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RESEARCH METHODOLOGY
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RECOMMENDATIONS/SUGGESTIONS
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SUSTAINABLE CONSTRUCTION SOLUTION FOR CHINA'S PUBLIC RENTAL HOUSING: INDUSTRIALIZED BUILDING ADOPTION

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ABSTRACT

With a new trend in China that the Public Rental Housing (PRH) becomes a main part of indemnificatory housing, as a new kind rental oriented indemnificatory housing, PRH presents new challenges for housing sustainability. This paper aims to solve the sustainable construction problem for PRH by adopting the Industrialized Building (IB). The research processed with an extensive literature review, and then the common barriers for the IB adoption in housing industry were investigated. Combine with the characteristics of PRH, the barriers and advantages for adopting IB in China indemnificatory housing was analyzed. Furthermore, the sustainability principles for China's PRH construction were discussed in three aspects, which are economics sustainability, environmental sustainability and social sustainability. The results shown that PRH is able to overcome most of common barriers of IB adoption in commercial buildings, such as high initial cost and lack of market demand. However, increased industrial scale, optimized supply chain and improved the make recognition are still key challenges for IB adoption in PRH project. The research finding will help developers to understand the barriers and advantages for adopting IB in China's PRH project, and achieve sustainable development for PRH.

KEYWORDS

construction solution, public rental housing, industrialized building adoption.

1. INTRODUCTION

With rapid development of China's urbanization and industrialization, improving the living conditions of middle and low-income urban residents has become an important livelihood issue for the Chinese government. Over the past thirty years, China's construction industry has made great strides towards improving the residents' living conditions. The average per capita living space in 2012 was 36 m^2compared to 6.4 m^2 in 1978 (ISSS, 2012) [1]. Meanwhile, the construction industry became an important drive for economic growth and provides abundant working opportunities. However, this growth comes at a cost as the urban commercial housing price increased 115% from 2003 to 2012 (NBSC, 2013) [2]. The commercial building price exceeded the affordability of most low-income or moderate-income families. The indemnificatory housing has become a focused topic in improving social welfare and a key solution to reducing the economic burden for the middle- and low-income families and improving their living conditions.

Over the past thirty years, the indemnificatory housing policy has experienced rapid development. However, due to the rapid growth of China's urbanization, housing shortage are still acute problems for middle- and low-income households, especially for new city immigrants and new graduates(Chen and Deng, 2014) [3]. Recently, the "twelfth Five-Year plan" of China proposes a plan to deliver 36 million units of indemnificatory housing to improve middle- and low-income group's resident conditions within next five years . China has ushered in a large-scale construction period of indemnificatory housings, in February 2013, the State Council issued "The notice on further keeping on controlling the real estate market", which required the completion of 4.7 million units and initiated the construction process for building another6.3 million units of affordable housing within the same year.

With large-scale indemnificatory housing construction, China is also facing a series of new challenges in indemnificatory housing construction, such as high quality control, renewable energy and materials utilization, environmental sustainability and convenient maintenance. In November 2013, the central government presented gradually cancelling the Economic and Comfortable Housing (ECH), and increasing the supply of Public Rental Housing (PRH). Before the central government decision, some cities have begun to stop new ECH projects due to the new socio-economic situation, such as Zheng Zhou City stopped new ECH project in 2012; Shen Zhen City launched the last batch of ECH in February 2013 and Guang Zhou City suspended the application of ECH since April 2013 and include the new qualified people into the scope of protection of PRH. Thus, it has become a general trend that PRH will replace ECH to be the main part of indemnificatory housing in China (Shen *et al*., 2013) [4]. Based on this situation, new rental-oriented indemnificatory housing PRH presents new requirements for housing construction: (1) the PRH should has basic renovation which can meet the basic living requirements of the residents. This is significant difference between ECH and other sale-oriented indemnificatory housing, which also supplied by the government, but without renovation; (2) Due to the PRH will be rented by different residents, the renovation elements and other non-structural components should be easier to be replaced for the future renting; (3) With large-scale PRH construction, the sustainable construction method, low-energy consumption and high quality control should be considered. Based on this, the conventional construction mode is unable to meet the sustainable development requirements of PRH, and it is urgent for China to find a sustainable solution for RRH construction.

