CRITICAL SUCCESS FACTORS OF IMPLEMENTING INDUSTRIALISED BUILDING SYSTEM

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A project submitted in partial fulfilment of the requirements for the award of Master of Project Management

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DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

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APPROVAL FOR SUBMISSION

I certify that this project report entitled "**THE CRITICAL SUCCESS FACTORS OF IMPLEMENTING IBS**" was prepared by **LIM SHIN SHENG** has met the required standard for submission in partial fulfilment of the requirements for the award of Master of Project Management at Universiti Tunku Abdul Rahman.

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ABSTRACT

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Lim Shin Sheng

Industrialised Building System (IBS) has been recognized as a promising method to enhance overall construction performance in terms of better construction quality and productivity, minimising risks related to occupational safety and health, mitigate dependency on manual foreign labour, as well as reducing construction cost effectively. Whereas the advantages seem advantageous, the idealism behind industrialised construction is far from being feasible and beneficial for the majority of contractors. The situation leaves the contractors with noticeable difficulties in implementation while trying to maintain profits and competitiveness. The latest data from Implementation Coordination Unit (ICU) dictates that 24% of public projects valued above RM 10 million manage to achieved a total IBS score of 70%. Construction Industry Development Board (CIDB) on the other hand, reports that only 14% of private projects achieved the IBS score of 50%. Therefore, the objective of this research is to identify the barriers that contractors have to cope with when implementing IBS in construction projects, and also to determine the critical success factor of implementing IBS in construction projects. Qualitative research method was selected for this research seek insight from the participant's viewpoint; with its distinct institutional and social context intact. The target population for this study are contractors who are experienced in implementing IBS in construction projects. Semi structured interviews were carried out to collect data, and analysed using qualitative content analysis. The findings of this research show the barriers that contractors have to cope with when implementing IBS in projects are insufficient knowledge and skill, supply chain fragmentation, payment mechanism, and the lack of incentive and directives, while the critical success factors are training existing employees, establishing good working collaboration with others, powerful leadership, extensive planning and process coordination, standardisation, design and build, and utilise information technology to improve designing and communication process. The outcome of both objectives is to improve contractor's general readiness towards the implementation of IBS in construction projects.

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LIST OF ABBREVIATIONS

IBS	Industrialised Building System
CIDB	Construction Industry Development Board
KM	Knowledge Management
CPD	Continuous Professional Development
IT	Information Technology
BIM	Building Information Modelling
ICT	Information and Communication Technology
IPD	Integrated Project Delivery
DB	Design and Build
ACA	Accelerated Capital Allowance
ICU	Implementation Coordination Unit
CSF	Critical Success Factors
M&E	Mechanical and Electrical
JIT	Just in Time
SCM	Supply Chain Management
HDB	Housing Development Board

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CHAPTER 1
INTRODUCTION

1.1 Introduction

The term Industrialised Building System (IBS) is applied by the Malaysia's government to embody the implementation of construction industrialisation as well as the application of prefabricated components. IBS is generally described as a construction method, whereby the components are fabricated in a controlled environment, mobilize, position and assemble in to a structure with minimum site work (Rahim & Qureshi, 2018). It includes various type of systems, such as precast concrete system, prefabricated timber structures, innovative mould systems, customised steel structure, and modular block systems (Adnan, Baharuddin, Hassan, Mahat & Kaharuddin, 2019).

There is a need for the construction industry to embrace IBS as it is considered a modern construction method that brings many advantages such as achieving better construction quality & productivity, minimising risks related to occupational health and safety, mitigate dependency on manual foreign labour, as well as reducing construction cost effectively. Additionally, IBS may also offer lower wastage, fewer type of site materials, thereby having a hygienic and tidy environment (Rahim & Qureshi, 2018). Many local scholars have published articles and agreed that IBS is perceived as the future for the industry players, and may make significant breakthrough for the construction industry milestone.

Whereas the advantages are very reasonable, the idealism behind the industrialised construction is far from being feasible and favourable to the majority of contractors. This scenario leaves the contractors with noticeable challenges in implementation while trying to maintain profits and competitiveness (Kamar, Alshawi & Hamid, 2012).

1.2 Importance of the Study

This research regarding Industrialised Building System (IBS) could be used as a guideline for future studies. The identification of barriers of implementing IBS in construction project provides data reference to better understand the barriers that contractor have to cope with if contractors consider to implement IBS in construction projects. Moreover, by determining the critical success factors of implementing IBS in construction projects, the data could provide a guideline to other contractors and assist them to implement IBS more successfully.

1.3 Problem Statement

According to Rahim and Qureshi (2018), the fact that Malaysia lacks local skilled workers and overflow of unskilled foreign workers urges Malaysia to act promptly against this issue. This leads Construction Industry Development Board (CIDB) to devised their first Industrialised building system (IBS) strategic plan and two IBS roadmaps to act against this issue. Ideally, the main goal of the first IBS strategic plan is to mitigate the dependency on foreign workers as well as to reduce remittance that are being transferred by the labours to foreign countries. Since then, all government projects are demanded to comprise at least 70% of IBS components in their project buildings. IBS survey report were conducted every year to reflect on Malaysia's achievement of IBS in the construction usage.

IBS score was promoted by CIDB in order to measure the level of IBS usage in construction projects. The scoring system is introduced as a structured assessment system that can be used to measure IBS usage in a consistent way. In order to align with IBS Roadmap 2003-2010, a number of strategies and aggressive means are devised to promote the implementation of IBS in Malaysia (Hadi, Muhamad & Othman, 2017) Firstly, Budget 2005 announces that it is mandatory for all newly build government building projects to have minimum 50% IBS score. Secondly, private developers are encouraged to achieve a minimum of 50% IBS score in housing projects in order to received levy exemption. Moving on in 2008, the Surat Pekeliling Perbendaharaan Bil. 7, emphasized that government projects must achieve a minimum of 70% IBS score. However, based on the latest data from Implementation Coordination Unit (ICU), only 24% of public projects valued above RM 10 million manage to attained an IBS score of 70%. CIDB on the other hand, reports that only 14% of private projects achieved the IBS score of 50% (Hadi, Muhamad & Othman, 2017).

Despite the idea and advantages of IBS seems plausible, IBS is still not widely implemented in the private sector. Even though the IBS survey report throughout the years stated that implementing IBS is an uprising trend and the benefits are well aware by many contractors, the adoption of IBS system is still relatively low. It was highlighted by many that the supply chain, processes, management behind IBS differs from the traditional method. The knowledge and skill for IBS construction is also very different from the traditional method because it changes from labour intensive to mechanisation based. Moreover, the underdeveloped payment mechanism and contract documents are not fully trusted by the industry stakeholders. Some researchers also pinpoint the lack of incentives and directives is perceived as a barrier by the contractors. Hence, the transformation process from traditional practice to IBS has left the contractors with noticeable challenges while mainlining profit and

competitiveness. Wet, traditional construction method is still perceived as a safer and reliable option to the private contractors (Nawi, Mydin, Nifa, Osman, 2015).

With other countries such as Singapore, Japan, United Kingdom & United States of America embracing IBS rapidly, and are willing to invest significant amounts into their research & development, it is proven that the countries are able to implement the modern construction technology/process/techniques/products into their projects effectively and efficiently (Azman, Ahamad, Majid & Hanafi, 2011). Comparing Malaysia's available technologies with other countries, it can be assumed that Malaysia's IBS achievement is more than just a few huge steps behind these countries. Even though the impact and consequences of ignoring IBS implementation may not be immediate, it is crucial for Malaysia contractors to realize that traditional methods will one day be eliminated, and we should upgrade ourselves before strengths turn into weaknesses and opportunities turn into threats.

An expansive view on the characteristic of IBS is needed. Rethinking the old processes is now vital in order for the industry to move forward. A comprehensive guidance on best practices and success factors is imperative to orchestrate a new construction system. There are consensuses of opinions that IBS is best handled from a holistic approach, where construction, manufacturing and design processes are able to synchronise with each other (Kamar, Hamid & Alshawi, 2013). More effort is needed on collaboration, supply chain partnering, standardisation, rationalisation, repetition, and more effective planning & project management. Contractors must realize IBS construction method should not be perceived as a threat to the conventional method. Both methods should be practice together and improve their process collectively. Nonetheless, there are still Malaysia contractors that are able to remain competitive and profitable while integrate IBS process into their projects. Therefore, this study intends to identify the barriers and critical success factors of implementing IBS in construction projects,

1.4 Research Aim

The aim for this study is improve the general readiness of contractors to adopt the IBS systems.

1.5 Research Objectives

1. To identify the barriers that contractors have to cope with when implementing IBS in their construction projects.
2. To determine the critical success factors of implementing IBS in construction projects.

1.6 Scope and Limitation of the Study

Scope of this research is limited to the barriers and critical success factors of implementing IBS. The targeted group for this research is stakeholders and practitioners from the Industrialised Building System (IBS) construction industry.

1.7 Research Methodology

A literature review was carried out to understand the topic better. The purpose of literature review is to define, compile, evaluate, interpret or organize contents of information from various sources. Completing a literature review is considered as a substantial intellectual achievement in its own right, involving interpretation and synthesis of previous work in such manner that new perception of works is uncovered, and the way is accessible for new research. The reading materials studied for this research are mainly published journal, news article, text books, and other pertinent reading materials.

Semi-structured interview was chosen as a research strategy as it creates casual setting of data collection. Semi structured interview will consist several key questions that help define the areas to be explored, as well as allowing the interviewer or interviewee to deviate in order to pursue an idea or response more detailly. This method allows the researcher to examine each argument detailly and gather deep and complex in terms of viewpoint and human experience which may be difficult to measure using quantitative research method. The flexibility of semi structured interview also allows the discovery and elaboration of information that is vital for the participants that may not have been previously consider as pertinent by the researchers (Gill, Stewart, Treasure & Chadwick, 2008). Qualitative content analysis was carried out to match and compare the potential CSFs that are identified in the literature search with evidences

captured in real construction setting, as it is suitable to use for analyzing human communication in a quantitative, systematic, and intersubjective way. Qualitative content analysis is commonly used to analyze documented information in form of texts, media, which may include films, interview transcripts, newspaper articles, advertisement, or observational protocols (Bhatia, 2018).

