DECISION MAKING TOOL FOR INDUSTRIALISED BUILDING SYSTEM ADOPTION THROUGH INTEGRATED LIFE CYCLE COST ANALYSIS

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DEDICATION

This thesis is dedicated to my family, who taught me that the best kind of knowledge to have is that which is learned for its own sake. To my husband who is anchor that holds me in place and because of him I laugh a little harder, cry a little less and smile a lot more .

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ABSTRACT

Industrialised Building System (IBS) as 2nd revolution that took place in early 20th century has contributed to a great shift in sustainable construction. Extensive steps have been taken by the Malaysian Government to encourage IBS usage in Malaysian construction industry through Construction Industry Transformation Programme (CITP) that established in 2016. In CITP, the government targeted to increase IBS usage in private and public sector. However, the major setback of IBS is the high cost in pre-cast material that may affect the overall project cost. At the same time, the negative perception in the high initial cost of the IBS project may lead to the slow adoption of IBS in Malaysian construction industry. Hence, the life cycle costing (LCC) analysis is used as an alternative for reducing the negative perception in IBS project that would contribute to more efficient decision-making in IBS project adoption. However, the current application of Life Cycle Costing is unable to consider the sustainable elements of IBS in cost distribution, Therefore, this study aims to develop a computerised programme application to integrate LCC and IBS cost factor as a tool for economic viability analysis in decision-making. This study was conducted using four stages questionnaires. First is to identify the IBS cost factors, second is to identify the level of knowledge of LCC among construction players, third is to identify LCC cost distribution factor and fourth to identify association of IBS cost factor and LCC cost components. The analysis of each stage was conducted using Confirmatory Factor Analysis (CFA). From the analysis, 5 main components for LCC calculation were evaluated, 17 sub-cost components were also calculated for pre-development cost, 8 sub-cost components for construction cost, 7 sub-components cost for operation cost, 5 sub-cost components for maintenance cost and 4 sub-cost components for disposal cost. It was found that 12 major IBS cost factors that contributed to the IBS project cost. Thus, an architectural framework of IBS-LCC calculator was developed using PHP programming, called COSTIBS. To confirm the accuracy of the factors, User Acceptance Test was applied. The result shows that the COSTIBS is applicable to reduce the negative perception as mentioned above. Thus, it is very helpful to speed up the decision-making process in LCC evaluation in IBS which can enhance the usage of IBS in Malaysian construction industry.

ABSTRAK

Sistem Binaan Berindustri (IBS) revolusi kedua pada awal abad ke-20 telah menyumbang kepada perubahan besar dalam pembinaan lestari. Langkah yang meluas telah diambil oleh Kerajaan Malaysia untuk menggalakkan penggunaan IBS di dalam Malaysia menerusi Program Transformasi Industri Pembinaan (CITP) yang ditubuhkan pada 2016. Di dalam CITP, kerajaan mensasar untuk meningkatkan penggunaan IBS di dalam sector kerajaan dan swasta. Walau bagaimanapun, kekurangan terbesar IBS ialah kos yang tinggi di dalam bahan pra-tuang yang mungkin memberi kesan kepada kos projek. Pada masa yang sama, persepsi negatif di dalam kos yang tinggi bagi projek IBS mungkin membawa kepada adaptasi yang perlahan terhadap projek IBS. Justeru, analisis Kos Kitaran Hayat (LCC) telah digunakan sebagai alternatif untuk mengurangkan persepsi negatif di dalam projek IBS yang akan menyumbang untuk membuat keputusan yang lebih efisien. Oleh itu, kajian ini bertujuan untuk membangunkan sebuah aplikasi pengaturcaraan komputer yang mengintegrasikan LCC dan faktor kos IBS sebagai alat asas untuk analisis kebolehupayaan ekonomi dalam membuat keputusan. Kajian ini dijalankan menggunakan empat peringkat soal selidik. Pertama ialah untuk mengenalpasti faktor kos IBS, kedua ialah untuk mengenalpasti aras pengetahuan LCC di kalangan pemain industri pembinaan, ketiga untuk mengenalpasti faktor pengagihan kos kitaran hayat dan keempat untuk mengenalpasti kaitan di antara faktor kos IBS dan kos agihan LCC. Setiap peringkat dianalisis menggunakan Analisa Faktor Pengesahan (CFA). Daripada keputusan, 5 komponen utama untuk pengiraaan LCC telah dinilaikan, dengan 17 sub-komponen kos juga telah dikira untuk kos Pra-Pembangunan, 8 sub-komponen kos untuk Kos Pembinaan, 7 sub-komponen kos untuk Kos Operasi, 5 sub-komponen kos untuk Kos Penyenggaraan dan 4 sub-komponen kos untuk Kos Pemansuhan. Adalah didapati bahawa 12 faktor kos IBS telah menyumbang untuk kos projek IBS. Dengan itu, rangka kerja arkitektural kalkulator IBS-LCC dibangunkan menggunakan pengaturcaraan PHP dipanggil COSTIBS. Untuk mengesahkan ketepatan faktor-faktor, Ujian Penerimaan Pengguna telah digunapakai. Keputusan menunjukkan bahawa COSTIBS boleh digunapakai untuk mengurangkan persepsi negatif yang telah disebutkan di atas. Dengan itu, ianya amat membantu untuk mempercepatkan proses membuat keputusan untuk penilaian LCC di dalam IBS yang akan meningkatkan penggunaan IBS di dalam industri pembinaan Malaysia.

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LIST OF ABBREVIATIONS

ABM	-	*Akademi Binaan Malaysia*
ANN	-	Artificial Neural Network
ASTM	-	American Society of Testing Materials
AVE	-	Average Variance Extracted
BQSM	-	Board of Quantity Survey Malaysia
CA	-	Cronbach Alpha
CB	-	Covariance Based
CFA	-	Confirmatory Factor Analysis
CIDB	-	Construction Industry Development Malaysia
CIMP	-	Construction Industry Master Plan
CITP	-	Construction Industry Transformation Plan
CQS	-	Consultant Quantity Surveyor
CR	-	Composite Reliability
EAC	-	Equivalence Annual Cost
EFA	-	Exploratory Factor Analysis
FA	-	Factor Analysis
FS	-	Factor Score
FS	-	Feasibility Studies
IBS	-	Industrialised Building System
ICT	-	Information Communication Technology
IT	-	Information Technology
LCC	-	Life Cycle Cost
LCCA	-	Life Cycle Cost Analysis
LV	-	Latent Variables
MC	-	Modular Construction
MMC	-	Modern Method Construction
OLS	-	Ordinary Least Square
OSC	-	Off-Site Construction
PFI	-	Private Finance Initiatives

PLS	-	Partial Least Square
PQS	-	Professional Quantity Surveyor
PWC	-	Present Worth Cost
ROI	-	Return On Investment
SEM	-	Structural Equation Modelling
SME	-	Small Medium Enterprise
SPSS	-	Statistical Package for Social Sciences
UAT	-	User Acceptance Test
UK	-	United Kingdom
VIF	-	Variance Inflation Factor
VM	-	Value Management

LIST OF SYMBOLS

β	-	Path Coefficient
λ	-	Value of Factor Loading
ρ	-	P values
t	-	Two-Tailed Test
ρ	-	Composite Reliability

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Malaysian development industry at present putting genuine regard for utilize innovative development procedure and to move from conventional practice to Industrialized Building System (IBS) development (Kamar et. al., 2010). IBS usage in Malaysia was further highlighted by Peniel et. al. (2017); whereby the Malaysian Government's seriously drive and future standpoint in uprising the mindfulness towards the usage of supportable components in development ventures, IBS is one of the methodologies that had been acquaints as an option with traditional structure technique and produce the new system of diminishing the misuse of materials in development. Due to the introduction of components replacing onsite construction, IBS gives speedier work consummation. Various advantages of IBS incorporate lessening development time, less waste, better quality and profitability and upgrading wellbeing and security, in this way empowering enhancements in cost sparing and work decrease (Blismas et. al., 2008, 2009; A. G. F. Gibb, 1999; Pan et. al., 2008).

The importance of IBS is highlighted under the Strategic Thrust 5: Innovate through R&D to adopt a new construction method in the Construction Industry Master Plan 2006-2015 (CIMP 2006-2015) which has been published as means to chart the future direction of the Malaysian construction industry. Government aspiration continues with the launch of Construction Industry Transformation Programme (CITP 2016-2020) , a national agenda which focusing in synergizing construction industry through 4 main thrust; Quality, Safety & Professionalism, Environmental Sustainability, Productivity and Internationalism. In CITP, IBS is highlighted under Productivity where adoption of new technologies and modern practices coupled with high-skilled, highly paid workforce being the criteria to success. In addition to that, CITP addressed the limitation adoption of modern practices, mechanisation and IBS.

In introducing new technology and methods through IBS, there are vast challenges and barriers feed by its performance of delivery. Amongst the problems addressed are vague definition of IBS and ailing in standard, high initial cost, absence of preparing for plan advisor on approaches to fuse IBS into their structures and powers to upgrade for assembling and get together, prompting delays, issues in real money streams for temporary workers who are granted IBS contracts during acquisition of IBS segments. Additionally, deficiency in project procurement also being highlighted as problems in limiting the emergence of IBS in Malaysia. As highlighted by Shamsuddin et. al (2017) in IBS projects, in common, production cost is the main cost factor considered in selecting the most appropriate construction method. Normally, the cost is set to the minimum, which is not necessarily improving the lifetime performance of the buildings. On the other hand, issues on high import obligations on IBS fabricating gear and establishment apparatus, hindering IBS appropriation for makers and contractual workers to take interest in IBS development (CIDB, 2016).

