

COLLABORATIVE PROCUREMENT STRATEGY IN PRIVATE SECTOR  
HOUSING PROJECTS USING INDUSTRIALISED BUILDING SYSTEM

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*This thesis is lovingly dedicated to my mom, dad, family and special friends...*

*Thanks for the love, support and memories*

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## ABSTRACT

Along with the global population growth, the demand for affordable accommodation is increasing. In this regard, the construction industry has been urged to change from conventional construction methods to Industrialised Building Systems (IBS) to increase construction quality and productivity by the Malaysian legislator. IBS reduces risks related to occupational safety and health, and alleviates issues for skilled workers and dependency on foreign labor. Despite acknowledging several benefits of using IBS, the construction industry has still slow in embracing this new construction method. In this thesis, a series of barriers were identified that affect the use of IBS within construction. It also verified multiple issues of private sector developers for not adopting IBS systems through literature review, questionnaire survey, semi-structured interview, and Delphi studies. Supply chains and procurement methods were identified as the main constraints that causing non-adoption of IBS. Further, procurement systems are a key factor that contributes to overall client satisfaction and success of IBS projects. An implementation framework for collaborative procurement strategies was developed to address this issue. This framework highlights procurement methods as a vital milestone to the success of IBS housing projects. Several criteria for a successful procurement system were tested in the questionnaire analysis. Since fragmentation in construction industry is also apart of an issue, this thesis promoted a framework of procurement strategy that give an advantages of consortium collaborations between project key players at the design stage. The results of this study revealed that collaborations between designers, contractors, and manufacturers in the design stages of a project have resulted in a higher level of success of IBS housing projects and lowering the levels of risk for stakeholders. The study reveals that the high successful rate of IBS can be obtained if procurement process was designed at early stage of the projects.

## ABSTRAK

Seiring dengan pertumbuhan penduduk secara global, permintaan kepada perumahan harga berpatutan semakin meningkat. Dalam hal ini, industri pembinaan digesa berubah dari kaedah pembinaan konvensional untuk Industrialised Building Systems (IBS) untuk meningkatkan kualiti pembinaan dan produktiviti oleh penggubal undang-undang Malaysia. IBS mengurangkan risiko yang berkaitan dengan keselamatan dan kesihatan pekerja, dan boleh mengurangkan masalah isu-isu tenaga pekerja mahir dan kebergantungan kepada pekerja asing. Walaupun diakui faedah-faedah penggunaan IBS, industri pembinaan masih berwaspada terhadap kaedah pembinaan baru ini. Dalam tesis ini, satu siri halangan yang menghindari penggunaan pembinaan IBS telah dikenal pasti. Kajian ini melalui kajian literatur, kajian soal selidik, temu bual, dan kajian Delphi telah mengesahkan pelbagai isu di pihak pemaju sektor swasta yang tidak menggunakan sistem IBS. Rantai bekalan dan kaedah perolehan telah dikenal pasti sebagai kekangan utama yang menyebabkan ketidakgunaan IBS. Di samping itu, sistem perolehan adalah faktor utama yang menyumbang kepada kepuasan pelanggan dan kejayaan projek-projek IBS secara keseluruhannya. Satu rangka kerja pelaksanaan bagi strategi perolehan jenis kerjasama telah dibangunkan untuk menangani isu ini. Rangka kerja ini menyetengahkan kaedah perolehan sebagai satu peringkat penting kepada kejayaan projek perumahan swasta IBS. Beberapa kriteria sistem perolehan berjaya diuji di dalam analisis soal selidik. Fragmentasi dalam industri pembinaan juga adalah salah satu isu dan tesis ini menyetengahkan strategi rangka kerja pemerolehan yang memberi kelebihan kepada kerjasama konsortium antara ahli pemain utama projek pada peringkat reka bentuk. Keputusan kajian ini menunjukkan bahawa kerjasama antara jurureka, kontraktor, dan pengeluar IBS di peringkat reka bentuk projek akan meningkatkan lagi kejayaan projek-projek perumahan IBS dan mengurangkan risiko bagi mereka yang berkepentingan dalam pembinaan. Kajian ini menunjukkan bahawa kadar kejayaan yang tinggi IBS boleh diperolehi jika proses perolehan direka bentuk di peringkat awal projek.

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## LIST OF ABBREVIATIONS

REHDA	-	Real Estates and Housing Developers Association Malaysia
BIM	-	Building Information Modeling
CIDB	-	Construction Industry Development Board
HDB	-	Housing and Development Board
NHP	-	National housing policy
PHP	-	People's Housing Programme
APH	-	Affordable Public Housing
CREAM	-	Construction Research Institute of Malaysia
IBS	-	Industrialised Building System
JKR	-	Jabatan Kerja Raya, Public Works Department
KPI	-	Key Performance Indicators
MBAM	-	Master Builders Association Malaysia
OSC	-	One Stop Centre, Local Authority Offices
PPP	-	Public Private Partnership
MHLG	-	Ministry of Housing and Local Government
LO	-	Local Authority
DO	-	Development order
SME	-	Small and medium enterprises
AE	-	Architectural Engineering
PFI	-	Private finance initiative
PMBOK	-	Project management body of knowledge
VFM	-	Value for money
PR	-	Pakatan Rakyat
BN	-	Barisan Nasional
BAIHP	-	Building America Industrialised Housing Partnership
PKNS	-	Perbadanan Kemajuan Negeri Selangor
LRT	-	Lightweight Railway Train

**LIST OF SYMBOLS**

%	-	Percentage
$\alpha$	-	Alpha
$\beta$	-	Beta
>	-	More Than
<	-	Less Than



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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Research background**

Around the world, housing is a major concern, especially for developing countries. Since the welfare of a country's population is reflected in its standard of living, residential and neighborhood satisfaction is an important indicator of housing quality and condition. In political plans, the provision of housing for each country is critical to ensuring social and economic stability as well as promoting national development. (Takim and Akintoye, 2002). In most developing countries, various housing ministries and organisations are largely responsible for housing provision, policy formulation, policy implementation, and strategic management. Some countries rely on the public sector and some countries provide opportunities to the private sector (Keivani and Werna, 2001).

In line with other developing countries, the Malaysian government outlined a housing policy forty years ago to provide affordable housing for all income levels, particularly low-income groups, by providing adequate, reasonably priced, and quality shelter. This housing provision began in Malaysia in 1971 and can be divided into four phases, Housing the Poor (1971-1985), Market Reform (1986-1997), Slum Clearance (1998-2011) and State Affordable Housing (2012-present). The formulation of housing policy and provisions in Malaysia is always based on achieving housing needs for different income level. The government monitors the selling price of low cost housing in Malaysia to ensure the targeted low income

groups have access to housing built by the government or private developers (Shuid, 2016).

Public and private developers and cooperative societies constitute the three parties that are responsible for developing housing projects in Malaysia. Housing development is based on economic plans established by the government through the Five-Year Malaysian Plans. Under the Seventh Malaysia Plan (1996-2000) and Eight Malaysia Plan (2001-2005), the Malaysian government committed to providing adequate, affordable, and quality housing for all Malaysians, particularly low income Malaysians. During the Ninth Malaysia Plan (2006-2010), continuous efforts were undertaken to ensure that Malaysians of all income levels had access to affordable homes, particularly low-income Malaysians. The private sector was encouraged to build low and low-medium-cost housing in their mixed-development projects while the public sector concentrated on building low-cost housing and housing for public sector employees, the disadvantaged, and the poor in urban and rural areas (Noraliah Idrus and HO Chin, 2008).

