

Application exploration of BIM and 3D printing technology in Lingnan rural revitalization construction

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Abstract. With the in-depth implementation of the rural revitalization strategy, farmers' living standards continue to improve, the demand for housing improvement increases, and farmers' self-built houses increase. Deep in the Lingnan Mountains, many natural villages have no planning, and the buildings are not integrated with the natural landscape, the construction quality is not high, the maintenance is difficult, the living needs and the lack of modern elements and other problems. In view of the existing problems of self-built houses in Lingnan villages, combined with the characteristics of self-construction of Lingnan rural buildings, this paper analyzes the role and defects of BIM and 3D printing technology in Lingnan rural construction, and discusses the feasibility of implementing this technology.

Keywords: BIM technology; 3D printing; Lingnan village self-built house.

According to statistics, 12 cities in East, west and North Guangdong and Zhaoqing City, a total of 901 towns and townships, 2,277 natural villages, and 1.615 million people out of poverty have fully entered the promotion of rural revitalization, and the focus of "agriculture, rural areas" has been shifted historically. The rural population in the east and northwest of Guangdong is mainly distributed in the mountainous areas, and the residents of farmers are scattered and lack reasonable planning. The self-built houses in most rural areas are not built according to any construction standards, and there are many security risks. In July 2023, the Guangdong Provincial Department of Housing and Urban-Rural Development issued a notice on the issuance of several provisions on the safety appraisal management of self-built houses (trial), to carry out the investigation and rectification of all rural houses within the scope of natural villages in the province, and to carry out a "comprehensive physical examination" of all rural houses. The housing safety hazards investigation and rectification work in July 2023 to July 2026, valid for 3 years, during which to enter the comprehensive investigation and rectification stage, there may be potential safety hazards of the house and used as management of rural self-built residential buildings, timely organization of relevant professionals to their housing safety performance assessment. It can be seen that the construction of rural self-built houses is related to people's livelihood and has been concerned by government departments.

1. Problems of self-built houses in Lingnan villages

1.1 Lack of professional planning in line with Lingnan cultural characteristics

In Lingnan villages, due to the lack of professional planning, modern elements cannot be added in combination with the current situation of village development and people's living needs, reflecting the "slow rhythm" of the countryside, and there is no new local style that can represent the countryside. As an important carrier of Lingnan culture, the planning of natural village should integrate natural landscape, moral tradition, folk customs and architectural aesthetics, so as to have profound cultural deposits and important values of history, culture, architecture, art and tourism. In the process of rural revitalization, planning is the key.

1.2 The construction quality of self-built houses is difficult to guarantee

First, the construction of the self-built houses did not comply with local regulations and standards. For example, in actual operation, there are often super high-rise buildings and large

construction area, which not only easily lead to a significant increase in construction difficulty, but also affect building safety.

Secondly, building materials and fire prevention facilities that meet the requirements are not selected in the construction process of self-built houses, leaving security risks in the construction process.

Finally, some people in the construction of self-built houses in order to save some costs, will choose to use low-quality building materials for construction, which will directly endanger the safety of the house.

1.3 Difficult later maintenance

Since most of the Lingnan villages are self-built houses with frequent rain and bad environment, the lack of a series of planning and design and later construction norms for reference makes the later maintenance cost of the houses very high. For example, the phenomenon of wall cracking and returning tide in rural self-built houses. After the house is done, in a few years, it is found that there are cracks in the wall, and more and more, more and more big and some even the floor will have cracks. This is the uneven settlement of the foundation, causing the wall to tear.

2. The role of BIM and 3D printing technology in Lingnan rural construction

BIM (Building Information Modeling) is the so-called large-scale architectural design model and engineering informatization. Building Information Model (BIM) modeling refers to the engineering technology of using computer BIM design software to simulate construction in the process of engineering practice, improve the whole engineering process and improve the quality of the project. The State Council's "Guiding Opinions on Improving the Quality Assurance System and Improving the Quality of Construction Projects" (State Office Letter (2019) No. 92) pointed out that the integrated application of building information modeling (BIM), big data, mobile Internet, cloud computing, Internet of Things, artificial intelligence and other technologies in design, construction, operation and maintenance should be accelerated. It reflects the guiding role of building information model (BIM) on the actual production, and promotes the improvement of the informatization level of the engineering construction industry. At present, BIM building technology has been widely used in the construction of modern construction in our country, and its actual application value and function also becomes more and more prominent, it is not only a brand-new modern construction technology, but also a new technical framework, new development planning and new strategies of the modern construction industry.