The object of this paper is to investigate new challenges for new rental-oriented indemnificatory housing in China, and develop a sustainable construction solution for PRH based on adopting Industrialization Building (IB) system. This paper processed with an extensive literature review, and then the common barriers of industrialized housing adoption were investigated, which followed by identifying the key barriers in PRH project construction. Finally, the sustainable principles in PRH projects were discussed in economics sustainability, environmental sustainability and social sustainability aspects. The research will help the government, design teams and construction teams to understand sustainable challenges in PRH projects and obtain a sustainable construction solution for PRH.

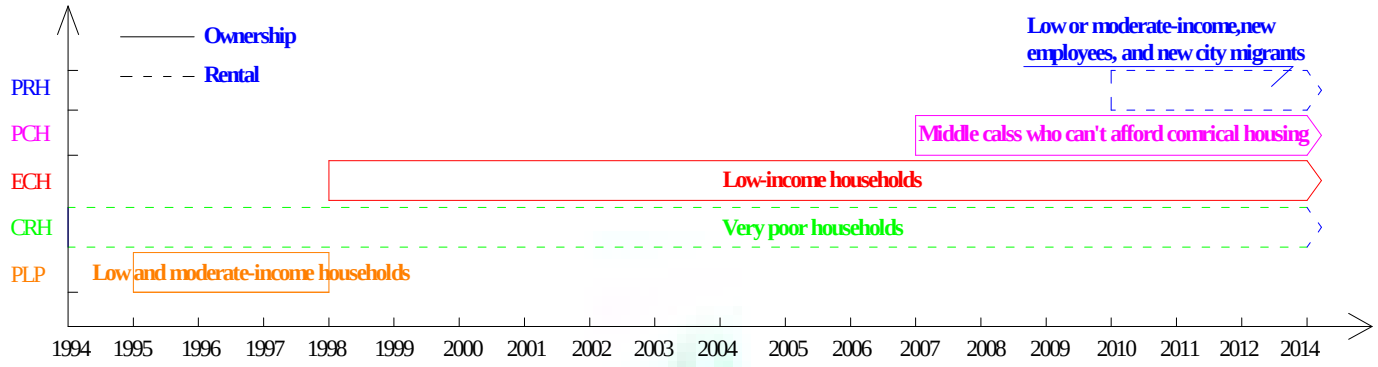
2. LITERATURE REVIEW

To achieve the sustainable development and find a sustainable construction solution for China's new Public Rent Housing projects, an extensive literatures review in related areas was conducted including the Indemnificatory housing in China, industrialized building (IB) utilization and sustainable principle adoption.

The indemnificatory housing in China is provided by government to improve the middle- and low-income families' living conditions. Ongoing housing reform fundamentally changed China's housing market, and meanwhile promoted the indemnificatory housing development in China. The indemnificatory housing issues were commonly discussed in previous literatures, which mainly focus on the policy reform, structure and practices(Zou, 2014; Huang, 2012; Logan et al.,2012; Lee & Zhu, 2006; Wang and Murie, 2000;) [5-9], investigating the financial strategies and financial gap of indemnificatory housing(Mao & Wang, 2012; Zhang & Zhang, 2013) [10-11] , and indemnificatory housing supplement analysis for low income families and housing policy(WANG Y.P.; MURIE A)[12]. However, there are limit researches focus on the indemnificatory housing construction in perspective of sustainability.

To understand new challenges for rental-oriented indemnificatory, it is necessary to review the history of indemnificatory housing programs in China. Over past thirty years, China has launched a series of indemnificatory housing programs, including the Comfortable Housing Project (CHP), the Economic and Comfortable Housing(ECH)program, the Cheap-Rent Housing (CRH) program, the Price-Cap Housing (PCH) program, the Public Rent Housing (PRH) program, and the Social Housing program as shown in Fig.1.