Despite of offering numerous benefits of IBS, CIDB report 2018 shows a low IBS uptake in the country with the overall IBS adoption stood at a mere 15.3% with 61% and 14% in both the government and private sector projects, respectively. With such low adoption rate, the ability of IBS in reducing foreign workers in the construction industry, which previously set as amongst the main objective of introducing this innovative method apart from other benefits, seems unrealistic.

However, as addressed in CITP, slow adoption of IBS is resulted from lack of data and information driven decision-making in the industry and further discussed by Sharifah Akmam et. al (2017) that IBS adoption decision is complex and influenced by many interconnected ‘aspects’, beyond government incentives, cost, attitudes and skills. Moreover, a more integrative approach that considers all factors is needed to make the IBS adoption decision. The issue is highlighted with concerns on a strong stigma that new technology needs bigger initial investment, lack of awareness on the benefits, insufficient reliable and comprehensive data including price and cost as well as lack of detailed and optimised analyses on data set that could be used to generate robust products and guide decision-making especially in feasibility stage. However, because the intensity of influence of these factors/aspects may differ country to

country, as may the nature of the construction industry, any attempt to develop a strategy or policy to increase IBS adoption or integration needs to be targeted.

Apart from that, the more extensive selection of IBS is additionally urged as a way to defeat natural issues related with regular strategies. CITP recommends improving the economics of IBS adoption through adoption of Life Cycle Costing (LCC) in IBS project development planning; introducing a comprehensive IBS catalogue harmonised with the Building Information Modelling (BIM) design library; improving overall regulatory support; increasing Information and Communication Technology (ICT) adoption and mechanisation in the industry; and innovations in building research. To date, several assessment tools have been develop which focusing on different theme such as BIM, environmental and economic assessment of a building and energy efficiency.

Hence, there is an urgency to provide solutions on a robust decision-making support tools to cater needs of the industry. In addition to that, in recent years, developers, designers, investors and building owners have begun taking an interest to build innovative constructions methods (Dwaikat and Ali, 2016). However, the lack of performing research and studies related to the costs benefits of green buildings make the worth of investment undetermined. Thus, the focus of Life Cycle Cost (LCC) analysis desires to have the best performance of green buildings in the near future (Kehily and Underwood, 2017). Heralova (2014) further highlighted that LCC is effective to be used in design stage and serve as a decision-making tools for further investment decision.

Even though there is guidelines in the preliminary studies of a project to prepare cost economic study particularly Life Cycle Cost (LCC), there is still low reporting analysis of the future cost. The LCC portrayed as the evaluation that gauges all related expenses of responsibility for that include capital costs, budgetary costs, activity costs, development costs, support expenses, and restoration and devastation expenses and rescue costs all through the lifetime of the offices from support to grave (BS ISO 15686-5, 2008, Langdon, 2010, Davis Langdon Management Consulting, 2006). The LCC examination is utilized to recognize among the choices that offer

noteworthy cost reserve funds (Boussabaine et.al., 2006). The results of the investigation are helpful regarding financial perspective that gives the best an incentive for cash. Researchers expressed that thought must be accentuated during the planning of dependable LCC. Mohd Fairullazi and Khairuddin (2013) expressed the vital factor that influence the unwavering quality of LCC are the accessibility, availability, cash and dependability of cost information that utilized as the contributions to the LCC investigation. What is more, further impediment looked by the specialists in Malaysia is the way to receive LCC practice in every development ventures. No standard rule and structure are accessible to be received in LCC investigation to gather and incorporate the cost information (Wan Hassan, et,al. 2014). Urgent endeavours are required to create suitable systems to experience the issues in achieving the dependable cost information and readiness of LCC examination in the Malaysian construction industry. In addition to that, the construction industry has been evolving new trends and techniques for preserving the natural resource and optimising its efficiency. To act as an environmentally friendly industry, it is opening their arms to the latest innovative technologies such as BIM, green IT, green building etc. (Deng and Wu, 2014). However, still, there is a need to develop a better, quick and time-saving decision-making tool.

Hence, in the spirit of Industrial Revolution 4.0 (IR 4.0), the needs of quick and digitalised decision making tools is helpful in cost economic analysis of any construction project. this research is essential and firmly suitable to demonstrates the best possible cost determination utilizing life cycle costing approach in evaluating IBS component in development venture. Since the green buildings generally and IBS have been on the floor for past many decades now, there is a vital way to improve that system with scientific data and automated systems based on the intent of things (Pitt *et al*., 2009). This enhanced approach will uplift more of the investors‟ interest to invest in green buildings. Green building consultants and facilitators or green managers usually use manual methods to produce the rating index and building life cycle assessment, which increases the construction costs and decreases the interest of investors in green building development.

1.2 Problem Statement and Research Gap

As a dynamic and unique industry, construction industry is constantly being improved in its methods, materials, mechanical and electrical and Information Technology system, business processes, procurement methods and management techniques. Since building frameworks are perplexing and incorporate a vastly different sort of parts, the capacity of the frameworks to ceaselessly perform their obliged capacities is of essential (Hunter et. al, 2005). Therefore, it is natural to develop an integrated costing method to keep up with other changes. An integrated cost method will able to provide a logical method for accurate determination of a true cost for the project (Mohamed et. al, 2007)

Astoundingly, IBS has innovatively changed the pattern of construction method in the construction industry. The advantages credited to IBS selection are various and all around reported, giving force to its usage in the business. Because of the presentation of segments supplanting nearby development, IBS gives speedier work culmination. Various advantages of IBS incorporate diminishing development time, less waste, better quality and profitability and upgrading wellbeing and security, along these lines empowering enhancements in cost sparing and work decrease (Blismas et al., 2008, 2009; A. G. F. Gibb, 1999; Pan et al., 2008). In IBS, cost and money showed up as one of the difficulties to the IBS supply chains. The situation of framework suppliers/makers requiring high beginning speculation cash-flow to set up their very own assembling plants and to acquire and retrain new innovation and gifted mastery is one of the difficulties to investigate (Zuhairi et. al., 2008). Besides, the troubles in acquiring money and profits for IBS development and forthright instalment to procure IBS segments, just as the difficulties on the dependable instalment component and contracts, prompted the monetary issues turning into the fundamental hindrance for development players to push ahead with IBS development (CREAM, 2009).

In IBS, coordinating maintainable configuration components into activities amid undertaking improvement and configuration stages can minimize building cost. Conversely, if sustainable design elements are considered late in the design process

and designers have to redesign the entire project overall cost can increase significantly. IBS building can be evaluated as financially savvy through the life cycle cost technique, a method for surveying aggregate building expense after some time. It consists of Initial Cost (design and construction), Operating Cost (energy, water/sewage, waste, recycling and other utilities), Maintenance, repair and replacement Cost and other environmental or social costs/benefits (impact on transportation, solid waste, water, energy, infrastructure, worker productivity, outdoor air emissions, etc.) (Shamsuddin et. al, 2015). However, the claim on the initial higher cost for going green and stigma that IBS needs a higher initial cost amongst construction players, give a doubt of escalation in future costing. In addition to that, CIDB in their 2011 report, stated that there is a lack of proper project management techniques, specifically for IBS, and there is no specific cost control mechanism adopted by contractors in IBS and there is no comprehensive cost analysis or economic performance measure that specifically tailored for IBS economic decision-making tools available in the industry to help catapulting the usage of IBS in Malaysia. Therefore, there is an urgent need to establish a simpler, user friendly tools for estimating IBS project in Malaysia.

On top of that, in IBS, cost and money showed up as one of the difficulties to the IBS supply chains. The situation of framework suppliers/makers requiring high beginning speculation cash-flow to set up their very own assembling plants and to acquire and retrain new innovation and gifted mastery is one of the difficulties to investigate (Zuhairi et. al., 2008). Besides, the troubles in acquiring money and profits for IBS development and forthright instalment to procure IBS segments, just as the difficulties on the dependable instalment component and contracts, prompted the monetary issues turning into the fundamental hindrance for development players to push ahead with IBS development (CREAM, 2009). As discussed by Shamsuddin and Zakaria (2016), they featured that the principle block in advancing manageable in IBS was the disgrace of mind-boggling expense for any pre-thrown material explicitly, by and large expense of improvement for the most part. As described by Olubodun et. al. (2010) cited by Shamsuddin & Zakaria (2016) suggested that the industry needs to respond to the greater demand of social, economic and environmental improvements of the industry, the price or cost to adhere such project, somehow is a burden to the

contractor. In the case of IBS construction, the claim on the initial higher cost for going green and stigma that IBS needs a higher initial cost amongst construction players, give a doubt of escalation in future costing. CIDB in their 2011 report, stated that there is a lack of proper project management techniques, specifically for IBS, and there is no specific cost control mechanism adopted by contractors in IBS and there is no comprehensive cost analysis or economic performance measure that specifically tailored for IBS economic decision-making tools available in the industry to help catapulting the usage of IBS in Malaysia.

Therefore, IBS indeed need a simpler ICT approach to increase the usage of it. Due to that, the government intends to make the adoption of IBS in construction projects compulsory in 2018 after discussion with various stakeholders of the construction industry, and unanimously committed to greater adoption of IBS going forward. Furthermore, in IBS, coordinating maintainable configuration components into activities amid undertaking improvement and configuration stages can minimize the building cost (S. M. Shamsuddin et. al., 2015). IBS can be evaluated as financially savvy through the life cycle cost analysis if, the use of it started as early as at design planning stage.

