Based on the development status of British BIM, exploring China's BIM road

Chu Tiangang[1], Li hui[1, a], Zhang shanjun[2], Jiang Ningshan[1], Zhang Dan[1], Zhang Yu[1], Bao Guibo[1]

[1]the Civil Engineering School of Qinghai university

[2]Kanagawa university Faculty of Science Department of Information Sciences

[a]email: huili_cug@hotmail.com

Abstract. This article mainly analyses the development and application status and development trend of BIM technology after the implementation of the British government, to explore the policies and methods that our government should carry out in the development of BIM. The article also summarizes and analyses the relevant policies and standards implemented by various provincial and municipal governments in promoting BIM technology in China and summarizes the strengths and weaknesses of each other by comparing the development status of the implementation of BIM policies in various provinces and cities. The article also analysed the obstacles encountered in the implementation of some specific projects at the current stage of BIM technology, and summarized the feasible solutions. The article mainly analyses the application prospects of BIM from the technical aspects of design, the application of technology in the construction process, and the strategic implementation and operation of the company, and provides a reference for promoting the application of BIM in the construction industry in China, especially in the western region.

1. Introduction

The construction industry faces serious problems such as serious time and budget cost overruns and material procurement irregularities [1]. The cost overruns for construction in developing countries were severe, and the total cost of construction completion averaged over the initial project budget 100% [2]. In Australia the research found that the probability of project cost increase due to rework was 52%, and 26% of the change in cost growth was due to changes in direct rework [3]. The cost of the Wembley Stadium in the UK exceeds 50%; The construction of the Scottish parliament has been delayed by three years and cost over 900% [4]. According to the Malaysian average percentage, 38%, 39% and 50% of the infrastructure projects, health and environment projects were timed out [5]. In Hong Kong, the average time-out periods for public buildings, private buildings, and civil engineering projects were 9%, 17%, and 14% respectively [5]. The core content of national government work reports is about how to solve the challenges facing the construction industry, and BIM's development will bring about a revolution in information technology to the construction industry. The promotion of BIM technology will become a new way to stabilize the construction market. Therefore, the widespread application of BIM technology in the construction industry is a goal that all governments in the new era are trying to achieve.

Under the new normal state of the economy, China's construction industry still occupies a pivotal position in the national economy. However, in recent years, the construction industry has seen a

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

declining trend. The number of newly approved construction projects has continuously decreased, while the workers and construction materials prices have increased. With continuous growth, these factors will inevitably lead to lower and lower profits in the construction industry. Therefore, the construction industry has made higher demands about management and technological innovation. So, the promotion and implementation of BIM technology in China is also very urgent.

BIM is used to promote cooperation between project teams and the sharing of project information. Using BIM systems to enhance collaboration processes can increase productivity, efficiency, infrastructure value, quality, and sustainability; It can not only reduce life-cycle costs, lead times, and iterations, but also eliminate waste, and improve coordination between design disciplines [6]. BIM simulation features allow the building in the three-dimensional model before construction can be integrated pipeline collision detection, lighting analysis, and construction of dynamic simulation, and then the probability of building a project in reality greatly reduced [7].Through the possibility of virtual construction of the entire project prior to the commencement of physical construction, BIM has increased the accuracy of quantitative and qualitative issues and overcomes the defects found when using traditional design methods [8]. BIM is considered as the key to the construction industry initiative to promote lean construction and sustainable development.

However, because of the large scale of BIM technology, the complex technology, the research and the development need to invest huge amounts. In addition, BIM will lead to the redistribution of benefits and management transparency in the construction industry. Various factors have made BIM's development in China not going well. In China, BIM is still in its early stages after ten years of development. According to statistics, there were 700,000 construction projects in 2017 in China, of which only 3,000 used BIM technology (data from the National Bureau of Statistics and the Ministry of Housing and Urban-Rural Development). It can be seen from this that the development of BIM in China is extremely slow.

