

The Common Approach in Off-Site Construction Industry

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Abstract: The construction industry have made the appropriate initiative to make a paradigm shift in the manufacturing construction industry in order to achieve a higher standard and to adapt to the global business trend. The government and researchers have played vital roles to educate the main players of the construction industry in the form of policies, financial incentives, strategy guidelines, workshops and seminars to increase the awareness among the end users and clients. This paper present the challenges faced by the construction industry to integrate the modern method with the existing traditional method, and to make a comparative study in the approaches used in off-site construction industry. The four countries involved in the studies are US, UK, Australia and Malaysia. The off-site manufacturing in the U.S. was started by Henry Ford. It was a big evolution that became a phenomena and spread to the rest of the world. UK and Australia have the similarity in terms of the approach towards research and categorization of off-site system. Malaysia adapted the advanced approach practiced by other countries. The research finds that the pattern of off-site construction industry will benefit both the government and the private sector in fulfilling the demand for off-site system in the long term with the expansion of the construction industry and its ability to compete globally.

Key words: Pattern, Off-site Construction Techniques (OSCT), Modern Method of Construction (MMC), Offsite Manufacturing (OSM), Industrialized Building System (IBS)

INTRODUCTION

The construction industry is highly aware of the need to improve the integration, planning and control of its mass quality production, open new economic global trend, achieving open construction system and developed the standardization of products in line with the global market. The government is aware of the importance of developing a capable construction industry driven by technological developments in the manufacturing and service industry that is able to contribute in a large scale towards the economy of the sector. In Singapore, the great concern has been made in the C21 report regarding the blue print of Singapore's construction industry which has identified six strategic thrusts required in order for Singapore to become a world-class construction industry (Dulaimi *et al.* 2004). The expansion of the Singapore's economy has its limitation especially in the growth of the construction sector, where they have to compete for projects in other countries. Ngowi *et al.* (2005) stated that the growth of multinational operations in global operations has been an important factor in the internationalization of construction.

In the US, off-site manufacturing in the construction industry is described as Off-site Construction Techniques (OSCT). However in the UK, the Modern Methods of Construction (MMC) is the term used by the government to describe a number of innovations in house building, most of which are off-site technologies. The term Offsite Manufacturing (OSM) is the term used both in Australia and the UK construction industry. In Malaysia, the definition used for off-site manufacturing in the construction industry is known as Industrialized Building System.

There is still a need to be more creative and innovative in ideas to assist in improving the usage of appropriate off-site technology suitable to the local condition. As in the olden days, construction materials performance characteristics is made to adapt to the climatic condition, natural resources and available collective local skills (Ngowi *et al.* 2004). The paper is divided into two sections. The first section explains the pattern of off-site construction industry in US, UK, Australia and Malaysia. The second section assesses the

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methodology of approach used in the study of off-site construction industry.

The Similarity of Pattern in Off-site Construction Industry:

The idea of improving the performance of the construction industry by learning from other industries is not new. Henry Ford developed the standard production line for car manufacturing which has opened a new era of ideas for producing houses in factories. The biggest impact of manufacturing system occurred in Japan 1950 after Toyota's President, Eiji Toyoda, spent three months at Ford's Rouge plant in the USA (Gann, 1996). This has resulted in Toyota developing a new approach of lean production, use of plant, management resources, quality control and relationship between producers and consumers (Womack 1990, Gann 1996). The great influence of the highly successful manufacturing system in Japan has resulted in researchers from US and UK coming to Japan to learn from the Japanese experience (Webster 1993, Gann 1996, Taylor *et al.* 2003).

U.S. has the highest spending capital on construction with seventy-four percent of the total spent capital in world construction (CMAA 2010). Yet, they still face problems at the off-site construction industry as reported in CMAA (2006) where more than 40% of the Construction Management Association of America experienced construction schedule overruns due to the shortage of skilled craft workers and resulted in escalation of project costs.