1.8 Outline of the Report

The structure of the project is as below:

Chapter 1: Introduction

This chapter of report would be introducing the relevant problems and issues of the project title. The problem statement shows the interest of study, aims and objectives to be research.

Chapter 2: Literature Review

The literature review will be compiled with relevant research journal. It discusses the background of the topic, study on the related topic to helps in formation of the research methodology.

Chapter 3: Research Methodology

This chapter will outline how the research will be carry out. It will explain the method chosen for this research, the sampling size, target population, questionnaire development, and the steps of analysing the data.

Chapter 4: Finings Analysis

Once the data are collected, this chapter will analyse the data based on the method that was described in chapter three. The findings will also be compared to the literature reviews in chapter two.

Chapter 5: Discussions

This chapter will describe the significance of findings. The author will also interpret the findings based on the author's understanding.

Chapter 6: Conclusions and Recommendations

This chapter will include the summary of research, limitations of study, and recommendations for future research.

CHAPTER 2
Literature Review

2.1 Introduction

The literature review will be compiled with relevant research information. The term Industrialised building system (IBS)is commonly used in Malaysia as a technique of construction. Generally speaking, IBS is defined as the construction works carry out in a controlled working space. It can be at-site or off-site as well. In other parts of the world, the concept of IBS is also being widely practiced, and commonly term with different names, such as Modern Method of Construction, Off-Site Construction, Prefabrication Construction and many other names. Another notable characteristic of IBS is, it could be either product or process. The definition captured and discussed in this paper revealed that IBS is not necessarily restricting its scope to the final product which is a system but mainly involves the processes which lead to the production of the system and its construction application. Thus, the answer either IBS is a product, process or system is heavily depending on its context and unit analysis of the observer. In general, a review on IBS definitions classified IBS into two categories; IBS as a method, approach and process and IBS as a product, system and technology.

2.2 Barriers of Implementing IBS

As highlighted earlier, IBS as it is considered a modern construction method that brings many advantages. Even though the idealism seems plausible, and the IBS survey reports throughout the years showing the contractors are aware of the need to overcome barriers when implementing IBS in projects, it is still not making headway as anticipated in the private sector. By transforming form traditional construction; labour intensive method to Industrialised method have lead contractors facing numerous obstacles. In an attempt to explore the poor diffusion of IBS, some researchers have identified a number of barriers that hinder the effective implementation of IBS. Below will elaborate all the barriers.

2.2.1 Insufficient Skill and Knowledge

An IBS projects requires the role of contractor to transform from “builder” to “assembler”, moreover, IBS construction method also demands high construction precision. Studies from Rahman and Omar (2006); Nawi, Lee and Nor (2011); Jusoh, Abidin, Amlus, and Ismail (2014); Abdullah and Egbu (2014); Ariffin, Lynn, Shukery Rahiman, Mahmud and Raslim (2018), imply that most local professionals and contractors are not equipped with sufficient technical knowledge and have very limited experience towards IBS. Moreover, many

local authorities are not proficient with modular co-ordination and standardization concept correlated with IBS design and assembling procedures (Jusoh et al., 2014; Abdullah & Egbu, 2014). This will impede building approval and causes unnecessary delay in the development process. Due to the unfamiliarity with IBS construction projects, local authorities tend to misunderstand IBS building guidelines thereby adding more delays in the approval process (Jusoh et al., 2014). This claim is also supported by Ariffin et al. (2018), as the researchers also validate that most clients or private consultant team lacks knowledge and experience towards IBS design. A typical example for this scenario will be the designer's drawing did not correlate with the structural engineer's drawing. The main contractor will have to redesign the drawings for the mismatch items and solve the mechanical and electrical (M&E) service when works are being carried out at site, thereby affecting the mechanical and electrical engineer's working efficiency. Additionally, findings by Ariffin et al. (2018) reveal that the drawings provided by consultant teams only indicate the IBS components without any detail drawings in order to execute the works.

Rahman and Omar (2006) pointed out that IBS subjects such as precast concrete design are not emphasized and delivered to the undergraduate students in many universities. Subsequently, many junior engineers are then not familiar with precast concrete technology. Rahman and Omar (2006) highlighted that there are cases where IBS building projects were awarded but carried out with many adversities. One of the problems that encountered most is the improper assembly of components such as column-to-base and beam-to-column connections. These problems usually occurs when the construction parties underestimate the importance of accuracy in setting out alignment and levelling of the bases. Precise levelling and alignment of bases are two of the most important aspects for rapid erection of precast concrete components. Hence, it can be said that the lack of scientific information will also discourage the implementation of IBS systems.

Rahman and Omar (2006); Abdullah and Egbu (2014) suggest that subjects such as construction of precast concrete should be embedded as part of the syllabus or offered as elective for graduated studies. The authors also recommend university to consider adding relevant topics or incorporate courses on technology, organisation, construction, and design of IBS, since IBS courses in Malaysia universities are lacking in exposure.

Likewise, IBS worker's skill level and job scope also tend to be more demanding compared to the traditional construction methods. Under IBS construction method, the skillset demand for on-site manual labourers, carpenters, bar benders, concreters are less needed, while skillset demand for machine-oriented skills and assembling skills are much more needed. This

will require companies to restructure their human resources in an organisation. Since Malaysia still lacks skilled workers generally, more specialized and intensive training programmes such as assembling knowledge and system integrating will be highly demanded. However, to achieve this also means to allocate a substantial amount of resources and time to train the site workers (Jusoh et al., 2014). Another reason that many local contractors are reluctant to train foreign workers is because every now and then, government will issue policies to restrict foreign workers from entering Malaysia or held country wide crackdowns on illegal foreign workers thereby forcing them to leave the country. The new batches of foreign workers that arrived later may not possess the essential skill for IBS and had to be retrained (Nawi et al., 2011).

Thus, poor knowledge and skills of industry players, labours that lack of training proves to be a major hurdle to adopt IBS in Malaysia construction industry. Specialized and additional engineering knowledge will be required to design, manufacture and construct a good IBS system. All parties involved from designers to erectors must have sufficient knowledge about IBS programs.

2.2.2 Supply Chain Fragmentation

Supply chain is defined as the network between a company and its suppliers to produce and distribute a specific product to its final buyer. This network may comprise various types of activities, people, entities, information, and resources. Supply chain management is view as a crucial process in many organisations because an optimized supply chain may result in lower costs and faster production cycle (Kenton, 2020). On the other hand, IBS construction supply chain is also similar, as it comprises of planning and managing activities, including logistics, procurement, work arrangement, between the industry stakeholders

One of the most significant characteristic of supply chain is, it is complex, covers many aspects, and there is no commonly-accepted approach or strategy for contractors to manage IBS construction supply chain. On the other hand, studies criticising the fragmented and disconnected industry can be often found in many studies. Research from Latham (1994); Abadi (2005); Nawi, Lee and Nor (2011); Kamar and Hamid (2011); Nawi, Lee, Azman, Kamar (2014); Fauzi, Hasim, and Mustafa (2018) implies that the fragmented and disconnected construction supply chain is one of the consequential causes of low IBS implementation.

2.2.2.1 Designing Process of an IBS project

To understand the reason behind the fragmented practice, Nawi et al. (2014) have tentatively elaborate the current practice of Malaysian IBS design process based on traditional approach. Under traditional approach, all designs and construction process were conducted in a sequential manner throughout the project life cycle.

The process starts with the client brief at the beginning of the project. The client will brief the architect to design a building based on traditional method of construction, such as brick work system or reinforcement concrete. The architect will then produce an architectural design by collecting and analysing information as well as execute the works essential for designing a project. For example, the architect will develop a series of rough plans/schematics in order to show arrangement of rooms and building on site.

In the next stage, all details, information, documentation will be provided for the structural engineers in order to formulate the structural elements. Meanwhile, the same set of information, details will be pass to the Mechanical and Electrical (M&E) engineer in order to produce M&E specifications and drawings. Once structural and M&E designs are completed, the drawing detail and specifications will be handover to quantity surveyor to calculate costings and prepare bill of quantities for the tender and contracting process.

The general practice of selecting main contractor is to base on the most appropriate submission with the lowest construction cost. Once a contractor is being award with the project, all relevant documents will be handover for the awarded contractor to commence construction work. However, the contractor is unable to start work because the given project drawings, documents, specifications, are still being prepared using traditional method of construction. Therefore, the contractor will need to discuss, or propose with IBS manufacturer or consultant in order to modify all traditional construction drawings into IBS standard, then only the construction works can commence.

2.2.2.2 Fragmentation Issue

Prior mentioned, researchers have revealed that the IBS supply chain in Malaysia is disconnected and fragmented. Furthermore, Latham (1994), and Abadi (2005) add on the traditional approach of handling IBS projects also generate fragmentation problems such as segregation of professionals, lacking coordination between industry stakeholders. This traditional approach is known to cause “over the wall” syndrome, which was already recognize by researcher Latham since 1994, and is still a common practice in the construction industry.

Latham (1994) pinpoint that traditional construction process involves industry players that are disengage from one another and work in isolation resulting in low efficiencies. The non-coordination effort between the parties may lead to confusion and has a negative impact on the design process and outcome. Fundamentally, the nature of traditional construction process is carried out in a sequential manner, and is constructed based on the approach by various professionals during design and construction phase. This approach minimizes the interaction between contractor and designer, which often leads to inefficiencies during construction phase, increases project complexity, project cost, construction duration and reworks. The lack in continuity to form effective teams resulted the inefficiency in the project delivery process.

On the other hand, Abadi (2005) defined fragmentation as the phenomenon result from the increasing number of organisation and professions involved in the process of constructing a project, which is caused by the growing demand for project specialisations, differentiation as well as the project size and complexity." Abadi (2005) also pointed out that there are mainly two forms of fragmentation in the construction industry, which are internal fragmentation and external fragmentation. External fragmentation refers to the involvement with non-alliance organisations, such as local authorities; while internal fragmentation refers to the coordination problems between alliance organisations, such as clients, consultants.

