design results through the BIM model. 3D modeling and space display are important aspects for BIM technology to play its advantages in practical applications; especially with the in-depth advancement of BIM general contracting and other application modes, the BIM model has become the application core of each system; all participants will work around the model; the construction unit determines the plan and calculates the cost through the model; the design unit optimizes the design scheme and drawings through the model; the construction unit guides the site quality, progress, safe and civilized construction, etc., through the refinement of the model; and the supervision unit can supervise various work on the construction site through the model; therefore, the accuracy, timeliness, and rationality of the model will become an important factor affecting the rapid and orderly progress of the project; it takes a lot of time and energy to invest in the BIM model work, and it is also necessary to study the application value points of the model stage. Through the in-depth analysis of the two new application modes of design general contracting and BIM general contracting, the BIM model plays a central role in the
application of the design stage, and all parties involved must carry out related work around the BIM model, which is of great application value to the model. The point has an important impact. In addition, the transformation from simple design subcontracting to design general contracting also has a profound impact on the entire design concept; the application value of the design stage is developing towards integration, diversification, and informationization; these changes provide an important basis for sorting out value points; it is helpful to select more scientific and reasonable value points for applied value research. From the definition and analysis of BIM, the model (model) is the core value point of BIM technology, and the building (build) and the information (information) are based on the extension of the model; the model is the basic platform and framework for the development and function expansion of BIM technology. Because the model plays an important role in BIM application, the model is the basic carrier of BIM application. In the model of commercial complex design, the models of various disciplines such as architecture, structure, and electromechanical finally form a complete model. Due to the complexity of the commercial complex model, the modeling stage requires a lot of time and effort, so it is necessary to study the value points of the model stage. The civil engineering model is the basis of the BIM model, and other professional models need to be attached to the civil engineering professional model. Therefore, the accuracy, depth, and efficiency of the civil engineering professional model will directly affect the entire design progress. In the civil engineering model, in addition to the main models such as walls, stairs, doors, and windows, detailed components such as steps, handrails, and reserved holes also have a great impact on the quality of the model. The main contents of the structural model include beams, slabs, columns, foundations, piles, and steel structures; since the BIM model needs to have the function of one-click measurement to provide a basis for cost verification and completion settlement, the structural model also needs to include a steel bar model. Due to the complicated sizes and types of steel bars in beams, plates, columns, pile foundations, and other parts, it brings great difficulties to the modeling of steel bars; it is necessary to continuously explore methods suitable for the characteristics of the project during the modeling process and improve model accuracy and modeling efficiency.

5. Conclusion

The number and scale of commercial complexes in China are growing rapidly; it has brought unprecedented challenges to operations that lack information technology management. The application of BIM technology is conducive not only to the realization of information management by the management parties working together but also to the analysis and organization of relevant data, so as to achieve effective supervision and control; at the same time, it can also provide managers with specific information and data and give their work reference content, which will ultimately help reduce management costs and improve management efficiency. However, the use of BIM technology means a new management mode; therefore, the author aims to seek a new mode of operation management by studying the operation management of commercial complexes based on BIM and to improve the management level by using the business innovation brought by BIM technology. Therefore, the author takes the operation management of large-scale commercial complexes as the research object, based on the BIM operation management model obtained by BIM technology, and obtained the BIM operation management model of the research commercial complex; it is of great significance to promote the management transformation and upgrading of the operation stage of China’s construction industry.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that they have no conflicts of interest.

References

[1] J. Zhang, W. Zhu, X. Wu, and T. Ma, “Traffic state detection based on multidimensional data fusion system of internet of things,” Wireless Communications and Mobile Computing, vol. 2021, 12 pages, 2010.

[2] T. Sheng, “Real-time ar technology assisted high-resolution image processing and its graphic design application,” Access, vol. 8, pp. 142916–142930, 2020.

[3] X. Pan, B. Zhong, X. Wang, and R. Xiang, “Text mining-based patent analysis of bim application in construction,” Journal of Civil Engineering and Management, vol. 27, no. 5, pp. 303–315, 2021.

[4] U. Perera, U. Kulatunga, F. N. Abdeen, S. Sepasgozar, and M. Tennakoon, “Application of building information modelling for fire hazard management in high-rise buildings: an investigation in Sri Lanka,” Intelligent Buildings International, vol. 14, no. 2, pp. 1–15, 2021.

[5] Z. Gao, “Intelligent building bim fusion data analysis framework based on speech recognition and sustainable computing,” International Journal of Networking and Virtual Organisations, vol. 25, no. 1, p. 83, 2021.

[6] Z. Wu, C. Ren, X. Wu, L. Wang, and Z. Lv, “Research on digital twin construction and safety management application of inland waterway based on 3d video fusion (July 2021),” IEEE Access, vol. 9, pp. 1–1, 2021.

[7] X. Guo and H. Hu, “Strategy of bim building operation and maintenance management based on lv-eg model,” Mathematical Problems in Engineering, vol. 2020, 13 pages, 2020.

[8] A. S. Borkowski and M. Wyszomirski, “Landscape information modelling: an important aspect of bim modelling, examples of cubature, infrastructure, and planning projects,” Geomatics Landmanagement and Landscape, vol. 1, no. 1, pp. 7–22, 2021.