FIG. 1: INDEMNIFICATORY HOUSING HISTORY IN CHINA



Source: Zou, 2014; Huang, 2012. Compiled by author

Fig.1 shows the major indemnificatory housing launched since 1994, the indemnificatory housing can be divided into two types, one is the ownership-type housing (CHP, ECH and PCH; Solid line), the other is the rental-type housing (CRH and PRH; dashed line). The ownership-type housings played an important role to support the housing reform, however, according to the new economic and social development requirements, the Ownership-type affordable housing will gradually withdraw from the stage of history, instead that the rental-type housing will become the main parts of indemnificatory housing (Shen et al., 2013)[4]. As shown in Fig.1, the PRH started in 2010, which will gradually merge with the CREH to form a new type rental-based indemnificatory housing system to enlarge the indemnify scope to new employee and new city migrants. The new rental-oriented indemnificatory housing system is more fit to China's rapid urbanization development needs, and meanwhile it presents a series of new challenges for construction industry, such as high quality control, high construction efficiency, build as move-in and environmental friendly etc.. Therefore, it is necessary to introduce the advanced construction mode into the indemnificatory housing construction.

Industrialized building can be defined as the introduction of industry manufacturing theory to building construction activities, which utilize the factory production, transportation and assembly on site (Dietz and Cutler, 1971) [13]. It also can be defined as a PPMOF (Prefabrication, Preassembly, Modularization, and Off-site Fabrication) construction mode. There is a burgeoning literature in this domain which examines the PPMOF utilization issues. Many researchers consider the PPMOF as an effective and efficient construction method to reduce the environmental impact, such as reducing construction wastage(Tam *et al.*, 2005; Tam *et al.*,2007;Lu & Yan,2012;Poon *et al.*,2011) [14-17], greenhouse gas emissions(Mao *et al.*,2013; Lu *et al.*, 2012) [18-19], and reduction energy and water consumption (Gibb and Isack, 2003; Blismas *et al.*, 2006) [20-21]. In reducing construction wastage aspects, Tam *et al.* (2005) pointed out that prefabrication can provide a better solution to the problem in huge waste generation on sit activities [14], and Tam *et al.* (2007) found that wastage generation can reduce up to 100% after adopting prefabrication, in which up to 84.7% can be saved on wastage reduction, and they also advised that early design stage should be considered for including the construction methods at the construction process for better implementation of prefabrication [15]. Lu and Yuan (2012) carried out a thorough investigation into the off-site CWS program in Hong Kong, and they found that since implementing CWS program in 2006, the off-site CWS program has contributed greatly to construction waste minimization by hitherto separating 5.11 million tons of construction waste in total[16]. In reducing greenhouse gas emissions (GHC) aspects, Mao *et al.* (2013) presented a method to examine greenhouse gas emission in semi-prefabrication projects in the construction stage. By comparing with the project under conventional construction, the project under semi-prefabrication can reduce about 1.1 tons per 100 m^2 in GHC emission [18]. Lu *et al.* (2012) carried out a comparative analysis of life cycle greenhouse gas emissions and energy between conventional concrete construction, prefabricated steel construction and prefabricated timber construction. Their study shown that the embodied energy of the initial steel building can be saved up to 81.3% by reusing the main steel structure of the prefabricated modules and other components in another new building[19]. Therefore, it is urgent for China to adopt the IB in indemnificatory housing construction to archiving sustainable development, and meanwhile promote the construction industrialization development in China.

Begun as an international movement in 1993, sustainable construction can be defined as "creating a healthy built environment using resource-efficient, ecologically based principles". It looks at the entire life cycle of the built environment: planning, design, construction, operation, renovation, retrofit and the end-of-life fate of its materials (Kibert, 1994)[22]. Sustainable construction considers the resources of construction to be materials, land, energy, and water and has an established a set of principles to guide this new direction(Kibert, 2002) [23]. Sustainable construction can be examined in three different categories, economics sustainability, social sustainability and environmental sustainability(Shen *et al.*, 2007) [24]. Chen *et al.* (2010)investigate the sustainable performance criteria for construction method selection in economics, social and environmental aspects, the ranking analysis of their survey results shows that social awareness and environmental concerns are not as high as economic criteria, but they were considered as increasingly important in construction method to achieving the sustainable development [25].