After more than 30 years of development, 3D printing technology is becoming more and more perfect, especially in the last decade, 3D printing has been applied to large permanent buildings, such as Bridges, shelters, houses and offices. This revolutionary technology has huge market potential and could even completely disrupt the traditional construction industry in the near future.

3D printing housing construction is commonly used in modular printing and assembly, which refers to the production of independent units through 3D printers, and the interior of the module is decorated in the factory, and then transported to the scene, and the module is connected to the building as a whole by lifting.

With the rapid growth of China's economy and information technology, BIM technology and 3D printing technology carry out information integration and innovation, prefabricated buildings can establish a three-dimensional model through BIM technology, and then use 3D printing equipment for model printing, which is used to compare and select a better prefabricated building design scheme.

Compared with traditional construction technology, the integration of BIM technology and 3D printing construction technology can greatly improve the efficiency of the construction industry and the sustainability of the building, improve the quality of construction and reduce costs.

2.1 Improve the level of construction

In the field of architecture, with the rapid development of computer hardware technology and three-dimensional graphics and image technology, computers can quickly process big data, high-performance graphics and images, etc., and some complex three-dimensional modeling software, calculation analysis, simulation and other software that can only run in workstations have been launched in microcomputer versions. Therefore, in the field of construction engineering, 3D modeling, visualization, simulation, data exchange and other technologies are integrated, and technological changes such as BIM and 3D printing are focused on improving the level of construction.

The combined application of BIM technology and 3D printing technology in Lingnan rural prefabricated buildings helps to predict and prevent the pre-consequences and prognostic consequences on the basis of ensuring the normal operation of construction projects, promote the optimization of design, improve efficiency and guarantee of project quality, improve the life cycle time of prefabricated buildings, and reduce safety hazards.

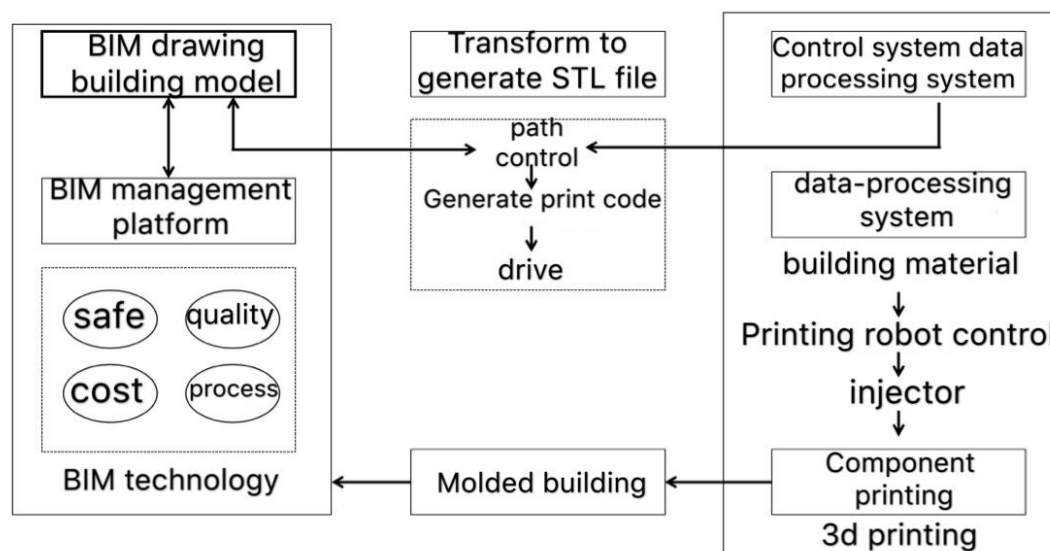


FIG. 1 Schematic diagram of building application based on BIM and 3D printing technology

2.2 Improve design quality

BIM model is used to analyze the dynamics of the natural village site and its surrounding landscape environment to achieve accurate design space layout. According to the actual parameters, BIM technology is used to establish a BIM 3D model and directly generate information such as the name, quantity and specifications of the required materials, which can intuitively display the relevant cost information in the construction process. At the same time, the work of engineering quantity segmentation can be completed more efficiently and the cost proofreading and control plan can be implemented more effectively, and the decision-makers and villagers themselves can be assisted to accurately estimate the cost of the project, so as to improve the accuracy of decision-making. By checking in advance, the problems of both sides can be guaranteed to avoid the over-investment and waste of various resources. At the same time, the application of this technology will also make farmers more willing to actively participate in the process of standardization of self-built housing design.