With that, LCC which provides a holistic approach of the life cycle and less focuses are being paid attention on the life cycle of an IBS project. Though, several other tools are also available such as NPV, FV, and Cost-Benefit Analysis for certain period of time which does not cover the life cycle. LCC is a technique to create a total cost of ownership includes all stages of construction of each project. Thus the results of LCC analysis may be used to assist management in decision-making process for choosing the best option for the construction to be done (Bakis et al, 2003). While Bakis et. al (2003) also highlighted that regardless of its importance, LCC has found limited application so far and as suggested by Shamsuddin & Zakaria (2016) to diminish the strong stigma of initial cost of IBS is always on a high note, better understanding and simpler approach of LCC can perhaps slowly reducing the negative perception on the cost of IBS.

Hence, the usage of LCC can be seen as tool that can helps portraying the cost incur for the particular project for its whole building life cycle. To be in line with government's intention to incorporate digitalization in construction to increase productivity and profitability, a digital LCC is perhaps the best way to translating the usage of digitalization in construction industry generally, for IBS project specifically.

Currently, Santos et. al (2019) develop an assessment tools focusing on the environmental and economic impact of the construction, which integrates the building information modelling (BIM) technology with the life cycle assessment (LCA) and life cycle costing (LCC) methodologies for the environmental and eco- nomic assessment of buildings, called BIM-based Environmental and Economic Life Cycle Assessment (BIMEELCA). Recent articles that explored focused mostly on the construction solutions (i.e. elements), on a cradle-to-gate approach and on the environmental impacts quantification (Bueno et al., 2018; Crippa et al., 2018; Rock et al., 2018). Other than BIMEELCA, Harvard Green Life Cycle Costing calculator is developed by Harvard University to help Harvard decision makers in considering all present and future costs related to new construction, renovation, equipment replacement or any other project that involves upfront and ongoing expenditures. However, this tool created with the integration of energy efficiency elements to meet the requirement of green building certifications. In addition to that, World Class Manufacturing (WCM) calculator which calculate the LCC using but not specifically used for construction project and LCC Soft a software developed in Malaysia which focusing on generating alternatives of investment for building project. with no cost control weightage. All these calculator developed, has some deficiencies such as too complicated, not comprehensive and need to be subscribed to use.

Hence, there is a need to conduct further research that concern on a simpler, user friendly decision-making support tools using LCC to diminish or at least reduce negative stigma on IBS cost generally and LCC. This innovative tool moderates and stablishes the indicator of worthy on the IBS cost factors as cost control weightage with LCC cost distribution. If an automation tool is available to clear up their mindset for the long term viability of innovative construction, then the construction industry can be directed towards the well-being of environment, economy, and society. The

development of a computerised integrated IBS and life cycle cost analysis calculator will help investors in their decision making to calculate their initial cost, future cost, with cost control weightage distribution. This will also lead to getting a comprehensive, transparent, efficient and in a quick time outcome that increases their interest to proceed with IBS project in Malaysia and all over the world globally.

With that, there are gaps to fill through the emergence and development of the IBS and life cycle, costing into one model. The integrated tool will give an efficient, easy, quick and better decision-making platform for the score, level of certification and cost control weightage distribution. It will cut the project/green managers preliminary work, which effects on the reduction of building planning timeline and cost. This research develops the new trend and technique of automation IBS project investment in compliance with life cycle cost analysis. This proposed automated tool will help investors in their decision making to calculate their initial cost, future cost and the cost control weightage distribution in systematic automation. Such type of resilient green technology potentially can build human on moving faster, robust, and transparent in decision making.

The arising questions that initiate from the identification gap are:

i. What are the cost factors that influenced the IBS project cost?

ii. How LCC tools and calculator can helps in escalating the usage of IBS?

iii. How prepared Malaysian construction players in adopting LCC?

iv. How digitalization of LCC helps to support the decision-making in IBS project undertaking?

1.3 Research Aim

This research aims to develop a decision-making tool for Industrialised Building System adoption through integrated life cycle costing analysis. This research also aims to connect the integrated relationship between life cycle cost distribution and IBS cost factors to help decision-makers in selecting their best construction investment, especially in building project. By applying these manual methods to an automated system helps to enhance the productivity and decision-making system for the construction industry and especially project managers. The emergence of the current sustainable tools calculator such as carbon calculator and LCC calculator which is not integrated for green building assessment will profoundly benefit the green building to uplift and achieve the latest targets set by the Malaysian government. This research will provide ease to the construction project managers, this research develops a tool based on an LCC oriented system that integrates IBS cost factors and calculates the life cycle costing in an efficient, quick and appropriate way for decision making. (Deng & Wu, 2014).

1.4 Research Objectives

To achieve the aim , four objectives have been created to help achieving the aim of this research :

1. To identify IBS cost factors including drivers and hindrances associated with IBS implementation in the construction industry.

2. To analyse factor score and weightage of LCC cost distribution for IBS cost factor.

3. To develop framework of IBS cost calculator relative to LCC cost distribution

4. To computerised programming of IBS cost factor calculator that integrated with LCC analysis

1.5 Scope and Limitation of Research

The scope of this research focuses on the development of decision-making tool for Industrialised Building System adoption through integrated life cycle costing analysis. The two aspects of an integrated approach are IBS Cost Factor and Life Cycle Cost (LCC) analysis will devise a new trend of assessing the IBS cost-effectiveness and worthy of cost in future in the better interest of Malaysian construction industry. However, it can be potentially extended used internationally at every scale, nature, and scope of the project. In this era of fast communication and integrated construction, an automated tool for cost assessment is highly demanded to promote IBS and LCC with cost-effectiveness and its virtue to aid in decision making context.

This study was undertaken to develop an optimize decision making support tool not only the decision-making level in IBS related investors but also attracts new investors to the development project using IBS. Life cycle costing has been significantly important in the context of calculating cost control weightage distribution for the investors and developers. There is a potential to develop a new prototype and fill the research gap. Therefore, this study consolidates IBS cost factors and LCC cost distribution into a computerised tool. The research is also limited to assessing cost of the project only without incorporating energy efficiency element in the LCC. However, this does not amplify any effect on the output generated from tool for decision making process.

1.6 Significance of Study

The research findings obtained related to the challenges facing by the stakeholders in adopting IBS and LCC assist in creating a more reliable and realistic

economic assessment considering that economic viability plays an important role in today's construction economics. The greater demand for technological advance method of construction justifies that there is a need for comprehensive yet simpler, user friendly method for economic viability assessment.

By developing the computerised programme, perhaps it serves as a useful tools for the stakeholders during the decision-making process to obtain an insight on what are the real cost of the development and which element need to be emphasized for the consideration of the project execution. It can be a reliable source, significant guide and reference when to make decision about choosing the best method of construction for the project, especially the economic assessment focusing on the economic viability of the project.

1.7 Original Contribution to the Body of Knowledge

The novelty of this study brings an integrated approach of IBS and life cycle cost analysis towards the better solution of cost management and associated cost control weightage distribution-related implications within decision to adopt IBS project. The research study contributes to the body of knowledge by developing new innovative computerised tool of COSTIBS which had not been developed before for the quick, easy and time-saving decision-making process for IBS related project players and investors. This kind of dynamic invention will attract the building investors by benefiting them in determining the initial and future cost of IBS buildings for better building development and post occupancy management

However, this rigorous approach will be commercially available for all the stakeholders of the building industry through their industrial domain. Building investors, builders, contractor, project managers, engineers, designers, and planners will get great benefit out of this viable and easy usable dynamic tool. COSTIBS tool will help to prioritize the Malaysian government's initiatives, plans and strategies to make compulsory of all government's construction project to adopt IBS at 70% from total construction elements become reality. Private sectors can use this tools to assist

them in decision making in considering IBS adoption for their project development. Significantly, this tool will embark a new venture in IBS and construction industry at large.

1.8 Brief research Methodology

This study is carried out in several steps in order to achieve the research objectives. First and foremost is by identifying the problem or issue related to the study. It is followed by the determination of aim, objectives and scope of the study. The exploration of all information including literature review is executed through accessing the published journals, books, articles, previous thesis and other sources in order to get an overview of the study.

The first steps taken in order to develop a computerised programming application for IBS cost estimation calculator using LCC approach is by collecting data using a questionnaire survey. The study also focused on the benefit, hindrances as well as the IBS costing factors. LCC at the same time is focusing on the five costing components named pre-development cost, construction cost, operational/annual running cost and maintenance cost, disposal cost. The selection of respondents is based on cluster sampling which allows the researcher to make selection of respondents based on the geographic region. In this research, the data was collected in the region of Kuala Lumpur, Selangor, Negeri Sembilan and Melaka. The selection of respondents is based on their experience and knowledge towards IBS and LCC. All the information obtained is presented prioritising the significant outcomes, especially in IBS costing factors and LCC potential selected by respondents using Structural Equation Modelling – Partial Least Square (Smart PLS) as a tools for Confirmatory Factor Analysis and as a reduction method. The weightage of cost distribution also was analysed to develop the factor score in the calculation. The initial framework for the web based programming is developed to helps on the later IBS user friendly LCC analysis called COSTIBS.