3. RESEARCH METHODOLOGY

The literature reviews, comparison and Meta-analysis are used in the paper as the research methodology. Kenly (1998) contended that construction management should make sufficient use of existing research for Meta-analysis, and rigorous and proper meta-analysis can identify new trend and new relationship, and it also can avoid draw collusions from one single project study[26]. Due to the IB adoption in China's PRH project is still in initial stage, there are limit literature or projects data. But the common issues for IB adoption, indemnificatory housing construction, and sustainable construction have been widely studied. Therefore, it's valuable to adopt literature review, comparison and Meta-analysis method to investigate the sustainable construction solution for China's PRH projects based on existing literatures.

4. BARRIERS ANALYSIS OF IB ADOPTION IN CHINA'S PRH PROJECTS

4.1 COMPARISON BETWEEN OFF-SITE AND ON-SITE CONSTRUCTION

Currently, the indemnificatory or commercial housing constructions commonly use the traditional on-site wet construction method. Although the on-site construction was adopted widely by construction industry, but it still has many defects need to be improved, such as heavy labor-intensive, poor quality control, environmental impact and high material waste. Therefore, indemnificatory housing construction should select a more sustainable construction method to avoid these defects.

Off-site construction is featured by (1) controlled production environment, (2) elements module production, (3) avoiding wet construction on site, (4) saving labors and (5) High working efficiency. In this research, the Off-site construction was chosen as an alternative construction method to achieving sustainability in indemnificatory housing construction, so it is necessary to compare different influence when choosing off-site or on-site construction method.

The comparison between them was taken in perspective of influence of indemnificatory housing construction. The comparison was divided into five categories, as shown in table 1.

TABLE 1: COMPARISON BETWEEN OFF-SITE AND ON-SITE CONSTRUCTION

Categories	Off-site/Prefabrication	On-site/Cast-in-Place
Quality control	Mechanized production in factory, high quality control.	Heavily depend on variable workers' proficiency, and hard to control the concrete quality due to on-site procedure
Cost control	*High initial cost and, need government support, integrate supply chain can reduce the cost.*	*Save 20% cost than off-site construction and can avoid the transportation fees.*
Construction time	High construction efficiency and saving the construction time, Limited impaction by the weather.	Should wait for the previous concrete work before the next step, and heavily depend on weather conditions.
Environmental impacts	All works taken in a factory environment and assembly on site. Greatly reduce the on-site environmental impacts.	On site construction generate great noise, dust and solid waste. Causing serious pollution to the surrounding environment
Resource Utilization	To maximize the reuse of the material, and save water and electricity consumption.	On site construction consume lots of water, electricity and materials due to wet construction

In table 1, there are four categories show that off-site construction has advanced performance potential than on-site construction, only the initial cost will be more than the on-site construction. For government lead project, the initial investment will be more guaranteed than the commercial projects. The real estate companies are more willing to consider the benefit and won't like promoting the new construction mode development. But for non-profit indemnificatory housing project, China government will be more willing to promote the new technology and new construction mode spreading, and promote the whole housing industry development. Therefore, off-site construction has great potential to be utilized in PRH construction.

4.2 CHARACTERISTICS ANALYSIS OF CHINA'S PRH

PRH is one kind of rental oriented indemnificatory housings, so it has significant characteristics different from the common indemnificatory housings, such as simple floor plan, policy and investment advantages, easy replacement, and basic renovation. All of these characteristics present new requirements for PRH construction.

The PRH should be oriented with green and low energy efficiency. China plan to built millions units of PRH, the PRH construction should consider the environmental friendship by using renewable materials and new type construction method. The prefabricated construction method can be used to reduce the environmental pollution and save energy consumption. Therefore, the prefabricated construction will be one kind of environmental friendly construction mode for PRH.

The PRH should have basic renovation. The PRH construction should avoid renovation in the traditional construction method. The basic non-structural elements should be produced in factory and assembly on site, such as prefabricate inner wall, prefabricate balcony, and prefabricate elevator.

