Proceedings of the 8th International Conference on Economic Management and Green Development
DOI: 10.54254/2754-1169/121/20242291

BIM Driving Innovation in Construction Industry: Advancements in Building Lifecycle Management and Facility Management

Muyun Wei[1,a,*]

[1]*School of Emergency Science and Engineering, Jilin Jianzhu University, Changchun, 130118, China*
a. wjf@cfmcc-ss.com.cn
**corresponding author*

Abstract: With the rapid development of the traditional construction industry, China's construction market is becoming saturated and overcapacity, and the global macro economy is facing uncertainty. Negatively impacted by global events and the climate crisis, the willingness of traditional architectural firms to invest in real estate, infrastructure and other projects needs to be higher. The enhancement of digital information technology has brought greater freedom and openness, and traditional architects are looking to BIM technology to stimulate creativity and build more dynamic buildings. This paper analyses the development and application of BIM technology from the perspective of the "BIM+" intelligent management model. It discusses the importance of upgrading the traditional construction industry, especially in building life cycle management. Through "BIM+" intelligent management, the traditional construction industry can handle the information in all project stages more efficiently and achieve the goal of resource integration. At the same time, the combination of BIM and facility management can realise intelligent operation and monitoring of building projects. This paper reviews related research and looks forward to the future research direction of combining BIM and building facility management.

Keywords: BIM, Building Lifecycle Management, Intelligent Management, Facilities Management, Construction Industry

1. Introduction

The conventional construction industry has experienced rapid development in the last 10 years, which has led to domestic construction market saturation and overcapacity; the entire construction market's ecological environment is nothing better than before. And because the COVID-19 Global Oscillatory Epidemic, the Russia-Ukraine War and the global climate crisis have had a negative impact on the world's macro-economy, many industries, including the traditional construction market, have faced economic revenues and the risk of labour shortage. Therefore, in the context of the macroeconomic slowdown, the environment and financing channels are unstable, exacerbating the uncertainty of the construction investment environment. The willingness to invest continues to be low for traditional Chinese construction enterprises on real estate, infrastructure and other construction projects.

DOI: 10.54254/2754-1169/121/20242291

With the improvement of digital information technology, people are freer and more open. Against this backdrop, traditional architects also hope to stimulate creativity and design and build more vibrant buildings. Hence, theories and concepts about architecture are constantly evolving. Particularly, the technology of BIM, praised as one of the basic ideas of Industry 4.0, has been booming in the construction industry [1]. At the same time, the "BIM+" intelligent management model formed as its core has provided technical support for transforming and upgrading the traditional construction industry. BIM is also called the n-D modelling or virtual model [2]. BIM technology integrates all the information collected during the building life cycle. Workers can use applications like Autodesk Revit, ArchiCAD to integrate into the information model throughout the building life cycle. BIM is a digital representation of physical and functional characteristics [2]. However, the "BIM+" intelligent management, a method to communicate and work with the information modelling, emphasises integrating all information like the building materials, construction period, construction personnel, project budget and so on into the BIM, which can promote interdisciplinary, cross-team collaboration and more holistic management of construction projects throughout the building life cycle. In brief, the lean management of the construction project life cycle can effectively process the information of each stage of the project and realise the sharing and storage of the information of the whole life cycle to achieve the goal of integrating resources. By using the technology of BIM, workers can manage building projects more easily and meticulously, deal with the information from all stages efficiently to ensure the information of the building sharing and storage and realise the purpose of integrating resources [3]. Simultaneously, with all kinds of architectural models involved in BIM, managers can also realise intelligent operation and monitoring with the help of these models, which are also considered to be a combination of BIM and facility management (FM). In facility management, BIM can work as a new way to help managers maintain equipment and property management, including space planning and inventory management, inspection, moving and property portfolio management [4].

Many essays reviewed the relevant research applications of BIM, such as Xu et al.'s review of the application of the "BIM+" Intelligent Data Decision Making System in ultra-high-rise project management [5]. Zhou et al. researched the diurnal status and development trend of the BIM application in China [6]. However, all these applications are decentralised and do not form a systematic management approach to project management. Since the publication of the contemporary paper, with the updated iteration of information big data, BIM has been developed rapidly, and nowadays, it can provide further modelling and data support for FM. Therefore, it is necessary to summarise and review the existing research related to BIM and to further look forward to the research value and direction of its combination with building facility management.

