CRITICAL SUCCESS FACTOR MODEL FRAMEWORK FOR LEAN MANAGEMENT APPLICATION IN INDUSTRIALISED BUILDING SYSTEM (IBS) PRODUCTION

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Laporan projek ini dikemukakan sebagai memenuhi
sebahagian daripada syarat penganugerahan
Sarjana Kejuruteraan Awam Dengan Kepujian

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DEDICATION

To

My husband, daughter and son
Syed Mohamad Syahir, Sharifah Ayra Inara and Syed Mohamad Aisy Irfan

My mother and late father
Sharifah Tambi and Mohd Noor Abd Aziz

My mother-in-law and father-in-law
Norliah Othman and Syed Mazlan Syed Mohamad

All my siblings and their family
Mohamad Shairul
Norfaizan
Norfaizren
Muhammad Yaser
Muhammad Syahid
Siti Fatimah
Nur Faizah
Sharifah Nadhirah
Syed Mohamad Firdaus
Syed Mohamad Afiq Aiman
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ABSTRACT

In Malaysia, Industrialised Building System (IBS) has been recognised as a potential solution in improving the deliverables of construction projects. However, the acceptance of this modern technology is still low. Most of the construction players prefer the conventional construction method which leads to a longer duration, lower productivity and poor quality of the building. The adoption of IBS requires systematic project management to ensure the best output in improving construction deliverables. Improper IBS project management can generate physical and non-physical waste in the production and construction tasks. This research aimed to evaluate on how to prevent waste and any types of loss during IBS construction by implementing lean management. This research examined the relation between critical factors in implementing lean management technique using the Interpretative Structural Modelling (ISM) method. In establishing ISM model, 51 influencing factors in implementing lean management based on lean construction key principles had been identified throughout an extensive literature review. The results from questionnaire survey identified 18 critical success factors for lean management adoption in IBS application. For further investigation, semi-structured interviews were conducted to collect the qualitative data for the critical factors. ISM analysis method was used to study the association between each critical success factor. The initial model was developed to promote the adoption of lean management technique in IBS construction. Deeper ISM analysis established a *Matrice d'Impacts Croisés Multiplication Appliqués à un Classement* (MICMAC). The MICMAC results in this research demonstrated that four important factors are categorised as Independent / Driving factors namely 'planning', 'educate labour', 'modularisation', and 'standardisation'. These factors were explored in detail to drive the performance elements categorised in Dependent factor which is 'reduce production time'. The findings provide a model that prioritised the critical success factors which lead to framework of lean management application in IBS production.

ABSTRAK

Di Malaysia, penggunaan Sistem Bangunan Berindustri (IBS) telah dijadikan sebagai satu jalan penyelesaian yang berpotensi untuk meningkatkan hasil pengeluaran projek pembinaan. Walau bagaimanapun, penerimaan teknologi moden ini dalam kalangan pengamal pembinaan masih rendah. Kebanyakan mereka lebih cenderung menggunakan kaedah pembinaan konvensional yang memakan masa lebih lama untuk siap dan mempunyai produktiviti serta kualiti bangunan yang lebih rendah. Penggunaan IBS memerlukan pengurusan projek yang lebih bersistematik agar pengeluaran terbaik dapat dihasilkan sekaligus meningkatkan mutu pembinaan. Pengurusan projek IBS yang tidak cekap boleh menyumbang kepada penjanaan sisa fizikal dan juga bukan fizikal dalam aktiviti pengeluaran dan pembinaan. Kajian ini dijalankan bertujuan untuk menyiasat cara untuk mencegah sisa dan sebarang jenis kerugian semasa pembinaan IBS dengan melaksanakan Teknik *lean management*. Kajian ini telah mengkaji hubungan antara faktor kritikal dalam melaksanakan teknik *lean management* dengan menggunakan kaedah *Interpretive Structural Modelling* (ISM). Dalam menghasilkan model ISM, sebanyak 51 faktor yang mempunyai pengaruh dalam pelaksanakan *lean management* telah dikenal pasti berdasarkan prinsip utama *lean construction* melalui kajian literatur. Hasil soal selidik pula telah mengenal pasti sebanyak 18 faktor kritikal yang mempengaruhi pelaksanaan *lean management* untuk diaplikasikan dalam IBS. Bagi siasatan lanjut, temu bual separa berstruktur telah dijalankan untuk mengumpul data kualitatif dan mengkaji faktor kritikal dengan mengupas isu-isu berkaitan. Kaedah analisis ISM digunakan untuk mengkaji hubungan antara setiap faktor kritikal. Model awal dihasilkan untuk menggalakkan penggunaan teknik *lean management* dalam pembinaan IBS. Analisis ISM yang lebih mendalam pula telah menghasilkan *Matrice d'Impacts Croisés Multiplication Appliqués à un Classement* (MICMAC). Keputusan MICMAC dalam kajian ini menunjukkan terdapat empat faktor penting yang dikategorikan sebagai faktor Bebas / Memacu iaitu 'perancangan', 'mendidik buruh', 'pemodularan', dan

'penyeragaman/ pempiawaan'. Faktor-faktor ini telah diteroka secara terperinci untuk memacu unsur-unsur prestasi yang dikategorikan dalam faktor kebergantungan iaitu 'mengurangkan masa pengeluaran'. Dapatan ini telah dapat menyediakan rangka kerja inisiatif untuk pengamal binaan dalam perancangan yang cekap untuk pengurusan nilai yang lebih baik dalam pembinaan IBS.

