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The Application of Computer BIM Technology in Prefabricated Construction Project Management

Wenbin Gong [1,*], Nan Li [2]

[1] Southwest Minzu University, Chengdu, Sichuan, China
[2] Yunnan University of Finance and Economics, Kunming, Yunnan, China
[1] zz1609@yufe.edu.cn*
* corresponding author

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Abstract

The construction industry is a pillar industry of the national economy, and it occupies a pivotal position in our country's economic development. With the rapid development of the construction industry today, traditional construction methods can no longer satisfy the use of information, data and resources in the management of construction projects. It is necessary for BIM technology to be applied to the management of prefabricated construction projects. In order to expand the scope of application of BIM technology in construction projects and enhance people's trust, this paper studies the application of computer BIM technology in prefabricated construction project management. This article mainly uses theoretical analysis, comparative analysis and statistics to deepen the understanding of BIM technology, discovers the characteristics of traditional construction methods and construction methods supported by BIM technology, and studies the application in construction project management. The survey results show that the scope of application of BIM technology in our country's construction industry is becoming wider and wider. After five years of development, the application rate of BIM in most areas has increased by more than 10%.

Keywords: BIM, Prefabricated, Construction Engineering, Project Management

1. Introduction

With the accelerated development of China's science and technology, new materials, structures, and equipment have been continuously improved, and at the same time, they have provided a strong guarantee for the safe construction of buildings. In the process of developing housing industrialization in our country, the imperfection of the relevant legal construction system also affects the development of housing industrialization in our country. In addition, our country also lacks a mature housing industrialization technology system, and the development of housing industrialization is difficult without the support of a technology system. Therefore, this paper proposes the application research of BIM technology in prefabricated construction project management.

There are many research results on the application of computer BIM technology in prefabricated construction project management. For example, Hu Ying believes that the application of BIM technology in the design and construction of prefabricated buildings makes the design of prefabricated buildings more in line with the development needs of modern urbanization, and at the same time the quality of building construction can be guaranteed [1]. Yan Y said that BIM technology is an innovative and efficient technical tool. It is the product and direct application of information technology in the construction industry. He said that through BIM technology, the standardized management of PC construction and the refined expression of PC architecture can be realized. BIM technology guarantees construction quality, improves design efficiency, reduces costs, and shortens construction period [2]. In order to promote the realization of precision control, assist construction organization management and construction safety guarantee, he combined the advantages of BIM technology in the installation of prefabricated buildings and the research situation of BIM technology in recent years, and analyzed in detail the installation of BIM technology in prefabricated buildings. The main application situation and results in [3].

This article first studies BIM technology, including its philosophy, value, category, etc. Secondly, this paper studies virtual construction and prefabricated building construction simulation. Then, they have a deep understanding of the life cycle management of prefabricated buildings and the application of BIM technology in the integrated management of engineering projects. Finally, experiments were designed, surveys were conducted, and conclusions were drawn.

2. Application of BIM Technology in Prefabricated Construction Project Management

2.1. The Realization Environment of BIM Technology in Construction Engineering

2.1.1. Technical concept

The ultimate goal of BIM technology is to enable the entire project to effectively save resources and energy, reduce costs, reduce environmental pollution, and improve the overall efficiency of the construction industry at every stage of the entire life cycle. BIM technology is used to break the fragmentation of various stages of the construction industry and connect the information of each stage. In our country, the use of BIM technology has positive significance for building a conservation-oriented society and creating a harmonious society. It also promotes the further development of "smart cities" and indirectly improves people's quality of life [4, 5].

2.1.2. Application value.

The emergence of BIM technology has further promoted the development of the construction industry, so the value brought by BIM technology cannot be ignored. BIM technology not only brings value to the design unit, but also brings different degrees of value to the developers, construction units and other participating units of the project.

