



# SWOT analysis and Internet of Things-enabled platform for prefabrication housing production in Hong Kong



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## ABSTRACT

Housing has been a major concern in Hong Kong for the past several decades, increasing pressure on the Hong Kong Housing Authority to pursue ambitious housing plans. As a sustainable construction technology, prefabrication has been increasingly adopted in the delivery of housing plans to alleviate various constraints, such as labor shortage, time, safety, and environmental protection. However, few studies have conducted a strategic analysis of the current situation and planning management of prefabrication housing production (MPHP) in Hong Kong. By performing a strengths, weaknesses, opportunities, and threats (SWOT) analysis, the current study attempts to facilitate a more in-depth understanding of the MPHP development status in housing production in Hong Kong. Data underpinning the SWOT analysis are collected from various channels, including literature review, prefabrication-related regulations, interviews with experts, and government reports. This study provides an opportunity for major stakeholders to perceive the external and internal conditions of prefabrication development in Hong Kong. Internet of Things (IoT)-enabled platform deploying BIM to re-engineer offshore prefabricated construction processes, which are proposed based on the identified SWOTs for solving weaknesses and dealing with threats, are significant for improving MPHP in Hong Kong.

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## 1. Introduction

The balance of housing supply and demand is one of the most crucial concerns in Hong Kong, which is one of the most densely populous areas in the world. Hong Kong has an area of 1104 sq. km. and an average population density of 6420 persons per sq. km (Jaillon & Poon, 2008). Limited availability of land and expensive land prices have resulted in the prevalence of high-rise building construction in Hong Kong. However, only a small percentage of the people can afford the high prices of dwellings in private housing, with about 50% of the population residing in public housing. More than 100,000 applicants are on the waiting list of the Housing Authority for public rental housing (PRH), with a possibility of

having to wait at least seven years to move into a rental place considering PRH demand and supply (Chua, Wong & Shek, 2010). Housing issues in Hong Kong have resulted in widespread discontent. The Hong Kong construction industry has also witnessed a series of dilemmas and constraints, including safety, labor shortages, time, and environmental protection. Under this socio-economic background and as a solution to housing problems, prefabricated construction is envisioned to gain momentum in Hong Kong.

Prefabrication is a manufacturing process that generally occurs in a specialized facility where various materials are combined to form the component parts of the final installation (Gibb, 1999). Prefabricated construction has long been recognized internationally to have numerous advantages that benefit the majority of participating parties in the construction process. Prefabrication is also recommended as a key vehicle in alleviating the adverse environmental impact of conventional cast in-situ construction, as well as in emphasizing efficient construction within developed construction industries (Li, Shen & Alshawi, 2014a; Mao, Shen, Pan, & Ye, 2013a). However, compared to other developed countries,

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such as Germany and Japan, the application of prefabrication technologies and practices of management of prefabrication housing production (MPHC) in Hong Kong remain at a low level. Possible reasons for this low level issues, such as the lack of accurate information on precast element management, poor information sharing among various enterprise systems, and fragmentation and discontinuity of the entire prefabrication supply chain, that confront the prefabrication housing production process. For instance, the processes of design, manufacturing, storage, transportation, and assembly on site are fundamentally fragmented. These processes are subjected to discontinuity of different parties designated to perform different tasks. Design information and orders for prefabricated components should be transmitted to prefabrication plants without any ambiguity to allow for effective manufacturing. MPHC practices should also have definite norms to regulate the precast concrete construction market. In general, industry stakeholders also lack awareness on the actual costs and underestimate potential savings in raw materials consumption when adopting prefabrication technologies. Most construction projects adopting prefabricated components do not conduct a comprehensive evaluation of the potential effects of prefabrication application. These problems illustrate the pressing need to enhance current MPHC practices to raise productivity in the Hong Kong construction industry.