This study is organised according to the following lines. Firstly, the author introduces the development and application of the technology of BIM, especially points out what the "BIM+" management pattern formed around BIM technology; then analyses the significance of promoting the development of the traditional construction industry under the "BIM+" management mode in the perspective of the building-lifecycle-management; finally, summarises the whole essay and looks forward to the relevant research prospects and directions.

2. "BIM+" Intelligent Management

BIM was first used in architectural design; the main focus was on 3D modelling to improve the design structure of the building. Under the development of big data, BIM has also gradually expanded into the engineering and construction field from the late 2000s to the early 2010s, introducing more information attributes such as cost, schedule, and material attributes, which this phase mainly focuses on improving the integration of Building-lifecycle-management. Under the development during this decade, BIM has also been further integrated with digital engineering

DOI: 10.54254/2754-1169/121/20242291

technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and so on. For this reason, managers can know the real world and put forward intelligent decisions or predictive maintenance methods. Simultaneously, it has further contributed to forming the "BIM+" intelligent management model, a method of organising and coordinating projects and teams based on BIM. Generally speaking, the formation of the model results from the gradual application and promotion of BIM in construction and engineering, summarised through practice and experience.

3. Promoting Building Lifecycle Management through "BIM+" Management

3.1. Benefits of Employing BIM in Initial Project Design Phases

3.1.1. Advantages of BIM Compared to Traditional 2D CAD Model Design

The most differences between BIM and CAD are the model dimension and information richness. Designers paid close attention to the plane rendering and graphic design in the past. Although, to a certain extent, CAD can also represent 3D structures, the model made by CAD is usually formed by bidimensional lines and shapes, mainly based on the expression of the ichnography. However, BIM models are based on 3D models; the design process used in BIM extends from a simple design of matter to a very thorough design of a structure [7]. For example, detailed information about the properties of geometric shapes and architectural elements is included in BIM. The primary distinction between CAD and BIM is that CAD is a fundamental drafting and representation tool.

In contrast, BIM models are built by addressing the form, function, and behaviour of building systems and components [8]. At the same time, BIM provides a shared digital platform for architectural design teams. In the initial phases of traditional building design, engineers and architects frequently work alone, which may lead to neglecting structural performance in architectural design [9]. But, based on the platform made by BIM, designers from different fields can cooperate and communicate with each other on the same platform at the same time, which makes the design solution more in line with the actual construction conditions to reduce the delay and error of information transmission and promote the information synergy [10]. Taking many super high-rise building project management as an example, there are many problems, such as large project volume and difficult construction technology [11]. It is complicated to plan the overall construction of a building with the original 2D technology; to keep the people away from the problems that may be encountered in the later construction, construction enterprises will survey and collect the field data and input the collected data into the established platform database, to complete the BIM platform modelling work for the overall intelligent building [12]. The results indicated that effective use of BIM could minimise errors during the early stages of building design and reduce their concomitant impacts by facilitating the flow of information [10].

3.1.2. BIM-Enhanced Budgeting and Fund Cost Control

Unlike other industrial sectors, the construction of buildings always brings unique results due to different construction techniques and target buildings, which require appropriate price estimates [13]. In general, the cost of a construction project depends on the cost estimate in the design stage; with the engineering basic data collected by BIM during the design phase, workers can count the consumables and the funds required for consumables during the building. In budget management, the key areas where the BIM application's benefit is seen are time-sensitive databases, resource planning functions, and so on [14]. The relevant building materials are at a fluctuating price in the market. The time-sensitive database will be adjusted dynamically according to the actual market situation, which allows project participants to have a better command of the project budget even at the moment.

DOI: 10.54254/2754-1169/121/20242291

3.2. BIM-Driven Management Innovation

The construction project management covers not only design management and project budget management at the early stage of the project, as mentioned above, but also includes safety management, construction task management and schedule management at the mid and late stages of the project. Using BIM, managers can have good control of the project construction.