At present in the United States, the United Kingdom and other European developed countries, not only BIM advanced ideas have been widely disseminated, but also in the actual project on the implementation of BIM technology has been improving the construction industry production efficiency, increase construction revenue [9]. Developed countries such as the United States and Europe, the United Kingdom have all used BIM technology for government-funded public building projects before they have been demonstrated and promoted, and gradually applied to non-public building projects [10]. Foreign BIM researchers can truly combine theory with practice and find problems in practical engineering applications, then they can conduct theoretical analysis, and propose more targeted BIM optimization recommendations, which promotes the development of BIM in a more mature and mature direction. However, domestic research on BIM is still in its infancy, and the application of BIM is far from being realized, far behind foreign countries. This article mainly revolves around the research status and its change characteristics of BIM application in the United Kingdom and the domestic development status of China and puts forward feasible suggestions for promoting the research and development of BIM in China.

2. Status of BIM development in the UK

The British government's BIM Level 2 process has made the UK a global leader in BIM. The most convincing and comprehensive description of the UK's BIM development application is that the National Building Specification (NBS) released the "National BIM Report 2017" on May 11, 2017. The British government used the BIM technology in the public construction field and announced the details of the reduction in construction costs to find a way for the civilian construction project. The British government began enforcing BIM Leve 2 in April 2016. All core government departments are using the BIM Level 2 standard, but enforcement involves only projects invested by the central government in the UK, excluding local government and private projects. BIM Level 2 needs to gradually go into marketization and expand into various fields. By 2020, BIM Level 2 will be extended to a wider range of industries, laying the foundation for BIM Level 3 in 2025 [11].

2.1. The first survey report is about the use of BIM in the United Kingdom
The British have a general knowledge of BIM technology and the adoption rate of BIM is also on the rise. In 2017, 35% of people said that they knew but they didn't use BIM, and 62% people said they would use BIM for the project, which is 8% higher than in 2016. From 2011 to now, the number of BIM users has grown steadily every year. The detailed investigation of the use situation is shown in figure 1 below.

2.2. The second survey report is about the proportion of projects that used BIM in the past year.
All projects in the use of BIM enterprises accounted for 18%, and only 75% project in the use of BIM enterprises accounted for 29%, as shown in Figure 2.

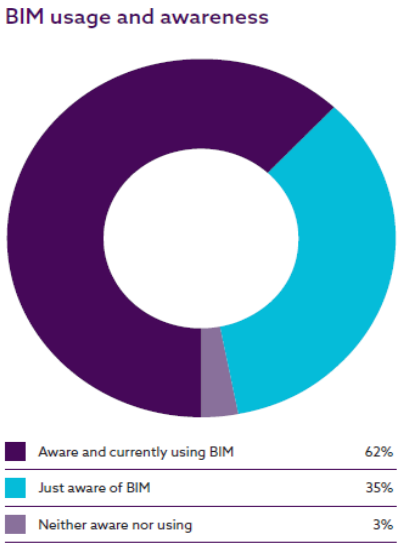

Figure 1.

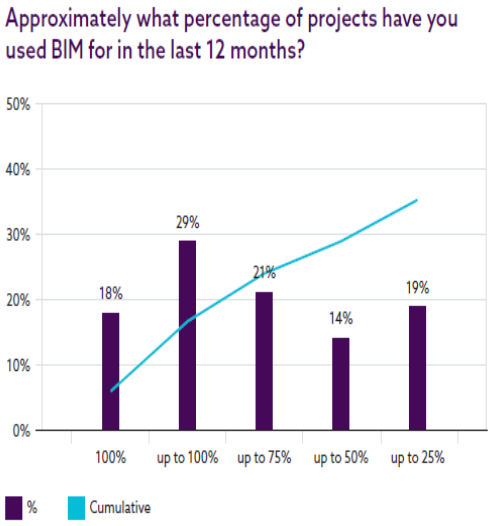

Figure 2.