According to Kamar and Hamid (2011), the fragmented supply chain practices is developed by poor communications, mistrust, conflicting relationships, and the relationship between parties are driven by cost agenda. Contractors are found to have the practice of organising suppliers and subcontractors in order to search for the lowest short-term costs thereby information and communication flows are obstructed and less transparent.

Studies by Nawi, Lee and Nor (2011) identified that scarcity or delayed supply of IBS information, equipment, materials has been an vital barrier to the successful implementation of an IBS projects. The problem will deteriorate if the distance between IBS manufacturers and contractors are far away. The distance will lead contractors to incur extra logistic expenses in order to get IBS components delivered to site. This situation is also agreed by Fauzi et al. (2018), and recognize this problem as a major hindrance of implementing IBS in Malaysia's construction industry. Fauzi et al. (2018) conduct a research on stakeholder constraints that prevent them for fully implement supply chain management in delivering IBS. The authors summarize the stakeholder's viewpoint into four main points, which are namely less working collaboration, effective communication channel, negative attitude, and lack of knowledge management of supply chain & logistics.

Therefore, there is an urgent need for paradigm shift within the IBS traditional approach. It is suggested that the lifecycle process of IBS construction should involve the adoption of new business model, within the aim of incorporating the functional practices at the beginning stages of project. The ought for further collaboration between project design and project delivery is paramount towards a more successful IBS implementation in Malaysia construction industry. This section concludes that developing relationship and communication process are important requirements in order to implement an integrated approach in design and construction, as it may minimise the fragmentation gap in the current Malaysia construction projects.

2.2.2.3 Underdeveloped Payment Mechanism

The implementation of IBS has been recognized by many as one of the crucial steps to improve Malaysia's construction industry, but the progress of implementing IBS is still slow in the private sector. Despite the government's effort of introducing IBS Roadmap was already long ago in 2003, no specific building guidelines or regulations for procurement systems or contract documents regarding IBS have been brought to light.

An explicit procurement system is required for IBS projects as it comprise procedures which varied from traditional methods. Researchers such as Shukor, Mohammad and Mahbub (2011); Jaafar and Radzi (2013); Jalil, Nuruddin, Mastura, Jaafar and Mydin (2015); Hung, Hamid, Din and Norman (2015); Mohammad, Mahbub, Musa and Yusof (2017); Dzulkalnine, Azman, Bing and Hamid (2017) had revealed that that current procurement methods available were not applicable especially the payment mechanisms. The only feasible reference pr guidelines for IBS project are only related to product-based information. Since there is no detailed procurement method for IBS projects, many problems regarding project delivery system arises thus becoming a barrier for adopting IBS.

As mentioned by Jalil et al. (2015), there are reasons that many Malaysia contractors are unwilling to adopt IBS system, and prefer continuing using traditional construction method, is because the existing procurement and contracting system does not favour both pre-casters and contractors utilizing IBS construction methods. Prior mentioned, Nawi et al. (2014) elaborate the tender process in detail whereby IBS manufacturer and contractors are only involved after the tender stage. Many researchers recommended that IBS manufacturer and contractors should collaborate with each other from the initial design stage to allow integration of IBS designers, engineers, pre-casters and contractors. Consequently, Jalil et al. (2015);

Dzulkalnine et al. (2017) stated that IBS projects in Malaysia are unable to reach cost effectiveness as it precluded the IBS manufacturer from the early-stage designs. Besides, contractors are expected to pay capital cost for IBS manufacturers by utilizing their own money before contractors can claim the work done amount from client.

Findings by Jalil et al. (2015) show majority of IBS manufacturer were very concerned about the payment issues as well. The manufacturers were unease about the contractor's capability and commitment based on current payment mechanisms. Due to high set up cost, payments are vital for IBS manufacturers as this would ease the burden on financing costs and cash flow. Payments are expected to be made to the manufacturers before fabrication process starts, not when the components are delivered to site. This argument was agreed by Shukor et al. (2011), whose research on the IBS supply chain affirm that the current procurement system was not applicable for IBS projects because IBS manufacturers will only receive payment when the components are delivered to the site, not when the precast components were being manufactured. As IBS components are usually huge in size and weight, issues such as site storage will derive as well. The factors describe above poses a huge adversity for the IBS manufacturers and expose them to high financial risks. With the initial payment absent, and are only able to obtain payment after the IBS components are delivered to site, the researchers concluded that traditional procurement method have not addressed this very pertinent issue, which is more favourable to the client and unfair to the IBS manufacturers. The researchers also concluded that a new, equitable, and fairer payment mechanism or procurement should be introduced.

Dzulkalnine et al. (2017) add on that the current progress payment method that is commonly practice in Malaysia shouldn't be implement in an IBS project. For instance, the traditional construction method uses the S-curve method, which the payment is based on progress at site. The payment method for IBS construction should not be manage as the same as the conventional one due to the difference of setting up the factory, material preparation on site, and supply skilled labor for installation purposes.

Jaafar and Radzi (2013) proposed that there is a need to develop new procurement systems when there are major changes in the construction's aspect. There is also a need to adopt a new procurement system. Applying unapplicable procurement methods in an IBS project will affect the construction team's efficiency and project's progress, due to misinterpretation of the regulations. Jaafar and Radzi (2013) also added that a suitable procurement system for IBS projects will invariably expedite a project's success. On the other hand, Hung et al., (2015)

indicate that IBS projects differs from traditional method projects, and requires a distinct set of strategy on planning, scheduling, supply chain, as well as the purchase of materials

Therefore, this section concludes that the current procurement systems available in Malaysia hinders contractor's capability to implement IBS in their project. The lack of fair payment mechanism contributes to project delays, as contractors would always have to allocate extra capital to procure IBS products before the factories can initiate manufacturing.

2.2.4 Lack of Incentive and Directives from the Government

Since the IBS roadmap was endorsed by Government in 2003, there are still no specific, explicit IBS standard guidelines or building regulations, let alone suitable contract documents or procurement systems in terms of tendering, design, construction and operation of a project. The main references or guidelines are IBS catalogues published by CIDB, such as Precast Concrete Building Components for Residential Buildings, Joint and Tolerances for Building Construction published by CIDB. The lack of structured, unified information will affect construction professionals because of misinterpretation and misunderstood regulations, as well as affecting authorities in terms of project approval. The lack of standard guidelines does not encourage IBS implementation (Nawi, Lee, Azman, Kamar, 2014)

According to Nawi et al. (2014), directive regarding IBS implementation from government or private agencies are inadequate, hence lead to poor implementation of IBS in construction projects. As highlighted by Faizul (2006), a number of pivotal factors such as IBS program-based adoption strategy, continuous affair strategies on IBS forums/ workshops, creation of an implementation agency on IBS need to be addressed in order to regulate and reinforce the various industry initiatives of IBS. Moreover, Kamar, Alshawi, Hamid (2009) stated that there are no dedicated evaluation or certification systems for IBS products, installers, manufacturers in Malaysia's construction industry. This evaluation system is very crucial to assess the current performance in order encourage further improvement of IBS implementation in the future.

On the other hand, lack of incentive training among construction professionals were also identified as a potential barrier to the widespread adoption of IBS (Hamid, Kamar, Zain, Ghani & Rahim, 2008; Hussein, 2007). A survey of IBS industry players by Hussein (2007) identified a need for apprentice and on the-job training in a few aspects such as casting moulds, casting skills and assembly of components. This issue arises due to incomprehensible and

uncoordinated training awareness among practitioner, students, or Malaysia's education institutes.

According to Foo (2016), president of the Master Builders Association, 2016, the government should reduce the dependence on foreign workers by encouraging the utilization of heavy construction machinery and provide attractive incentives for the adoption of IBS and Building Information Modelling (BIM). The researcher also believes the encouragement and incentives may directly reduce the dependence on foreign workers as well as promotes long-term stability.

Foo (2016) also suggested to lower importing duties and tax on heavy construction machineries and equipment that are not manufactured locally, as old machinery used by the industry players are reaching the end of their life cycle and are not suitable to uptake more challenging job nowadays. Modern machineries are believed to be more productive and enhances safety since there's less risk of machine failure. Incentives, such as tax rebate on purchasing heavy lifting equipment should be awarded for the adoption of IBS, or special loan scheme can be devised by banks for IBS project. Foo (2016) emphasize that the construction industry needs every bit of assistance to help the industry move forward and incentives are believed to be able to overcome problems that are increasing each year.

The research finding by Hadi, Muhamad and Othman (2017) show majority of the industry players agree on the lack of incentive implementing IBS for small contractors. Their findings also show that the incentives only have direct effect towards the main contractor and developer due to the fact that levy exemption only benefit the main party of the IBS project. For example, a small contractor that undertakes the installation of IBS components did not receive the said levy exemption due to the contract amount was below RM500,000.

From the budget 2006 announcement, IBS manufacturer would receive Accelerated Capital Allowance (ACA) as expenses use for purchasing casting moulds. The idea behind the tax benefits is to motivate industry players to invest more in IBS. However, findings by Hadi et al. (2017) show that most industry players are not aware of the announcement and only precast concrete manufacturers are being benefit from ACA. Their study concluded that the incentives facilitation policy by the government is unfair and developed in favour of large stakeholders, such as manufacturer and developers. It might be because large stakeholders are viewed to be the main driving forces of promoting IBS implementation in Malaysia.

Hence, the policy maker has to equitably formulate a new strategy that assists each stakeholder in IBS implementation. It was also suggested that the government should impose a reduction of company's tax for a company that is willing to uptake the implementation of IBS projects where all parties will receive impartial benefits.

2.3 Success Factors of Implementing IBS in Construction Projects

In most construction projects, an opportunity is given to the contractor to set prices during the project tender stage. Profits are earned by the contractor's ability to save capital from project sequences and project management. The transformation process from traditional construction method to IBS construction method requires noticeable effort on several key areas. Other than elaborating CSFs, this part of literature review will also add in other relevant factors, recommendation, practice that may help with the implementation of IBS in construction project by various authors.