The PRH should be built with flexible replacement element. For example, the government will choose the other qualified residents to rent the house after a period of rent, and then the non-structural element may need to be replaced for new residents. Therefore, the rental oriented PRH should be easier to replace the renovation or nonstructural elements.

The PRH always has simple floor plans which can be suited the basic residents requirements. The governmental will choose a series of mature and simple floor plans design to be used in the PRH construction. Therefore, it is easier to achieve the serialization and standardization in PRH design, which are foundation of prefabricated construction.

The PRH has policy and investment advantages. Most of real estate developers don't have motion to use new construction method, and put huge initial investment to implant new construction method. Therefore, PRH has incomparable policy and investment advantages as a government lead projects, the new construction method will be easier to be adopted than commercial projects.

4.3 BARRIERS ANALYSIS FOR IB ADOPTION IN CHINA'S PRH CONSTRUCTION

As an alternative to conventional building system, IB is featured by high quality control, low energy consumption and low environmental impact. However, IB is still not widely adopted in the building construction industry. There are lots of literatures analyzed the barriers for IB adoption [27-30]. The previous research investigated various barriers factors for IB adoption, which can be classified into four categories including the Policy & Structure, Economic, Technology and Market& Awareness, as shown in Tab.2.

TABLE 2: PRELIMINARY BARRIERS FOR IB ADOPTION

No.	Policy &Structure (P&S)	Economics(E)	Technology(T)	Market& Awareness (M&A)
1	Lack of government supporting policy	High Initial cost	Complex interfacing between systems	Uncertain market demand
2	Lack of manufacturers and suppliers	Difficulty of bidding price	Unable to freeze the design early on	Lack awareness of market and public
3	Lack of local R&D institutes and services	High cost pressure without economics scale	Lack of practices and experience from local project	Risk of adverse culture
4	Fragment of industry structure	High logistics costs	Lack of experienced worker, designer and contractors	Client skepticism
5			Lack of design code and standers for IB	Fear of historic failures

Source: Mao *et al.*, 2014; Arif and Egbu, 2010; Pan *et al.*, 2007

Most of previous studies investigated barriers based on question surveys, and ranking each barriers factors. Pan *et al.* (2007) point out the higher initial cost is the most significant barrier factor for IB adoption [28]. Mao *et al.* (2014) ranks 30 factors based on the their relative importance from the perspective of developer, their research results show that the greatest obstacle is lack of governmental regulations and incentives, followed by high initial cost and dependence on traditional construction method[26]. Although with different survey samples and different local circumstances, the research results show that high initial investment, lack of governmental supporting policy and uncertain market demand are recognized as the main barriers for IB adoption.

China's indemnificatory housing is also facing these barriers when adopting the IB as an alternative for traditional construction. PRH has incomparable advantages at urban plan, standers implementing, investment advantage than the commercial housing. So some existing common barriers in commercial housing projects can be overcome by the PRH due to its special characteristics. Therefore, it is worthwhile to analyze the barriers combine with indemnificatory housing characteristics. To analyze how barriers can be reduced in the PRH projects, the analysis of adoption IB in indemnificatory housing were carried out in positive aspects and negative aspects , as shown in Tab.3.

To compare with the common barriers in commercial buildings, the analysis was also classified into four categories. The analysis results show that PRH are able to overcome most of barriers, it has positive potential to promote the IB adoption. However, PRH projects are more conducive to the formation of industrial clusters, but it still lack of industrial scale, and it also need optimizing the whole supply chain to reduce the cost. The design code and experienced designer, worker, manager and contractors are still lack in the industry, and the government should deliver more IB project to enhance the market and public recognition, and then reduce the unsafe impression of public.

