Research on Industrial Residential Buildings Based on Computer Big Data

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Abstract. As an inevitable choice for sustainable urban development, industrialized residential buildings are being paid attention to and adopted by more and more countries and regions in the world. Compared with traditional construction methods, IRB has the advantages of reducing environmental pollution, improving production efficiency and ensuring construction quality. Over the past 15 years, leading international architectural journals have published a number of articles on prefabricated construction management, off-site construction management, and industrial construction. This paper studies the latest research trends in this field, and qualitatively analyzes 80 research papers published in 10 major journals from 2005 to 2020 from the aspects of research content, research methods, and core research fields (now available online). This paper USES computer big data to analyze the literature. Analysis shows that the impact of the IRB on the construction industry as a whole is increasing.

Keywords: Industrialized Residential Building, Industrialized Building, Off-Site Construction, Prefabricated Construction, Computer Big Data

1. Introduction

As of 2016, China's urbanization rate reached 57.35% (National Bureau of Statistics of China, 2016). The rapid development of the city has stimulated the housing needs of urban residents. While the construction industry is developing rapidly, it has also caused problems such as environmental damage and low production efficiency (Huo & Yu, 2017). IRB is recognized as an effective solution to these problems (Li et al., 2018). IRB refers to the structural components of residential buildings that have been prefabricated off-site before production and installation on site (Pan, Gibb & Dainty, 2012). The emergence of IRB is due to its advantages, including reduced demand for production workers, cost
reduction and reduction in resource consumption and less Construction waste (Li, Shen & Xue, 2014).

IRB has received more and more attention in the field of residential construction, but there are not many articles on IRB published by academic journals worldwide. The lack of analysis of the only literature content has hindered further research in this area. Much of the published articles are about industrialized building (IB) or off-site construction (OSC) and prefabricated construction (PC). OSC and PC are the specific construction techniques in the IRB project. From the perspective of the literature review, the academic community's interest in IRB is still in its infancy. Specific distribution Fig. 1. As can be seen from Fig. 1, among the 80 papers published from 2005 to 2020, there are the most about IB, PC, and OSC. Among them, there were 26 articles containing IB in the title of published papers and 27 articles containing PC in the title of published papers. A separate analysis of IB and IRB papers is shown in Figure 2. After 2005, IB research reached its peak in 2014, and IRB research articles appeared in the same year[1].

![The number of papers published in related fields from 2005 to 2020](image1)

**Figure 1.** The Number of Papers

![Publication of IB and IRB papers from 2005 to 2020](image2)

**Figure 2.** Publication of IB and IRB

This article analyzes the academic papers published from 2005 to 2020 (contains an article already included but published in 2020), finds the research focus and makes research trend analysis. The literature search was chosen from 2005 because the prefabrication rate of developed countries such as Denmark and the Netherlands reached 40% in the 1990s, while China is just in its infancy (Li et al., 2018). The specific research content is: (1) determine the publication of relevant IRB papers published in 10 high-level journals; (2) determine the countries in which IRB research focused; (3) explore the main research methods in IRB research; (4) analyze the critical content of existing research to provide references for researchers in this field.

2. **Background of IRB**

The use of IRB improves the efficiency of residential construction, enhances the urban environment, and improves the quality of housing (Li et al., 2018), increasing productivity and construction safety. In previous studies, there were many terminology related to IRB, including IB, industrial houses, industrial housing systems, precast concrete buildings, off-site prefabrication, OSC (Li, Shen & Xue, 2014).

Some scholars believe that IB began in Japan and was widely adopted and well developed in Europe and North America. In Europe, some scholars believe that France is one of the first countries
in the world to implement IB (Li, Shen & Xue, 2014). Some scholars believe that IRB is one of the most critical developments in the IB field in recent years. In some developed countries, the residential prefabrication rate had reached more than 50% by 2010[2]. In China, IRB was gradually becoming a significant form of a residential building to replace the traditional architectural way. But in the past 20 years, IRB has not been well promoted in China (Li et al., 2018). Some people think that the main obstacle to IRB not being promoted is because IRB requires higher capital investment compared to traditional construction techniques.