1.9 Outline of the Thesis

This thesis is divided into five chapters. The five chapters comprise of Introduction (Chapter 1), Literature Review (Chapter 2), Research Methodology (Chapter 3), Analysis and Results (Chapter 4), and lastly is a Conclusion (Chapter 5). A brief summary of each chapter is outlined as follows:

Chapter 1 is the thesis introductory section which is developed to provide direction of this research investigation. This chapter also states the research background, problem statement, research gap and research questions, aim and objectives, scope and limitation, a brief discussion of research methodology, expected findings, significance of the study, and original contribution to the body of knowledge.

Chapter 2 addresses a relevant literature from the current state of knowledge. Areas covered in this chapter consists of explanation with the key terms used in this research such as industrialised building system, benefits and barriers, cost estimation, economic viability and Life Cycle Cost. The literature review also covers the application of web based application which justify the needs of this study in order to see the outcome of economic viability of IBS project. Besides, the literature also discuss the theoretical and conceptual framework which directly lead to the establishment of COST-IBS, where identification of four major steps performing LCC; pre-development cost, construction cost, operation/annual running cost, maintenance cost and disposal cost for IBS project.

Chapter 3 presents the research methodology, including research methods, research process by explaining in details the initial comprehension, data collection and questionnaire development (pilot testing, questionnaire validation, sampling, sampling size, questionnaire analysis and the development of web based application tool). Besides, the research methodology also covers on the focus group discussion method focusing on the LCC development criteria as well as the validation. The last part of the chapter is concerned with the ethical consideration which explains the researcher commitment throughout the research activity.

Chapter 4 reveals the results of the statistical analysis conducted in this research. Besides, findings on the focus group discussion also presented. It consists of the overview of the data collection techniques and description of the samples. The results of the Structural Equation Model (SEM) through Partial Least Square (PLS) and relevant discussions pertaining to the result analysed are presented. This chapter also presents the factor score and weightage score for cost distribution that later used in the development of the web based application with the establishment of COST-IBS.

Chapter 5 developed the conclusion towards the research outcome based on the respective research objectives. This chapter also presents the research limitations and recommendation for future research.

REFERENCES

Abdul Rashid, K., & Ayob, M. F. (2016). *Cost and contract administration in construction; divine perspective*: IIUM Press.

Agency, J. I. C. (2018). *Feasibility Study On High Priority Urban Toll Expressways in Cairo*. Japan: Japan International Cooperation Agency.

Aghimien, D., Aigbavboa,C., Oke, A. & Koloko, N. (2018).Digitalisation in construction industry: costruction professional prespective. in Streamlining information transfer between construction and structural engineering. ISEC Press

Ahmad Baharuddin, A. R., & Wahid, O. (2006, 5-6 September 2006). *Issues and Hindrances In The Implementation of Industrialised Building Systems in Malaysia.* Paper presented at the Asia-Pacific Structural Engineering and Construction Conference (APSEC 2006), Kuala Lumpur, Malaysia.

Ahuja, H. N., & Campbell, W. J. (1988). *Estimating : from concept to completion*. Englewood Cliffs, N.J. : Prentice-Hall.

Aktacir, M. A., Büyükalaca, O., & Yılmaz, T. (2006). Life-cycle cost analysis for constant-air-volume and variable-air-volume air-conditioning systems. *Applied Energy, 83*, 606-627.

Alaghbari, W., Salim, A., Abdul Kadir, M. R. & Asonway, A. (2008) *Factors effecting speed of Industrialised Building System Projects in Malaysia*. Paper presented at 2nd International Conference on Built Environment in Developing Countries, 4th December 2008, Penang, Malaysia

Ali, H. H., & Al Nsairat, S. H. (2009). Developing a green building assessment tool for developing countries - Case of Jordan. *Building and environment, 44*(5), 1053-1064.

Arashpour, M., Wakefield, R., Lee, E. W. M., Chan, R., & Hosseini, M. R. (2016). Analysis of interacting uncertainties in on-site and off-site activities: Implications for hybrid construction. *International Journal of Project Management, 34*(7), 1393-1402.

Arditi, D., & Nawakorawit, M. (1999). Designing buildings for maintenance, designers

perspective. Journal of Architectural Engineering, 5, 107-116.

Arja, M., Sauce, G. & Souyri, B. (2009). External uncertainty factors and LCC: A Case Study. *Building Research & Information, 3*(37), 325-334.

Arpke, A., & Strong, K. (2006). A comparison of life cycle cost analyses for a typical college dormitory using subsidized versus full-cost pricing of water. *Ecological Economics*, 58, 66-78.

Ayob, M. F., & Abdul Rashid, K. (2013). *Strategies to Enhance Quality Data Input Requirements Of Life Cycle Cost (Lcc).* Paper presented at the International Conference of Architecture and Built Environment 2013 (ICABE2013). International Islamic University of Malaysia.

Azlan Shah, A., Syahrul Nizam, K., Raha, S., & Peng, Y. C. (2010). Factors affecting housing maintenance cost in Malaysia. *Journals of Facilities Management, 8*(4), 285-298.

Badir, Y. F., & Razali, A. (1998). Theory of Classification: its Application and Badir-Razali Building System Classification. *Journal of the Institute of Engineering, Malaysia (IEM)*(October 1998).

Baharuddin, M. N., Bahardin, N. F., Zaidi, M. A., Lokman, I., & Mohd Nawi, M. N. (2016). A Barriers and challenging criteria of IBS formwork: A current scenario amongst stakeholders. *Rev. Tec. Ing. Univ. Zulia, 39*(9), 14-21.

Barringer, H. P. (2003). *A life cycle cost summary*. Paper presented at the International Conference of Maintenance Societies, Perth, Western Australia.

Beeston, S. T. (1983). *Statistical Methods for Building price Data*. London: E & F. N. Spon.

Benjamin, R. (2019, 1st April 2019). Create need for skilled labour. *The Star*.

Bian, B (2019, March 2019). Moving forward with sustainable infrastructures. *Construction Beyond 2020*, 8-9

Björnsdóttir, A. R. (2010). Financial Feasibility Assessments: Building and Using Assessment Models for Financial Feasibility Analysis of Investment Projects. (Magister Scientiarum degree in Industrial Engineering), University of Iceland, Reykjavik, Iceland.

Bledsoe, J. D. (1992). *Successful Estimating Methods*: Kingston.

Blismas, N., & Wakefield, R. (2008). *Offsite manufacture in Australia - barriers and opportunities.* Paper presented at the Third International Conference of the Cooperative Research Centre (CRC) for Construction Innovation.

Blismas, N., & Wakefield, R. (2009). Drivers, constraints and the future of offsite manufacture in Australia. *Construction Innovation, 9*(1), 72-83.

Boehm, B., Abts, C., & Chulani, S. (2000). Software development cost estimation approaches - A Survey. *Annals of Software Engineering, 10*(2000).

Born, A. J. (2017). Modular Construction Offers Efficiency and Cost Savings. Retrieved from https://insights.globalspec.com/article/6072/modular-construction-offers-efficiency-and-cost-savings

Boussabaine, A., & Kirkham, R. J. (2006). *Whole life-cycle costing: risk and risk responses.*: John Wiley & Sons.

Bribian, I. Z., Capilla, A. V., & Uson, A. A. (2011). Life cycle assessment of building materials: Comparative analysis of energy and environmental impacts and evaluation of the eco-efficiency improvement. *Building and environment, 46*(2011), 7.

British Standards Institution. (2008). BS ISO 14686-5:2008- Building & constructed assets – Service life planning- Part 5: Life Cycle Cost,. In. London: British Standards Institution.

Brundlant, G. H. (1987). Our Common Future: Report of the World Commission on Environment and Development

Bull, J. W. (1993). *Life Cycle Cost for construction*. Glasgow, Scotland: Blackie Academic and Professional.

Byrne, B., M,. (2013). Structural Equation Modeling With AMOS: Basic Concepts, Applications, and Programming, Second Edition: Routledge.

Cavana, R., Delahaye, B. L., & Sekaran, U. (2001). *Applied Business Research: Qualitative and Quantitative Methods*. Australia: John Wiley & Sond Limited.

Celik, A. N. (2006). Present status of photovoltaic energy in Turkey and life cycle techno-economic analysis of a grid-connected photovoltaic-house. *Renewable and Sustainable Energy Reviews, 10*, 370-387.

Chang, B. K. (2019, March 2019). Digital Transformation of The Construction Industry.*Construction Beyond 2020, 26-27*

Chi, C. (2019). A Beginner's Guide to Data Flow Diagrams. Retrieved from https://blog.hubspot.com/marketing/data-flow-diagram

Chin, W. W. (1998). The partial least squares approach to structural equation modeling. In G. A. Marcoulides (Ed.), Modern methods for business research (Mahwah, NJ: awrence Erlbaum Associates. Carli, R., & S.

Chin, W. W., Peterson, R. A., & Brown, S. P. (2008). Structural Equation Modelling in Marketing : Some Practical Reminders. *Journal of Marketing Theory and Oractice, 16*(4), 288-298.

Chiurugwi, T., Udeaja, C., & Hogg, K. (2010). Exploration of drivers and barriers to Life Cycle Cost (LCC) in construction projects: professional quantity surveyors assessment. Paper presented at the International Conference on Computing in Civil and Building Engineering, Nottingham, United Kingdom.

Choong, P. M., and Sharratt, P.N. (2002). A life-cycle framework to analyse business risk in process industry projects. *Journal of Cleaner Production, 10*(5), 479-493.