2.3 Improve energy conservation, emission reduction, and maintenance efficiency

Because Lingnan villages are located in mountainous areas and the natural villages are scattered, the application of BIM technology can well solve the problems after the construction of houses. After the construction is completed, the operating residential data can be uploaded to the network

cloud platform using mobile devices, and the housing settlement data can be added to the BIM software model, which is of great significance for the later maintenance of the house.

BIM energy consumption analysis technology is used to deepen the comparison of architectural design schemes, combine with the actual local climate and environment, compare the raw material composition and characteristics of various materials, and then choose the most suitable, the most environmentally friendly and energy-saving structural materials, and promote the development of ultra-low energy consumption buildings through BIM technology. BIM technology is used to clarify the building orientation, carry out building cooling design, lighting design, and optimize energy utilization.

2.4 Promote the application of new technologies such as BIM in village and town construction

Under the background of rural revitalization strategy, BIM and 3D printing technology are combined with the reconstruction of self-built houses and dilapidated old houses to solve the problem of self-construction and renovation of rural dilapidated old houses by traditional backward methods. In the process of self-construction and transformation, we adhere to the people-oriented purpose, in-depth exchanges with different villagers, combined with BIM technology modeling to adopt targeted solutions so that the masses can choose the most suitable plan, and realize the real "live and work in peace and contentment".

3. Analysis of defects in rural construction based on BIM and 3D printing technology

3.1 The understanding and importance of BIM technology are seriously insufficient

BIM technology can help designers understand the building more comprehensively and build a complete model to accurately describe the location, space, shape, size and various related properties of the building. It has made obvious achievements in some important and complex projects, and has also been applied to small and medium-sized construction projects in the later development process, but there are few application cases in rural construction, and BIM technology has not given full play to the application value and application advantages of BIM technology in rural construction. By strengthening the publicity of new technologies such as BIM by county and township governments and territorial enterprises, the local industry can improve its understanding of new technologies such as BIM, get rid of the restrictions of traditional thinking mode, and deepen the correct understanding of new technologies such as BIM by rural construction personnel. At the same time, the construction units and construction units in rural areas can also start from the construction engineering designers and stimulate the enthusiasm and initiative of the staff through effective means, so as to provide strong support for high-quality rural construction and help the efficient implementation of the rural revitalization strategy.

3.2 There is a serious shortage of talents to master new technologies such as BIM

The emergence of BIM technology marks that the construction industry has officially entered the era of information development, and the industry should also carry out the construction of information talents to keep up with the pace of development of The Times. Moreover, the emergence of BIM technology puts forward higher requirements for the technical level of technical personnel, and it is difficult for technical personnel to self-study BIM technology, resulting in a large gap of BIM technical personnel. It is more difficult for regions to carry out professional talent construction. According to the requirements of the Guangdong Provincial Department of Human Resources and Social Security, Guangdong Provincial Department of Education, Guangdong Provincial Department of Natural Resources, Guangdong Provincial Department of Housing and Urban-Rural Development, Guangdong Provincial Department of Agriculture and Rural Affairs on the Issuance of the "Guangdong Province" "Rural Artisans" Project Implementation Plan "(Letter

(2020) No. 38), Accelerate the establishment of a team of practical skills that can meet the needs of agricultural and rural development, promote the revitalization and development of rural areas, in order to provide high-quality technical talents for village and town construction, and solve the practical problems in the application of new technologies such as BIM through these professionals.

Conclusion

With the increasing development of Internet information technology, the era of "construction industry 4.0", which is mainly characterized by BIM, Internet of Things, and prefabricated buildings, is quietly coming. As a part of "Industry 4.0", "Construction industry 4.0" means the traditional construction industry from manual operation to building automation; The basic model shift from centralized control to decentralized enhanced control aims to establish a highly flexible production model for personalized and digital construction products and services. Under the background of rural revitalization, there are a large number of construction market opportunities in more than 2,000 administrative villages in the province. Among them, the construction demand represented by rural housing and infrastructure is highly consistent with the vision and goal of rural revitalization, and the construction of rural housing and infrastructure will gradually realize capitalization, industrialization and scale.

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