The great challenge faced by the construction industry in UK is to integrate the 'traditional' technology with the appropriate off-site technology. In UK, the strong 'traditional' technology that comprises of brick/concrete block cavity wall methods, timber/precast floors and timber truss roofs (Pan *et al.* 2007). Thus, the house buyers are strongly influenced by the negative perceptions of the MMC innovation in houses construction that it will spoil the authentic 'traditional' house image (Edge *et al.* 2002). This has affected the construction industry and the innovation building technologies where the industry players face difficulty in implementing new concepts to the building system (Pan *et al.* 2007; Ball 1999; Barlow 1999; Roskrow 2004). Notwithstanding, the MMC is also known as OSM (Taylor *et al.* 2004). UK and Australia have the similarity in applying the OSM in their countries. Goodier and Gibb (2004) have difficulty in accessing the historic value of OSM in Australia. Thus a vague boundary exists between the traditional and OSM approaches, as well as data report on the performance of the construction and manufacturing industries.

In Malaysia, the IBS was initiated in 1964 by the Housing and Local Government after making reference to the success of several European countries (Thanoon *et al.* 2003). The players in the industry preferred to use the conventional method until the Construction Industry Development Board (CIDB) educated the industry on the essential usage of IBS components and conducted awareness programs on usage of IBS since 1998. As part of the government policy in encouraging the use of IBS, the government has mandated that 70% of IBS components should be used in government projects with the value of RM10 million (Treasury 2008). The use of IBS system is vital as a means to reduce the number of foreign workers which in turn will reduce outflow of Malaysian currency. This has created phenomena where construction industries have changed and moved to IBS as shown in Table (1). The trend in the construction industry to move to the manufacturing system is not only occurring in Malaysia but worldwide. As an example automotive, computers, books and electronic items have their own modular standard when produced by the respective manufacturer. Therefore, the construction industry should also adopt the modular standard when manufacturing the IBS components.

With regards to the development of technology for the off-site construction industry and the various off-site construction industry systems, the government and the researchers have come out with a guideline categorizing the off-site system as shown in Table (2). Table (2) also shows the pattern and the degree of technology changes. The US, UK and Australia have achieved the modular building standard but Malaysia is still in the initial stage to achieve it. The three countries have the similarity in off-site preassembly but UK and Australia have divided the off-site preassembly into non-volumetric and volumetric order. Thus, UK and Australia share the same similarity categorization of off-site system where most of the Australian researchers referred to UK. Malaysia is still in the stage of hybridization system and the evolution pattern of the categorization of off-site system is shown in Figure (1).

The Research Approach on Off-site Construction Industry:

Similar research methodology to study the status of off-site construction industry has been based on Table (3). The design of the pilot survey was based on the latest information on off-site construction industry and literature reviews. The design of the pilot survey is a vital procedure to enhance the validity and reliability

Table 1: The trend construction industry Malaysia

Traditional	Construction	Manufacturing
Project based	Project based	Product based
Short term project	Short term project	Long term project
Undefined profit and gain low profit	Profit from customized solutions	Profit in volumes of similar products
Take long time to complete project	Delay project (Lim and Mohamed 2000, Alaghbari <i>et al.</i> 2007)	(Gann 1996) Early completion project/ meet timeline (Kadir <i>et al.</i> 2006)
Very manual	Manual	Higher mechanization due to repeatability process and able to produce high quality

Table 2: Categorization of off-site system

No	Countries	Categorization of Off-site System	Author
1	US	Offsite preassembly Hybrid system Panellized system Modular building	Lu (2009)
2	UK	-Component manufacture & sub-assembly -Non-volumetric preassembly -Volumetric pre-assembly -Modular building	Goodier and Gibb (2004)
3	Australia	-Non-volumetric preassembly -Volumetric pre-assembly -Modular building	Blismas and Wakefield (2008)
4	Malaysia	-Pre-cast concrete systems -Formworks systems -Steel framing systems -Prefabricated timber framing systems -Block work systems -Innovative product systems	IBS Info (2010)