1) The value brought to the design unit. The biggest advantage of BIM technology to the construction industry at this stage is still in the design stage. The model designed with BIM technology contains all the building information, and the design plan can be inspected by specialties at the beginning of the design stage. Compared with traditional technology, it is more accurate, convenient and fast, and can reduce labor costs. The simulation simulation created by BIM technology can communicate the design effect with the construction party, prefabricated component manufacturers, developers and other departments during the construction simulation period, avoiding various problems during construction [6, 7].
2) The value brought to the construction unit. According to the actual application of BIM technology, compared with other units, BIM technology can bring greater value to construction enterprises. BIM technology can increase the bid winning rate of construction units, improve the management and control capabilities of construction units, and solve construction problems.
3) The value brought to developers. For developers and owners, it is the most beneficial part of BIM technology. After the use of BIM technology, the developer's investment in the design phase will increase partly, but in addition to the design, the capital investment in construction, management, and operation can be greatly reduced [8, 9].
4) The value brought to the manufacturer of prefabricated components. From the perspective of the advantages that BIM technology brings to the manufacturing industry, BIM technology can also bring great advantages to the production of prefabricated components. In the production process of prefabricated components, the combination of BIM technology and digital technology can ensure the accuracy of component production, reduce errors in mechanized production, and improve the production efficiency of prefabricated components, thereby saving construction costs for prefabricated component manufacturers and ensuring production quality [10, 11].
5) The value brought to operation management. By using the information stored in BIM technology, it is easy to find all the information of the equipment. When the equipment needs repair, it can quickly locate the location where the equipment needs to be repaired or replaced. The use of BIM technology can analyze the energy consumption of the building, and reduce unnecessary energy consumption of the building through performance analysis, which can not only meet the energy requirements required by the building but also achieve the purpose of saving energy.

2.1.3. Classification of BIM software

The development of BIM technology is based on the development of BIM software. There are many types of BIM software. In foreign countries, these softwares are mainly based on four companies, Autodesk, Bentley, Nemetschek Graphisoft, Gery Technology Dassault. The main domestic companies are Luban, Lizheng, Hongye, Bochao, etc.[12, 13].

1) Revit. The software can perform performance analysis and conflict checking on the completed model, and can also be linked with other software for data exchange. The reason why Revit has a powerful function is because Revit has a super parameter change engine, which can automatically modify all designs after modifying and adjusting a problem [14].
2) AutodeskNavisworks. Navisworks is also a software developed based on BIM technology, which is the core part of the BIM technology workflow. Navisworks is divided into four parts, namely NavisworksManage, NavisworksSimulate, NavisworksReview, NavisworksFreedom.