2.3.1 Training and Education

Trainings are considered to be an integral part of a company's learning. Trainings are often used to addressed skill deficiencies, and also embraces adult learning, experiential learning and cognitive abilities (Manubuild, 2007).

2.3.1.1 Training Existing Employees

Goodier and Gibb (2007) highlighted that the skill required for low level industrialisation was similar, but more skills and technique are required for advanced and mechanised system in IBS. Wilson, Smith and Deal (1998) identified that it is imperative for management and project team receive proper and comprehensive training of site installation. In certain context, the contractor's team is trained by the manufacturer to acquainted them with IBS systems. The trainings provided by the manufacturer usually include implementing, supervising, managing and assembling of building panels. A comprehensive learning program must be developed to teach these specialised skills (Clark, 2002; Goodier & Gibb, 2004). Pan, Gibb, and Dainty (2008) claims that IBS construction method required specialised technique and high-level precision compared to traditional construction method. Undoubtedly, it is much easier to attain high level of specialities and knowledge from professional education and high level of trainings. By taking the above-mentioned points and arguments, investing in educational programs to master IBS skill is critical for contractors to succeed in implementing

IBS. Goodier and Gibb (2006) suggested a training program that focuses on the role as a site system coordinator to integrate activities should be developed.

2.3.1.2 Knowledge Management

According to Mclnerney (2002), knowledge is a form of awareness that an individual knows through experience, study, reasoning or associate through various types of learning. Devenport and Prusak (1999) defines knowledge as a mixture of contextual information, beliefs, values, expert insights that is able to absorb new information and experiences. On the other hand, knowledge management (KM) is defined as any form of practice, process that is able to identified, captured, transferred, shared, available knowledge to enhance organisation performance and learning opportunities (Egbu, 2000). Egbu (2001) claims that KM is vital to increase project efficiency and improve organisational competitiveness. KM became essential for the construction industry as it is constantly fuelled by the need for innovation, competency, client satisfaction, and improved business performance. It is widely acknowledged that KM plays an important role to process knowledge, then share or transfer from individual to another or groups.

According to, organisation KM nowadays rely much on information technology (IT), information system (IS) and tools that assists the transfer and storage of knowledge (Egbu, 2000). It is suggested by Kadir, Lee, Jaafar, Sapuan, and Ali (2005) that the role of KM and IT plays a notable role in IBS in Malaysia when it showed improvement in structural performance. Studies by Clark, (2002) postulated with Goodier and Gibb (2004) that the implementation of new construction system method shall require the consideration and expertise from knowledgeable designers, in order to develop a competent decision-making process. Abdullah and Egbu (2010) assert that the KM process must be recognised by the designers and project stakeholders to realise the viability of structural or building systems alternative through the application of IT design support tools. Rashid (2009) claims that studies learnt and examination took between designers and manufacturers of IBS shows the mismatched between designing and manufacturing of local IBS products. Hence, the role of KM to share and transfer relevant knowledge seems to be significant in this context.

2.3.1.3 Continuous Professional Development (CPD)

Continuous Professional Development (CPD) is defined as a life-long learning process that maintains, enhances, or increase the knowledge and skills of professionals in order to

ensure their knowledge and ability are pertinent to the society needs (Abdullah and Egbu, 2010). Professional bodies such as Board of Engineer or Board of Architects are responsible to ensure current issues are being address and the level of knowledge acquired among the professionals are relevant. The life-long learning process will help professionals to be more prepared when facing spectrum changes, and take advantage of the opportunities that may arise, as well as underpin the value of their professional qualification.

Findings by Ariffin and Torance (2008) indicate that CPD is able to update and exposed the practitioners to the latest information and construction technologies. The initiatives of CPD organize by various professional boards and bodies through serials of trainings, conference, short courses, and seminars will complement the professional's practice and sharing of knowledge.

2.3.2 Organisation Culture & Communication Skills

Studies from Nam and Tatum (1997) indicated that organisational inflexibleness is a barrier towards the implementation of new technologies. An organisation structure that is open, emphasize on good communications, have good leadership, being supportive and willing to embrace innovation tends to be more successful in adopting IBS in their construction projects.

2.3.2.1 Working Culture and Behaviour

In order to change from a fragmented IBS industry to an integrated one requires a change in the mind-set of all IBS practitioners. Majority of clients, designers, contractors, system providers, manufacturers and installers are found out to emphasize much on the importance of positive working culture and behaviours such as seriousness, good commitment, working jointly as a team, aligning people's needs, agreement on decisions and developing a common understanding of goals for a more successful IBS implementation (Shukor et al., 2011).

2.3.2.2 Powerful Leadership

Studies by Shukor et al., (2011) revealed that leadership in decision-making was recognized as an influential factor by designers, contractors, IBS manufacturers and installers. Great leadership often leads to great integration and project coordination. A determined leadership is important in order to persuade the use of innovative technology to own organisation and other stakeholders. A leadership that demonstrates technical competence will ensure sensible risk taking and is able to remain competitive in the construction industry market

(Bleyse and Manley, 2004). A good leadership characteristic is also vital to manage cultural challenges such as own organisation's resistance towards IBS, or introduce positive working cultures on site and management team.

2.3.2.3 Top-Down Commitment

Commitment from project manager towards their workers is also vital to ensure successful IBS implementation (Ismail et al., 2012). It includes active modelling and motivating desired behaviours and value, involving in learning system and change efforts, and the willingness to live with the inevitable confusions and conflicts that comes with organizational change. Top-down commitment is needed in all stages of IBS construction works including initial works, components manufacturing, transportation process, installation and finishing works (Harjeev et al., 2011).

2.3.2.4 Good Working Collaboration

Collaboration is a repetitive process whereby two or more people or organisations work collectively to achieve their shared goals. All related personnel can be split into following parties based on their functions, such as: design, management, supervision, construction, and inspection. At construction site, there would be personnel such as project manager, land surveyor, project engineer, site engineer, foreman, machinery operators, labourers, and inspectors. Good collaboration effort is especially important between designing, manufacturing, logistic, and assembling processes as those are important factors to taken care of. (Haas and Fangerlund, 2002; Li, 2006; Vrijhoef et al. 2002 and Lessing, 2006).

Research conducted by Charnwasununth, Yabuki and Tongthon (2009) analysed that problems of team collaboration usually arises due to the lack of information storing, sharing, and management practice among different types of personnel working at site and at the main or branch offices. Rahman and Omar (2006) stated that good working collaboration between all parties at the initial works of IBS process is crucial to ensure the success of IBS project implementation. Rashid (2009) suggests that collaborative approach between a designer and manufacturer on making joint decision in finalizing IBS design is rather important and significant. Other than initial stage, materials management and supply chain scheduling also require coordination effort between each party in the construction stage. Good working collaboration according to Kamar et. al (2010) is able to solve problems such as complex coalition between systems and ensure smooth process sequence in manufacturing plant and at construction site.

2.3.2.5 Effective Communication Channel

Communication process in a construction project involves information progressing forward, backward and sideway. Communication channels refer to the way the information flows within the organisation and with other organisations. Effective communication channel between all parties in the initial stage of IBS process is crucial to ensure the success of IBS project implementation. Aziz (2007) recommended that an understanding of communication skills and knowledge will impact the decision making on the adoption of IBS in Malaysia is important as well. Ochieng and Price (2010) perceived communication process as a professional practice where suitable tools and regulations can be tested in order to enhance the utility of data communicated. In view of the increasing complexity and coordination involved in IBS projects, effective communication is very important. Blissmas (2007) pointed out that communication should not be limited to verbal communication, but should also include the flow of documents and drawings. According to Kamar et. al (2010), it is necessary to establish effective communication channels within the supply chain to coordinate the entire process from the beginning to the completion of the project. At the designing stage, communication and integration among the IBS players such as designer team, construction team and manufacturers are essential, and the lack of communication will often lead to redesign of plan and drawings, which results in additional costs and time (Kamar et. al., 2009). At the construction stage, a good communication channel can support important real-time information between the factory and the project site to ensure that the correct manufactured components are delivered to the site in a timely manner. (Malik, 2006)

2.3.3 Site Management & Process

Compared with traditional construction methods, the design, manufacturing, assembly and other related processes in IBS projects require a more comprehensible process plan and control structure to reduce defects and mistakes. (Gibb, 2001). Generally, contractors serve as a system integrator of the whole construction process at site, and are responsible for organizing, planning, scheduling and controlling site operations. Hence, it is common that contractors have their own systematic procedures to regulate the complexity of the interface between systems including transportation and logistics. (Pan et al. 2008; Hamid et al. 2008 and Blissmas, 2007). According to Azman et al, (2011), the best concept for centralizing the construction industry to meet international standards and requirements is to concentrate the three main areas in one

company. The three main fields are the designers, manufacturers and contractors. Those parties could manage and monitor the project quality as well as achieve cost-effectiveness.

2.3.3.1 Extensive Planning and Scheduling

In terms of planning and scheduling, all stages including initial works, manufacturing process at a factory, transportation works to site location, installation and finishing works must be thoroughly involved to ensure successful IBS project implementation. A well-planned schedule could also ensure all parties to comprehensively understand their own job task. Other than Ismail et al., (2012), Cheung et al., (2012) also agrees that effective planning and scheduling are vital towards successful IBS implementation. The planning process is highly complicated, but nonetheless still leads to significant bottom-line benefits. Ismail et al. (2012) stated that scheduling is the process of developing and maintaining daily or weekly optimal tactical and operational plans, with the objective of extracting maximum value from the available options. All aspects must be taken into consideration when planning and scheduling. By doing so, it would be able to provide a critical link between corporate planning and plant operations.

Many aspects will need to be taken into consideration during planning and scheduling activity for an IBS project. Below will demonstrate a few examples of what to consider during planning stage. During the installation phase, contractors need to identify the ground conditions, size of the site, and the best routes and time to the project site before starting the installation works (Ahmad, 2005). In certain situations, access to site is restricted, the building itself may have to be designed so the components are placed in an easy-to-install location. Before the fabrication starts, all construction schedules must be decided through consultation and must be agreed upon. (Neala et al. 1993). Furthermore, Sanderson (2003) added that it is not practicable for adopters to implement the IBS techniques on-site for quick assembly but still maintain traditional planning and scheduling.