Chung, L. P., & Abdul Kadir, M. (2007). *Implementation Strategy for Industrialised Building Systems.* (PhD), Universiti Teknologi Malaysia, Universiti Teknologi Malaysia.

CIDB. (2003a). *CIDB (2003) National IBS Survey 2003*. Kuala Lumpur, Malaysia: CIDB Malaysia.

CIDB. (2003b). Industrialised Building Systems (IBS) Roadmap 2003-2010. Retrieved from Kuala Lumpur:

CIDB. (2007). Construction Industry Master Plan 2006-2015. Kuala Lumpur.

CIDB. (2016). Construction Industry Transformation Programme 2016-2010. Kuala Lumpur.

CIDB. (2009). Industrialised Building System (IBS): Implementation Strategy from R & D Perspective. Kuala Lumpur, Malaysia.

CIDB (2018). Construction Industry Review & Prospect 2018/2019. Kuala Lumpur, Malaysia.

CIDB Singapore (1992). *Raising Singapore's Construction Productivity*. Retrieved from Singapore

Clark, L. A., & Watson, D. (1995). Constructing validity: basic issues in objective scale development. *Psychological Assessment,, 7*(3), 309-319.

Cohen, L., Manion, L., & Morrison, K. (2007). *Research Methods in Education*. USA: Routledge.

Cole, R. J., & Sterner, E. (2000). Reconciling theory and practice of life-cycle costing. *Building Research and Information, 28, 5/6, pp.368-375., 28*(5/6), 368-375.

Colin, G. (1998). Construction as a manufacturing process. . London: E & FN Spon.

CREAM. (2009). 1st CIDB/CREAM IBS Roundtable Workshop (IRW01). Kuala Lumpur.

Creedy, G. (2006). Creedy, Garry D. (2006) Risk factors leading to cost overrun in the delivery of highway construction projects. (PhD), Queensland University of Technology,

Creswell, J. W. (2012). Educational research: planning, conducting and evaluating quantitative and qualitative resarch (4th Ed.). Boston: Pearson Education Inc.

Creswell, J. W., & L., C. V. (2007). *Designing and conducting mixed method research* California: SAGE Publication Inc.

Damodaran, A. (2007). *Return on Capital (ROC), Return on Invested Capital (ROIC) and Return on Equity (ROE)*. Retrieved from http://people.stern.nyu.edu/adamodar/pdfiles/papers/returnmeasures.pdf

DeCoster, J. (1998) *Overview of Factor Analysis*. Retrieved from http://www.stat-help.com

De Troyer, F. (2013). "System Building" or "Industrialised Building": A Review of Approaches and A Vision For The Future.

Dien, J., & Frishkoff, G. A. (2005). Introduction to Principal Components Analysis of Event-Related Potentials in Event Related Potentials: A Methods Handbook. Cambridge, Massachussets, USA: MIT Press.

Ding, G. (2008). Sustainable construction -The role of environment assessment tools. *Journal of Environmental Management, 86*(3).

DiStefano, C. & Mandrilã, D. (2009) Computing factr scores, *Practical Assessment, Research & Evaluation*, 14(20)

Dombaycı, Ö. A., & Gölcü, M. (2009). Daily means ambient temperature predictionusing artificial neural network method: A case study of Turkey. *Renewable Energy, 34*, 1158-1161.

Drury, C. (2008). *Management and cost accounting, 6th Edition*. London, United Kingdom: Cengage Learning.

Dulaimi, M. F., Ling, F. Y. Y., & Ofori, G. (2001). *Building a world class construction industry: motivators and enablers*: Singapore University Press, Singapore.

Economic Planning Unit, E. (2010). *The Malaysia plan (2011-2015)* Putrajaya, Malaysia.

Eldash, K. (2012). *Construction cost management.* Retrieved from https://www.researchgate.net/publication/271909645_Construction_Cost_Management_Course_Note

Evbuomwan, N. F. O., & Anumba, C. J. (1998). An Integrated Framework For Concurrent Life-Cycle Design and Construction *Journl of Advances in Engineering Software, 29*, 2.

Fabrycky W., & B., B. (1991). *Life cycle cost and economic analysis*: Prentice Hall.

Faghininejadfard, A., Mahdiyar, A., Marsono, A. K., Mohandes, S. R., Omrany, H., Tabatabaee, S. & Md Tap, M. (2015). Economic comparison of Industrialised Building System and conventional Building System using Building Information Modelling. *Jurnal Teknolog,* 78(1), 195-207.

Fellows, R., & A., L. (2008). *Research Methods for Construction (3rd Ed.)*. United Kingdom: Wiley-Blackwell Publishing Limited.

Ferry, D. J. O., & Flanagan, R. (1991). *Life Cycle Cost - a radical approacg*. Retrieved from London:

Flanagan, R., & Jewell, C. (2005). *Whole Life Appraisal*. Oxford, United Kingdom: Blackwell Publishing.

Flanagan, R., Norman, G., Meadows, J., & Robinson, G. (1989). *Life Cycle Cost Theory and Practice*. Oxford: BSP Professional Books.

Fornell, C., & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. . *Journal of Marketing Research, 18*(1).

Francis, V. (1998). *Linking Design and Construction*. Paper presented at the Innovation and Structural Engineering Conference, Canberra, Australia.

Fuller, S. (2016). Life-Cycle Cost Analysis (LCCA). Retrieved from https://www.wbdg.org/resources/life-cycle-cost-analysis-lcca

Gane, C. P., & Sarson, T. (1979). *Structured Systems Analysis: Tools and Techniques*: Prentice Hall Professional Technical Reference.

Gibb, A. G. F. (1999). Off-site fabrication: Prefabrication, pre-assembly and modularisation: Whittles Publishing.

Gibb, A. G. F., & Isack, F. (2003). Re-engineering Throgh Pre-Assembly: Client Expectation and Drivers. *Journal of Building Research & Information, 31*(2), 14.

Gibb, A. G. F., & Pendlebury. (2005). Glossary of term Buildoffsite UK. In *Glossary of term Buildoffsite UK*. United Kingdom.

Gilmore, W. J. & Bryla, B. (2007). Beginning PHP and Oracle. Apress

Gluch, P., & Baumann, H. (2004). The Life Cycle Cost (LCC) approach: a conceptual discussion of its usefulness for environmental decision-making. *Building and Environment,, 39*, 571-580.

Goh, K. C., Yap, A. B. K., SEOW, T. W., Masrom, M. A. N., Goh, H. H. & Tey, J. S. (2015). *Strategies in Dealing with Cost Overrun Issues: Perspective of Construction Stakeholders.* Springer, Singapore

Gold, A. H., Malhotra, A., & Segars, A. H. (2001). Knowledge management: an organizational capabilities perspective. *Journal of Management Information Systems, 18*(1), 185-214.

Gomes, V., & Gomes, M. (2005). Exploring sustainable construction: implications from Latin America. *Building Research & Information, 33*(5), 428-440.

Green Building Index Sdn. Bhd. (2009). Green Building Index. Retrieved from http://www.greenbuildingindex.org/green_building_index.htm

Greenhalgh, B. (2013). *Introduction to estimating for construction*. London: Routledge.

Günaydın, H. M., & Dogan, S. Z. (2004). A neural network approach for early cost estimation of structural systems of buildings. *International Journal of Project Management, 22*, 595-602.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate Data Analysis. Seventh Edition.* . Upper Saddle River, New Jersey.: Prentice Hall.

Hair, J. F., Hult, T. M., Ringle, C. M., & Sarstedt, M. (2014). A primer on partial least square structural equation modeling (PLS - SEM). Sage Publications.: Sage Publications.

Hamsa, A. (2010). *Public Private parnership Unit (3P.U)*. Paper presented at the Malaysia's Public Private Partnership Seminar (IIUM), International Islamic University Malaysia (IIUM).

Harvey, G. (1976). Life-cycle costing: a review of the technique. *Management Accounting*(343-347).

Hendrickson, C. (1998). Project Management for Construction - Fundamental Concepts for Owners, Engineers, Architects and Builders. Pittsburgh, USA: Prentice hall.

Henseler, J., & Chin, W. W. (2010). A comparison of approaches for the analysis of interaction effects between latent variables using partial least squares path modeling". *Structural Equation Modeling, 17*(No. 1), 82-109.

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of The Academic of Marketing Science, 43*(1), 115-135.

Hill, M. (2015). *Evolution of dynamic feature usage in PHP*. 22nd Internation Conference on Software Analysis, Evolution and Reengineering. Quebec, Canada.

Hilton, R. W., Maher, M. W. , Selto, F. H. (2003). *Cost Management Strategies foor Business Decisions* (2nd Edition ed.). New York: McGraw-Hill Irwin.

Hoar, D., & Norman, G. (1990). LIfe cycle cost management:Quantity Surveying Technique - new directions. Oxford, United Kingdom.

Hogg, K. (1999). *Value management: A failing opportunity?* . Paper presented at the COBRA 1999. , London.

Hongren, C. T., Forster, G., & Datar, S. M. (2000). *Cost accounting: a mangerial emphasis, 10th Edition*. New York: Prentice-Hall.

Horman, M. J., Riley, D. R., Lapinski, A. R., Korkmaz, S., Pulaski, M. H., & Magent, C. S. (2006). Delivering Green Buildings: Process Improvements for Sustainable Construction. *Journal of Green Building, 1*(1), 17.