2.1.4. Virtual construction

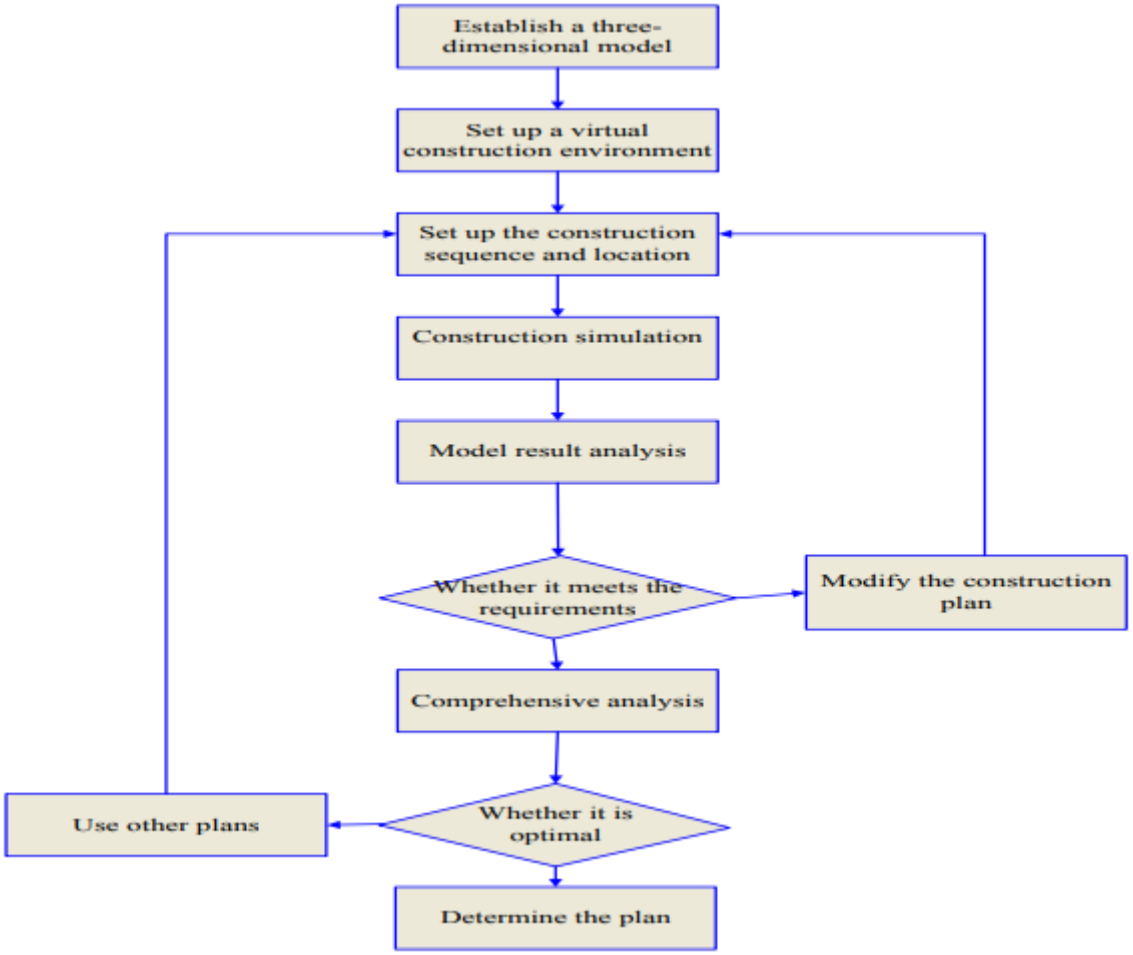

Figure 1. Virtual construction flow

As the name suggests, virtual construction is the construction process in a virtual environment, that is, based on the virtual environment, using 4D, 5D and even ND technology in different aspects such as time, space, and safety. The virtual construction process is shown in Figure 1.

2.1.5. Markov logic network of BIM and construction projects

Markov logic network effectively merges first-order predicates and undirected graphs. Moreover, the Markov logic network has better performance than the first-order predicate logic in dealing with contradictions and uncertainties,

and the Markov logic network is more concise and effective in the expression of features than undirected graphs. One of the main points of the Markov Logic Network is that a criterion in the knowledge base is violated by a possible world. The probability of the existence of this possible world will decrease, but it will not drop to zero. The higher the value of the weight attached to the logic formula criterion, the greater the restriction on the Markov logic network.

According to the definition of Markov Logic Network, for a possible world a of Markov logic network N_{ts} , its probability distribution is as formula (1):

$$S(A = a) = \frac{1}{c}\varpi_1\Phi_1(a\{1\}) \quad (1)$$

Where a{l} represents the lth clique in the undirected graph, that is, the lth node, and C represents the normalization factor. Use the exponential function to express the potential function of each clique in the Markov logic network, so that formula (2) can be obtained:

$$S(A = a) = \frac{1}{c}\varpi_1\Phi_1(a\{1\})\ {}^{n}i \quad (2)$$

Where mi represents the number of instantiations of the criterion Gi in the possible world a, and a{i} represents the instances where the value in the criterion Gi is true.

2.2. Prefabricated Building Construction Simulation

2.2.1. Features of prefabricated building

Prefabricated buildings are the product of the industrialization of construction. Compared with traditional buildings, the characteristics of prefabricated buildings are shown in Table 1.

Table 1. Features of prefabricated buildings

Environmental protection	Through mechanized production, installation is carried out on the construction site, wet work is reduced, and a large amount of construction waste caused by onsite construction is reduced.
Energy saving	The prefab wall has an insulation layer, which can function as warm in winter and cool in summer, thereby reducing energy consumption
Shorten the construction period	The traditional method of on-site pouring is changed, and the installation of prefabricated components is combined with the on-site pouring construction, which reduces a large number of procedures, reduces the work intensity of the construction site, and shortens the overall construction period.
Reduce labor cost	The on-site assembly-type construction technology is adopted with a high degree of mechanization, which can greatly reduce on-site operators, save a lot of labor costs, and improve construction efficiency at the same time.
Security	Improve the working environment of construction workers and avoid casualties caused by construction

2.2.2. Prefabricated building construction process

1) The components are transported to the site
2) Exterior wall panel installation
3) Wall panel connection component installation and board seam treatment
4) Installation of laminated beam
5) Installation of interior wall panels
6) Concrete pouring of shear walls and columns
7) Formwork and oblique support removal
8) Set up the top support of the laminated board
9) Laminated board installation
10) Stair installation
11) Pre-embedded floor pipelines and lashing of steel bars on laminated floor slabs

12) Floor concrete pouring, pounding and calendering

2.2.3. Construction site layout planning and simulation

The layout of the construction site should be designed based on the actual situation of the construction site. The layout of the construction site should start with the foundation, temporary construction facilities, mechanical layout, and prefabricated component stacking area.