In Malaysia more than 1.3 million low cost housing units were built by both the private and public sector from 1971 to 2010 to address the housing needs of the poor throughout the country, significantly reducing the number of people living in slums. To address housing need for the growing middle-income group and changing lifestyles, another 1 million affordable housing units are planned to be built from 2016-2020 through state affordable housing programs (Shuid, 2016).

Since construction is the longest and most crucial level in implementing housing plans, the success of the housing projects must be monitored. A housing project is called succeed if it is successfully completed and handed over to the client on time, within budget, without any claims, satisfies clients, and is of appropriate quality (Takim and Akintoye, 2002). There are some barriers towards providing enough successful housing projects.

One of the main issues in housing projects are delivery methods and related problems. A delay in delivering a house to an anxious buyer may mean delaying his

right to basic human needs. While waiting for houses to be completed, buyers may need to make double payments, one for the 'in progress' house and another for a rented house (Naemah *et al.*, 2014). The construction industry is widely criticised for its fragmented approach to project delivery and its failure to form effective teams. Poor performance is attributed to the continued use of procurement practices that do not encourage integration. Proper delivery systems and procurement methods are helpful to fulfilling national targets for housing development (Baiden *et al.*, 2006).

There are several delivery methods common in housing projects such as design and build, turnkey, build-operate-transfer, management contracting, and cost plus contracting. Mainly, two types of delivery systems are practiced in Malaysia, Sell-Then-Build (STB) and Build-Then-Sell (BTS). STB is a more popular concept in many Asian countries such as Hong Kong, Singapore and Taiwan. The literature on STB shows that it has been used in Malaysia for more than four decades (Yusof *et al.*, 2007). Even though STB systems have successfully supplied houses in Malaysia, increasing problems faced by STB house buyers have caused the government to identify solutions and initiate more effective housing delivery systems such as the novel Build-Then-Sell (BTS) approach (Mustafa and Ghazali, 2012). A study by Nuruddin *et al.* (2015) highlighted that key project players are responsible for ensuring that housing delivery systems are efficient and meet user expectations in terms of time, cost and quality. Choosing a sustainable delivery system leads to the success of a housing project.

Along with delivery systems, decisions on construction methods are a significant factor for the success of a housing project. Conventional construction methods currently practiced by the construction industry have been unable to meet the government plans for providing residential buildings. The Malaysian construction industry has taken action to improve construction performance. Industrialised Building Systems (IBS) are an innovative approach introduced by the Malaysian government to improve project delivery performance in housing projects. These methods are practiced by many countries to speed up the construction process (Kadir *et al.*, 2006).

In Singapore, concern for using modern construction methods was stated in the 21st annual report (reinventing construction) on their construction industry. This report found that Singapore lags behind from Australia, Japan and the United States in construction performance. (Dulaimi *et al.*, 2004). IBS construction is an off-site construction process that includes the application of products, techniques, components, logistics, and construction systems with integrated prefabricated components and structural systems. There are several types of IBS including Steel Frame Systems, Timber Frame Systems, Block Work Systems, and Precast Concrete Systems (Kamar *et al.*, 2011).

To promote IBS in the construction industry, the Malaysian government implemented two pilot projects for precast concrete structures in 1966. The first project was a 17-storey flat building named “Tunku Abdul Rahman” located in Kuala Lumpur, consisting of 3000 residential flat houses. The project adopted the Danish System, which uses large prefabricated industrialised walls and floor paneling. The second project was located in Penang and was called the “Rifle Range Road Flats”, comprising 66 shop lots and 3699 residential units along the Rifle Range Road (Majid *et al.*, 2011).

Despite the many advantages of IBS, it is still a high-risk investment for manufacturers due to need for large amounts of capital for precast plant set up costs and erratic construction demand (Abdul Kadir *et al.*, 2006). A survey in 2003 on the IBS Roadmap 2003-2010 (Anuar *et al.*, 2012) indicated that approximately 15% of overall construction projects in Malaysia use IBS. However, a study in 2006 published in the IBS Roadmap Review showed that only 10% of completed projects used more than 70% IBS components. Additionally, less than one third of total construction projects used at least one IBS product (Nawi *et al.*, 2013). Despite a huge publicity campaign by the government, this percentage is lower than expected. The expected projection for percentage of completed projects using IBS were 50% in 2006 and 70% in 2008 (Anuar *et al.*, 2012).

Toor and Ogunlana (2008) stated that the key problems faced by many construction projects are frequently caused by insufficient understanding of the

procurement process, discrepancies between construction and design, a lack of resources, numerous variations in orders, communication gaps, cultural differences, different participant interests, poor levels of productivity, and a lack of experts and skillful contractors for IBS systems.

Several researchers identified the importance of procurement factors (Pocock *et al.*, 1997; Walker 1997; Kumaraswamy and Chan, 1999; Walker and Vines, 2000). Dissanayaka and Kumaraswamy (1999) defined procurement as the framework within which construction is brought about, acquired or obtained. Two attributes are used to measure this factor, procurement and tendering. Procurement is the selection of organisations for project design and construction. Tendering is a procedure adopted for the selection of project teams such as the main contractor (Chan *et al.*, 2004).

Criticisms for current procurement methods in housing projects that used IBS revealed that additional power was needed to avoid abandoned projects. A lack of integration was evident in team's inability to deliver mutual benefits to all members. This is achievable by focusing individual teams on their organisational targets. Common project goals and objectives are still viewed from an organisational point of view, rather than from a collection of mutually beneficial perspectives. Combining experts from diverse companies to form new groups is still a challenge on projects due to traditional attitudes (Baiden *et al.*, 2006). Many researchers have argued that competition in the construction industry is no longer between individual organisations, but between their supply chains (Edum- Fotwe *et al.*, 1999).

## **1.2 Problem Statement**

An increasing demand for quality and affordable housing has forced governments to prepare appropriate provisions for fulfilling demands for shelter. The right to adequate housing that is safe, secure, healthy, available, and affordable is enshrined in the UN Habitat Agenda (UN-Habitat, 2001). The Malaysian government created housing policies to provide affordable housing for all income

levels, particularly low-income groups. There are several barriers to the implementation of Malaysian housing provisions.

Inappropriate delivery system selection affects developer performance in housing projects. Without a well-defined and sustainable delivery system, government provisions for providing affordable housing are not easy to achieve. As the immediate aim of developers is to sell their houses, choosing effective delivery systems that include high sales volumes and satisfies customers is of utmost importance.

Procurement methods and supply chain are other constraints towards successful housing projects. The importance of procurement has increased among the main stakeholders in the construction industry and it is necessary for all parties to choose the most suitable procurement methods in the decision making stage. Assessment of several procurement methods such as design and build, and Engineering Procurement Construction (EPC) are needed to change the culture of the construction industry and move it from a traditional adversarial relationship into a cooperative and collaborative relationship. Complexity, uncertainty and time pressure characterise construction projects and show the need for this change (Mohammad Hasanzadeh *et al.*, 2014).