2.3.3.2 Just in Time Logistic Management

Just in time (JIT) is a form of logistic management used in IBS projects, and is defined as a production concept based on a plan to eliminate all waste and continuously improve productivity. (Ahmad, 2005). This concept is an important method for IBS projects as it can advance the work from one process to the next when the successor needs it (Ballard and Howell, 1997). The benefits of JIT are to shorten the production cycle, reduction of working capital,

reduction of work in progress inventory and contributes to continuous improvement. Peng and Chuan (2001) added that as long as the JIT is installed, materials or components can be delivered to the site when it is needed, thereby minimizing the space required for storing materials. Long-term partnerships with IBS manufacturers is one of the key pillars of the adoption of JIT logistics management in the construction industry.

2.3.3.3 Standardization

Standardization is said to be one of the core features in internal process planning and monitoring. According to Voorbij (2007), standardization increase efficiency by simplifying the process of communication, reduced project costs by process simplification, shorter time to adjust business processes and make better use of human resources.

Study by Haas and Fangerlund (2002) also corroborate with Voorbij (2007), and suggested that in order to maximize the efficiency of resources, standardization should be applied in building products, forms of contract, details, design or specifications and processes, procedures or techniques of a specific project to reduce the overall project cost. Mole (2001), stated that standardisation is the process of formulating and agreeing on technical standards. Standards are documents that establish technical specifications, methods, standards, practices, processes, and unified engineering. Moe (2001) also added that standardisation is suitable for IBS projects because of high repetition use of similar components, and IBS project needs to emphasize the concept of standardization and repetition whereby the component is recorded in a systematic manner which allows all components are repeatedly installed in the same way.

However, Ranns and Ranns (2005) point out standardisation of IBS components also has its own drawback. Ranns and Ranns argued that the concept of standardization merely focuses more on the execution of the organizational work process, but not on the end results. The lack of attention to the results-oriented process will not bolster the adoption of IBS.

2.3.3.4 Invest in heavy machineries

The term mechanisation is usually use whenever the machinery perceived as the employee that is able to ease the labour's work. Generally, precast concrete system will be accompanied by some mechanisation (Kamaruddin et al., 2013). The problems associated with the construction industry such as, labour shortages, occupational safety and inferior working environment, decreasing quality and productivity have highlighted the need for innovative solution within the construction industry, which includes the push for further use of

mechanisation, construction automation and robotics application on site (Kamaruddin et al, 2013). Kamaruddin et al., (2013), indicates that mechanisation, automation and robotics have been proof of improving the construction process in multiple aspects. A few significant advantages of implementing mechanisation is it can speed up construction, reduce production time, improve work conditions, reduce dangerous works, and carry out works that human labour cannot perform.

2.3.3.5 Design Freeze Policy

It is widely acknowledged that decision made on conceptual design stage has the greatest impact on the overall expenses of a project (Tizani, 1996). The IBS researchers have a consensus that IBS specialists or manufacturers should participate in the initial design stages. With the cooperation between designers and the IBS specialists, it can assure the design does not limit the benefits of implementing IBS. (Pan et al. 2008; Blismas, 2007; Sanderson, 2003 and Gibb, 2001). Gibb (1999) explains that designer should ask for professional advice in the early stage on transportation and installation. Additionally, it is essential for the designer to obtain manufacturing information at an early stage of the project. Pan et al. (2008) stressed out that it is critical for the contractors to take part in the design stage as well because it is important to consider contractor's opinion in the aspects of manufacturing, design coordination and constructability. Later design changes during the construction phase are not favourable, difficult to implement, and affects the production schedule. According to Eger (2007), introducing the 'design freeze principle 'into the project schedules is beneficial in helping mitigate the effects of late changes. For instance, 'specification freeze' defines the set of requirements the entire design will be based on, while 'design freeze' elaborates the end point of the design phase at which a technical product description is handed over to production.

2.3.4 Supply Chain & Procurement

According to Kamar, Alshawi and Hamid (2012), it can be defined that the industry relationship between the main contractor and the supplier is similar to the "master to servant" relationship, where industry stakeholders usually do not emphasize on togetherness, and the practice of information protectionism is very common in the construction industry. It is worse whereby the current supply chain practices in the construction industry are supported and fragmented by the unfavourable relationship, lack of commitment and trust, poor relationship and communication, and driven by own cost agenda. (Wood and Ellis, 2005). To cope with the problem described above, Hong-Minh et al. (2001) and Goodier and Gibb (2004) suggests the procurement system and supply chain practice needs to be improve in order to improve IBS implementation.

2.3.4.1 Partnering Approach

One of the sensible suggestions is to adopt a partnership and strategic alliance approach to project delivery by generating a common project vision and setting complementary goals among project participants. Faizul's (2006) analysis of IBS's Supply Chain Management (SCM) shows that good supply chain characteristics combine the planning and management of all activities, including procurement, logistics, conversion, and contractors, intermediaries, suppliers, and third parties within and throughout the organization through the coordination structure among three-party solution providers. Establishing partnerships with component manufacturers and suppliers at the initial stage of the project sequence can significantly ensure high-quality supply and efficient delivery of specialized products. (Faizul, 2006). Wilson et al. (1998) recommended that the partnership should not be limited to the simple exchange of commodity or services, but should also act as a strategic partner to integrate design, marketing, distribution and knowledge exchange with partners. Kamar and Hamid (2011) indicates that supply chain partnering is suitable for either large or small organisations. By providing a wider spread of products and services without having to pay high initial costs, risk and reward sharing, resource concentration, and rapid focus on core capabilities and responsiveness to market demand, it provides numerous opportunities to improve their conduct of business. Supply chain partnering creates opportunities for sharing innovative ideas and knowledge to be incorporated. Supply chain partnering is especially beneficial for industry players that are not familiar with IBS method because it can then merge with an experienced contractor to implement modern yet unfamiliar technological approach in IBS. Kamar et al. (2009),

Ariffin et al. (2018), also agrees that partnering was a good innovative procurement system that involves an agreement among the parties in order to achieve mutual objective, continuous improvement and problem resolutions. Partnering can incorporate all relevant construction parties from design till construction stage that comprise of life cycle-oriented performance and cost certainty. Hence, partnering may solve a few challenges in traditional procurement method such as lack of early involvement, or increase buildability; all industry players were integrated and coordinated together from design stage till construction stage in order to overcome obstacles.

Nonetheless, partnering or strategic alliance also received their fair share of criticism from various observers. It is clear that a good partnership with suppliers and subcontractors is beneficial towards the successful implementation of IBS, however, the competitive tendering process system demands contractors to prioritize the component's pricing, which means contractors may be unable to offer repeat business opportunities to their respective partners and alliances. This induces contractors to remain independent and tends to choose the lowest tender bid in order to achieve competitiveness (Kamar & Hamid, 2011). Moreover, findings by Ariffin et al. (2018) have shown that risk and profit share among each other was not practical nor applicable in Malaysia's construction industry because there's a lot of unforeseen risk and obstacles could not be foresee early and the insufficient experience of utilizing IBS as the main construction method.

Therefore, Chen and Chen (2007) indicate that qualities such as collaborative culture, consistent goals, long-term quality focus and resource sharing are necessary for successful partnership. Gibb (1999) highlighted that establishing a partnership in IBS projects requires a huge effort to have mutual understanding and agreement in the first place. Partnering is only feasible if all the project teams shared the mutually agreed on the objective, goal and form of contract. BRSIA (1998) stated that dispute procedures and effective feedback mechanism should also be discuss afore the starting of partnering.

2.3.4.2 To Create IBS Cluster, Consortium

When a company is participating in a project tender and realize that it does not have all the necessary expertise for this project, the company can attempt to form a joint venture with other parties that are able to provide the necessary expertise. But forming a joint venture can be complicated and challenging. An alternative option is to go into consortium when responding to a tender. A consortium is an association of two or more individuals or

organisations with the objective of participating in a common activity, such as pooling their resources or responding to a tender in order to achieve a common goal. A consortium is formed by contract, and within the consortium, each party retain their separate legal status and consortium's control over each party is only limited to the activities involved in the joint endeavour, particularly the divisions of profits (Rooyen, n.d.). Furthermore, a major factor in the delivery of successful construction projects is the positive integration of supply chain. Contractors can consider creating an IBS cluster or consortium of integrated team when it is needed (Kamar and Hamid, 2011). An integrated team may bring together a series of different companies composed of key players in IBS (client, designer, contractor, and manufacturer) which are interconnected through practice, information, financial and contractual relationships flow. This allows them to operate on design and construction practices for a common goal and objective. By forming a cluster or consortium allows people, system, business structure, construction practice integrate into one and encourages horizontal information flow. Team members are expected to work together to make a decision or to solve arising problems throughout the design, fabrication and construction phases. The authors believe this approach can help IBS flourish in a much shorter time and develop more integrated and capable supply chain (Kamar and Hamid, 2011)

2.3.4.3 Design and Build

According to Azman et al, (2011), the best-case scenario for utilizing IBS system is using design and build procurement method. Design and build method would allow the contractor to control the entire project flow. The design and build procurement method illustrate construction drawings based on conventional method, while the IBS drawings will be generated concurrently while the earth-work or piling works are being carried out on site. Mechanical and Electrical drawings also need to be incorporate during the early stages of construction if IBS systems are being applied.

The process still requires consultation with project owners or clients to conclude the design works. the potency of IBS drawings is it able to phase out repetitious works in conventional method, specifically during the superstructure stage. In most situations, construction works of design and build contracts are still using conventional method of construction. Adjustments would need to be carry out between the substructure or superstructure stage. This process will then delay the project milestone and even raise the whole project cost. Conversely, the IBS drawing system indicates that once the concrete works have

been started on site based on the final construction drawings, it will not be able to make any adjustments or structure design amendments except if the project owners or clients have the consent to impose the additional cost for the extra renovation works.