Arrangement principle:

- Scientifically plan the site and road;
- Reasonably arrange the site operation area and the position of the tower crane to avoid staggering;
- Arrange the material stacking position reasonably to ensure the efficiency of hoisting;
- All construction arrangements must meet the requirements of "conducive to construction, convenient for life, safe fire prevention and environmental protection".

2.3. Life Cycle Management of Prefabricated Buildings

2.3.1. Problems in the development of prefabricated buildings

Although the development of prefabricated buildings in our country has achieved fruitful results, we must also be soberly aware that there is still a big gap in technical support, supporting capacity building, and management mode transformation in our prefabricated buildings at this stage.

The standard specification system needs to be improved, and standards at different levels have not formed a synergy.

The integrated design ability is insufficient, and the comprehensive advantages of prefabricated buildings are not fully utilized. Due to the division of labor in the construction industry in the past ten years, there has been a serious disconnection between architectural design and project planning and organization, production and construction, technology and product application, quality and quality assurance, and design subcontracting is common. The teacher's overall control ability on prefabricated building technology, quality, efficiency and benefit is insufficient.

The overall level of prefabricated construction is not high, and hidden quality hazards cannot be ignored. Inappropriate technical systems have increased the difficulty of construction.

The regulatory mechanism and management methods are relatively lagging, and reform and innovation are urgently needed. our country's current engineering construction management model often leads to gaps in the technical connection of prefabricated construction projects.

2.3.2. The concept of life cycle management of construction projects

Building lifecycle management (BLM) refers to a management method that realizes the effectiveness of centralized management of construction project information through the application of technology, information, and human resources during the construction process of construction projects. The advantage of this management model is that it focuses on the management and sharing of project construction data as the core of the research. By reducing the redundant investment in the traditional construction process, avoiding resource waste, realizing the application of major technologies, and improving the commercial value of construction products. At this stage, the life cycle management of China's construction projects is still in its infancy, and the degree of integration of management ideas, management systems and corresponding laws and regulations is limited, especially when it comes to information creation, technology integration and sharing, there is a lack of more diversified professional software to be applied to reality under construction. Currently, Building Information Modeling (BIM) can apply the technical advantages of its highly integrated sharing platform to the life-cycle management process of buildings.

2.3.3. Analysis of the management process at each stage of the life cycle

1) Management in the decision-making stage. Project management at this stage involves: project feasibility study, project planning, project development procedures, etc. The tasks that should be completed include: obtaining the land use right of the target plot, issuing a standard feasibility study report, determining the

whole construction planning process, and obtaining various building permits. This is an important core link in the development of construction projects. The focus of its management is mainly on the interface planning of the internal functional departments of the owner. It is necessary to ensure the efficient and timely dissemination and update of all kinds of information, so as to optimize the quality of the whole process planning.

2) Design phase management. This stage mainly manages the technical points of each link. Through the transformation of information technology in the construction phase to entities, the reasonable resolution of different conflicts can be realized. If these problems cannot be properly resolved, it is likely to cause potential crises in future work. Management items in the design stage include: drawing design, reliability confirmation of design interface, etc. However, these problems cannot be completely effectively dealt with in actual project operations. Especially for large and complex buildings, the accuracy of drawings is limited. This article uses BIM technology as a processing tool to try to coordinate and coordinate design drawings professionally. Error correction.
3) Management during the construction phase. The content, responsibilities and obligations of the contract will be fully fulfilled during the construction phase. Implementation of dynamic control, active control and prior control of the interface is the main means to solve the problem. Compared with the parallel contracting project interface, the general contracting project interface will be greatly reduced in number. The scope and interface work will also be handed over to the general contractor with more experience in construction management for determination and specific management, which greatly reduces the cost. The risks brought by the interface management to the project.
4) Use and operation management. According to the specific operation management process in the trial phase, the work content between the owner and the property management has obvious crossover characteristics. Because the main content of management is property management, business management, as well as contractor's project warranty period maintenance, and specific return visits to the experience of building use. Another thing is that property management as after-sales service should be taken seriously, forming a complete independent system that can be connected with construction and management to achieve the optimization of the final stages of project construction. Modifying the design according to the actual situation of the property management is an important prerequisite for achieving a good management effect during the construction phase.