Construction methods are another important issue associated with declining performance. In the Malaysian national plans, Industrialised Building Systems (IBS) were suggested to accelerate the construction process in residential projects. IBS was utilised by the Malaysian construction industry since the 1960's. In other countries, it was recognised by other terms such as Modern Methods of Construction, Off-Site Manufacturing, Off-Site Construction, and Prefabrication. This system generates greater control over human resources and cost, shortens the construction period, increases building quality, and improves occupational health and safety (Blismas *et al.*, 2005; Luo *et al.*, 2008).

Despite the many benefits of using IBS in Malaysia, key players in the construction industry have been hesitant to use IBS. The construction industry is an

old industry with many legacies and less efficient culturally-embedded practices, so the introduction of anything perceived as new or different threatens existing businesses.

CIDB's 2003 annual report on the use of IBS in construction indicated the existence of a large percentage difference between planned and actual IBS use in projects (Anuar *et al.*, 2012). The IBS Mid Term Review in 2007 indicated that approximately 10% of completed projects used IBS in 2006, compared to a forecasted IBS use of 50% in 2006 and 70% in 2008 (Hamid *et al.*, 2008). IBS is often associated with gloomy images due to its unattractive appearance (Rahman and Omar, 2006). IBS is unfamiliar and has deep negative associations in the construction industry due to factors such as:

- IBS is not popular among conventional construction designers due to misunderstandings on how the building components will structurally behave during manufacturing, transportation, assembly, and use.
- A lack of understanding about IBS benefits among architects, client and contractors.
- Slow adoption among contractors toward the use of IBS and an inability to meet the high degree of skills, coordination, logistic and assembly necessary for IBS.
- Lack of proper IBS supply chain vendors and safe markets for investors for IBS manufacturing.

Although IBS is recognised as increasing efficiency, little effort has been taken to boost IBS implementation in Malaysia. A lack of a secure supply of components and safe markets to obtain standardised parts makes contractors and assemblers reluctant to use this method for housing projects.

Based on a study by Nawi *et al.* (2011), the barriers of IBS adoption were categorised into five sections related to construction project stakeholders:



1. Business Model (cost and finance)
2. Skills and knowledge
3. Project delivery and supply chains
4. Perception of clients and professionals
5. Lack of government incentives, directives and promotion.

From a holistic viewpoint, improvements in procurement and delivery methods for housing projects are a practical solution for implementing IBS. Despite many studies in this area, there is lack of applicable procurement implementation strategies for housing projects using IBS construction methods. The focus of this thesis is on housing projects, sustainable delivery systems, and procurement methods for IBS housing projects.

### **1.3 Aim and Objectives**

This study aims to develop a procurement framework as a systematic and generic reference to IBS procurement practices in the construction industry. This study reviews the literature regarding to housing projects in Malaysia, delivery systems, procurement methods, and barriers to implementing IBS in housing projects.

To fulfil this study's goals, the following research objectives are imperative:

1. To review the drivers and barriers to implementing Industrialised Building Systems (IBS) in Malaysia
2. To detect the most vital barrier hindering construction players to use IBS systems
3. To identify the most practical approach to promote the use of IBS housing projects in Malaysia
4. To develop a practical procurement framework for housing projects using IBS systems

5. To examine and validate the effectiveness of the promoted procurement framework with the aid of statistical analytical techniques

In addition, this study makes the following anticipated contributions to assisting IBS implementation in Malaysia.

1. Return Of Investment (ROI) for manufacturer investment
2. Fulfilling client expectations
3. Satisfying end user demands
4. Lowering the risk for contractors in terms of cost and time when using IBS methods
5. Minimising the design changes and uncertainties in housing projects

#### **1.4 Research Question**

The research questions in this study are:

Question 1: What are the main factors hindering various private sector housing developers towards using IBS systems?

Question 2: What are practical solutions to solving the main barriers preventing the implementation of IBS in private sector housing projects in Malaysia?

Question 3: How competitive are the developed procurement methods in private sector housing projects in comparison to current methods, and what are their advantages?

## 1.5 Methodology

There are several methods for data gathering used in this study to fulfill this study's research aim and objectives. Table 1.1 depicts the methodology in detail regarding each objective.

**Table 1.1:** Main steps of the methodology to attain project objectives

Phase	Objective and action	Tool
1	To review the drivers and barriers to implementing Industrialised Building Systems (IBS) in Malaysia	Systematic literature Review
1-1	To verify the identified barrier groups and solicit expert ideas	Critical literature Review
2	To identify the most significant group of barriers which are improveable by academic research	Delphi round 1: Ranking method (Kendal coefficient) using SPSS software
2-2	To verify the identified barrier groups and solicit expert ideas	Delphi round 2: Semi-structured interviews
2-3	To test the generalise the results of the Delphi round 1 and 2	Delphi round 3: questionnaire distribution and hypothesis testing using SPSS
3	To develop the initial procurement framework regarding the primary research and interviews	Brainstorming with construction experts
3-1	Discussion with experts to identify the most effective procurement framework for achieving this study's final version	Expert input - using Porter's 5 forces analysis
4	To validate the workability of the developed framework and compare it with two other common procurement methods	Questionnaire analysis : Using one way Anova to compare 3 different methods/Anova tests to identify strengths and weakness of each method using SPSS

## 1.6 Thesis Structure

This study consists of six chapters, involving a combination of theoretical and empirical studies of IBS project procurement practices as shown in Table 1.2.

**Table 1.2:** The thesis structure

<b>Chapter 1</b>	<b>Introduction</b>
<b>Chapter 2</b>	Literature Review
<b>Chapter 3</b>	Research Methodology
<b>Chapter 4</b>	Results and Analysis
<b>Chapter 5</b>	Findings and discussion
<b>Chapter 6</b>	Conclusion

Chapter 1 consists of an introduction, problem statement, study aim and objectives, research methodology, research scope, and study organisation.

Chapter 2 discusses the necessity of housing and its current position in Malaysia through a literature review. Specific plans from the government such as roadmaps and national plans are elaborated. The use of new construction methods to speed up the construction of housing projects is highlighted. Barriers and drivers to using Industrialised Building Systems (IBS) are listed. Moreover, new approaches to build up IBS with adoption approach from developed countries are reviewed.

Chapter 3 explains the research methodology. It highlights the methods of data collection from the literature review, Delphi methods involving semi-structured interviews and questionnaire surveys. To achieve this study's objectives, several methods of data analysis such as ranking methods, validity, reliability, correlation, regression, and ANOVA were carried out.

Chapter 4 shows the results of the data analysis for all steps of data collection, including a detailed description of the quantitative and qualitative data analysis.

Chapter 5 discusses the findings of each step with regard to the research objectives. Findings from the literature review revealed a list of barriers to implementing IBS in housing projects. From the Delphi study, it is realized that supply chains and procurement methods need to be improved. It was suggested by

experts and a literature review of previous studies that collaborative procurement methods are effective for implementing IBS.