Hulland, J. (1999). Use of partial least squares (PLS) in strategic management research: A review of four recent studies. *Strategic Management Journal, 20*, 195-204.

Hunter, K., Subashini, H. and Kelly, J. 2005. A Whole Life Costing Input Tool for Surveyors in UK Local Government, Structural Survey. 23(5): 346-358.

IBS Modular Sdn. Bhd. (2009). Industrialised Building System In Malaysia - Part 1. In (Vol. 2013).

Idrus, D. (2012). *IBS Roadmap - Status Towrds 2015*. Paper presented at the TheInternational Constructional Steel Conference (ICSC) 2012, Kuala Lumpur.

ISO. (2004). ISO/DIS 15686-5 Buildings and constructed assets-service lifeplanning,. In: International Organization for Standardization.

Jaapar, A., & Torrence, J. V. (2006). *Contribution of value management to the Malaysia construction industry: a new insight*. Universiti Bung Hatta, Indonesia and Universiti Teknologi Malaysia.

Jaillon, L., & 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), 9.

Jaillon, L., & Poon, C. S. (2010). Design issues of using prefacrication in Hong Kong building construction. *Construction Management and Economics, 26*(9), 13.

Janz, D., & Sihn, W. (2005). Product Redesign Using Value-Oriented Life Cycle Cost. *Manufacturing Technology, 54*(1), 9-12.

Jiang, R., Zhang, W. J., & Ji, P. Selecting the best alternative based on lifecycle cost distributions of alternatives. . *International Journal Production Economics, 89*, 69-75.

Joshi, A., Kale, S., Chandel, S. & Kal, D. K. (2015) Likert Scale: Explore and Explained, *British Journal of Applied Science and Technology.* 7(4), 396-403

Jung, P. K., Seo, J. W., Lim, J. K., Lee, J. S. & Cho, K. K. (N.D). Value analysis methholodology using probabilistic life cycle cost analysis for public water supply system. Retrieved from https://pdfs.semanticscholar.org/6840/4c70b6f0a659b7bfd88d8f22307be3202c59.pdf

Kamar, K. A. M., Hamid, Z. A., & Alshawi, M. (2010). *The critical success factors (CSFs) to the implementation of Industrialised Building System (IBS) in Malaysia*. Paper presented at the CIB World Congress, Rotterdam, The Netherlands.

Kamarani, M. K. (2002). Reforming Malaysian Construction Technology Towards. Asian Forum 2002. Kuala Lumpur: CIDB Malaysia.

Kamarul Anuar, M. K., Mustafa, A., & Zuhairi, A. H. (2009, 29-30 January 2009). *Barriers To Industrialised Building System (IBS) : The Case of Malaysia.* Paper presented at the BuHu 9th International Postgraduate Research Conference, Salford, United Kingdom.

Kamarul Anuar, M. K., Zuhairi, A. H., Mohamed Khairolden, G., & Ahmad Hazim, R. (2007). Industrialised Building System: Current Shortcomings and The Vital Role of R & D. *Masters Builders, 2nd Quarter*.

Kamarul Anuar, M. K., Zuhairi, A. H., Mohamed Nor Azhari, A., & Mohd Sanusi, S. A. (2011). Industrialised Building Syste (IBS) : revisiting Issues of Definition and Classification. *International Journal of Emerging Sciences, 1*(2), 12.

Kaufman, R. J. (1970). Life Cycle Cost: a decision-making tool for capital equipment acquisition. *Cost and management*(21-28).

Kaya, E. (2009). *Life cycle cost awareness among architects: the case of Turkey,.* Izmir Institute of Technology, Graduate School of Engineering and Sciences

Kelly, J., & Hunter, K. (2009). *Life Cycle Cost sustainable design.* Royal Instuitute of Chartered Surveyors (RICS). United Kingdom.

Khairani, A. (2011). *Construction Economics* (2nd Edition ed.). Malaysia: Pearson malaysia Sdn Bhd.

Khalfan, M. M. A., & McDermott, P. (2006). Innovating for supply chain integration within construction. *Construction Innovation, 2006*(6), 143-157.

Khalil, F. D. A. A., Aziz, F. N. A. A., Hassim, S. & Jaafar, M. S. (2016) A Review on Industrialised Building System Issues in Malaysia, *Matec Web of Conference, 47,* 04019

Kibert, C. J. (2008). *Sustainable Construction*: John Wiley & Sons.

Kim, H. H., Ku, B. C., Kim J. Y., Park, Y. J.& Park, J. Y. (2016) Confirmatory and exploratory factor analysis for validating the phlegm pattern questionnaire for healthy subjects. *Evidence-Based Complementary and Alternative Medicine*, 2016

Kirk, J. S., & Dell 'lsola, J. A. (1995). *Life Cycle Cost for design professionals. 2nd ed.* . United States of America: McGraw-Hill, Inc.

Kishk, M., Al-Hajj, A., Aouad, G., & Pollock, R. (2005). *A practical cost break down structure for effective whole-life costing of built assets,*. Paper presented at the 2nd International SCRI Symposium, University of Salford.

Kishk, M., Al-Hajj, A., Pollock, R., Aouad, G., Bakis, N., & Sun, M. (2003). *Whole lifecosting in construction: a state of the art review*: RICS Foundation.

Kline, R. B. (2011). Principles and practice of structural equation modeling. New York: Gullford Press.

Korpi, E., & Ala-Risku, T. (2008). Life Cycle Cost: a review of published case studies. *Managerial Auditing Journal, 23*(3), 240-261.

Krozer, Y. (2008). Life Cycle Cost for innovations in product chains. *Journal of Cleaner Production, 16*(310-321).

Kumar, R. (2005). *Research Methodology*. London: SAGE Publication.

Kumar, R. (2011). Research Methodology A Step-by-Step Guide for Beginners. 3rd Edition. . New Delhi: Sage.

Kumar Singh, Y. (2006). Fundamental Of Research Methodology And Statistics: New Age International.

Kumaraswamy, M., & Matthews, J. (2000). Improved subcontractor selection employing partnering principles. *Journal of Managament in Engineering, 16*(3), 47-57.

Kwakye, A. A. (1994). *Understanding Tendering and Estimating*: Gower, London.

Langdon, D. (2010). Development of A Promotional Campaign for Life Cycle Cost in Construction Final Report 19 January 2010. Retrieved from United Kingdom:

Lee, D. E., & Melkanoff, M. A. (1993). Issues in product life cycle engineering analysis. *Advances in Design Automation*, 75-86.

Lee Jiang, Zhongfu Li, Long Li & Yunli Gao (2018) Constraints on the promotion of of prefabricated construction in China. *Sustainability* 10(7)

Lei, P. W., & Wu, Q. (2000). Introduction to Structural Equation Modeling: Issues and Practical Considerations. *Educational Measurement: Issues and Practice, 26(3), 33–43, 26*(3), 33-44.

Lessing, J., Stehn, L., & Ekholm, A. (2005). *Industrialised housing: definition and categorization of the concept.* Paper presented at the Prefabrication, Assembly and Open Building, Sydney, Australia.

Lim, P. C. (2006). *Implementation Strategy for IBS* (Masters of Science in Construction Management), Universiti Teknologi Malaysia, Skudai, Johor.

Lou, E. C. W., & Kamarul Anuar, M. K. (2012). Industrialised Building Systems: Strategic Outlook for Manufactures Construction in Malaysia. *Journal of Architechure Engineering, 18*, 5.

Love, P. E. D., Gunasekaran, A., & Li, H. (1998). Concurrent Engineering: A Strategy for Procuring Construction Projects. *International Journal of Project Management, 16*.

Lu, N. (2007). Investigation of The Designers' and Contractors' Perceptions of Offsite Construction Techniques in the United Staes Construction Industry. (Doctor of Education (Career and Technology Education) Doctorate Thesis), Clemson University, USA, Clemson University, USA.

Lutz, J., Lekov, A., Chan, P., Whitehead, C. D., Meyers, S., & McMahon, J. (2006). Life cycle cost analysis of energy efficiency design options for residential furnaces and boilers. *Energy, 31*, 311-329.

MacCallum, R. C., & Austin, J. T. (2000). Applications of structural equation modeling in psychological research. *Annual Review of Psychology,, 51*, 201-226.

Mahmud, Z. (2008). *Handbook of Research Methodology: A Simplified Version*. Shah Alam: University Publication Centre (UPENA) UiTM.

Malaysian Productivity Council, M. (2014). *Productivity Performance of The Construction Sector*. Retrieved from www.mpc.gov.my

Maletta, H.& Aires, B. (2007) Weighting, Spsstools. 12 May 2019, 1-19. Retrieved from http://www.spsstools.net

Mamen, A., & Rupawala, M. (2015). Cost Comparison of Modular Construction with Ordinary Site Construction. *International Journal of Scientific & Engineering Research, 6*(12), 326-328.

Mao, C., Xie, F., Hou, L., Wu, , P., W., J.,, & Wang, X. (2016). Cost analysis for sustainable off- site construction based on a multiple-case study in China. . *Habitat International, 57*, 215-222.

M. L. Marceau , L. Bushi , J. K. Meil , and M. Bowick (2012) *Life Cycle Assessment for Sustainable Design of Precast Concrete Commercial Buildings* in Canada 1st International Specialty Conference on Sustaining Public Infrastructure Edmonton, Alberta

Mardhiah, Z. (2009). *Effectiveness of Industrialised Building System (IBS) Implementation For Malaysian Construction Industry.* (Master thesis), Universiti Teknologi Malaysia, Universiti Teknologi Malaysia Skudai.