Gibb (1999) and Blissmas et al. (2006) both agreed that it is critical that IBS is chosen as the construction method at the early stage of the project in order to obtain the maximum benefit from IBS. IBS would not be beneficial if it is applied as an afterthought, or introduced after the designing stage. Neala et al. (1993) emphasis that the best practice to carry out IBS designing process, is the designers to proceed no further than preparing the performance specification and outlining the design. The detailed design should only be produced after contractors or manufacturer to contribute their knowledge and expertise.

2.3.4.4 Integrated Project Delivery

Ariffin et al, (2018) explained that Integrated Project Delivery (IPD) was a business structure for designing, implementing and transmitting the building works by incorporating, integrating, assembling a productive team of project players such as project owners, architect, engineer, main contractor, sub-contractor, manufacturer, supplier and others. Integrated project delivery is a relatively new concept of project delivery method that was introduced in the industry. This form of project delivery method is being implement widely in other developed countries for a better integration among project team members throughout the project duration, in order to deliver a more effective and comprehensive project.

The explanation above indicated that IPD was a business structure use for design, implement and transmit the building works by incorporating a productive team of project players. According to Nawi, Haron, Hamid, Kamar and Baharuddin (2014) and Ariffin et al. (2018), all construction parties participating in a project using IPD method were all incorporated with Building Information Modelling (BIM) software to execute works from design stage till completion stage. Moreover, findings from Nawi et al (2014) explains that IPD method was a design and build procurement that incorporates BIM.

For example, the architect produces or changes design at the initial stage. All other parties would be notified and could easily amend the work or measurement in the BIM software. Hence, this kind of procurement could overcome design problems due to main contractor was involved at the initial stage. Besides, BIM software was perceived as one of most effective tools to assist construction parties to manage all the unforeseen obstacles between design stage and construction stage. Furthermore, for construction players who lack knowledge, experience,

and understanding in industrialised building system, IPD procurement could serve as a channel to share knowledge and ideas between the project members.

Nevertheless, half of the respondents from Nawi et al, (2014) claims that IPD was useful and suitable for large scale and complex project types. Additionally, BIM software requires large amount of capital to invest such as license software, workshops, training and others. Hence, main contractor shall prepare some capitals to invest in this software. Overall, partnering approach and integrated project delivery were rated as the highest innovative procurement suitable for IBS implementation from the research by Nawi et al (2014), and it is because each innovative procurement was relationship-based procurement method that could overcome challenges on lack of early involvement, lack of integration and collaboration between design stage and construction stage.

2.3.5 Information Technology

2.3.5.1 Implement Building Information Modelling to Improve Designing Process

Information technology (IT) is proven to be a key facilitator in the product design aspect of implementing IBS in construction industry. For instance, a complex and large-scale engineering project such as the development of 'Concorde' aircraft is only possible with the use engineering software intertwine with applicable 3D design software (Jaeger, 2007). Similarly, a complicated construction project such as modular houses can only be developed and produced using extensive and modern designing software.

Rahman and Omar (2006) add on that with advance knowledge in computer aided design, IBS buildings can be designed and presented digitally using Building Information Modelling (BIM) prior carrying out actual construction works. The 3-dimensional drawings can be illustrated to show accurate IBS components, dimensions and ensure buildability. Erection and construction works can also be replicate digitally and extensively planned with the use of computer software. Moreover, feasibility studies on utilizing different building systems can be carry out without incurring much cost. Complication, or unforeseen obstacles can also be detected and anticipated. Any rectification implications to the components design can be attained before the actual manufacture process. The computer technology and system accessible nowadays can help contribute to a well-planned and systematic IBS system. IBS building projects constructed in the 90s have shown notable improvements in terms of architectural features and structural performance with the help of advance computer-aided design software.

2.3.5.2 Implement Information Communication Technology to Improve Communication

Information and Communication Technology or "ICT," includes products that store, process, transmit, convert, duplicate, or receive electronic information. Verweij and Voorbij (2007) and Oostra and Jonson (2007) pinpointed that the role of information technology software is to form communication between project team and suppliers also act as a medium for quality controls of project deliveries. The communication channel allows successful 'feedback-respond' effects between design and production where inaccuracies can be detected more early thus avoiding problems during the manufacturing and assembly phase.

Nawi et al. (2014) added that the developments of Building Information Modelling (BIM) software initially are targeted to solve the common practice of information sharing and communication. In the earlier days, information delivery process depends much on paper-based communication. Errors and omissions in paper documents happen frequently and often leads to unexpected costs, delays, and eventual lawsuits between various parties in a project team. The researchers further identified that one of the most common problems associate with paper-based communication during the design phase is the heavy amount of time and expenses required to establish critical assessment information about the proposed design, cost estimates, structural details, and energy-use analysis. These analyses are usually complete last, when it is already too late to make important adjustments. Hence, there is a need to develop an integrated product and process information that offers potential improvement in terms of collaborative works.

CHAPTER 3
METHODOLOGY

3.1 Introduction

This chapter will explain how the research is conducted, what methods are used for collecting data, the sampling and population target and methods of analysing the data.

3.2 Qualitative Research Methodology

Qualitative research is an interpretative approach which aims to seek insight into specific meanings and behaviours experienced in a certain social phenomenon (Polgar and Thomas, 2000). By going through the subjective experiences of the participants, the researcher builds abstract, concepts, hypothesis or theories by querying questions such as “why”, “how”, and “in what way” (Mertens, 2005). Fundamentally, qualitative research methods use description and wordings to comprehend human experience and realities from the subject’s point of view. It is often a continual process whereby theory, hypothesis emerges from the data as it is collected, while the researcher then keys in the data collected and analyse the processes. The study is design to be flexible and emergent, and is able to response to changing conditions as the study progresses. The goal is to investigate the phenomenon from the participant’s viewpoint; with its distinct institutional and social context intact. Examples of qualitative methodologies includes interview, focus group, chart review, or observation.

3.2.1 Literature Review

Literature review is the first phase of research, in which the secondary data will be derived from published journal, news article, text books, thesis, dissertations, reports, conference proceedings and other pertinent reading materials. The literature focuses on identifying potential critical success factors that may help promote the wide spread of Industrialised building system (IBS) implementation. The purpose of literature review is to define, compile, evaluate, interpret or organize contents of information from various sources. Completing a literature review is considered as a substantial intellectual achievement in its own right, involving interpretation and synthesis of previous work in such manner that new perception of works is uncovered, and the way is accessible for new research.

3.2.2 Semi Structured Interview

The second phase of research involves the collection of primary data through semi-structured interviews. Semi-structured interviews are chosen as a research strategy as it creates casual setting of data collection. Semi structured interview will consist several key questions that help define the areas to be explored, as well as allowing the interviewer or interviewee to deviate in order to pursue an idea or response more detailly. This method allows the researcher to investigate arguments in detailly and gather deep insights, human experience and tacit knowledge which may be difficult to measure if applying quantitative approach. The flexibility of semi structured interview also allows the discovery and elaboration of information that is vital for the participants, and explore viewpoints that may not have been previously consider as pertinent by the researchers (Gill, Stewart, Treasure & Chadwick, 2008). Palmer and Bolderston (2006) added that the characteristic of semi-structured interview is even though the questions are formatted in advance, the interviewer may still deviate from the scheduled question if an unforeseen discussion point is proving fruitful. This would allow critical issues and key factors encountered during the process of implementing Industrialised Building System (IBS) being addressed and elaborate by respondents spontaneously. That being said, the data generate from semi-structured interview can be rich and provide more in-depth appreciation of a subject matter than a questionnaire. The objectives of the research are shown as below:

1. To identify the barriers that contractors have to cope with when implementing IBS in their construction projects.
2. To determine the critical success factors of implementing IBS in construction project.

3.3 Sampling and Population

3.3.1 Sampling Size

Sandelowski (1995) identified that sample size can be assess in terms of the number of incidents, events, and experiences, and not solely in terms of number of participants. Sandelowski's (1995) recommendation towards sample size make reference to the number of descriptions of an experience rather than just numbers of informants. Other the other hand, Parse (1990) recommends that interviews should be limit between 2-10 participants in order to achieve 'redundancy or saturation', while Kuzel (1999) recommends that 5-8 participants are sufficient in a homogeneous sample. Hence, this study aims to interview at least 5 respondents who are experienced in industrialised building system in order to achieve the research objective.

3.3.2 Target Population

Respondents of this research will be selected from those registered under IBS contractors under Grade 7 in Malaysian construction industry. Respondents were selected based on their past experiences on IBS project and their general perception.

Grade 7 IBS Main Contractors

The reason that this research will be focusing on G7 Malaysian Contractors who practices IBS, is because contractors are usually the major stakeholder in charge of managing the project and solving arising issues on a day-to-day basis. The contractors are responsible for the methods practice in the construction project, purchasing materials, machineries, tools, manpower and services essential for completing a construction project. Compared to other wide range of industry stakeholders, there is a general notion that contractors hold the most influential position to assure the success of IBS implementation. Contrary to the assumption that IBS are usually client driven, findings by Abdul Aziz (2007) revealed that contractor plays the most influential role and are the main drivers in IBS adoption, and transforming effort from conventional to IBS method largely revolve around the readiness of contractors.

Experienced IBS Practitioners

According to Edum-Fotwe and R. McCaffer (2000), a practitioner must have at least 10 years of experience or participates in at least six to ten projects, prior becoming an astute project decision maker of a construction project. Findings by to Edum-Fotwe and R. McCaffer (2000) also stated that 64% of project manager acquire at least 10 projects before they achieve a project manager status.

Hence, all respondents the author approach for this research will be those working for a Malaysia G7 contractor firm, have at least 5 years of experience towards IBS construction projects, or participate in at least 10 IBS construction projects. Project directors, project managers, cost estimators, site personnel and job positions alike would be considered for this research.