Chapter 6 highlights the conclusion of this study, which are the effectiveness of collaborative procurement and project player engagement in the early stages of a project. Using IBS project managers with sufficient experience in this area is advised.

## **1.7 Scope of Research**

The Malaysian government has put a significant focus on building affordable housing for the people, mainly the low and middle-income levels of society. Despite efforts by the government and public sector, affordable housing projects that are on time, on budget and of sufficient quality have not been attained. Research carried out in this regard found barriers such as a lack of proper delivery systems, procurement methods, supply chains, and construction methods.

Aziam and Ghazali (2012) stated the importance of alternative delivery systems that foster effective housing construction practices. They reviewed two main delivery systems currently in use in Malaysia, which are Sell-Then-Build (STB) and Build-Then-Sell (BTS). STB systems have been successful in meeting the housing needs for all income groups for over 40 years, but this system has intrinsic risks such as the fact that risk is passed on to buyers by the developers in terms of the capital required for uncompleted houses. House-buyers are heavily impacted financially if they borrow from banks to defray progress payments. They need to meet monthly payments and interest for two or three years, which is the minimum period for a project to be completed. In BTS systems, buyers have the opportunity to examine and evaluate the house as the first step towards house purchasing. The house buyers may consider purchasing if the house meets their expectations. Whether it is pure BTS or partial BTS, the risk is not burdensome to house buyers.

Along with delivery systems, a study by Nuruddin *et al.* (2015) stated that government rules and regulations for housing projects need to be revised. The government must be adaptive and flexible policy-wise to housing development and encourage financial institutions to redefine rules and procedures relating to the approval of bridging loans. Any policy review within one country must take into account both specific national economic and political factors and wider forces at work in the global economy. Developers should negotiate and actively interact with policymakers, because the interaction between developers and government is imperative and needs to be pragmatic as well as participatory, especially in terms of policy changes.

The Malaysian construction industry has started programs to speed up construction performance. Industrialised Building Systems (IBS) are an innovative approach introduced by the Malaysian government to enhance project delivery. Industrialised Building Systems (IBS) are a construction method where components are modularly designed, manufactured in a factory with a controlled and monitored environment, and transported and installed on site with a minimal workforce. There are several types of IBS; Steel Frame Systems, Timber Frame Systems, Block work Systems, and Precast Concrete Systems (Kamarul *et al.*, 2011)

Despite several merits of using IBS in housing projects, there is a gap between the government plans and actual use of this system in housing projects. Due to a number of constraints, key players in the construction industry are reluctant to plan housing projects using IBS. Laili *et al.* (2013) studied barriers of implementing IBS in housing projects and found that there are several issues in managing IBS construction projects, which lead to delays, poor quality, and cost overruns. Laili categorised these constraints into pre construction, construction, and post construction. A majority of issues were found in the construction phase. There are several studies in this field that accelerate housing projects using IBS. Project management issues, enormous capital costs, insufficient knowledge, component standardisation, transportation, coordination, on-site construction processes, procurement and supply chains, planning and implementation, and a lack of integration were identified as the main barriers to implementing IBS in housing

projects in Malaysia (Izatul *et al.* 2013; Kamar *et al.*, 2012; Pan *et al.*, 2012; Sadafi *et al.*, 2011; Nadim and Goulding, 2010).

Procurement methods are a main concern of stakeholders as they play a significant role in the success of a housing project. Appropriate procurement method should be chosen based on project type. In a study by Molavi and Barral (2016), it was highlighted that procurement methods in prefabricated and modular construction systems differ from conventional methods. They perceived that contractors or suppliers should be involved during the design phase to ensure that fabrication, transportation, storage, and installation occurs in a timely and cohesive manner.

This study covers three main subjects. The areas that will be explored are sustainable delivery systems, procurement methods, and supply chains in IBS housing projects. This study contributes proper procurement strategies for housing projects designed using IBS in Malaysia. Private sector developers in the Malaysian states of Johor and Kuala Lumpur were used as samples in this study.

Regarding suggestions for future research in the literature, improvements in procurement methods were chosen to be the focus of this study. Delphi methods were carried out to choose optimum procurement methods for housing projects using IBS. According to the literature review, Delphi methods are suggested by Chan *et al.* (2001) for construction research to find proper procurement methods. To get a procurement framework for IBS implementation in housing projects in Malaysia, several interviews with government authorities and private sector experts were carried out. Annual reports prepared by the IBS center, the Construction Research Institute of Malaysia (CREAM), and the Construction Industry Development Board Malaysia (CIDB) were chosen as a reliable source of statistics for IBS implementation in Malaysia. To get data from expert's, semi-structured interviews and questionnaires were used as data collection tool. In order to analyse the gathered data, Statistical Package for the Social Sciences (SPSS) version 21 was used to get more accurate results.

## **1.8 Research Significance**

The results of this study are expected to have a significant effect on housing development research. Creating proper strategies for housing project procurement using IBS will fulfil the IBS roadmap for Malaysia so that teamwork and cooperation among construction industry key players will increase and medium and small-sized enterprises can join bigger projects under consortium organisations. IBS can encourage clients to accept collaborative procurement methods that will lower project risk and enhance project productivity. The advantages of this study can affect the national economy, construction industry growth, dependency on unskilled foreign labor, and improve the quality of housing projects.



## REFERENCES

- Abd Rahman, A.B. and Omar, W. (2006). Issues and challenges in the implementation of industrialised building systems in Malaysia. *Proceedings of the 6th Asia-Pacific Structural Engineering and Construction Conference*, (September), pp.C-45 – C-53.
- Abd Shukor, A. S., Mohammad, M. F., Mahbub, R. and Ismail, F. (2011). Supply chain integration in industrialised building system in the Malaysian construction industry. *The Built and Human Environment Review*, 4(1).
- Abdul Kadir Marsono, Masine Md. Tap, N.S.C. and A.M.M. (2006). Simulation Of Industrialised Building System Components Production. *Proceedings of the 6th Asia-Pacific Structural Engineering and Construction Conference (APSEC 2006), Kuala Lumpur, Malaysia*, 87-93(September), pp.87-93.
- Abdul Kadir, M. R., Lee, W. P., Jaafar, M. S., Sapuan, S. M. and Ali. (2006). Construction performance comparison between conventional and industrialised building systems in Malaysia. *Structural Survey*, 24(5), 412-424.
- Abdullah, M. R., and Egbu, C. O. (2009). Industrialised building system in Malaysia: issues for research in a changing financial and property market. In *Proceedings of the BUHU 9th International Post Graduate Research Conference* (Vol. 1, pp. 15-25). University of Salford.
- Abdullah, M.R. and Egbu, C. (2010). Selection Criteria Framework For Choosing Industrialised Building Systems. , (September), pp.1131-1139.
- Abidin, A. R. B. Z. (2007). *Simulation of industrialised building system formation for housing construction* (Doctoral dissertation, Universiti Teknologi Malaysia).
- Adler, M., and Ziglio, E. (1996). Gazing into the oracle: The Delphi method and its application to social policy and public health, Jessica Kingsley Publishers, London.