Particularly in safety management. By using BIM, managers can draw and control the important production factors of the construction, which can strengthen the safety planning work. Furthermore, with the help of BIM, managers can enable the construction process of unsafe behaviour, and unsafe states can be reduced and eliminated to ensure that no accidents are caused by such sources of danger that will injure people. And it can also ensure the objectives of the project's benefits are achieved. BIM typically applies to safety design (duct and conductor selection and equipment placement) and building fire code review [15]. One of the most noteworthy is the emergency rescue simulation work. Owing to the unpredictability of construction projects, it takes a lot of work to make emergency plans in the traditional way of thinking. Therefore, the author holds that we can use BIM with Animator animation tools to achieve simulation so that emergency treatment can be orderly during an accident[16]. Secondly, based on the building information provided by BIM, we can establish a task list for comprehensive construction. Regarding schedule management, BIM can also simulate the building construction process, and possible conflicts and problems can be detected in advance to avoid delays in the schedule. At the same time, through the integration of BIM and construction management software, the project progress can be monitored in real time, and the project team can accurately control the consistency of the actual progress and the planned progress to improve the overall efficiency of the project.

3.3. Innovative Research on Facility Management Based on BIM

3.3.1. Facility management (FM)

In the current marketplace, facility management, or FM, is a relatively new field [17]. Many scholars have carried on the relevant interpretation of facility management. For example, Salaj and Lindkvis have discussed Urban facility management [18]. Zofia analysed and predicted the facility management in Qatar: current state, perceptions and recommendations [19]. Azman probed the facility management history and evolution [20]. In combination, facility management refers to building facilities or real estate facility management, a comprehensive management approach to efficiently operate and maintain buildings, infrastructure, and associated properties and services. FM concerns not only the physical structures of the buildings but also the ownership systems of these structures, equipment, and services that support those structures. The key lies in equipment maintenance, space management, and asset management. In these three areas, equipment maintenance refers to the planning and preventive maintenance of equipment, mechanical systems and technical facilities in the building to ensure their normal operation. Space management refers to the optimisation and management of the use of space within the building to ensure optimal layout and resource utilisation. Asset management manages the various assets within the building facility, such as furniture, equipment, and technical facilities, including procurement, maintenance, and renewal.

In conclusion, FM uses information technology, data analysis, and computer planning tools to improve productivity and responsiveness. As a result, BIM models can also play an important role in FM management, helping to enable more granular facilities management and data-driven decision-making.

DOI: 10.54254/2754-1169/121/20242291

3.3.2. Application of BIM in FM

BIM has the characteristic of a comprehensive data model, which can help us expressly improve the efficiency of building maintenance and space optimisation.

First of all, in terms of facility maintenance. The document information about the construction, structure, and decoration design was integrated by BIM [21]. Operators can propose specific maintenance plans. Meanwhile, integrating BIM with sensors and other technologies allows real-time monitoring of the status of equipment and buildings so facility management teams can quickly identify potential problems, take maintenance measures in advance, and reduce the risk of unexpected failures [22]. Certainly, the facility management team can understand the health of the equipment, anticipate maintenance needs and take preventive maintenance actions immediately, for the equipment's maintenance history and repair records are recorded in BIM. The second is space management; through this modelling, we can understand the location of all the facilities in the building space, including pipeline and cable equipment, and this can help the management team to maximise the use of the space and optimise work efficiency. Lastly, in building safety risk management, the facility managers can assess the safety of the building and identify potential risks through the analysis made by BIM. With the help of this analysis, managers can develop emergency plans and improve the overall safety of the building.

4. Conclusion

BIM is one of the core technologies applied in the contemporary construction industry, which injects fresh blood into the traditional building industry. With BIM's vigorous information integration ability, we can manage building facilities adequately to ensure the feasibility of pre-construction design and management efficiency during the project construction period. At the same time, with BIM, the conventional FM has been improved to a high level, which was more optimised in many aspects like facility maintenance, space optimisation and safety management. However, the author finds many challenges in spreading BIM into construction management during this research time; for example, BIM training costs much more than other technologies used in building construction. In other words, domestic construction projects usually adopt traditional and simple management patterns in the operation and maintenance stage; these management methods do not include the BIM structure or even the CAD plane application module. Therefore, though BIM is a burgeoning technology, it still needs to be simplified to integrate into traditional building management. Besides, BIM is too complex, and the implementation cost is expensive. The application of this technology in some specific small building construction often exceeds the actual needs of the project, and it even causes the investment to be higher than the income. In addition, because there are few types of research on the protection of architectural and cultural heritage by using BIM, we can utilise BIM to restore information such as the structural features of the buildings to help us fix or rebuild the historic buildings in the future, since BIM is a large data information model.

