Enhancing housing production in Hong Kong through BIMatizing offshore prefabrication

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Housing production and its constraints

Housing production is a grave concern in Hong Kong. Currently, housing in Hong Kong is mainly supplied through three channels: private housing; public rental housing (PRH), and; subsidized housing under home ownership schemes (HOS)[1]. By the end of March 2012, there were 2,599,000 permanent residential flats in stock, of which 1,447,000 (56%) were private flats, 761,000 (29%) were PRH, and 391,000 (15%) were subsidized housing. On the demand side, a total of 48,841 marriages were recorded between 2004 and 2011 in Hong Kong while only13,609 new private flats were built during this period, leaving 3.6 couples competing for one private flat (Knight Frank, 2012). The upsurge price of private housing has made it only affordable to a small portion of the people while nearly half of the population is now residing in some form of public housing (CSD, 2007). There were over 100,000 applicants on the waiting list for PRH, in which about 30% of the households in Hong Kong reside (CSD, 2007). These applicants have to wait for at least seven years to move into the PRH. There is a widespread discontent over housing issues in Hong Kong. In light of this, the new Government has implemented a series of interventions since July 2012. To produce more public housing is a long-term strategy on the agenda. According to Hong Kong Housing Authority's forecast (2012), approximately 77,800 PRH and Subsidized Sale Flats will be built 2012/13 to 2016/17. This is reiterated by the Chief Executive of HKSAR, Mr. C.Y. Leung in the Policy Address 2013, of which a considerable number of pages tried to tackle housing problems.

However, on the production sphere, the capacity to deliver the ambitious housing plan over such a short period of time is questionable. First of all, there is a severe labor shortage in the construction industry. Construction is a big employer, hiring about 294,400 employees, accounting for 8% of the total labor force in Hong Kong. Of these, about 50,000 are at worker level. Owing to reasons such as an ageing population (CSD,

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1 Local Hong Kong residents whose income exceeds the limit to recent a public housing but cannot afford private housing (This is known as "sandwich class") can apply for this HOS.

2012a), and a booming local construction market (e.g. ten mega-infrastructure projects), the industry is suffering from a severe labour shortage. Labour cost is becoming extremely high in Hong Kong; an often cited example is that the average daily wages for a bar bender and fixer, a mason, and a bamboo scaffolder are HK$ 1295.5, 1247.5, and 1147.0 respectively (CSD, 2012b). Yet, it is still difficult to find sufficient workers to produce the houses. Secondly, safety is another problem to be faced by the housing plan. The number of industrial fatalities in the sector was 23, a return to a plateau again. There is a danger that increasing housing production will cause more construction-related safety accidents if no action is taken. Thirdly, the implementation of the ambitious housing plan may further impact the environment. In spite of its significant contribution to built environment development, construction is also perceived as a contributor to degradation of the natural environment. The latest figures on solid waste ending up at landfills reached 13,458 tons per day (tpd) in 2011, of which 25% is construction waste (EPD, 2012). It exerts huge pressures on valuable landfill space in this compact city.

In short, Hong Kong is witnessing a series of dilemmas between the level of demand for housing production and constraints on its construction such as labour shortages, time, safety, and environment protection. Against this socio-economic background, prefabricated construction as a solution is gaining momentum in Hong Kong.

Offshore prefabrication

Prefabrication has been increasingly advocated owing to its potential benefits such as faster process, cleaner and safer working environment, and better quality. Prefabrication construction has been adopted in many economies such as the US, the UK, Japan, and Singapore. It is not new to Hong Kong either. Prefabricated buildings were first developed along with the public housing programs in Hong Kong. In the mid-1980s, prefabrication, combined with standard modular design, was introduced in public housing projects (Mak, 1999). In 2005, a pilot project extended the use of precast components to 65% including the use of precast kitchen and structural walls (HKHA, 2005). In contrast, the adoption of prefabrication in the private housing sector has been sluggish but this has been changed since the Construction Excellence report was published by the Construction Industry Review Committee in 2000. Following the report, the Joint Practice Notes (JPN) 1 and 2 were issued by the Hong Kong Buildings Department, Lands Department, and Planning Department, whereby building developers could receive gross floor area (GFA) exemptions if green building technologies, including prefabrication, were adopted.[2]

A relatively new initiative is that the whole prefabrication sector in Hong Kong has been moved to the offshore areas in the Pearl River Delta such as Shenzhen, Dongguan, Huizhou, Zhongshan, and Shunde. This offshore prefabrication is a natural response to the dilemmas discussed above. Hong Kong imports all its construction materials and Mainland China is one of the major material suppliers to Hong Kong construction industry. Offshore prefabrication also makes it possible to exploit cheap materials and the abundant labour force there. All these socio-economic factors have driven both Hong Kong and PRD governments to direct contractors' attention toward residing the prefabrication industry in the PRD of Mainland China. The offshore prefabrication processes in the Hong Kong – PRD setting can be illustrated in Figure 1. However, the potential benefits of using prefabrication cannot be cultivated without overcoming its inherent drawbacks such as fragmentation, discontinuity, poor interoperability, and lack of real-time information visibility and traceability, which are further exacerbated by offshore practices.