- Al-Harthy, H., and Salim, A.(2006). The consultancy fee for structural design changes of reinforced concrete buildings in Oman. (*Doctoral dissertation, Universiti Teknologi Malaysia, Faculty of Civil Engineering*).
- Amar, N. Z. M., Ismail, Z. and Sahab, S. S. (2012). Advanced industrialised building system (IBS) initiative model. In *Business, Engineering and Industrial Applications (ISBEIA), 2012 IEEE Symposium on* (pp. 673-677). IEEE.
- Anon (2007) . *CIDB, Implementing IBS Roadmap: Mid-term review of IBS Roadmap 2003-2010, Lumpur, 2007.*, Construction Industry Development Board (CIDB), Kuala.
- Anon (1951). Coefficient alpha and the internal structure of tests. *cronbach.* , 16(3).
- Anon (2006). *Construction Industry Master Plan 2006-2015 (CIMP 2006-2015) (2006)*, Construction Industry Development Board (CIDB) Malaysia, December 2006, Kuala Lumpur.
- Anon (2014). *Irish Department of Public Expenditure and Reform 2014 Progress Report*,
- Anon (2009). National Precast Concrete Association Australia. *National Precaster*, 53.
- Ashworth, A. (1991). *Contractual Procedures in the Construction Industry (2nd ed)*, 2nd ed., Harlow UK: Longman Scientific and Technical Group.
- Aziam Mustafa and Maznah Ghazali.(2012). Issues in housing delivery systems and customer satisfaction. *Elixir Marketing Management*. 48 .pp.9395-9399
- Badir, Y. F., Kadir, M. R. A. and Hashim, A.H. ( 2002). Industrialised building systems construction in Malaysia,. *Journal of Architectural Engineering-ASCE*, 8(1), pp.19–23.
- Baiden, B.K., Price, a. D.F. and Dainty, a. R.J. (2006). The extent of team integration within construction projects. *International Journal of Project Management*, 24, pp.13–23.
- Baiden, B.K. and Price, A.D.F. (2011). The effect of integration on project delivery team effectiveness. *International Journal of Project Management*, 29(2), pp.129–136.
- Belassi, W. and Tukel, O.I. (1996). A new framework for determining critical success/failure factors in projects. *International Journal of Project Management*,, 14(3), pp.141–151.

- Barclay, J. (1994). A comparison between traditional and non-traditional forms of contracting for the procurement of building projects, *B.Sc. thesis, School of Construction Management, Queensland University of Technology*.
- Blismas, N. and Wakefield, R. (2009). Drivers, constraints and the future of offsite manufacture in Australia. *Construction Innovation: Information, Process, Management*, 9(1), pp.72–83.
- Bresnen, M. and Marshall, N. (2000). Partnering in construction: a critical review of issues, problems and dilemmas. *Construction Management and Economics*, 18(2), pp.229–237. Available at:
- Bresnen, M. and Marshall, N. (1998) . Partnering Strategies and Organisational Cultures in the Construction Industry. , 2(September), pp.9–11.
- Cantrell, M. A., and Lupinacci, P. (2007). Methodological issues in online data collection. *Journal of advanced nursing*,, 60(5), pp.544–549.
- Caulley, D.N. (1992) . Writing a critical review of the literature. *La Trobe University: Bundoora*.
- Cavana, R. Y., Delahaye, B. L. and Sekaran, U. (2001). Applied business research: qualitative and quantitative methods. *New York: John Wiley and Sons, Inc*.
- Chan, A.,and Scott, D (2004). Factors affecting the success of a construction project. *Journal of construction engineering and management*. pp.153–155.
- Chan, A. P., Yung, E. H., Lam, P. T., Tam, C. M., and Cheung, S. O. (2001). Application of Delphi method in selection of procurement systems for construction projects. *Construction Management and Economics*, 19(7), 699-718.
- Chan, A.P.C., Chan, D.W.M. and Ho, K.S.K. (2003). An empirical study of the benefits of construction partnering in Hong Kong. *Construction Management and Economics*, 21(5), pp.523–533.
- Chan, D. W. M., and A.Kumaraswamy, M.M. (1997). comparative study of causes of time overruns in Hong Kong construction projects. *International Journal of Project Management*,, 15(1), pp.55–63.
- Chan, D.W. M., and Kumaraswamy, M.M. (1995). Reasons for delay in civil engineering projects: The case of Hong Kong. Hong.,. *Hong Kong Inst. Eng. Trans*, 2(3), pp.1–8.

- Chiang, Y. H., Chan, E. H. W. and Lok, L. K. L. (2006). Prefabrication and barriers to entry—a case study of public housing and institutional buildings in Hong Kong. *Habitat International*, 30(3), 482-499.
- Chung, L. P. and Kadir, A.M. (2007). *Implementation Strategy for Industrialised Building Systems*. PhD thesis, Universiti Teknologi Malaysia (UTM), Johor Bahru.
- CIDB (2007). *IBS Roadmap Review (Final Report) (2007)*
- CIDB (2003). *Industrialised Building System (IBS) Roadmap 2003-2010* Construction Industry Development Board (CIDB),.
- CII (1991). *In Search of partnering Excellence*, Austin, TX: CII Special Publication, Construction Industry Institute.,.
- Class, F. students in the C.E. (2005). *Supply Chain Restructuring Based On Integrated Procurement*, China: Thelink.,.
- Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*, 2nd editio., Erlbaum, Hillsd.
- Cooper, D. R., Schindler, P. S., and jianmin Sun, J. (2006), 2006. Business research methods. *New York: McGraw-hill.*, 9.
- Cunningham, T. (2012). *Does The Public Works Contract for Building Works Designed By The Employer Achieve Value for Money?: An Appraisal*.
- Dainty, A.R.J., Briscoe, G.H., and Millett, S. (2001). Subcontractor perspectives on supply chain alliances. *Construction Management and Economics*, 19, pp.841–848.
- Dammann, S. and Elle, M. (2006). Environmental indicators: establishing a common language for green building. *Building Research and Information.*, 34(4), pp.387–404.
- Datuk, E. and Loi, C. (2012). By Datuk Eddy Chen Lok Loi. EHDA Malaysia.
- Datuk Seri Michael KC Yam. (2014). *The Housing Delivery System in Malaysia Opportunities and Challenges*. Immediate Past President Real Estate and Housing Developers' Association. 11 – 12 September. Munich, Germany
- Davis, L.L. (1992). Instrument review: Getting the most from a panel of experts. . *Applied Nursing Research.*, 5, pp.194–197.
- Din, M., Bahri, N. and Dzulkifly, M. (2012). The adoption of Industrialised Building System (IBS) construction in Malaysia: The history, policies, experiences and lesson learned. *ISARC, issue 1*.