References

[1] *Doan, D., Ghaffarianhoseini, A., Naismith, N., Zhang, T., & Tookey, T. (2019) What is BIM?: a need for a unique BIM definition.*

[2] *Azhar, S., Khalfan, M., & Maqsood, T. (2012) Building information modelling (BIM): now and beyond. Australasian Journal of Construction Economics and Building, The, 12(4), 15-28.*

[3] *Chen, Jingwu & Ban, L. J. (2020) A lean management model based on building information modelling for promoting lean construction of assembly buildings. Science and Technology Management Research (10), 196-205.*

[4] *Sierra-Aparicio, M. V., Ponz-Tienda, J. L., & Romero-Cortés, J. P. (2019) BIM coordination oriented to facility management. In Advances in Informatics and Computing in Civil and Construction Engineering: Proceedings of*

the 35th CIB W78 2018 Conference: IT in Design, Construction, and Management (pp. 123-128). Springer International Publishing.

[5] *Xu, J., Li, M., & Liu, W. (2022) Application of BIM+ intelligent data decision-making system in ultra-high-rise project management. Urban Architecture, 29(S1), 187-188+191.*

[6] *Zhou, L., & Zhou, Q. (2024) Research on the current situation and development trend of BIM technology application in China. Engineering Construction and Design, (01), 141-144.*

[7] *Pruskova, K., & Kaiser, J. (2019) Implementation of BIM Technology into the design process using the scheme of BIM Execution Plan. In IOP Conference Series: Materials Science and Engineering (Vol. 471, p. 022019). IOP Publishing.*

[8] *Deniz, G. O. (2018) Emerging CAD and BIM trends in the AEC education: An analysis from students' perspective.*

[9] *Omrany, H., Ghaffarianhoseini, A., Chang, R., et al. (2023) Applications of Building Information Modelling in the early design stage of high-rise buildings. Automation in Construction, 152, 104934.*

[10] *Luo, J. P. (2023) Application of BIM technology in construction project management. Urban Architecture and Development, 4(18), 85-87.*

[11] *Xu, J., Li, M., & Liu, W. (2022) Application of BIM+ intelligent data decision-making system in ultra-high-rise project management. Urban Architecture, 29(S1), 187-188+191.*

[12] *Li, M. Z. (2022) Research on the application of BIM technology in high-rise residential construction. Smart Buildings and Smart Cities, (11), 96-98.*

[13] *Vitasek, S. (2019) Using Building Information Modelling (BIM) in construction budget: benefits and barriers. In 18th International Scientific Conference Engineering for Rural Development (pp. 1699-1706).*

[14] *Zong, S., Liu, P., & Li, M. (2022) BIM Based Construction Project Budget Management. In 2022 International Conference on Computer Science, Information Engineering and Digital Economy (CSIEDE 2022) (pp. 575-583). Atlantis Press.*

[15] *Garzia, F., & Lombardi, M. (2018) The role of BIM for Safety and Security management. Building Information Systems in the Construction Industry, 51.*

[16] *Deng, L., Zhong, M., Liao, L., et al. (2019) Research on safety management application of dangerous sources in engineering construction based on BIM technology. Advances in Civil Engineering, 2019, 1-10.*

[17] *Steenhuizen, D., Flores-Colen, I., Reitsma, A. G., & Branco Ló, P. (2014) The road to facility management. Facilities, 32(1/2), 46-57.*

[18] *Salaj, A. T., & Lindkvist, C. M. (2020) Urban facility management. Facilities, 39(7/8), 525-537.*

[19] *Rybkowski, Z. K., Shepley, M. M., Bryant, J. A., et al. (2017) Facility management in Qatar: Current state, perceptions and recommendations. Facilities, 35(5/6), 335-355.*

[20] *Nor, M., & Azman, N. (2014) Facility management history and evolution. International Journal of Facility Management, 5(1).*

[21] *Zhang, N., Sun, S. J., & Lu, Y. (2023) Research on the archiving of BIM 3D electronic files in construction projects. Archives Research, (06), 128-135.*

[22] *Yang, Z. (2024) Building project safety management based on BIM and IoT technology. Shanxi Architecture, 50(04), 193-195+198.*