Journal of Cleaner Production 152 (2017) 387–398

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Analysis of stakeholder relationships in the industry chain of industrialized building in China

Yue Teng [a, b, c], Chao Mao [b, c, *], Guiwen Liu [b], Xiangyu Wang [c]

[a] Department of Civil Engineering, The University of Hong Kong, Hong Kong
[b] School of Construction Management and Real Estate, Chongqing University, Chongqing, China
[c] School of Built Environment, Curtin University, Perth, Australia

ARTICLE INFO

Article history:
Received 11 June 2016
Received in revised form
13 March 2017
Accepted 15 March 2017
Available online 22 March 2017

Keywords:
Industrialized building
Industry chain
Stakeholder relationship
Industrial symbiosis
Symbiosis system

ABSTRACT

The industrialized building has been increasingly advocated as a sustainable construction technology for its potential merits of a cleanly built environment, enhanced quality performance, and reduced time and labor. However, the uncertainty within the industry chain caused by the lack of understanding of stakeholder roles and relationships affected the widespread industrialization in China. Therefore, this study aims to define the roles and determine the relationships of stakeholders within the industry chain of industrialized building using stakeholder and industrial symbiosis theories. Several methods, including literature review, face-to-face interviews, and chain referral sampling method, were used to identify stakeholders. Stakeholder relationship was determined through a quantitative symbiosis model. The data underpinning this model were collected from various channels, including expert interviews, official websites, statistical yearbooks, and annual reports. A case study of VANKE was employed as a validation object to explore the optimized strategies toward the stakeholder symbiotic relationship and system stability. The results show that developers contributed more to the symbiosis system compared with others. However, the unbalanced development of designers, module suppliers, and surveyors, as well as the lack of public acceptance destabilized the industrialized building symbiosis system. Optimized strategies were proposed, including improving public acceptance, strengthening the design process, reforming the module suppliers' production mode, and establishing the Standardized Module System. The industrial symbiosis model serves as an effective tool for quantitatively optimizing the stakeholder relationship of the industrialized building industry, which offers valuable references for practitioners to identify the process that should be optimized and the source of system instability. Therefore, both optimum resource distribution and sustainability can be achieved.

1. Introduction

The construction industry, as one of the major contributors to both environmental and socio-economic issues, is vital in achieving sustainable development (Roufechaei et al., 2014). However, the Chinese construction industry still relies heavily on the conventional cast in-situ method, which has long been criticized for labor intensiveness, low productivity, high waste, and poor safety (Eastman and Sacks, 2008). This “labor intensive, dangerous, and polluting” mode hinders construction sustainability. To alleviate the environmental burden and low productivity associated with conventional construction, the recent global trend is to promote industrialization. Industrialized building (IB), an idea borrowed from the manufacturing industry, is defined as a production process integrating the processes of prefabrication, mechanization, automation, robotics, and reproduction (Richard, 2005). Compared with traditional on-site construction, the upstream process of industrialization usually occurs in a specialized factory, where various materials are combined to form a component of the final installation in the downstream. During the whole process, developers deliver new products to users and set up new connections to material suppliers and vendors. Finding new ways to achieve revenue growth (Liu et al., 2016), improve quality (Cao et al., 2015), and reduce construction period (Mao et al., 2013) is important. The tradition on-site manual work will be dramatically replaced by mechanical work, which saves labor (Kamali and Hewage, 2016)

* Corresponding author. School of Construction Management and Real Estate, Chongqing University, Chongqing, China.
E-mail address: maochao1201@126.com (C. Mao).

http://dx.doi.org/10.1016/j.jclepro.2017.03.094
0959-6526/

and reduces safety risks (Li et al., 2016) for contractors. Higher capacity of transportation and erection is required for the deliveries of module suppliers. Standard design lowers the workloads and mistakes of designers when handling projects. Waste reduction and energy saving, which are benefits from the dramatically decreased on-site tasks, contribute to sustainability (Tam et al., 2015).

However, the implementation of IB is not widespread and mature in China, where various projects still apply the traditional approach (Mao et al., 2013) because, in the new mode, the appearance of the new role and relationship of stakeholders leads to an uncertain environment (Li et al., 2016). Therefore, entrants who lack systematic understanding of their new roles and interrelations burden various risks and require high initiative investment. For example, new module factories and advanced transportation equipment are indispensable to module suppliers, by which precast components can be manufactured and transported to sites (Goodier and Gibb, 2007; Pan and Sidwell, 2011). Therefore, contractors with new technology for hoisting and delivering are required to efficiently communicate with module suppliers to fit in with the schedule of on-site assembly in a seamless connection (Li et al., 2016). The design results dramatically affect production and installation processes, which mean that designers have to burden more risks and responsibility during the life cycle. Therefore, several potential entrants are reluctant to take on the IB mode because of its high uncertainty, especially for small and medium organizations (Liu et al., 2016). They are more likely to accept stable, though unexciting returns, rather than to attempt changes that seen as “too difficult.” The absence of stakeholders exacerbates the fragmentation and discontinuity of the industry chain, which hinders the widespread implementation of the IB mode. Consequently, the increased awareness of stakeholder roles and relationships in IB industry chain is crucial in the current stage.