- Dissanayaka, S. M., and Kumaraswamy, M.M. (1999). Evaluation of factors affecting time and cost performance in Hong Kong building projects. *Engineering, Construction and Architectural Management*, 6(3), pp.287–298.
- Dulaimi, M.F., Ling, F.Y.Y. and Ofori, G. (2004). Engines for change in Singapore's construction industry: an industry view of Singapore's Construction 21 report. *Building and Environment*, 39(6), pp.699–711.
- Edum-Fotwe, F.T, Thorpe, A. and McCaffer, R. (1999). Organisational relationships within the construction supply chain , in Bowen,P.A. and Hindle,R.D. (Eds.),. In *Customer Satisfaction-A Focus for Research and Practice in Construction*. Cape Town, pp. 186–194.
- Edum-Fotwe, F.T., Thorpe, A. and McCaffer, R. (2001). Information procurement practices of key actors in construction supply chains,. *European Journal of Purchasing and Supply Management*, 7, pp.155–164.
- Eichert, J., Kazi, A. S. (2007) Vision and Strategy of Manubuild- Open Building Manufacturing (edited by) Kazi, A. S., Hannus, M., Boudjabeur, S., Malone, A. (2007), Open Building Manufacturing – Core Concept and Industrial Requirement', *Manubuild Consortium and VTT Finland Publication*, Finland
- Egan, J. (1998). Rethinking Construction, The Egan Report. *Department of the Environment, Transport and the Regions, London*.
- El-Gohary, N. M., Osman, H., and El-Diraby, T. E. (2006). Stakeholder management for public private partnerships. *International Journal of Project Management*, 24(7), 595-604.
- Elo, S. and Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing*, 62(1), pp.107–115.
- Esa, H. and Nurudin, M. (1998). Policy on Industrialised Building Systems. ... *on Industrialised Construction Systems, Kuala Lumpur*. Evbuomwan, N.F.O., and Anumba, C.J., 1998. An integrated framework for concurrent life-cycle design and construction. *Advances in Engineering Software*, 29, pp.7–19.
- Faizul, N.A. (2006). Supply chain management in IBS industry. *Malaysia International IBS Exhibition (MIIE), Kuala Lumpur, Malaysia*.
- Faul, F., Erdfelder, E., Lang, A. G., and Buchner, A. (2007). G\* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior research methods*, 39(2), pp.175–191.

- Fellows, R. and Liu, A. (2008). *Research Method for Construction*, 3rd ed., Blackwell, Oxford.
- Gibb, A.G.F. and Isack, F. (2001), Client drivers for construction projects: implications for standardization. *Management, Engineering Construction and Architectural*, 8(1), pp.46–58.
- Gann, D.M. (1996). Construction as a manufacturing process. Similarities and differences between industrialised housing and car production in Japan. *Construction Management and Economics*, 14(5), pp.437–450.
- Gibb, A. and Isack, F. (2003). Re-engineering through pre-assembly: client expectations and drivers. *Building Research and Information*, 31(2), pp.146–160.
- Gibb, A.G.F. (2001). Standardization and pre-assembly- distinguishing myth from reality using case study research. *Construction Management and Economics*, 19(3), pp.307–315.
- Greenlaw, C. and Brown-Welty, S. (2009). A comparison of web-based and paper-based survey methods testing assumptions of survey mode and response cost. *Evaluation Review*, 33(5), pp.464–480.
- Grundy, T. (2006). Rethinking and reinventing Michael Porter's five forces model. *Strategic Change*, 15(5), 213-229.
- Hacker, R. (1988). The Delphi technique. *Project Appraisal*, 3(1), pp.55–56.
- Hamid Z A, Kamar K A M, Zain M Z M, Ghani M K, and R.A.H.A. (2008). Industrialised building system (IBS) in Malaysia: The current state and RandD initiatives. *Malaysian Construction Research Journal*, 2(1), pp.1–11.
- Hamid, Z.A. (2011). Industrialised Building System ( IBS ) Construction Supply-Chain Strategies of Malaysian Contractors.
- Hamzah, N. H., Nafi, M. N. A., and Yacob, J. (2010). A Study on the Acceptance of IBS in Construction Industry in Kelantan: Application of Logistic Regression Analysis. pp.297–306.
- Hart, C. (1998). *Doing a literature review: Releasing the social science research imagination*. sage.
- Hassan, A.Q. (1995). Don't burn that bridge. *Journal of Management and Engineering*, 11(6), pp.22–31.

- Hassim, S. and Jaafar, M. (2009). The Contractor Perception Towers Industrialised Building System Risk in Construction Projects in Malaysia. *American Journal of applied sciences*, 5(6), pp.937–942.
- Higgin, J. and Jessop, N. (1965). *Communications in the Building Industry*, London.: Tavistock,.
- Hussein, J. (2007) Industrialised Building Systems: The Challenge and the Way Forward. In Keynote Address at Construction Industry Research Achievement International Conference, Putra World Trade Centre (PWTC). Kuala Lumpur.
- Jaafar, M. and Radzi, N. M. (2012). Building procurement in a developing country: a comparison study between public and private sectors. *International Journal of Procurement Management*, 5(5), 608-626.
- Jaafar, M. and R.N.M. (2013). Level of satisfaction and issues with procurement systems used in the Malaysian public sector. *Australasian Journal of Construction Economics and Building*,, 13(1), pp.50–65.
- Jabar, I. laili, Ismail, F. and Mustafa, A.A. (2013). Issues in Managing Construction Phase of IBS Projects. *Procedia - Social and Behavioral Sciences*, 101, pp.81–89.
- Jacqueline, G. (1999). *The future for precast concrete in low-rise housing*. *Precast Housing Feasibility Study Group, U.K.*,
- Jaillon, L. and Poon, C.S. (2008). Sustainable construction aspects of using prefabrication in dense urban environment: a Hong Kong case study. *Construction Management and Economics*, 26(9), pp.953–966.
- Jaillon, L. and Poon, C.S. (2009). The evolution of prefabricated residential building systems in Hong Kong: A review of the public and the private sector. *Automation in Construction*, 18(3), pp.239–248.
- Jepsen, A. L., and Eskerod, P. (2009). Stakeholder analysis in projects: Challenges in using current guidelines in the real world. *International Journal of Project Management*,, 27(4), pp.335–343.
- Johnson, R.B. and Onwuegbuzie, A.J. (1990). Mixed Methods Research : A Research Paradigm Whose Time Has Come.
- Junid, S.M.S. (1986). Industrialised building system. *Proceedings of a UNESCO/FEISEAP Regional Workshop, UPM Serdang, Malaysia*.