3.4 Questionnaire Development

A questionnaire was designed and developed in order to meet the purpose of this research after a comprehensive review of the literature. It was divided into three sections. Section A include the respondents' background information such as industry background, job designation, working experience and etc. Questions of section B was design to collect data

regarding the barriers of implementing IBS in construction projects. Question of section C was design to ask about the critical success factors of implementing IBS in construction projects. The questionnaire designed consists of open-ended questions. An email consists of brief introduction and invitation to participate in this research is written and attached with the designed questionnaire. The email is sent to the potential interviewees a week in advance. The reason of sending them a week in advance is so the respondents have reasonable time to think of the issues comfortably. A follow-up phone call is made in order to identify if the participants are qualified for the research, and also to secure the interview arrangement. All interviews are voice recorded and transcribed into wording. Each interview takes approximately one and half hour. Respondents are informed orally that the interview session will be voice recorded, and all information provided by the respondents are voluntary, and will remain confidential.

3.5 Data Analysis

Qualitative content analysis is carried out to match and compare the potential CSFs that are identified in the literature search with evidences captured in real construction setting. Qualitative content analysis is suitable to use for analyzing human communication in a quantitative, systematic, and intersubjective way. Qualitative content analysis is commonly used to analyze documented information in form of texts, media, which may include films, interview transcripts, newspaper articles, advertisement, or observational protocols (Bhatia, 2018). Below will explain the qualitative content analysis process recommend by Luo (2021).

3.5.1 Define Units and Categories

Once data are collected, the researcher define the units and categories of analysis. To analyse the content, it is important to divide the collected content into categories so that it can be managed better. This is a process of selective reduction where the text is reduced into categories, so the research can be focused on the categories. The categories can be in the form of specific words or patterns that will answer the questions of the researcher. The categories or codes can also be in the form of a word, a phrase, a sentence, numbers, brand names, countries, competitor names, emotions, an article and much more (Luo, 2021). For example, words like ‘contractors, manufacturers, designers, consultants, engineers, subcontractors, can be categorize as ‘Industry Practitioners’.

3.5.2 Develop a set of rules for coding

Coding involves organizing the units of meaning into previously defined categories. It is important to clearly define the rules for what will and won't be included to ensure that all texts are coded consistently (Luo, 2021). For example, the researchers decide which titles should be associate with this category word. For example, with the word 'reliable', the researcher can decide specific words, such as 'dependable, responsible, trustworthy' to associate with the word 'reliable'. Those specific words will then also be coded into that category.

In the meantime, a number should be assigned to each category during the coding process. The codes should be mutually exclusive, as it serves as a set of rules that explain the method of observing the content in the given text. Coding identifies four important characteristics, which are frequency, intensity, direction and space.

- Frequency will display the number of times a particular code occurs within the text
- Intensity indicates the amount of the strength towards a particular direction.
- Direction refers to the way the content appears, as it can be positive, negative, opposite and support.
- Space denotes the amount of space assigned to the text or the size of the message.

3.5.3 Code the Text According to the Rules

The next stage involves the testing of codes that was designed by the researcher. The codes need to be validated for reliability. The codes need to be tested to check if it indeed measures what it intends to measures, and to check if the results are consistent. All written texts are gone through by the researcher and write down all relevant data in the suitable categories (Luo, 2021).

3.5.4 Analyse the results and draw conclusions

Once the coding process is completed, the collected data can now be examined to find patterns and draw conclusions in response to the research question. The researcher explore the correlations or trends, discuss interpretations of what the results mean, and make assumption about creators, context and audience of the texts

For instance, the results reveal that the words and phrases associate to the word 'reliable' appeared in the same sentence as an IBS component supplier more frequently than they did in

the same sentence as an IBS consultant. From these results, the researcher conclude that the respondents claim that IBS component supplier are more reliable than IBS consultant, and might have an effect on the overall construction time duration. After completing the analysis, there will be several sets of information organized into files. The files are presented in a report format that can be easily understood by the recipients. The report includes review of final results and identified patterns (Luo, 2021).

CHAPTER 4
DATA ANALYSIS AND FINDINGS

4.1 Introduction

This chapter will analyse the data collected using qualitative content analysis. The findings will also be compared to the literature reviews from chapter two.

4.1.1 Survey Response

Ten respondents are identified as suitable candidates for interview, and an invitation note were sent to them through Emails or WhatsApp. However, due to circumstances of time availability, only five of them are able to participate in the research interviews. Names of the participants will remain anonymous and coded as respondent 1 (R1), till respondent 5 (R5).

4.1.2 Respondent background

1. The first respondent (R1) is a project manager who have more than 20 years of experience, and has experience using precast concrete system and light weight block system in building projects. He was involved in 5 IBS projects in the past.
2. The second respondent (R2) is currently a CEO of a construction public listed company based in Johor, and a former director of Jabatan Kerja Raya (JKR). He has 42 years of experience in construction industry, and has involved in more than 20 IBS projects.
3. The third respondent (R3) is a project manager who has 24 years of experience, and was involve in more than 15 projects that uses IBS. Previously employed in Singapore, he was also involved in a handful of Housing and Development Board (HDB) apartment projects in Singapore.
4. The fourth respondent (R4) is a project manager who has 18 years of experience. One of the most notable IBS projects he partakes in is the high-rise buildings at Forest City, a project that was pitched under China's Belt and Road Initiative.
5. The fifth respondent (R5) is a project director of a contractor firm. He has more than 25 years of experience, and was involved in more than 7 high rise apartment project that uses IBS system. The respondent is familiar with precast concrete system and aluminium formwork systems.

	Job Position	Years of Experience	Number of IBS project involved
Respondent 1	Project Manager	20	5
Respondent 2	Chief Executive Officer	42	20
Respondent 3	Project Manager	24	15
Respondent 4	Project Manager	18	12
Respondent 5	Project Director	25	7

Figure 1: Respondent Backgrounds

4.2 Defining Categories

4.2.1 First objective

The first objective is to identify the barriers that contractor have to cope with when implementing IBS systems in their construction projects. The data to be analyse are collected from questionnaire section B. Four categories have been listed out from the data collection process.

Category 1: Barriers of insufficient skill and knowledge

Category 2: Barriers of supply chain fragmentation

Category 3: Barriers of payment mechanism

Category 4: Barriers of lacking Incentive and directives from the government

4.2.1.1 Category 1: Barriers of Poor Skill and Knowledge

Meaning Unit	Condensed Meaning Unit	Code	Respondent
From my point of view, I think the IBS knowledge and skills are still not enough among the industry players, it is because in many IBS project cases, the construction industry players still depend really much on suppliers. Our site workers are used to use conventional method carrying out works, so they are definitely idealess on how IBS is used.	IBS knowledge and skills are still insufficient among the industry, have to depend much on suppliers. Site workers are idealess of how IBS can be used	Industry stakeholders are not equipped with sufficient knowledge and skills	R1
No, I think the industry stakeholders are still not familiar with the IBS. Still insufficient. Both at professional levels as well as the industry players to the level of this field work. The problem now is developer, private developers are not so keen, even the architects are not so keen, their contractors and engineers are very keen, so now, the problem is lie with the architect and developer. So, as an engineer, they should also learn how to use precast.	IBS knowledge and skills are still insufficient, developer and consultants are not willing to adapt or to try IBS systems.	Industry stakeholders are unwilling to learn or to adapt IBS systems	R2
The problem is in our universities; our practices are not training people to go precast. From what I know, most course or subjects still focus more on traditional construction process and do not focus on the design and construction for IBS products	The syllabus of IBS design or construction process in universities is limited	IBS knowledge are not covered well in Universiti programs	R2
Normally, consultants and architects do not really have any practical knowledge on precast system. Only a little of those market players, who have been in this industry for a very long time, really do have a good knowledge on the IBS system. From what I know, a supplier name 'Eastern Pretech' have good knowledge on precast systems, as they have their own in-house engineer team that specialised in IBS field.	General consultants and architects do not have practical knowledge on precast systems, and only a few industry stakeholders have good knowledge regarding IBS	Industry stakeholders are not equipped with sufficient knowledge and skills	R3

So, in general, local professionals such as architects and engineers have really little knowledge on this precast system. They (architects and engineers) are unable to include IBS elements into their drawings, specifications and more detail information would need be clarified once again with the manufacturers. Even consultants have to ask supplier for advice.	Professionals are not knowledgeable enough on IBS system, thus unable to incorporate detail specification or IBS elements in their drawings	Industry stakeholders are not equipped with sufficient knowledge and skills	R4
The situation in Malaysia now is most of the consultants or developer are from the older generations, I think they find it very difficult to accept or adapt new technology, especially new practice that contrasts with their current practice. Also, it's difficult for consultant to recognize the shop drawings produced by the manufacturer	Developer and consultants are not willing to adapt or to try IBS systems	Industry stakeholders are unwilling to learn or to adapt IBS systems	R4
Most of the industry players are not equipped with IBS knowledge. It can be observed when they came for the job interview. In the early days, it is really hard to hired someone with IBS knowledge or experience. However, I think more and more personnel in management level will have this knowledge and experience. This is because in Johor Bahru already have at least 30 precast manufacturers, and I think the personnel that equipped with IBS knowledge will slowly increase.	Most practitioners are not equipped with IBS knowledge, but more and more personnel with relevant knowledge can be found among the industry	Industry stakeholders are not equipped with sufficient knowledge and skills	R5
Yes, I would like to say that the knowledge of Malaysian construction team is not sufficient yet. We (contractors) are unable to hired such workers due to unattractive wages. Very skillful IBS workers will go Singapore instead of working in Malaysia. The wages are not attractive compared to the neighboring countries for the same depth of knowledge required in precast technology.	Most practitioners are not equipped with IBS knowledge. It is also difficult to retain skilled or knowledgeable workers because foreign countries offer more attractive wages for the same set of knowledge and skill	Wages are not attractive enough to retain knowledgeable or skilful IBS practitioner	R5

If the client didn't request for it, why would the contractors or consultant willingly adapt the new technology. Granted IBS is indeed useful, but the mentality of contractors and consultants is that there's no need to expand their knowledge unless it is to fulfil client needs	Consultant or contractors are unwillingly to adapt new technology, or expand their knowledge unless it is required to fulfil client needs	Industry stakeholders are unwilling to learn or to adapt IBS systems	R5