2.4. Application of BIM Technology in Integrated Management of Engineering Projects

2.4.1. Integrated project management

Integrated management is the integration of spatial structure information systems in the three dimensions of time, logic, and knowledge. It has the following characteristics:

1) Subjectivity. Integrated management is a kind of conscious behavior activity that focuses on people.
2) Functionality. It can reduce costs while improving the efficiency of management projects.
3) Integrity. It realizes the integrity of the project through the conscious selection and abandonment of the subject of the behavior.
4) Compatibility. The effective connection and integration between the various elements of the project makes the projects compatible, which is the basis for the project to achieve integrity.

2.4.2. Integrated management of construction projects

The integrated management of construction engineering projects takes the engineering project as the core, starts from the whole life cycle of engineering construction, uses information technology and integrated thinking, and intelligently controls the personnel, content, schedule and management objectives of the project, and realizes the overall value function of the project. The integrated management of construction projects mainly includes four aspects:

1) Organizational integrated management. Through the integration of organization and management, all participants can share risks and minimize engineering risks.

2) Main body integrated management. Through the use of scientific information technology, the integrated management of each participant is used to clarify the tasks and responsibilities of each party.
3) Integrated management of elements. The elements of engineering projects mainly include quality, cost, schedule, safety, etc. The integrated management of elements is to link all parties together to maintain the consistency of the elements of all parties, so as to avoid the occurrence of missing elements between the parties that affect the realization of the goals.
4) Information integration management. Collect and integrate information in the whole life cycle. of construction projects to guide the construction of the project and improve the profitability of the project.

2.4.3. Application of BIM technology in integrated management of engineering projects.

At present, the construction mode adopted by most projects in our country is design, bidding, and construction. Under this mode, each discipline has the advantages of clear division of labor, detailed management, and prominent focus. The artificial separation between them, such as design, procurement, construction, construction, structure, water supply and drainage, etc. This has led to the inefficiency of information transmission between the parties and the consequences of increased losses. As mentioned earlier, BIM technology is a technology that provides services for the entire life cycle of a building based on three-dimensional digital technology. The integrated management of engineering projects can use information technology based on BIM technology, comprehensively consider, start from the overall project, and intervene in efficient information transmission and data sharing from the beginning of the project design until the end of the entire construction project and the subsequent operation stage. The overall project is optimized efficiently to improve the management level and management efficiency. With the unfolding of design, procurement, construction, management and other stages, information "reflows" in construction management. Due to the lack of information platforms, the information connection at each stage of the project is not timely, resulting in information loss.

3. BIM Application Simulation in the Life Cycle Management of Prefabricated Buildings

3.1. Experiment Preparation

This paper studies the specific selection of Autodesk software products, Revit Architecture and Navisworks Manage, as tools for model simulation analysis to complete the modeling analysis. Revit Architecture software can automatically create accurate floor plans, elevations, sections, three dimensional views and schedules, and calculate the area and material usage according to the specifications. The changes made during the design period of the platform can ensure that the floor plan, schedule and construction drawings are fully coordinated. Navisworks Manage software is used for construction simulation, project overall analysis and interactive analysis, so as to ensure that construction parties can maintain good communication, lay a good foundation for collaborative construction, and predict possible problems during construction in advance, so as to make targeted formulations Response plan.

3.2. Experimental Process

The life cycle of prefabricated construction projects mainly includes four stages, which are specifically divided into planning and design, manufacturing, construction, and operation and maintenance.

3.2.1. 3D model establishment

In this paper, Autodesk's Revit software is selected to establish a 3D model of the building, including architecture, structure, and MEP models, and based on these professional models, a complete BIM model is constructed. At the same time as the model is established, the visualization view is completed at the same time, and it is very convenient to make corrections later. The modification of the model will change the content corresponding to the view, thereby ensuring the consistency of model parameters and drawing information, which is the unity of model, data and drawings. With the help of the BIM information management platform, other participants in the project can browse the BIM model without installing specific software to display the BIM model.

3.2.2. Collaborative work and conflict detection in the design phase.

The design process of prefabricated prefabricated buildings is designed to the collaborative work of multiple professionals. As far as the prefabricated building project itself is concerned, the traditional two-dimensional design methods are independent of each other and will not affect each other, which can easily lead to the design of various professionals Conflict and inconsistency between design and construction. The establishment of the information

building model enables various majors to coordinate work in the design stage, and all participants can more intuitively understand the content of the project design. We can use Revit or import the 3D model into Navisworks Manage software for collision checking.