- Kaid, L.L., Emmert, P., and Barker, L. L. (1989). *Measurement of communication behavior*. Longman Publishing Group.
- Kamar, A. M., Hamid, Z. A., Azman, N. A., and Ahamad, M. S. S. (2011). Industrialised Building System(IBS): Revisiting Issues of Definition and Classification. *International journal of emerging sciences*, 1(2), 120-132.
- Kamar, K. A. M., Alshawi, M., and Hamid, Z. (2009). Barriers to industrialised building system (IBS): The case of Malaysia. In *BuHu 9th Int. Postgraduate Research Conf.(IPGRC)* (pp. 471-484). University of Salford, Salford, UK.
- Kamar, K. A. M., Hamid, Z. A., and Alshawi, M. (2010). The critical success factors (CSFs) to the implementation of industrialised building system (IBS) in Malaysia. In *Proceedings: TG57-Special Track, 18th CIB World Building Congress, Rotterdam: CIB*.
- Kamar, K. A. M., Hamid, Z. A., and Ismail, Z. (2010). Modernising the Malaysian Construction Industry Through The Adoption Of Industrialised Building System (IBS).
- Keivani, R. and Werna, E., 2001. Modes of housing provision in developing countries. *Progress in planning*, 55(2), pp.65-118.
- Kelly, J., Male, S., and Graham, D. (2014). *Value management of construction projects.*, John Wiley and Sons.
- Khalfan, M. M. A., McDermott, P. Vrijhoef, R. and Asad, S. (2005). Effect of procurement on the integration of supply chain within construction industry, in Kahkonen, K. and Sexton, M. (Eds.), 13-16 June, 11th CIB Symposium., In *Understanding the Construction Business and Companies in the New Millennium*. Helsinki, Finland, pp. 14–25.
- Krejcie, R. V and Morgan, D.W. (1970). ACTIVITIES. , 38, pp.607–610.
- Kumaraswamy, M. M., and Chan, D.W.M. (1999).Factors facilitating faster construction.”” *Journal of Construction Procedure.*, 5(2), pp.88–98.
- laili Jabar, I., Ismail, F. and Mustafa, A. A. (2013). Issues in managing construction phase of IBS projects. *Procedia-Social and Behavioral Sciences*, 101, 81-89.
- Lam, P.T.I., Wong, F.W.H. and Chan, A.P.C. (2006). Contributions of designers to improving buildability and constructability. *Design Studies*, 27(4), pp.457–479.
- Latham, M. (1994). *Constructing the team: Final report.*, London.: HMSO.



- Lee, C. (2013). Malaysia ' s GE13 : A Tale of Two Manifestos. *Researchers At Singapore's Institute Of Southeast Asian Studies, Singapore*, 24(ISSN 2335-6677).
- Lessing, J. (2006). Industrialised house-building. *Licentiate thesis, Division of Design Methodology, Lund Institute of Technology*.
- Liew, C. and Haron, N.A. (2013). Factors Influencing the Rise of House Price in Klang. *International Journal of Research in Engineering and Technology*, 02(10), pp.261–272.
- Linstone, H. and Turoff, M. (1975). The Delphi Method: Techniques and Applications. *Addison Wesley, Reading, MA*, pp.3–12.
- Liu, A.M.M. and Walker, A. (1998). Evaluation of project outcomes. *Construction Management and Economics*, 16(2), pp.209–219.
- Loader, K. (2007). The challenge of competitive procurement: Value for money versus small business support. *Public Money and Management*, 27(5), pp.307–314.
- Loraine, R.K. (1993). *Partnering in the Public Sector*.
- Love, P.E.D., Skitmore, M. and Earl, G. (1998). Selecting a suitable procurement method for a building project. *Construction Management and Economics*, 16(December 2014), pp.221–233.
- Luo, Y., Riley, D. R., and Horman, M. J. (2005). Lean Principles for Pre-fabrication in Green Design-build (GDB) Projects Paper presented at 13th International Group for Lean Construction Conference: Proceedings; Sydney.
- Mahathir, M. (1991). The way forward: Vision 2020. See [www. Wawasan2020.com/vision/in](http://www.Wawasan2020.com/vision/in).
- Majid, T. A., Azman, M. N. A., Zakaria, S. A. S., Yahya, A. S., Zaini, S. S., Ahamad, M. S. S., and Hanafi, M. H. (2011). Quantitative analysis on the level of IBS acceptance in the Malaysian construction industry. *Journal of Engineering Science and Technology*, 6(2), 179-190.
- Masterman, J.W.E. (2002). *An introduction to Building Procurement Systems*, Spon PR, London.
- Mayer, S., Guinard, D., and Trifa, V. (2012). Searching in a web-based infrastructure for smart things. In Internet of Things (IOT), 2012. *october 2012,3rd International Conference on the IEEE.*, pp.119–126.

- McMurray, A. J., Pace, R. W., and Scott, D. (2004). *Research: a commonsense approach.*, Sydney, Australia: Thomson.
- Meehan, J., Ludbrook, M. N., and Mason, C. J. (2016). Collaborative public procurement: Institutional explanations of legitimised resistance. *Journal of Purchasing and Supply Management*.
- Molavi, J. and Barral, D. L. (2016). A Construction Procurement Method to Achieve Sustainability in Modular Construction. *Procedia Engineering*, 145, pp.1362-1369.
- Murphy, M. K., Black, N. A., Lamping, D. L., McKee, C. M., Sanderson, C. F. B., Askham, J., and Marteau, T. (1998). Consensus development methods and their use in clinical guideline development. *Journal of Health Technology Assessment*, 2(3), 1–88.
- Mustaffa, N.E. and Hashim, M. (1998). Problem Resolution Process To Avoid Disputes in Partnering Projects – the Uk Experience .
- Nagahama, M. (2000). *Japan's prefabricated housing construction industry. A review. GAIN Report.*
- Naouin, S. G., and Langford, D. (1987). Management contracting-the client's view. *Journal of construction engineering and management*, 113(3), 369-384.
- Nawi, M. N. M., Anuar, H. S., and Lee, A. (2013). A Review of IBS Malaysian Current and Future Study. *International Journal of Engineering*, 2(10), pp.2378–2383.
- Nawi, M., Lee, A. and Nor, K. (2011). Barriers to implementation of the industrialised building system (IBS) in Malaysia. *The Built and Human Environment Review*, 4, pp.22–35.
- Nawi, M. N. M., Nifa, F. A. A., Abdullah, S., and Yasin, F. M. (2007). A Preliminary Survey of the Application of Industrialised Building System (IBS) in Kedah and Perlis Malaysian Construction Industry. In *Conference on Sustainable Building South East Asia* (Vol. 5, p. 7)
- Nawi, M. N. M., Lee, A., and Arif, M. (2010). The IBS barriers in the Malaysian construction industry: A study in construction supply chain perspective. In *TG57-Special Track 18th CIB World Building Congress May 2010 Salford, United Kingdom* (p. 77).

- Neala, R., Price, A. and Suer, W. (1993). *Prefabricated modules in construction*, Bourn Press Limited, Bournemouth.
- NEDO (1988). *Faster Building for Commerce*, HMSO, London.
- Norusis, M.J. (1998). *SPSS 8.0 Guide to Data Analysis.*,
- Noraliah Idrus and HO Chin Siong. (2008). *Seminar of Sustainable development and Governance at Department of Civil Engineering, and Architecture, Toyohashi University of Technology.*
- Nuruddin, A. R., Bakar, S. P. S. A., and Jaafar, M. (2015). Unveiling the Challenges Faced By Malaysian Housing Developers through Government Policy Changes. *Journal of Construction in Developing Countries*, 20(2), 37-52
- Onyeizu, E. N., Hassan, A., and Bakar, A. (2011). The Utilisation of Industrialised Building System in Design Innovation in Construction Industry. *Applied Sciences*, 15(2), 205-213
- Oostra, M., Joonson, C. (2007). *Best practices: Lesson Learned on Building Concept* (edited by) Kazi,.
- Osborn, A.F. (1963). *Applied Imagination; Principles and Procedures of Creative Problem-solving: Principles and Procedures of Creative Problem-solving.*, Scribner.
- Pan, W., Gibb, A.G.F. and Dainty, A.R.J. (2007). Perspectives of UK housebuilders on the use of offsite modern methods of construction. *Construction Management and Economics*, 25(2), pp.183–194.
- Pocock, J. B., Liu, L. Y., and Kim, M. K. (1997). Impact of management approach on project interaction and performance. *Journal of construction engineering and management*, 123(4), 411-418.
- Polat, G., Arditi, D., Ballard, G. and Mungen, U. (2006). Economics of on-site vs. off-site fabrication of rebar. *Construction Management and Economics*, 24(11), pp.1185–1198.
- Polit, D.F. and Beck, C.T. (2004). *Nursing research: Principles and methods (7th ed.) Philadelphia: Lippincott, Williams, and Wilkins.*,
- Porter, M.E. (2008). The five competitive forces that shape strategy. *Harvard business review*, 86(1), pp.25–40.
- Potts, K. (1995). *Major construction works: Contractual and financial management.*, Longmans Scientific and Technical.