TABLE 3: IB ADOPTION ANALYSIS IN CHINA'S PRH

No.	Policy and Structure (P&S)	Economics(E)	Technology(T)	Market and Awareness (M&A)
Positive aspects	1.PRH projects are easier to adopt the unified planning 2.PRH projects can promote the Industry regulation and code development	1.Government provide initial investment 2.the land and tax supporting policy 3.PRH can improve the economic development indirectly	1.The guidance policy are conductive to promote the IB technology 2.The government support many large scale research project to solve critical technical issues 3.Demonstration project provide cumulative experience for the whole industry	1. PRH projects have determine market demand 2.PRH projects can reduce the client skepticism 3.Simple floor plan can reduce failure and enhance success confidence
Negative aspects	PRH is conducive to forming industrial clusters, but still lack of industrial scale	Optimization of the whole supply chain to reduce logistics cost are still need to be studied	Design code and experienced designer, worker, manager and contractors still need more training	Still need more projects to enhance market and public recognition, and reduce unsafe impression of public

Based on the analysis above, PHR projects are more conductive to adopt the IB than commercial building to adopt the IB. Meanwhile, IB can provide more flexible scheme for PRH, which make PRH achieving more sustainability development. Therefore, IB can be recognized as a sustainable solution for China's new rental-based indemnificatory housing, and large-scale indemnificatory housing construction can also promote the industrialization development in China.

5. SUSTAINABILITY PRINCIPLES FOR PRH BY IB ADOPTION

Sustainable development is a key target for PRH construction, IB adoption provide a feasible path to gain sustainable construction of PRH. Sustainable construction can be examined in three categories, economics sustainability, social sustainability and environmental sustainability(Shen *at al.*, 2007) [31]. Therefore, this study mainly investigate the sustainably principles meanings in indemnificatory housing construction in these three aspects, and then the recommendations for indemnificatory housing construction were proposed.

5.1 ECONOMIC SUSTAINABILITY PRINCIPLES

The economic sustainability principles for indemnificatory housing are mainly refers to two aspects, one is financial operation sustainability, the other is reducing the construction cost. The financial operation sustainability mainly refers to raise the construction investment to ensure the investment operation at each stage. Such as Urmi presented that the government should encourage the private sector to invest in the PRH project via PPP cooperation mode, and then enlarge the funds resource. The rent subsidies, tax subsidies and preferential land policy provide by government also can enhance the economics sustainability.

This study mainly focus on reducing the cost by IB adoption. As discussed previously in this paper, the initial cost is one of the main barriers for IB adoption, which belongs to the short term cost. For IB adoption in the construction industry, it needs a large initial investment to build the prefabricate element factory, and it also has inventory costs. All these cost will be part of product price, and the high initial cost will generate RMB 300-RMB 400 per m^2 greater than conventional buildings, approximately 20% higher than the total cost of conventional buildings (Mao et al., 2014). For indemnificatory housing, the government is developer, so it will provide more favorable policies and investment to promote industrialization housing development, and are easier to form economic scales. In China, government plays a key role in real east market, especially in the indemnificatory housing construction. The current large scale indemnificatory housing construction provides a good opportunity for industrialization development in China.

For economic sustainability, the government should provide a series of stage to promote the IB adoption in indemnificatory housing. (1) Present financial mechanisms, such tax rebate, land policy and low loan interest rates to encourage the developer participate in the prefabricate projects; (2) Make a specific plan which directly enforced the indemnificatory housing project to adopt the IB, guide the industrialization housing forming a scale to reduce the initial cost via indemnificatory housing projects; (3) optimize the industrialized supply chain to reduce the production cost, logics cost and assembly cost.

Although, the IB needs high initial cost, but when consider the life cycle cost, the long term cost can be reduced when prefabrication is used. Many professional believe that by adopting life cycle costing approach, the first cost of prefabrication can be largely offset by other factors such as potential reductions in construction time, on-site activities and labor requirements, waste and resources.(Chen et al.,2010). Therefore, the IB can be used in indemnificatory housing to gain the economics sustainability, the government need to help the developer overcome the initial cost barriers, and then the whole industry will gain long term benefit.

5.2 ENVIRONMENTAL SUSTAINABILITY PRINCIPLES

Comparing to the commercial building, PRH pays more attention on environmental sustainability. As a government lead project, the goal of PRH is to build a low carbon emission, high energy efficiency and renewable-material housing. Reducing the waste, decreasing the carbon emission, and avoiding the redecoration are the main advantages of the IB.