Marjuki, M. b. (2006). Computerize building estimating system (Masters Thesis). Universiti Teknologi Malaysia Skudai

McMillan, D. G. (2009). Forward interest rate premium and asymmetric adjustment: Evidence from 16 countries. *International Financial Markets, Institutions andMoney, 19*, 258-273.

Meng, Y. C. (2017). A game changer. *The Star*.

Meredith, J., & Mantel, S. (2002). *Project management: a managerial approach.*: Wiley.

Milad, S., & Narian, G. (2012). The Implementation of Industrialised Building System (IBS) in Iran Construction Companies. *IOSR Journal of Mechanical and Civil Engineering (IOSRJMCE), 1*(3), 6.

Mitchell, R. J. (2001) *Design and analytical of ecological experiments.* Oxford: Oxford University Press

Mohamad, M. F., Baharin, A.S, Musa, M. F. & Yusof, M. R. (2016). The potential applicatiom of IBS modular systemin the construction housing scheme in Malaysia. Procedia-Social and Behavorial Sciences, 222, 75-82

Mohamad Kamar, K. A., Abd Hamid, Z., Ghani, M. K., Abdul Rahim, A. H., Mohd Zain, M. Z., & Ambon, F. (2012). Business strategy of large contractors in adopting Industrialised Building System (IBS) : The Malaysia Case. *Journal of Engineering Science and Technology, 7*(6), 774-784.

Mohamad, M. (2019) Digital IBS will boost government efforts to build affordable housing.

Mohamad, M. I., Zawawi, M., & Nekooie, M. A. (2009). Implementing industrialised building system (IBS) in Malaysia : Acceptance and awareness level, problems and strategies. *Malaysian journal of civil engineering, 21*(2), 219-234.

Mohamed, O., Mohd Nor, F., Abdul Karim, S. B. Kho, M. Y. 2007. The Practice Of Life Cycle Costing (LCC) In The Malaysian Construction Industry-Application During Design Stages Management. Conference Proceeding in Construction and Researchers Association (MICRA) Meetings and Conference. 28-29 August, Shah Alam, Selangor, Malaysia.

Mohd Mazlan, C. M. (2006). *Towards Maintenance Cost Optimisation Through Value Management* Paper presented at the National Seminar of Developinng A Maintenance Culture, Petaing Jaya, Selangor.

Moledina, M. M. G, Goh, W. P., Enegbuma, W. I., Ali, K. N. & Adenuga, K. (2017). *Building Information Modelling Technological Innovations in Industrialised Building Sytems Cost Estimation*. International Conference on Research and Innovation in Information System, Universiti Teknologi Malaysia Skudai

Moles, P., & Terry, N. (1997). *The handbook of International Financial Terms*. Oxford: Oxford University Press.

Muhammad Azani, Y., & Muhamad Nur Safwan, S. (2012). Level of Acceptance Towards Industrialised Building System (IBS) in Malaysia. *International Journal of Sustainable Construction Engineering & Technology, 3*(1), 7.

Mustapa, F. (Producer). (2012, 9 April 2019). General Components of Construction Costs. [Opercourseware notes]

Nadim, W., & Goulding, J. S. (2010). Offsite production in the UK: the way forward? A UK construction industry perspective. *Construction Innovation, 10*(2), 181-202.

Nasibeh, S. (2012). Adaptable Industrial Building System: Construction Industry Perspective. *Journal of Architecture Engineering, 18*(2), 7.

Nawi, M. N. M., Elias, E. M., Hamid, M. S. A., & Yusoff, M. N. (2005). *A Study of IBS Framework Usage in the Malaysian Construction Industry.* Paper presented at the National Seminar on Engineering Support Course, Universiti Teknologi Perlis, Malaysia.

Nawi, M. N. M., Lee, A., & Nor, K. M. (2011). Barriers to Implementation of the Industrialised Building System in Malaysia. *The Built & Human Environment Review, 4*, 13.

Nawi, M. N. M., Nifa, F. A. A., Abdullah, S., & Yasin, F. M. (2007). *A Preliminary Survey of the Appllication of IBS in Kedah and Perlis.* Paper presented at the Conference of Sustainable Building, Malaysia.

Nawi, M. N. M., Nifa, F. A. A., Arif, M., & Haron, A. T. (2009). Collaboration Among Project Participants Towards Sustainable Construction : A Study of IBS in the Malaysian Construction Industry. Paper presented at the 2nd Construction Industyr Research Achievement International Conference (CIRAIC 2009), CIDB, Kuala Lumpur, Malaysia.

Nawi, M. N. M., Nifa, F. A. A., Musa, S., & Sudirman, M. D. (2007). *A Preliminary Survey of the Application of IBS in Malaysian Construction Industry: Barriers To Implement in Kedah and erlis.* Paper presented at the Conference Institut Teknologi Bandung, Bandung, Indonesia.

Neville, B., Malik A. A. , K., & Tayyab, M. (2013). Off-Site Construction of Apartment Buildings. *Journal of Architecture Engineering, 19*(1), 7.

Ng, S. T., & Tang, Z. (2010). Labour intensive construction sub-contractors: their critical success factors *International Journal of Project Management, 28*, 732-740.

Nor Azizah, M. R., & Zainal Abidin, A. (2010). *Integrating Green Building Design to Life Cycle Cost Model : A literature review*. Paper presented at the Post

Graduate Seminar on Engineering, Technology and Social Science, Universiti Tun Hussein Onn Malaysia.

Nor Azmi, A. B. (2008). *Exploring the types of construction cost modelling for IBS projects in Malaysia.* Paper presented at the International Conference on Industrialised, Integrated, Intelligent Construction, London, UK.

Norman, G., & Flanagan, R. (1984). Life Cycle Cost: theory and practice. *Surveyors*.

Ntuen, C. A., & K., m. A. (1987). Applying artificial intelligence to project cost estimating. *Cost Engineering, 29*(5), 4.

Nwokoro, I. & Onukwube, H. (2011) Sustainable or Green Construction in Lagos, Nigeria: Principles, Attributes and Framework. *Sustainable Development* 4(4)

Öberg, M. (2005). *Integrated Life Cycle Design - applied to concrete multi-dwellingbuildings.* . Division of Building Materials, Lund University. Lund University.

Office of Government Commerce. (2007). Whole-Life Cycle Cost and cost management: achieving excellence in construction procurement guide. London: Office of Government Commerce.

Ofori, I., Duodu, P. M. & Bonney, S. O. (2015). Establishing Factors Influencig building maintenance practices: Ghanaian perspective. *Journal of Economic and Sustainable Development, 6(24)*, 184-193.

Ojoko, E. O., Osman, M. H., Rahman, A. B.,Omaw, W. S. & Enegbuma, W. I. (2016). Stakeholders Perception of Project Success Criteria for Industrialised Building System in Nigerian Mass Housing Scheme Development, 2nd International Conference on Science, Engineering and Social Sciences, Universiti Teknologi Malaysia Skudai

Okada, Y., Mann, I., Mukai, T., & Köhler, M. (2008). Extended calculation of polarization and intensity of fractal aggregates based on rigorous method for light scattering simulations with numerical orientation averaging. *Journal of Quantitative Spectroscopy & Radiative Transfer, 109*, 2613-2627.

Olanrewaju, A. L., Khamidi, M. F., Idrus, A., & Shobowale, K. (2010). A comparative analysis of value engineering and Life Cycle Cost techniques: a literature review.

Olubodun, F., Kangwa, J., Oladapo, A., & Thompson, J. (2010). An appraisal of the level of application of Life Cycle Cost within the construction industry in the UK. *Structural Survey, 28*(4), 11.

O'Rourke, N. & Hatcher, L. (2013) A step-by-step approach to using SAS for factor analysis and structural equation modeling, Cary, NC; SAS Press

Pan, W., Gibb, A. G. F., & Dainty, A. R. J. (2008). Leading UK housebuilders' utilization of offsite construction methods. *Building Research & Information, 36*(1), 56-67. doi:10.1080/09613210701204013

Park, J. H., Seo, K. K., Wallace, D., & K.I., L. (2007). Approximate Product Life Cycle Cost Method for the Conceptual Product Design. *Manufacturing Technology, 51*(1), 421-424.

Pasquire, C. L., & Connolly, G. E. (2003). *Design for Manufacture and Assembly.* Paper presented at the 11th Annual Conference of the International Group for Lean Construction, Blacksburg, USA.

Peng, C. S. (1986). *The Scenario of Industrialised Building System in Malaysia.* Paper presented at the UNESCO/FEISEAP Regional Worksyop, Universiti Putra Malaysia, Serdang, Malaysia.

Perera, H. S. C., Nagarur, N., & M.T., T. (1999). Component part standardization: A way to reduce the life-cycle costs of products. . *International Journal of Project Economics, 60-61*, 109-116.

Peurifoy, R., & Oberlender, G. (2012). *Estimating Construction Costs*. United States: McGraw Hill.

Potts, K. (1995). Major Construction Works: Contractual and Financial Management Longmans Scientific and Technical.

Pozin, F. (2017). Improving communication in managing inductrialised building system project: virtual environment. *Malaysian Construction Research, 2*, 1-13.

Puva, Hishamuddin, M. A., Shazliaza, Amin Uddin, H., Aziz, F., & Jibril, D. (2010). Stochastic Life Cycle Cost model of cost effectiveness in facilities management. *Facilities*, 244-254.