- Powell, C. (2003). The Delphi technique: Myths and realities. *Journal of advanced nursing*, 41(4), 376–382
- Preston, J., and Van de Velde, D. (2002). Competitive tendering of public transport: theme A. *Transport Reviews*, 22(3).
- Pringle, J., and Huisman, J. (2011). Understanding universities in Ontario, Canada: An industry analysis using Porter's five forces framework. *The Canadian Journal of Higher Education*, 41(3), 36.
- Rashid, K. A. (2002). *Construction Procurement in Malaysia: Processes and Systems: Constraints and Strategies*. Research Centre, International Islamic University Malaysia.
- Rea, L. M. and Parker, R.A. (2005) . *Designing and conducting survey research:a comprehensive guide* (Third ed., United States of America: Jossey-Bass, A Wiley Imprint.
- Reed, M.S. (2008). Stakeholder participation for environmental management: A literature review. *Biological Conservation*,, 141(10), pp.2417–2431.
- Roodhooft, F. and Abbeele, A.V.D. (2006). Public procurement of consulting services: Evidence and comparison with private companies. *International Journal of Public Sector Management*, 19(5), pp.490–512.
- Sazalli S. A. A. H, Greenwood D, Morton D and Agnew B. (2012) Industrialised Building System (IBS) in Malaysian housing: An emerging innovation system explanation In: Smith, S.D (Ed) Procs 28th Annual ARCOM Conference, 3-5 September 2012, Edinburgh, UK, Association of Researchers in Construction Management, 89-98.
- Skitmore, R.M., and Marsden, D.E. (1988). Which procurement system?, Towards a universal procurement selection technique. *Construction Management and Economics*, 6(3), pp.71–89.
- Sogand.M, Mujtaba Hosseinalipour and Mohammadreza Hafezi. (2014). Collaborative procurement in construction projects performance measures, Case Study: Partnering in Iranian construction industry. *Social and Behavioral Sciences*, 119, pp.811– 818
- Songer, A.D. and Molenaar, K.R. (1997). Project characteristics for successful public sector design-build. *Journal of Construction Engineering and Management*, 123(1), pp.34–40.

- Shuid, S. (2016). The housing provision system in Malaysia. *Habitat International*, 54, pp.210-223
- Shukor, A. S. A., Mohammad, M. F., Mahbub, R., and Ismail, F. (2011). Supply chain integration challenges in project procurement in Malaysia: the perspective of IBS manufacturers. In *Proceedings of the 27th annual ARCOM conference, association of researchers in construction management* (pp. 495-504).
- Swierk, E. (2005). Prefabricated residential construction, Project report for ARCH 030.
- Takim, R., and Akintoye, A. (2002). A conceptual model for successful construction project performance. Greenwood, D (Ed.), *18th Annual ARCOM Conference, 2-4 September 2002, University of Northumbria. Association of Researchers in Construction Management*.
- T O'Connor, J. and Dodd, S.C. (2000). Achieving integration on capital projects with enterprise resource planning systems. *Automation in construction*, 9(5), pp.515–524.
- Tam, V.W.Y., Tam, C.M. and Ng, W.C.Y. (2007). On prefabrication implementation for different project types and procurement methods in Hong Kong. *Journal of Engineering, Design and Technology*, 5(1), pp.68–80.
- Thanoon, W. A. M., Peng, L. W., Kadir, M. R. A., Jaafar, M. S., and Salit, M. S. (2003). The Experiences of Malaysia and other countries in industrialised building system. In *Proceeding of International Conference on Industrialised Building Systems, Sep* (pp. 10-11).
- Toor, S.U.R. and Ogunlana, S.O. (2008). Problems causing delays in major construction projects in Thailand. *Construction Management and Economics*, 26(4), pp.395–408.
- Torbica, Z.M and Stroh, R. (2001). Customer satisfaction in home building. *Journal of Construction Engineering and Management*, 127(1), pp.82–86.
- Turner, A. (1990). *Building Procurement*, London: Macmillan Education Ltd.,
- Turoff, M. (1970). The design of a policy Delphi. Technological forecasting and social change, Vol. 2, Elsevier, Orlando, pp.149–171.
- UN Habitat. (2001). National Trend in Housing Production Practices(Nigeria: *United Nations Centre for Human Settlements*. Vol 4, pp.60-69

- Vogt, W.P. (1999). Dictionary of Statistics and Methodology. *Thousand Oaks, Sage, London.*
- Walker, D.H.T. (1995). An investigation into construction time performance. *Construction Management and Economics*, 13(3), pp.263–274.
- Walker, D. H. T., and Vines, M.W. (2000). Australian multi-unit residential project construction time performance factors. *Engineering, Construction and Architectural Management*, 7(3), pp.278–284.
- Warszawski, A. (2003). *Industrialised and Automated Building Systems: A Managerial Approach*, Routledge.
- Waskett, P., Phillipson, M. and Yates, A. (2001). DTI Construction Industry Directorate Project Report : Prepared for : New and Improved Technologies and Techniques Defining the Sustainability of Prefabrication and Modular Process in Construction Approved on behalf of BRE.
- Womack, J. P., Jones, D. T., and Roos, D. (1990). The Machine That Changed the World. , *Rawson Associates, New York.*
- Yates, J.K. (2003) . Master builder project delivery system and designer construction knowledge. *journal of construction engineering management*, 129(6), pp.635–644.
- Young, L.F. (1983). Right-brained decision support systems. *ACM SIGMIS Database*, 14(4), pp.28–36.
- Yunus, R. and Yang, J. (2012). Critical sustainability factors in industrialised building systems. *Construction Innovation: Information, Process, Management*, 12(4), pp.447–463.
- Yusof, N.A. and Mohd Shafei, M.W. (2011). Knowledge creation and sharing in the malaysian housebuilding industry: improving the housing delivery system. In: Al-Shammari, ed. 2011. Knowledge Management in Emerging Economies: Social, Organisational and Cultural Implementation. United States of America: IGI Global. Ch. 8.132.
- Zhang, G.and Z. and P.X.W. (2007). Fuzzy Analytical Hierarchy Process Risk Assessment Approach for Joint Venture Construction Projects in China., *Journal of Construction Engineering and Management*, 33(10), pp.771–779.
- Zhang, X., Skitmore, M. and Peng, Y. (2014). Exploring the challenges to industrialised residential building in China. *Habitat International*, 41, pp.176–184.