In China, construction waste is one of biggest challenges for environmental sustainability. Construction waste is defined as the by-product generated and removed from construction, renovation and demolition workplaces or sites of building and civil engineering structure. With China's high development of building industry, the new built building generate 40 million Ton construction waste per year, which accounts to 40% of the city solid waste. The construction waste seriously affects the environmental sustainability of building industry, especially for large scale Indemnificatory housing construction, the government facing a serious challenge.

The on-site and off-site environmental pollution can be effectively reduced by introducing the IB into PRH project. Parts of the structural elements can be produced in factory environment, and the element will be transport to be assembly on site. The on-site construction can be reduced effectively, and avoid the wet construction on site, and then reduce the environmental impact. IB also can achieve high energy efficiency as it produce the element in a factory and use high efficiency mechanized production. It save much labor and avoid rework which are common in the traditional construction method. Therefore, in perspective of project life cycle, the IB will be more efficiency than the traditional construction, although it will consume a little more energy to transport the element to the work site.

To achieving more environmental sustainability, China government should encourage the prefabricate element enterprise to participate in the indemnificatory housing project, and make specific plan for IB adoption in indemnificatory housing project. First, the government should present the explicit goal of environmental sustainability and specific indicators for indemnificatory housing. Second, set up an evaluation system, and evaluating the environmental sustainability based on the local green building rules. Third, improving the public and market recognition via demonstration housing project construction, and changing the unsafe awareness in the public mind. By adopting the IB in indemnificatory housing, the China housing construction industry not only achieves he sustainability, but also promotes the industrialization housing development in China.

5.3 SOCIAL SUSTAINABILITY PRINCIPLES

IB is a new type build system, which is still not widely used in China. Since the dependence on traditional building system, the safety and quality of industrialized housing is still not recognized clearly by society, lack social awareness of industrialized housing are one main barriers for IB application. In addition, as a labor intensive industry, the working environment, and safety are main aspects of social sustainability.

To achieving the social sustainability, the government can improve the recognition by promoting the IB adoption in indemnificatory housing, improving the management and construction level, and eliminate unsafe awareness of the IB. Meanwhile, the working environment and safety can be improved via high mechanical production adoption.

6. CONCLUSION

Sustainability has become the key challenge for China's indemnificatory housing construction. Meanwhile, the large scale indemnificatory housing construction provides a developing opportunity for China's building construction industry. PHR was delivered as a new kind of indemnificatory housing for renting which presents new requirements for industry housing construction. IB is defined as high efficiency, high quality control and green renewable. Therefore, the IB can be used as an alternative construction method for China's indemnificatory housing to achieve sustainable development.

However, there are many barriers for IB adoption in China. Based on the investigation of the common barriers for IB adoption, the high initial investment, lack of governmental supporting policy and uncertain market demand are recognized as the main barriers for IB adoption. These barriers are also main barriers for IB adoption in the PRH construction, but by investigation in this study , the results show that most of common barriers can be overcome by the indemnificatory housing's own characteristics, such as high initial investment, lack of support policy and the uncertain market. Therefore, the IB will be easier to be adopted in PRH projects than the commercial housing projects. By adopting the IB system, The economic sustainability, environmental sustainability and the social sustainability of PRH projects will be effectively improved.

7. ACKNOWLEDGEMENTS

The author wish to thank for the funding of "2014 Humanity and Social Science Youth Foundation of Ministry of Education of China (Grant No. 14YJC630016)", "2014 Humanity and Social Science Foundation of Liaoning Educational Committee, China (Grant No. W2014205)", "2014 Humanity and Social Science Foundation of Liaoning Educational Committee, China (Grant No. W2014221)", "2015 International collaborative research funding of Dongbei University of Finance and Economics, China (Grant No. DUFE2015GY02)" and "2015 Graduated education Reform project (YJYB-201502)". The author wishes to thank the Dongbei University of Finance and Economics for funding him to do these works at Department of Building Construction Management, Purdue University as a Visiting Postdoc Scholar.

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