2.3. The third report is about the level of popularity of BIM grades. The BIM Level 1,2,3 is divided by the UK government
22% of businesses still stay at BIM Level 1, which is an initial stage and represents that the design team began designing in a three-dimensional environment and exchanged certain data in the general environment.70% of companies or organizations have reached the BIM Level 2 level. This level is the cooperation phase and the models representing the parties are merged together for data exchange. However, the most advanced integration stage, only 7% of enterprises or institutions can achieve the BIM Level 3 of full life cycle informatization. As shown in Figure 3.

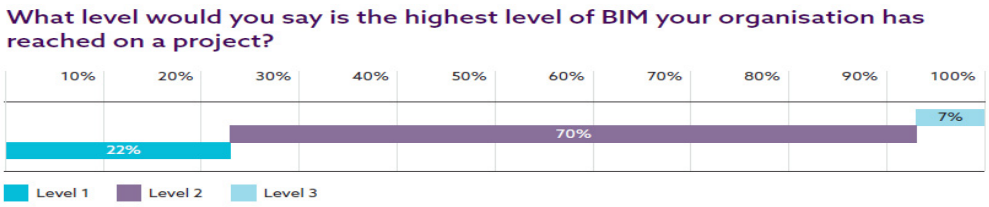

Figure 3.

3. Development of China's national government standards

The development of any enterprise needs to be integrated with national conditions, it requires companies to fully study relevant national policies when it planning development routes. Similarly, when each person chooses his or her work direction, it also needs to pay attention to some national policies. Next, we will comb and interpret the BIM policy of the country for 15 years.

（i）The earliest BIM policy can be traced back to November 14, 2003.The Ministry of Housing and Urban-Rural Development issued the "2003-2008 Outline of the Outline of the Informatization Development Plan for the Construction Industry in China". The outline requires companies with international and domestic large-scale project contracting capacity focus on building "one platform, three systems". It can be said that this outline has opened the prelude to the study of information technology in the construction industry.

In 2009, the National Centre for Housing Engineering carried out research on BIM standards and proposed the China Building Information Models Standard Framework (CBIMS), which mainly includes data transfer format standards, information classification, data dictionary and flow rules.

（ii）On May 10th, 2011, the Ministry of Housing and Urban-Rural Development issued the “Outline for the Development of Informatization in the Construction Industry 2011-2015”. For the first time, the BIM technology was directly mentioned in the Outline. The overall development goal is to basically realize the construction enterprise during the “Twelfth Five-Year Plan” period. The popularization and application of information systems has accelerated the application of new technologies such as building information model (BIM) and network-based collaborative work in engineering.

（iii）On June 16, 2015, the Ministry of Housing and Urban-Rural Development issued the "Guiding Opinions on Promoting the Application of Building Information Models". It pointed out the exploration direction of applying BIM in the construction industry and elaborated the application meaning, basic principles, development goals and priorities of BIM. The development target set to 2020 is Grade A survey and design unit for the construction industry, and the premium and first-class construction companies should implement integrated integration of BIM technology, enterprise management systems, and other information technologies; At the end of 2020, state-owned funds will be used for investment. For large and medium-sized buildings, green building public buildings, and green ecological demonstration areas, the project application rate for BIM will reach 90% in the survey, design, construction, and operation and maintenance of these projects.

（iv）On August 23, 2016, the Ministry of Housing and Urban Development issued the "2016-2020 Development Outline for the Construction Industry Informatization", which further refined and expanded the application requirements for BIM. In this outline document, the term BIM was mentioned a total of 28 times before and after, with particularly emphasis on the integrated application capabilities of BIM and information technologies such as big data, intelligence, mobile communications, cloud computing, and the Internet of Things.