Fig. 1: Evolution pattern of off-site construction industry

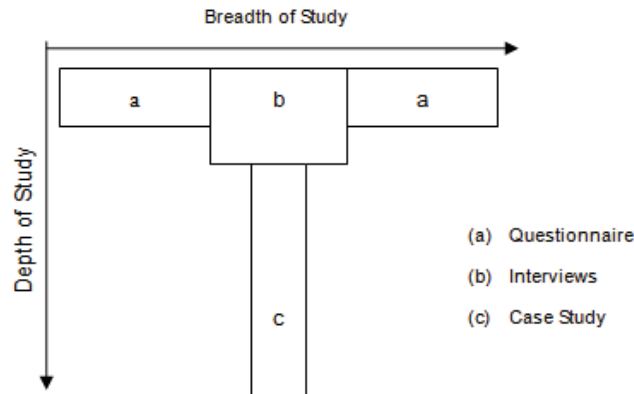


Fig. 2: Breadth and depth of triangulation (Source: Fellows and Liu, 2008)

of the survey instrument. The respondents of the pilot survey will help to strengthen the content, scope, question structure and response scales. Qualitative and quantitative approach is applied in the research, which uses the approach of triangulation method that uses two or more research methods in order to investigate a particular event, project or program. Based on Fellows and Liu (2008) research work using the case study approach, which is typically developed or shaped up based on literature review, may yield deep into the studied case but may produce narrow results. The use of questionnaire may cover a wider range of data scope but with a shallow depth. Interview could generate a deeper depth of the research field but the scope covered is restricted to the knowledge and experience of those involved only. As a result, the limitation of each single approach has driven researchers to apply all approaches within the triangulation technique in their research studies as shown in Figure (2).

Table 3: The methodology of the researchers

Countries	Methodology	Sampling	Analysis
US (Lu 2009)	<ul style="list-style-type: none"> •In depth open ended interviews •Structure interview questionnaire (majority conducted by phone) •Pilot study 10 representative to improve questionnaire •1200 questionnaires were mailed to architects/engineers (A/Es) & general contractors (GCs). •Using seven points Likert scales 	Random	SAS computer program
UK (Pan <i>et al.</i> 2007)	<ul style="list-style-type: none"> •Interview (face to face and by phone call) (Top 40) •Postal questionnaire survey (Top 100) •Pilot interview •Using five points Likert scales (Oppenheim 1992) 	Top 100 house-builder	Microsoft Excel & QSR NVIVO
Australia (Blismas & Wakefield 2008)	<ul style="list-style-type: none"> •Web-search: Indicate fast types & variety of products OSM and the methodology is weak but makes sense scope of OSM •Workshops: Open discussion on the issue of OSM and recorded all the discussion by 'note taker'. 45 participants among clients, designers, constructors, suppliers and researchers. •Interview surveys: to support the workshops data •Case studies had involved site visits and interviews to key persons in the organizations and project teams. 	50 manufacturer 45 participants 18 interviewers 7 case studies	NVIVO
Malaysia (Majid <i>et al.</i> 2010)	<ul style="list-style-type: none"> •Pilot survey •Based on Technology Acceptance Model (TAM), David (1989) •6886 questionnaires were mailed •Interview surveys: government agencies and contractors •Using five points Likert scales 	Population	SPSS

Conclusion:

The off-site construction industry has gone through a few transitions from the pre-assembly of components to the modular building system. The establishment of OSCT, IBS, MMC and OSM in the construction industry will only be possible if the construction industry achieve global standard, in touch with the latest technology and there is growth in the economy. Follow-up action need to be taken by the government to ensure that the policies in place are implemented by the construction industry following initial effort to promote off-site manufacturing. There should be a common effort to share and exchange the knowledge on off-site manufacturing among countries in order to ensure that the construction industry will be able to move to higher level of development.

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