Richard, R. B. (2006). Individualisation and industrialisation. *Adaptability in Design and Construction*.

Riduan, Y. (2012). *Decision-making Guidelines For Sustainable Construction of Industrialised Building System.* (Doctor of Philosophy), Queensland University of Technology, faculty of Built Environment and Engineering.

Sakurai, M. (1996). *Integrated Cost Management*. Portland, Oregon, USA: Productivity Press.

Sarantakos, S. (2013). *Socail Research (4th Ed.)*. London: Palgrave Macmillan.

Sarja, A. (1998). State of the art and trends in open industrialisation. In A. Sarja (Ed.), *Open and Industrialised Building* (pp. 1-85). London: E & FN Spon.

Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research Methods for Business Students (5th Ed.)*. London: Pearson Education Limited.

Schade, J. (2007). *Life Cycle Cost Calculation Models for Buildings*. Department of Civil, Mining and Environmental Engineering. Lulea University of Technology, Lulea, Sweden. Lulea University of Technology, Lulea, Sweden.

Schuette, S. D., & Liska, R. D. (1994). *Building construction estimating*. Singapore: McGraw-Hill.

Seeley, I. H. (1996). *Building economics.* London: Palgrave;Macmillan Publishers Limited

Sekaran, U. (2003). Research Methods for Business: A Skill building approach (4th Ed.). USA: John Wiley & Sons.

Shahrul Nizar, S., & Elias, I. (2003, March 2003). Promoting The Usage of Industrialised Building Systems (IBS) and Modular Coordination (MC) in Malaysian Construction Industry. *Board of Engineers Magazine*.

Shaikh, N. (1999). How to select the proper subcontractor. *Hydrocarb Process, 78*(6), 91-96.

Sheen, J. N. (2005). Fuzzy financial profitability analyses of demand side management alternatives from participant perspective. *Information Sciences, 169*, 329-367.

Shook, C. L., Priem, R. L., & McGee, J. E. (2003). enture Creation and the Enterprising Individual: A Review and Synthesis. *Journal of Management Information Systems, 29*(3), 379-399.

Siti Mazzuana, S., Rozana, Z., & Sarajul Fikri, M. (2013, 4-6 September 2013). *Economic Attributes in Industrialised Building System in Malaysia.* Paper presented at the Asiz Pacific International Conference on Environmental-Behaviour Studies, University of Westminster, London, UK.

Smullen, J., & Hand, N. (2005). *A Dictionary of Finance and Banking,* . Oxford University: Oxford University press.

Society of Automative Engineers, S. (1999). Life Cycle Cost : Reliability, Maintainability and Supportability Guidebook, 3rd Edition. Warrendale, USA: SAE International.

Soft, R. (2013). Six Basic Stages of Software Development Life Cycle.

Spangenberg, J. H. (2002). Institutional sustainability indicators: an analysis of the institutions in Agenda 21 and a draft set of indicators for monitoring their effectivity. *Sustainable Development, 10*(2), 103-115.

Spangenberg, J. H. (2002a). Institutional sustainability indicators: an analysis of the institutions in Agenda 21 and a draft set of indicators for monitoring their effectivity. *Sustainable Development, 10*(2), 12.

Sri Velamati (2012). Feasibility, benefits and hindrances of modular construction in high rise development in the united states: a developer's perspective (Masters Thesis). Retrieved from https://core.ac.uk/download/pdf/10128748.pdf

Standford University Land and Buildings (2005). Report on Guideline for Life Cycle Cost Analysis. Retrieved from https://sustainable.stanford.edu/sites/default/files/Guidelines_for_Life_Cycle_Cost_Analysis.pdf

Swaffield, L. M., & McDonald, A. M. (2008). The contractor's use of Life Cycle Cost on PFI projects Engineering. . *Construction and Architectural Management, 15*(2), 132-148.

Sharifah Akmam Syed Zakaria, Thayaparan Gajendran, Martin Skitmore & Graham Brewer (2018) Key Factors Influencing The Decision To Adopt Industrialised Building Systems Technology In The Malaysian Construction Industry: An Inter-Project Perspective, Architectural Engineering And Design Management, 14:1-2, 27-45, Doi: 10.1080/17452007.2017.1298512

Tang, H. (2001). Report of the construction industry review committee. Retrieved from Hong Kong:

Teo, M., & Loosemore, M. (2003). Changing the Environmental Culture of the Construction Industry *Construction Research Congress - Winds of Change: The Integration and Innovationof Construction 120,* 1.

Teo, T. S. H., Srivastava, S. C., & Jiang, L. (2008). Trust and electronic government success: an empirical study. *Journal of Management Information Systems, 25*(3), 99-132.

Thanoon, W. A., Lee, W. P., Mohd Razali, A. K., Mohd Saleh, J., & Mohd Sapuan, S. (2003, 10-11 September 2003). *The Essentil Characteristics of Industrialised Building System.* Paper presented at the International Conference on Industrialised Building Systems, Kuala Lumpur, Malaysia.

Theong, M. C., & Rosli, A. R. (2011). *Industrialised Building System and The Impacts on Malaysian Construction Business Environment*. Paper presented at the 14th South East Asia Survey Congress, Kuala Lumpur, Malaysia.

The Star (2010). IBS to speed up building of public housing. Retrieved from https://www.thestar.com.my/news/community/2010/08/05/ibs-to-speed-up-building-of-public-housing/

Thompson, B. (2004) Exploratory and confirmatory factor analysis: Understanding concepts and applications, Washington D.C, American Pyschological Association Association

Thomsen, A., Schultmann, F. & Kohler, N. (2011). Deconstruction, demolition and deconstruction. *Journal Building Research and Information*, 39 (4), 327-332

Thorbjoern, M. (1992). *Building Economics for Architects*: Van Nostrand Reinhold.

Trikha, D. N. (1999, 19-21 Juy 1999). *Industrialised Building System - Prospects in Malaysia.* Paper presented at the World Engineering Congress, Kuala Lumpur, Malaysia.

Tysseland, B. E. (2007). Life cycle cost based procurement decisions: a case study of Norwegian Defence Procurement projects. *International Journal of Project Management*, 1-10.

Uman, D. M. (1990). Is a standard needed for estimating building design and construction cost. *Cost Engineering, 32*(8), 3.

Vennström, A., Olofsson, T., Fawcett, W., Dikbas, A. and Ergen, E. (2010). Determination and costing of sustainable construction projects: option based decision support. Paper presented at the CIB W078 Conference on Applications of IT in the AEC Industry, Cairo, Egypt, October 2010

Wan Hassan, W. N. H., Zakaria, N., & Ismail, M. A. (2014). The Hindrances of Life Cycle Cost Application of Intelligent Building in Malaysia Construction Industry. . *Journal Design + Built., 7*.

Wan Hassan, W. N. H., Zakaria, N., & M.A., I. (2014). The Hindrances of Life Cycle Cost Application of Intelligent Building in Malaysia Construction Industry. *Journal Design + Build, 7*.

Warszawski , A. (1999). Industrialised and Automated Building Systems: A Managerial Approach. London: E & F.N Spon.

Warszawski, A. (1999). Industrialized and automated building systems - a managerial approach. London: E & FN Spoon.

Watt, A. (2014). *Project Management*. BCampus Open Textbook Project. retrieved from https://opentextbc.ca/projectmanagement/front-matter/about-the-book/

Westland, J. C.(2007) *Confirmatory Analysis With Partial Least Square* textbook retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.117.3014&rep=rep1&type=pdf

White, G. E., & Ostwald, P. F. (1976). The life cycle cost of an item is the sum of all funds expended in support of the item from its conception and fabrication through its operations to the end of its useful life. *Management Acounting, 57*(7), 39-42.

Wilkinson, D., & Birmingham, P. (2003). *Using Research Instruments: A Guide for Researchers*. London: Routledge Falmer.

Wold, H. O. A. (1982). Soft Modeling: The Basic Design and Some Extensions. In: Joreskog, K.G. and Wold, H.O.A., Eds. Systems under Indirect Observations: Part II, . North-Holland, Amsterdam, .

Wong, P. S. P., Tsoi, J. N. Y., & Cheung, S. O. (2004). Identifying obstacles against implementation of supply chain management in construction. *Hong Kong Surveyor, 15*(2), 12-22.

Woodward, D. G. (1997). Life Cycle Cost--theory, information acquisition and application. *International Journal of Project Management, 15*(6), 335-344.

Yang, J., & Lim, S. K. (2008). *Reality Check - The iIdentification of Sustainability Perception and Deliverables for Australian Road Infrastructure Projects.* Paper presented at the 3rd International Conference on Sustainability Engineering and Science, Auckland, New Zealand.

Yitmen, I. (2005). Globalization and Competitive Strategies for Sustainable Construction in a Developing Country: North Cyprus Construction Industry. Paper presented at the 10DBMC Internation Conference on Durability of Building Materials and Components, Lyon, France.

Yoon, K. P. & Hwang, C. L. (1995) *Multiple attribute decision making: an introduction*. SAGE Publication, London

Yunus, R. (2017, September 14). Ajiya engages learning institutions to spur IBS adoption. *The Malaysian Reserve.*

Zuhairi, A. H., & Kamarul Anuar, M. K. (2008). Industrialised Building System (IBS) In Malaysia : The Current State and R & D Initiatives *Malaysian Construction Research, 1*(2), 11.