- Survey and design enterprises: To popularize and apply BIM technology, carry out simulation analysis, optimization, drawing, review of design solutions, and delivery of results and visual communication.
- Construction enterprises: Study the construction management mode and coordination mechanism under the application of BIM technology, establish a project management information system based on BIM technology, and conduct integrated application research of BIM and IOT, cloud computing, 3S and other technologies.
- Engineering general contracting enterprises: Researching multi-cooperative work model under the “Internet +” environment, developing and applying collaborative work systems based on the Internet, and achieving efficient collaboration and information sharing among multiple parties. Formulate results delivery standards based on BIM technology to realize digital delivery and full lifecycle information sharing from design, construction to operation and maintenance.

- In terms of supervision of the project: To explore the delivery, review and archive management of digital products based on BIM. Develop white map alternative blueprints and digital pilot plans. To explore the project completion record model based on BIM, to construct the engineering quality and safety supervision mode and mechanism based on BIM, large data, intelligence, mobile communication, cloud computing and other technologies.

（v）February 21, 2017, the State Council issued the "General cabinet on the promotion of sustainable development of construction industry," put forward to accelerate the construction information Model (BIM) technology in the planning, reconnaissance, design, construction and maintenance of the whole process of integrated application, to achieve the project construction project lifecycle data sharing and information management, Provide the basis for Project plan optimization and scientific decision.

From the information technology proposed in 2001, to collaborative work and visualization technology in 2003, and then to clearly propose the development direction of BIM technology in 2011, a clear time limit will be set for the development goals of all parties in the construction industry in 2015. Then in 2016, The combination of BIM technology and other new technologies was described. In 2017, the relevant requirements were mentioned again in the documents issued by the State Council. After so many years of development, BIM technology has gained more and more attention in the upper layers of the country.

4. The relevant standards issued by the provinces

(i) Beijing

Beijing has more relevant units involved in the promotion of BIM technology. Beijing's local BIM policy can basically be divided into two aspects.

On the one hand, the government promote the dissemination of relevant knowledge of BIM and the training of application skills actively. The government will have some open classes and training. the BIM practitioner who interested in it can always pay attention; on the other hand, encourage and support some enterprises to take the lead in applying BIM and establish new construction industry. Technical application demonstration projects, such as China Zun, Wangjing soho, continue to accumulate BIM technology application experience and data.

(ii) Shanghai

On August 8, 2016, Shanghai Construction and Construction Commission issued the Notice on Further Strengthening the Promotion and Application of Shanghai Building Information Model Technology (Consultation Draft), which clearly stipulates the Shanghai BIM service pricing rules: The construction unit takes the lead in organizing and implementing The BIM technology application project applies BIM technology in the two phases of design and construction, with a subsidy of RMB 20 per square meter, and a maximum of RMB 3 million; a subsidy of RMB 30 per square meter if all BIM technologies are applied at the design, construction, and operation stages. Yuan, no more than 5 million yuan. From this we can feel the determination and action of the Shanghai municipal government to develop BIM technology.

(iii) Shenzhen

On January 12, 2017, the Shenzhen Housing and Construction Bureau issued the “Notice of the Shenzhen Municipal Housing and Construction Bureau on Accelerating the Advancement of Prefabricated Buildings”. The article mentioned that the prefabricated construction project should be in the stage of design, production, construction, operation and management. Apply information technology to form a Building Information Model (BIM). It is important that the text emphasizes that it is necessary to use building energy-saving development funds, focusing on supporting prefabricated buildings and BIM applications, and granting a maximum funding of no more than 2 million yuan.

5. Conclusion

As a new tool, BIM is considered as the revolutionary concept and milestone technology of the global construction industry, it brings revolutionary changes to the construction industry. At present, BIM

technology in China still stays in the cognitive stage and has not yet developed into practice. In view of the impact of BIM technology on the construction industry, it is very necessary to popularize the application of this new technology. Currently, BIM technology has rapidly spread in China's construction industry. The first real-world BIM application project in Shanghai has received a lot of attention from the beginning, but at the overall level, the application of BIM in China is still in the initial stage of exploration. During the exploratory phase, the main body used the design company as the mainstay, and in many case it was also the application of ideas, not the real BIM practice. In addition, the application of domestic BIM is mostly self-published by the market. It has not risen to the level of government promotion as in Japan, the United States, Europe, South Korea, and other countries and regions. The BIM technology has also been adopted in the National 12th Five-Year Plan for Development of Building Informatization. The content of the study was included, but it lacked practical policy rules and a good external environment. Given China's unique institutional and cultural context, government-led promotion policies and the creation of the external environment are the preconditions and important conditions for BIM applications, and it is also an urgent task.