Figure 1 The offshore prefabrication processes

[2] The Departments have updated the JPNs 1&2 in 2011. At the core of the updates is that an overall cap of 10% GFA exemptions for a number of features which still qualify for concession is imposed.

BIMatizing the offshore prefabrication processes

BIMatizing is not a typo here. It is defined as the reengineering of the offshore prefabrication processes using Building Information Modeling (BIM) and its peripheral technologies. BIM is "a digital representation of the building process to facilitate exchange and interoperability of information in digital format" (Eastman, 1999). The information normally comprises building geometry, spatial relationships, and quantities and properties of building components. Davies and Harty (2011) elaborated that BIM is a term used to refer to a family of technologies and related practices used to represent and manage the information used for, and created by, the process of designing, constructing and operating buildings.

With its 3D presentation and virtual reality simulation capability, BIM was introduced as a technical tool that can be applied to improve productivity in a number of areas, such as improving design quality, construction plan rehearsal and optimization, and construction site management (CIFE, 2007; Li et al., 2009). On the other hand, BIM has an indirect, yet probably more significant impact on project by reengineering of architecture, engineering, and construction processes. For instance, with its information interoperability and 3D presentation, BIM can improve communication amongst parties (Fischer and Kunz, 2004). As a continuing digital platform, it can retain the information or knowledge (e.g. design rationale) to reduce the discontinuity (Li et al., 2009). BIM can also be used to encourage integration and collaboration (Taylor and Bernstein, 2009). Rhetorically, BIM can be designated as a facilitating platform through which the benefits of the offshore prefabrication can be better cultivated. The concept of BIMatizing the offshore prefabrication processes can be illustrated in Figure 2.

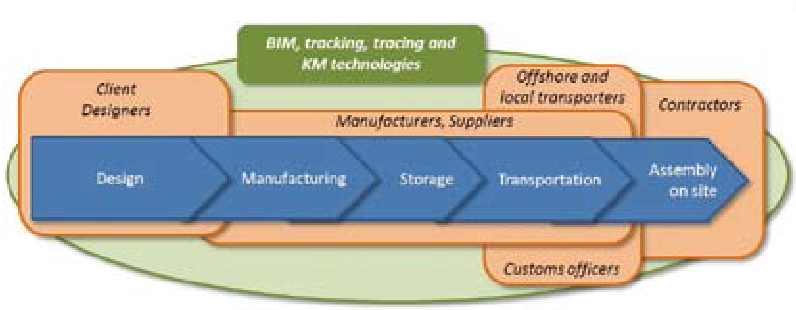

Figure 2 An illustration of the BIM-integrated prefabrication process

Challenges

There are various challenges to BIMatize the offshore prefabrication processes. The first is to make sense the information flow amongst stakeholders, processes, and BIM systems. Due to the separation of design, manufacturing, storage, transportation, and assembly, efforts should be spent to understand the stakeholders, processes, and the information (e.g. design rationales, order information, Bill of Quantities, and component information) flowing through them. In addition, practitioners reflect that the information standard for the whole offshore prefabrication sector should be developed. Currently, information such as XX-HC/YY1B/8/39/PH is marked on the prefabrication components, making them like "Da Vinci code" that is difficult to be deciphered.

The second challenge is to increase real-time information visibility and traceability by enabling current BIM talk to real-life housing production processes through peripheral technologies such as laser scanners, Auto-ID systems, webcams, or GPS. Unfortunately, current BIM is a "blind BIM"; the model cannot synchronize with the prefabrication processes. Successful experience of connecting BIM and building components using RFID technologies in Hong Kong has been reported. But given the uniqueness of building components such large in size, and harsh site environment, how to develop more accurate RFID technologies is yet to be realized. In addition, a more systematic way to explore increase real-time information visibility and traceability is desired.

Third is to prevent the new "information islands". Based on their information needs, different stakeholders have over the past few years developed their own enterprise information systems (EISs), e.g. the Housing Construction Management Enterprise

System (HOMES) by HKHA, or purchasing standard ERP packages (e.g. SAP). The information captured in these systems may have greatly facilitated the operations undertaken by individual stakeholders. However, owing to many reasons such as different databases, functions, and operating systems, these heterogeneous systems cannot talk to each other. This is called "information islands", a metaphor for bodies of information that needs to be shared but has no network connection. BIM was promoted as one of the solutions to bridge the information islands but this is a grave technical challenge.

Recently, a strong multidisciplinary team comprising researchers from the Faculty of Architecture and Faculty of Engineering at the University of Hong Kong, and Faculty of Construction and Environment at the Hong Kong Polytechnic University has been formed to tackle the above challenges. Prospective researchers, organisations, or companies are encouraged to contact the author for more information about the research on BIMatizing the offshore prefabrication processes.

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