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LIST OF ABBREVIATIONS

AEC	=	Architectural, Engineering and Construction
BIM	=	Building Information Modelling
CIDB	=	Construction Industry Development Board
CIMP	=	Construction Industry Master Plan
CITP	=	Construction Industry Transformation Programme
CMSM	=	Construction Method Selection Model
CMU	=	Concrete Masonry Unit
CREAM	=	Construction Research Institute of Malaysia
GDP	=	Gross Domestic Product
GNP	=	Gross National Product
IBM	=	International Business Machines
IBS	=	Industrialised Building System
ISM	=	Interpretive Structural Modelling
JIT	=	Just-in-Time
LPD	=	Lean Project Delivery
LPS	=	Last Planner System
MICMAC	=	Matrice d'Impacts Croisés Multiplication Appliqués à un Classement
MIDF	=	Malaysian Industrial Development Finance
MPC	=	Malaysia Productivity Corporation
MS	=	Malaysian Standard
TPS	=	Toyota Production System
TQM	=	Total Quality Management
TVD	=	Target Value Design
UK	=	United Kingdom
URL	=	Uniform Resource Locator
USA	=	United States of America
RM	=	Reachability Matrix
SD	=	Standard Deviation
SPSS	=	Statistical Package for Social Science

SSIM	=	Structural Self-Interaction Matrix
VSM	=	Value Stream Mapping

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Construction productivity plays one of the prominent roles in the national economic development in Malaysia. The nature of construction industry is unique and complex due to the integration of many parties and consumption of multiple resources such as materials, labours and machineries (Lim, 2008). As a developing country, the adoption of modern construction such as Industrialised Building System (IBS) is vital to double up the construction sector's productivity (Malaysia Productivity Corporation, 2017).

IBS is a modern construction system involving both construction and manufacturing processes, using uniform building components. The components were massly produced in a factory or on site, then transported and assembled to form a structure using particular machinery and equipment with minimum workmanship on site (CIBD, 2003). However, the take-up rate of IBS in the Malaysian construction industry is still low compared to developed countries (Yunus and Yang, 2014). Moreover, failure in practising a good construction management in IBS will lead to additional reworks, idle time, costs overruns and many other physical and non-physical wastages (Kamar, Azman, & Nawi, 2014). To overcome the hitches, lean management based on lean construction principles has been introduced in the construction sector.

Due to common features involving production and services system, the construction industry has applied the lean philosophies that were originally being implemented by Toyota in their manufacturing process to reduce wastage and focus on conversions and flows of activities (Koskela, 1992; Howell, 1999).

According to Chauhan and Singh (2012), lean management is an operation management approach that aims for waste elimination in every area of design, production, factory management and supplier network. Meanwhile in construction, it is known as an approach to the management of the construction process, by changing the focus on conversion activities to a balanced focus considering both conversion and flow activities (Hirota & Formoso, 1998).

Lean construction management is a set of philosophies. The philosophies are 1) focus on customer, 2) people and culture, 3) organisation and standardisation of workplace, 4) waste prevention, and 5) continuous quality improvement served to eliminate waste, improve the value stream and hence, increase the value for customer (Polesie, 2012). Koskela projected three lean philosophies that can be used at early project phase including management philosophy, manufacturing method, and application of various tools and techniques (Marsono & Sadeghifam, 2017). With the appropriate selection of lean tools and techniques in construction, it is possible to increase productivity, making a company more competitive, promise a better quality, cost effective and reduce accident rates (Hermes, 2006; Tam *et al.*, 2014).

1.2 Problem Statement

Decreasing quality and productivity, unskilled labour, occupational safety, and inferior working conditions are some of the growing issues related to Industrialised Building System (IBS) associated with construction (Najib *et al*., 2019). For over 50 years since its first introduction and practice of IBS in the Malaysian housing projects in 1960's, the adoption and uptake on IBS in the Malaysian construction industry are still low (Mohd Nawi *et al*., 2011; Ali, Abas, Affandi, & Abas, 2018).