The second purpose is to improve the "competitiveness" of the construction industry. The construction industry all over the world is a “low production efficiency” industry, and due to the reduction of construction demand in developed countries, this inefficiency turns to high quality. In contrast, in China, we often criticize that it is a short construction period. In fact, for the industry, it is both a disadvantage and an advantage. At this time when domestic construction demand is still high and the demographic dividend has not completely disappeared, the coupling of information technology and industry reform is proposed. It will help improve China's competitiveness in the international market.

The rapid development and remarkable results of BIM have made people truly appreciate its benefits in the use process. Like other advanced technologies, the concept and practical application of BIM has not only been confined to the construction industry, has begun to expand into other fields.

Acknowledgments
The author appreciates the support of four research projects, The Natural Science Foundation of Qinghai province(2016-ZJ-766), the National Natural Science Foundation of China (Grants No. 51768060), The Natural Science Foundation of Qinghai province(2015-ZJ-722) and the Cooperation Program of Qinghai Province (Grants No.2017-HZ-804), the open fund project of national key laboratory of water sand science and water conservancy and hydropower project of Tsinghua University, Chunhui Plan of Department of the Ministry of Education：Research and Application of Visualization for Construction Process Based on BIM Technology.

6. References

[1] A. Sawhney, R. Agnihotri, V.K. Paul, Grand challenges for the Indian construction industry, Built Environ. Proj. Asset Manag. 4 (4) (2014) 317–334.
[2] A.H. Memon, I. Abdul-Rahman, N.Y. Zainun, Abd-Karim, Web-based risk assessment technique for time and cost overrun (WRATTCO)-A framework. Procedia- Social behavioural, Sciences 129 (2013) 178–185.
[3] P.E.D. Love, Influence of project type and procurement method on rework costs in building construction projects, J. Constr. Eng. Manag. 128 (1) (2002) 18–29.
[4] Z. Shehu, G.D. Holt, I.R. Endut, A. Akintoye, Analysis of characteristics affecting completion time for Malaysian construction projects, Built Environ. Proj. Asset Manag. 5 (1) (2015) 52–68.
[5] P. Love, D. Edwards, Z. Irani, Moving beyond optimism bias and strategic misrepresentation: an explanation of social infrastructure project cost overruns, IEEE Trans. Eng. Manag. (2011)
[6] A.L.C. Cirinini, S.M. Ventura, M. Paneroni, Implementation of an interoperable process to optimise design and construction phases of a residential building: a BIM pilot project, Autom. Constr. xxx (2016) (pp. xxx-xxx).

[7] V.K. Vernikos, Optimising Building Information Modelling and off-site construction for civil engineering, Civ. Eng. 165 (CE4) (2012) 147.
[8] C. Zhang, T. Zayeb, W. Hijazi, S. Alkass, Quantitative assessment of building constructability using BIM and 4D simulation, Open J. Civ. Eng. 6 (2016) 442–461.
[9] GUO H L., LI H., SKITMORE M. Life cycle management of construction projects based on Virtual Prototyping technology[J]. Journal of Management in Engineering ,2010 ,26(1):41-47.
[10] Bryde, D., Etal., The project benefits of Building Information Modelling (BIM), International Journal of Project Management (2013).
[11] Arayici Y., Coates P, Koskela L, et al. Technology adoption in the BIM implementation for lean architectural practice[J]. Automation in Construction ,2011 ,20(2):189-195.