In general, a strengths, weaknesses, opportunities, and threats (SWOT) analysis and the Internet of Things (IoT)-enabled strategic development of MPHC can contribute to the development of MPHC practices of a particular region from several perspectives. First, the analysis can assist both construction industry stakeholders and the government in developing an in-depth understanding of MPHC status quo in the studied region. Second, SWOT analysis and MPHC facilitate identification of the main problems confronted by the construction industry when adopting prefabrication technologies, thereby allowing for corresponding actions to be introduced for enhancement. Third, the analytic results can provide valuable reference in the formulation of related platform to help improve both short- and long-term MPHC developments in the region. To solve weaknesses and deal with threats identified in SWOTs analysis, critical Internet of Things (IoT)-enabled platform are proposed for the development and promotion of prefabricated construction at the strategic level of housing production in Hong Kong. The specific objectives of the current study are as follows: (1) review the current MPHC practices in Hong Kong and develop major questions for interviews; (2) perform a SWOT analysis on MPHC based on survey results; and (3) propose the corresponding IoT-enabled platform and policy recommendations for MPHC development.

## 2. Prefabrication housing production in Hong Kong

Prefabricated construction refers to structures built at a location different from their location of use. Prefabrication occurs in a manufacturing plant designed specifically for this type of process and is typically in contrast with traditional on-site housing production. Several studies tend to use the terms modular buildings and modular housing to emphasize products composed of multiple sections called modules, which are prefabricated in a manufacturing plant. Individual building modules are constructed in the factory and then transported to the site via specially designed trailers. Therefore, the generally agreed upon benefits of using prefabrication include reductions in cost, time, defects, health and safety risks, and environmental impact, as well as a consequent increase in predictability, whole-life performance, and profitability (Li, Shen, & Xue, 2014b; Long, Zou, & Liu, 2009; Mao, Shen, Shen, & Tang, 2013b; Pons & Wadel, 2011).

Prefabricated construction technology has been applied in many countries, including Singapore, Japan, the US, and the UK; the use of said technology is also no longer new in the construction industry in Hong Kong (Jaillon & Poon, 2009). Fig. 1 illustrates the prefabricated housing construction process. Often, a client will hire designers to develop architectural and engineering designs, with special considerations given to the adoption of modules and their structural safety, buildability, and transportation convenience. Unlike the processes embedded in conventional cast in-situ construction, prefabricated housing is considered a significant process innovation that can alleviate problems in housing production, including time overrun, poor quality, and harsh working environment (Wang, Li & Tam, 2014). However, other problems besetting the construction industry remain unchanged. For example, the processes of design, manufacturing, storage, transportation, and assembly on site are fundamentally fragmented. These processes are subjected to discontinuity of different parties designated to perform different tasks. The problems of fragmentation and discontinuity are common in prefabrication housing production in Hong Kong. Design information and orders for prefabricated components need to be transmitted to prefabrication plants without any ambiguity to allow for effective manufacturing. Components should be manufactured and transported to sites to synchronize with the schedules of the work crew. Managing information (e.g., improving real-time information visibility and traceability throughout the entire prefabrication process) is a particularly notable challenge among the many challenges in cultivating the benefits of using offshore prefabrication (Lu, Huang, & Li, 2011). These problems could be exacerbated further because the entire prefabrication sector has been transferred to offshore areas in the Pearl River Delta (PRD) region. With the above mentioned issues, conducting a SWOT analysis is necessary to gain in-depth understanding on MPHC in the Hong Kong construction industry.

## 3. Methodology

### 3.1. Research framework

The most crucial tool adopted for the strategic analyses of MPHC in Hong Kong is the SWOT analysis approach, which is a useful tool for the strategic planning process. SWOT analysis is recognized extensively and constitutes an important means for learning about a situation and designing future procedures that can be considered necessary to enable strategic thinking. The SWOT analysis approach has been broadly applied in a variety of disciplines for investigating problems from a strategic perspective. For instance, in the research field of waste management, an investigation into the development of construction waste management in Shenzhen, Mainland China, is conducted and a set of concrete strategic action plans are subsequently proposed to improve the management in that region (Yuan, 2013), while the similar analyses are also witnessed in the research filed in construction industry (Lu, Li, Shen & Huang, 2009), and urban planning (Zuxin, Xinran & Zhenliang, 2009). The general process of SWOT can be divided into four main parts: (1) investigating current development of housing production, (2) forming research question for SWOT, (3) conducting SWOT analysis, and (4) proposing corresponding platform.

Fig. 2 shows the methodology adopted for the analysis in this study. In the first step, the current housing challenges confronted by the Hong Kong government are presented in detail through an analysis of collected materials. These materials are collected from two channels: through an investigation of the relevant government guidelines and reports and by consulting stakeholders involved in housing production, such as manufacturers, logistics personnel, and contractors. Second, research questions are designed to

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