3. Research methodology

This critical review collected a total of 80 peer-reviewed articles. They come from two databases: Science Direct and Google Scholar.

According to the previous research methods of scholars in the field of prefabricated construction management research (Li, Shen & Xue, 2014), the author conducted another round of screening of academic journals in the field of IRB research and found ten journals: Construction Management and Economics(CME), Automation in Construction (AIC), Journal of Construction Engineering and Management (JCEM), Construction Innovation (CI), Building Research and Information (BRI) Habitat International(HI), Building and Environment(BE), Engineering, Construction and Architectural Management (ECAM), Journal of Cleaner Production (JCP), Sustainable Cities and Society(SCS).

4. Critical review by topic

Through a critical review of 80 articles related to the field of IRB, this research identified four topics: (1) performance evaluation, (2) design, production, transportation, and installation system(DPTI), (3) development and application, (4) Industry prospects.

4.1. Performance evaluation

In the research of IRB, many scholars first made a multi-angle comparison of prefabrication technology or off-site manufacturing technology widely used in IRB. The specific comparison is as follows: (1) Cao et al. (2015) believed that compared with traditional residential buildings, prefabricated residential buildings use energy more efficiently, reducing total energy consumption by 20.49% and reducing resource consumption by 35.82%. (2) Pan et al.,(2012) collected and analyzed 20 high-rise residential building data from a high-quality residential builder in the UK within five years. The prefabricated cross-wall technology saves costs by 25% compared to site-in-place technology. (3) Huo and Yu (2017) pointed out that the application of IBS in China is extremely limited because of the potential risks affecting the attitude of IB practitioners[3].

4.2. Design, production, transportation and on-site installation strategies

In the second theme, In the 'design, production, transportation, and installation strategies', system dynamic monitoring, and control of the IRB industry are widely considered to be of strategic importance. Teng et al. (2017) explored the symbiotic relationship of stakeholders in the IB industry chain, including design, production, transportation, and field installation[4]. They believe that
developers contribute the most to the entire system; the unbalanced development of designers and module suppliers have shaken the IB symbiosis system. Wikberg, Olofsson and Ekholm, (2014) used BIM software for platform development, clarified the hierarchical structure of building objects, and modularized the structure view as the first step to lock in customer needs.

4.3. Development and application

Li et al. (2018) believe that effectiveness, efficiency, and operability are the concerns that construction companies face when the government makes policies to promote IRB. Lessing and Brege (2018) analyzes the business models of 10 companies from Sweden and North America, and believes that a good match between supply, operating platform, and market positioning is the key to the success of developing companies in the IRB

4.4. Future research areas of the industry

Zhai, Reed and Mills, (2014) analyzed 21 independent variables and extracted 6 main factors of constructability implementation, social climate and attitude, building performance, cost calculation, supply chain and preparation stage, and considered that these factors increased an obstacle to China's off-site production. Zhang, Skitmore and Peng, (2014) consider high initial costs, lack of skilled workers, manufacturing capabilities and product quality, lack of supply chain, lack of norms and standards, and lack of government incentives and support as obstacles to the promotion of IRB in China. The Chinese government needs to develop better policies and strategies to encourage the further development of IRB in China. In the study, the SWOT method was used to analyze the advantages and disadvantages of IRB in the context of accelerating urbanization, indicating that IRB is a higher requirement for the sustainable development of the construction industry (Li et al., 2018).

5. Conclusion

IRB is receiving increasing attention in the residential construction industry because of its potential for sustainable development. Because IRB's growth is not only related to sustainable development of a country but also related to the impact of the global environment. This study provides a critical overview of the current status of IRB and provides a valuable reference for scholars in the field and the development of the IRB industry.

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