Therefore, this study aims to define the roles and determine the relationships of stakeholders in the industry chain of IB using stakeholder and industrial symbiosis (IS) theories. Few previous studies have proposed the IB stakeholder analysis. According to stakeholder theory, stakeholders are defined as those who can affect or is affected by the achievement of objectives (Mosgaard et al., 2016). This theory can be applied to identify stakeholders and manage their interrelationships for a better corporate objective; however, the qualitative analysis of stakeholder relationship cannot be achieved. Nevertheless, quantitative research is vital in pointing out the part of the IB industry chain that needs focus, the extent of their effects to others, and the manner in which it affects the entire system. To address this gap, industrial symbiosis (IS) theory is conducted to quantify stakeholder relationships; this theory has been applied in the manufacturing (Lieder and Rashid, 2016), steel (Dong et al., 2013), and chemistry industries (Wu et al., 2016). The degree of interaction among stakeholders, along with their collective influences on the whole system, is effectively determined using IS theory. The specific objectives of this study are outlined as follows: first, the IB industry chain is established to define the role of stakeholders and their business interaction, using stakeholder theory. Various methods, including literature review and face-to-face interview, and chain referral sampling method, are adopted. Second, the industrial symbiosis model is established to examine the stakeholder symbiotic relationship and stability of the IB symbiosis system using IS theory. Last, the case study of China Vanke Co., Ltd., a real estate company, is adopted to demonstrate the model. Previous problems and relevant optimized strategies are explored based on the results of the model. This study identifies the stakeholders within IB production and construction and releases the uncertainty and confusion of practitioners toward new role functions. Potential entrants are attracted, thereby achieving the scale effect of industrialization development and the integration of IB industry chain. Policy makers can emphasize the IB construction industry processes, which are useful to achieve the driving effects. The stability analysis shows the influence of each stakeholder to the whole system, which is of great significance to the optimum distribution of resources within the upstream and downstream of the IB industry chain. Therefore, practitioners can choose a relatively better way to achieve their corporate objective by understanding and strengthening their stakeholder relationship.

2. Review of previous work

2.1. Sustainability of industrialized building

Various interchangeable terms, such as prefabrication (Li et al., 2014b), off-site construction (Pan et al., 2008), modern methods of construction (Goodier and Gibb, 2007), and off-site construction (Hong et al., 2015), are associated with the industrialization mode. The term “Industrialized Building” or IB, is adopted in this study because it refers to the whole process, which includes prefabrication, mechanization, automation, robotics, and reproduction (Richard, 2005). Several scholars and practitioners have demonstrated the sustainability of adopting IB. Jaillon and Poon (2008) proposed that a major improvement on construction process can be achieved by IB because the components are produced in advance before the on-site assembly. Wilson et al. (1998) conducted a case study in the UK, demonstrating that the average overall productivity value can increase by nearly 2.5 times. Anson et al. (2002) revealed that site labor consumption is reduced by 43% when using industrialized construction as an alternative to in-situ casting. Jaillon et al. (2009) proved that the average waste reduction can be as high as 52% compared with conventional construction. Other benefits such as time-saving (Fischer et al., 2003), enhanced occupational health and safety (Tam et al., 2006), and improved construction quality (Chunfa and Lipan, 2014) have also been recognized, demonstrating the significantly sustainable performance improvement using IB. Reports and case studies worldwide have also shown that IB is becoming a common practice in many developed countries (Johnsson et al., 2007; Tam et al., 2007).

However, the achievement of sustainability not only relies on the stakeholders themselves but also on their integration within the IB industry chain (Kamar et al., 2009). In a normal industry chain, a firm can usually position itself competitively by developing collaborative relationships, which have been investigated by various other industries, including photolithography (Henderson and Clark, 1990), aircraft (Brusoni et al., 2001), and computer (Baldwin and Clark, 2000). These studies demonstrate the significant influences of the industry chain's structure designs on the interaction of stakeholders. Compared with the manufacturing sector, which has multiple products, companies in the IB industry are set up to the one-off product, where arm's length transactions are replaced by relationships based on integrated working (Hofman et al., 2009). For example, the design process requires a higher degree of communication among IB players, such as designers, contractors, and manufacturers (Wang et al., 2015). Designers have a corporation with contractors to handle the nodes in the construction process, while achieving the standard design. The collaboration of contractors with manufacturers guarantees the just-in-time assembly. Therefore, the interrelations between stakeholders in the industry chain consist of the supply relationships (e.g., contractors with manufacturers) and the technology cooperation (e.g., designers with contractors). The diversified relationships, together with the multi-stage participation of some stakeholders (e.g., designers), determine the complexity of the IB industry chain.