3.2.3. Engineering quantity statistics

The model based on BIM technology can quickly realize the calculation and pricing. The process is as follows: the design model is exported from the modeling software in the IFC format and imported into the calculation software, the calculation software checks the model, checks out the model errors, and the cost accounting staff modifies the model according to the inspection results. After the modification is completed, the calculation software can automatically apply the algorithm to quickly summarize the engineering quantity, so as to realize the accurate and automatic statistics of the BIM model engineering quantity using Revit software.

4. Analysis of the Application of BIM Technology in Prefabricated Construction Project Management in Various Districts in China

Judging from the 2015 data, in terms of domestic BIM technology implementation alone, Shanghai's BIM technology implementation rate accounted for 61% and ranked first, followed by Beijing's 59%. The details are shown in Table 2:

Table 2. The implementation of BIM technology in various regions in China

	South China	North China	East China	Southwest China	Central China	Beijing	Shanghai
2015	32%	47%	34%	39%	41%	59%	61%
2020	41%	56%	43%	46%	52%	78%	74%

According to Figure 2, by 2020, the implementation rate of BIM technology in Beijing accounted for about 78% and ranked first, followed by Shanghai with 74%. It can be seen that after 5 years of continuous application and development, this new technology has been greatly improved nationwide, and BIM technology has been favored and selected by more regions and more people

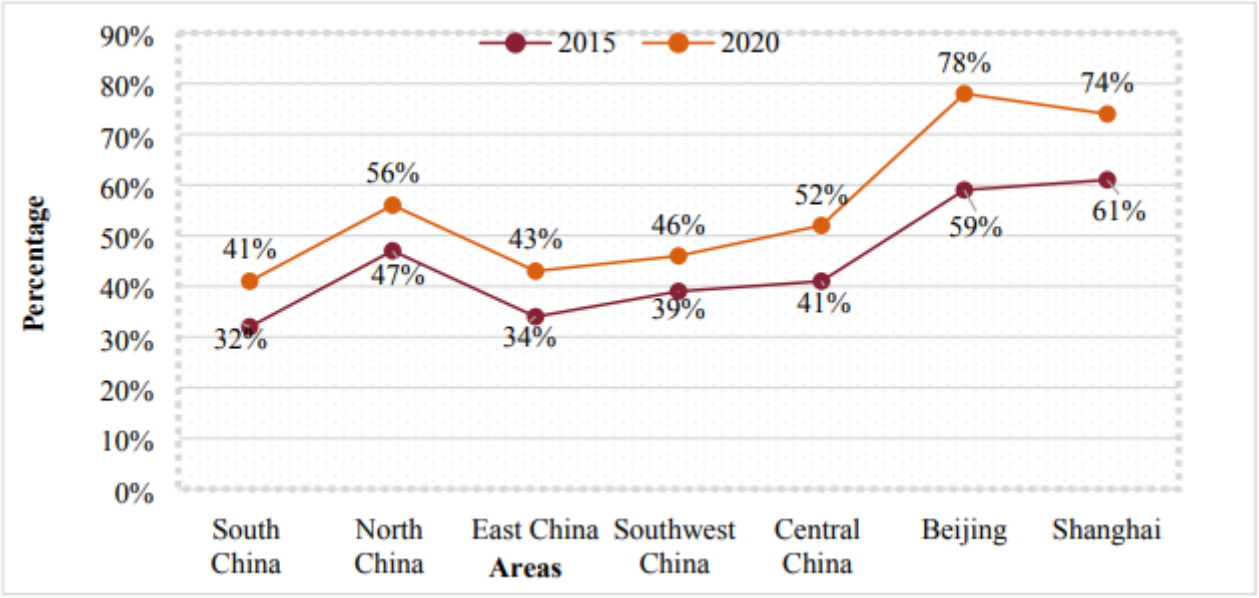

Figure 2. The implementation of BIM technology in various regions in China

5. Conclusion

Although BIM technology and prefabricated buildings have achieved rapid development in our country, they have not been popularized. They mainly rely on national policies, universities and large enterprises to promote them. At present, BIM technology has not been widely used in our country, so there are limitations in the use of BIM software. Many practical software have not yet realized the mutual conversion of formats and cannot complete the effective transmission of information. Whether it is the application and promotion of BIM technology or the rapid popularization of prefabricated buildings, one thing cannot be denied. Judging from the current scale of domestic residential industrialization, the application and promotion of prefabricated buildings in our country is still in its infancy. What is certain is that in the foreseeable future, BIM technology will completely realize the overall innovation from design to construction process through the traditional design technology CAD design method.

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