[9] G. Rwanyiziri, C. Kayitesi, M. Mugabwine et al., “Spatio-temporal analysis of urban growth and its effects on wetlands in Rwanda: the case of Rwampara wetland in the city of Kigali,” Journal of Applied Sciences and Environmental Management, vol. 24, no. 9, pp. 1495–1501, 2020.
[10] M. N. Maliha, B. A. Tayeh, and Y. Aisheh, “Building information modeling (BIM) in enhancing the applying of knowledge areas in the architecture, engineering and construction (AEC) industry,” *The Open Civil Engineering Journal*, vol. 14, no. 1, pp. 388–401, 2020.

[11] H. A. Rashid, O. A. Al-Juboori, and A. Mahjoob, “Identifying the key barriers and challenges of BIM implementation in the developing countries: case study of Iraq,” *Design Engineering (Toronto)*, vol. 2021, no. 4, pp. 374–381, 2021.

[12] R. Huang, P. Yan, and X. Yang, “Knowledge map visualization of technology hotspots and development trends in China’s textile manufacturing industry,” *IET Collaborative Intelligent Manufacturing*, vol. 3, no. 3, pp. 243–251, 2021.

[13] N. Zhu, B. Yang, Z. Zhang, and M. Wang, “Application of BIM in green building materials management,” *Journal of Physics: Conference Series*, vol. 1986, no. 1, p. 12024, 2021.

[14] C. Liu, “Energy consumption simulation of green building based on BIM system and improved neural network,” *Journal of Intelligent and Fuzzy Systems*, vol. 2, pp. 1–12, 2021.

[15] K. Kyivska and S. Tsiutsiura, “Implementation of artificial intelligence in the construction industry and analysis of existing technologies,” *Technology Audit and Production Reserves*, vol. 2, no. 58, pp. 12–15, 2021.

[16] M. Bradha, N. Balakrishnan, A. Suvitha et al., “Experimental, computational analysis of butein and lanceoletin for natural dye-sensitized solar cells and stabilizing efficiency by IoT,” *Environment, Development and Sustainability*, vol. 9, no. 1, pp. 8807–8822, 2022.

[17] I. V. Ponkin and A. I. Redkina, “Digital public administration: method of digital models-doubles (BIM) in law,” *Public Administration*, vol. 22, no. 2, pp. 64–69, 2020.

[18] J. Wang, C. Gao, S. Dong, S. Xu, and Y. Wang, “Current status and future prospects of existing research on digitalization of highway infrastructure,” *Zhongguo Gonglu Xuebao/China Journal of Highway and Transport*, vol. 33, no. 11, pp. 101–124, 2020.

[19] Y. Lu and L. Shi, “Bim architecture design from the perspective of smart city and its application in traditional residential design,” *Journal of Intelligent and Fuzzy Systems*, vol. 40, no. 12, pp. 3127–3136, 2021.

[20] H. Xu and S. Li, “Safety analysis of deep foundation excavation in water-rich soft soils based on BIM,” *Mathematical Problems in Engineering*, vol. 2020, 19 pages, 2020.

[21] A. Jc, B. Ji, L. B. Xin, A. Wg, Z. Jing, and C. Fra, “Degradation of toluene in surface dielectric barrier discharge (SDBD) reactor with mesh electrode: synergistic effect of UV and TiO\textsubscript{2} deposited on electrode,” *Journal of Intelligent and Fuzzy Systems*, 2021.

[22] T. Alqlami and H. Al-Alwan, “The application of bim tools to explore the dynamic characteristic of smart materials in a contemporary Shanashil building design element,” *International Journal of Sustainable Development and Planning*, vol. 15, no. 2, pp. 193–199, 2020.

[23] T. N. Thanh, T. D. Minh, and T. H. Xuan, “Overview of BIM application for bridge - highway and infrastructure projects in Viet Nam,” *The Transport and Communications Science Journal*, vol. 71, no. 7, pp. 760–774, 2020.

[24] Y. Zhang, X. Kou, Z. Song, Y. Fan, M. Usman, and V. Jagota, “Research on logistics management layout optimization and real-time application based on nonlinear programming,” *Nonlinear Engineering*, vol. 10, no. 1, pp. 526–534, 2021.

[25] D. R. Rizaldi, A. W. Jufri, and J. Jamal, “Phet: simulasi interaktif dalam proses pembelajaran fisika,” *Jurnal Ilmiah Profesi Pendidikan*, vol. 5, no. 1, pp. 10–14, 2020.

[26] J. Omran, “How to achieve sustainable building design and operation with building information modeling,” *Tishreen University Journal for Research and Scientific Studies*, vol. 42, no. 2, pp. 217–232, 2020.

[27] P. Ajay, B. Nagaraj, R. Arun Kumar, R. Huang, and P. Ananthi, “Unsupervised hyperspectral microscopic image segmentation using deep embedded clustering algorithm,” *Scanning*, vol. 2022, Article ID 1200860, 2022.

[28] G. Veselov, A. Tselykh, A. Sharma, and R. Huang, “Special issue on applications of artificial intelligence in evolution of smart cities and societies,” *Informatica (Slovenia)*, vol. 45, no. 5, p. 603, 2021, http://www.informatica.si/index.php/informatica/article/view/3600.