In 2003, Cabinet of Ministers endorsed IBS Strategic Plan as the blueprint for the total industrialisation of construction sector through the IBS Roadmap 1 2003-2010 followed with Construction Industry Master Plan (CIMP) 2006-2010 highlighted on the important of IBS. However, until 2006, the IBS usage in Malaysia is below expectations with overall volume of work was only 10–15% (Hamid *et al*., 2008; Kamar *et al.,* 2009; Nawi *et al*., 2011). Starting in 2010, the IBS Roadmap 2 2011-2015 was published to replace the previous roadmap aimed to sustaining the existing momentum of 70% IBS content for public sector building projects through to 2015,

and increase the IBS content to 50% for private sector building projects by 2015. Yet the Construction Industry Transformation Programme (CITP) 2016-2020 launched in September 2015 reported that, only 24% of public projects worth RM 10 Million and above have achieved IBS score of 70 meanwhile only 14% of target private projects worth RM 10 Million have achieved IBS score of 50 remaining below the target of 100% adoption rate for both public and private sector buildings.

According to Malaysian Productivity Corporation 23rd productivity report 2015/2016, construction industry records low productivity levels in comparison with other sectors in Malaysia. It is one of the biggest challenges faced by the local construction sector due to the lack of interest to undertake IBS leading to dampening productivity growth of the sector. The local and global labour productivity benchmarks reported in the CITP 2016-2020 reflect the limited modernisation in Malaysian construction methods and practices, as well as a reliance on a low-skilled workforce (Najib *et al*., 2019). According to the 24th Productivity Report 2016/2017 (MPC, 2017), modernisation of building methods application in other developed country has proven and found be able to improve productivity, reduce costs, offer workers better pay and help to save lives (MPC, 2017). Thus, this inferior working conditions have opened the possibility of more revolutionary solutions within the industry.

Therefore, it is crucial to encourage the uptake of IBS through industrialised construction work by nurture work culture emphasizes on excellence, performance, waste reductions, standards and systematic work processes practice focusing on lean management productivity tools adoption (CIDB, 2014).

The purpose of this research study will be to examine the motivational factors necessary to adopt lean management in IBS production use as a more reliable approach for preventing decreasing quality and productivity, unskilled labour, occupational safety, and inferior working conditions in IBS production application. To fulfil this purpose, three research questions were arisen to meet the objectives of the study. This research emphasises on the following research questions:

i) What are the driving factors and barrier factors for construction practitioners to adopt lean management fundamental in the application of IBS production?

ii) What are the significant factors required to be considered to implement lean management in the IBS production?

iii) How lean management can help to improve the productivity of IBS production?

1.3 Objectives

The aim of this study was to examine the motivational factors necessary to adopt lean management in IBS production use as a more reliable approach for preventing decreasing quality and productivity, unskilled labour, occupational safety, and inferior working conditions focusing on IBS production activities. The effects of lean management technique towards production of structural components for IBS construction were observed by considering the particular criteria required to complete this study. To fulfil the aim of the study and answer the research questions above, the following research objectives were set:

i) To analyse the key drivers on the potential lean management fundamental application in IBS production.

ii) To evaluate the critical success factors of the driver factors of lean management in IBS production.

iii) To create a model prioritising critical success factors on lean management adoption in IBS production leading to a final framework.

1.4 Scope and Limitation of Study

The scope of this study focuses on manufacturers and clients limited to IBS stakeholders across Peninsular Malaysia. The targeted respondents for both quantitative and qualitative data collections involve the top management, middle

management and skilled workers of IBS practitioners and clients. The IBS production is limited to only structural components.

1.5 Significance of Study

This research is expected to be beneficial especially for new entry IBS manufacturers and contractors in embarking their business in IBS. The results is expecting able to provide a basic understanding on the gains from lean management fundamental in IBS production application. This study provides an overview of the nature of the business of IBS stakeholders especially manufacturers. It outlines the drivers and barriers of lean management adoption in the IBS production and proposes factors or strategies to be prioritised in order to improve productivity towards operational excellence. Operational excellence which is a strategy to nurture work culture emphasizes on excellence, performance, waste reductions, standards and systematic work processes (CIDB, 2014). Compared to previous studies which only focus on five lean management pillars, this research extends the existing knowledge by linking IBS or building components prefabrication with other three lean management important aspects. The strategy comprises five fundamental of lean management namely focus on customer, people and culture, organisation and standardisation of workplace, waste prevention, continuos quality improvements (Forbes & Ahmed, 2011) and other additional aspects such as technical improvement (Tillema & van der Steen, 2015), performance improvement (Aziz & Hafez, 2013b) and tools and techniques (Kurdve, Zackrisson, Wiktorsson, & Harlin, 2014). Over the long term, the increase uptakes of IBS, adoption of modern methods such as lean management and proper operational strategies will benefit the construction industry through faster delivery time, boost productivity, reduction of unskilled workers and increase company competitiveness (Valente *et al.*, 2012; CIDB, 2014; Mohd Noor, 2018). It is hoped that the use of critical success model will provide a generic framework in planning and value management in IBS production, starting a business in the IBS manufacturing industry, encourage the involvement of additional construction players in the IBS industry, and thereby contribute to the growth of the Malaysia construction industry.

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