4.2.1.2 Category 2: Barriers of Supply Chain Fragmentation

Meaning Unit	Condensed Meaning Unit	Code	Respondents
Yes, I do agree that the supply chain is quite fragmented. But it depends on the type of system used. For example, simple systems such as light weight block system did not required input from many professionals, as it is more like an end product, no need much coordination between supplier or consultant. However, precast concrete system on the other hand requires a lot of coordination and communication between multiple parties because the process is complex, the quantity is huge and costly.	The supply chain is fragmented, especially for more complex IBS systems such as precast concrete system, as it needs many coordination and communication	Need many expertise and coordination from various parties.	R1
The industry itself, whether its conventional or IBS are both very fragmented. You need suggestions and input from other professionals in order to make a decision. For example, the bills of quantities of a precast concrete project for contractors to tender usually only states the meter square of the floor area, and not the breakdown on precast elements. Request for information (RFI) are used constantly and consultants or suppliers may be reluctant to reply.	The supply chain is fragmented, and it constantly need input from various professionals. Bills of quantities for precast concrete projects are often not clear	Need many expertise and coordination from various parties.	R2
It is rare to involved us (contractor) in the project designing stage unless it is a design and build project. A lot of details or information are easily overlooked, or not put into consideration because there's no input from contractors and IBS suppliers at the beginning. It always a mess to match the conventional drawings and newly draw IBS drawings. Sometimes the manufacturer will ask us if we are able to handle or store the heavy components, but rarely involved us in the designing stage.	The industry lacks coordination because contractors or suppliers are not involved in a project's designing stage	Contractor are not involved in the designing stage	R3

Yes, this happens often. Usually this happens when the client awards the project to a main contractor, and they face some unpleasant situations. Firstly, the cost exceeds the budget and the client wants to change to another method, such as precast, instead of conventional to decrease the cost. Or they may have faced labour shortage. In this kind of situation, they will have to change their method into precast, because precast have lower labour requirements. Only in these situations, they will think to bring in precaster to reduce cost or labour resources. From my past experience, one of the projects that have a lot of this issue is the plastering of external wall. At that time, labour shortage is happening and a lot of contractors are asking suppliers whether external walls can be changed into precast. Another common case is the contractors want to change the high-rise building staircase work from cast in situ into precast concrete, because the space is smaller and formwork are hard to set up. But then again because contractors didn't consider using precast at first, so contractors faced a lot of problems changing it into precast.	IBS project are often treated as an alternative solution, and not implemented at the beginning of the project. This phenomenon later then leads to many problems implementing IBS in construction projects.	IBS are treated as an alternative solution	R4
Yes, one classic case is because when client want to change from conventional into precast concrete system method, and IBS suppliers are only bought in later to provide their expertise and suggestions. It's really inefficient and disconnected. Many drawings need to be redesign and costings need to be recalculated. Many times, after having many meetings, client might still go back to conventional method because of higher cost thus making all the previous discussions pointless. It's the risk of doing business.	IBS method of construction is treated as an alternative method of construction, which leads to extra discussion, drawings, which is inefficient and disconnected.	IBS are treated as an alternative solution	R5
Mostly suppliers are not willing to convert the consultant's traditional drawings into IBS drawings, because supplier still might not get the project after all. And consultants are not willing to accept or recognize the redesign by the suppliers, because it is out of their capabilities and job scope.	Both sides have their own agenda, thus information exchange process becomes complicated	Industry stakeholder reluctant to exchange information	R5

4.2.1.3 Category 3: Barriers of Payment Mechanism

Meaning Unit	Condensed Meaning Unit	Code	Respondents
Yes, I agree the payment mechanism is underdeveloped. Even though supplier plays as important in a project, I think its maybe IBS is still not really popular around here, so it's not incorporated in contracts, for instance, the BQ they just stated some really common materials, we haven't reached the level of having proper contract for IBS projects in Malaysia, at least.	Agree the payment mechanism is underdeveloped, and do not have a proper contract for IBS projects	Payment mechanism are underdeveloped	R1
The situation now between contractor and supplier is just like a normal supplier that sell us their products, and we set the terms with them, it's the same like we buy stuff from someone else. But since the quantities are huge and costly, they will ask for a deposit.	Suppliers will ask contractors for first payment because the quantities are huge and costly	Contractors are expected to pay capital cost	R1
A lot of things need to be negotiated between developer and supplier. They don't really have a fix formula or payment procedure for it. Maintaining good relationship with the competent suppliers are important nowadays.	There are no known fix formula or payment procedure. Many things depend on negotiation and relationship	Payment process is not standardized, and based on relationship or negotiation.	R1
So far, there's no, I think our construction contract for our IBS projects still uses The JKR standard or the PAM standard. Basically, there's no, contract document dedicated purely for IBS. Most will be based on the PAM contract, which is very disadvantageous to the contractor, very good for the developer. Because what you produced or purchased from the factory, is not consider as progress until you install it at site.	There is no construction contract document dedicate purely for IBS. The current contractor use for IBS projects are disadvantageous towards contractor, because what contractor purchase from the supplier cannot be claim until the components is install	Payment mechanism are underdeveloped	R2

So, it is important the contractor negotiate between the developer and the supplier. The contractor can try to come out with an agreement demand a certain percentage to be paid by the developer. The contractor can demand the production aspect being constitute as part of the payment, installation part, maybe 70:30, or 50:50, depends on both sides to agree. It will then subject to the contractor's negotiation skills. The negotiation term may heavily depend on the relationship between each party as well	It is important for contractor to negotiate with the supplier, contractor can draft an agreement to demand a developer to make initial payments. Negotiation may heavily depend on relationship between each party.	Payment process is not standardized, and based on relationship or negotiation.	R2
It's risky using IBS in projects. Contractor are expected to pay capitals first before we can claim any amount. It's even worse if the project was being held under keep in view (KIV). With no progress on site then there's no claim. Have to worry about the storage some more.	Contractor think it's risky implementing IBS in projects, because contractors have to pay for capital before any amount can be claimed.	Contractors are expected to pay capital cost	R3
It is very subjective; suppliers are very different from each other and have their own way of processing it. For instance, a small-scale supplier will ask for deposits, because they are also worried about the contractors not paying them once the fabrication starts. Some larger scale supplier that are confidence will only collect payment once things are installed. So, it's all very subjective. Nobody likes to take up all the risk.	The way of processing payments is subjective and heavily depend on the company size or relationship with the supplier.	Payment process is not standardized, and based on relationship or negotiation	R4
They will often produce a shop drawing with all the dimension details first, and then ask for contractor's confirmation and deposit in order to start the fabrication. The supplier will sometime request letter of award from the contractor instead of just purchase order. The suppliers tend to minimize their risk using this method.	Suppliers will ask for contractors' confirmation and deposit before starting the fabrication.	Contractors are expected to pay capital cost	R4

There are none any formal payment mechanisms that I know of. This underdeveloped mentioned by you is a valid point. Fundamentally, the money from the contractors comes from the client and the capital of the client comes from the bank. Let us take the construction of a condominium as an example, assuming the IBS component for the project is already produced up to level 15, but installation only reaches until level 5. As a developer who needs to claim cash from bank, the bank will then assign valuer to site to evaluate the progress. The bank will only pay the sum of level 5 to the developer. This leaves a dilemma that whether the contractor can claim from developer or supplier can claim from contractor. If the cash flow is tight and cannot claim, what can contractor or supplier do? This kind of payment mechanism really put contractors and suppliers in a tough spot. This will be very challenging for the industry players to withstand or absorb delayed payments. This situation cannot be remedied unless the government implements some policy to support the precast industry. A frequent argument is that payments should be made once the materials arrived on site, but it is controversial that the materials can be moved elsewhere on another day after the evaluation	There is no payment mechanism dedicate for IBS projects. Contractors are unable to claim from client because client also needs to claim from the bank. Bank will be unable to pay client because payment from bank towards client is also based on progression. The under developed mechanism payment mechanism really put contractors and suppliers in a tough spot	Payment mechanism are underdeveloped	R5

4.2.1.4 Category 4: Barriers of lacking Incentive and Directives by the government

Meaning Unit	Condensed Meaning Unit	Code	Respondents
Relatively less information is available for contractors. It needs more effort from government's side in order to make this work. Contractors are also worried a lot of things, like effects we don't understand, some hidden risk we can't foresee, which leads to contractor not actively using IBS.	Relatively less information is available for contractors, contractors are worried about effects or hidden risk that are unable to foresee.	Lack of unified, structured information	R1
Incentive wise, there is none that I know of. I think incentives are more for developers instead of contractors.	Incentives are more for developer instead of contractors.	Lack of incentive	R1
There are not a lot of information or guidelines from government that may help the contractor practically. In the market now the party who know their products best is supplier, I think. But sometimes supplier have their own agenda, they won't tell you the neutral information, they will just tell you the good aspects of using their product, but it may be not suitable for the situation	Relatively less information is available for contractors, and contractors have to ask many information from supplier. But suppliers may be bias with their products.	Lack of unified, structured information	R2
Unfortunately, the incentives given by the government to promote the open system such as lightweight blocks are close to non-existent	Incentives by government is inadequate	Lack of incentive	R2
I think there is some form of information available. If I'm not mistaken you can find some information regarding precast concrete system from CIDB website. But what I know is, most of the information is copied from Building Construction Authority (BCA) from Singapore. Whatever BCA does, CIDB just copy. I also know that the CIDB have a precast technology centre at Kuala Lumpur Chan Sow Lin, and they will have some exhibition throughout a year, but it is mostly a platform for industry players to build their networking.	Information available online not mostly copied from foreign countries. Exhibition are more for networking instead of getting information	Lack of unified, structured information	R3

For incentive, what I heard is when a contractor uses IBS, CIDB will record down the contractor's IBS score. When it accumulates to certain amount, the contractor will be able to save certain cost. However, I am not clear about the exact amount and details because I remember the incentives are not attractive.	Contractor are not clear with incentives available, and think the incentives are not attractive	Lack of incentive	R3
The industry needs guidance and forms of assistance from the government to improve the industry's readiness towards IBS systems. Only information about the products is available, but there are no standards or certify information or ways to evaluate them, which makes contractor worry about if the product can be accept by the authority.	The industry needs more form of information from the government. Product's information can be found, but there are no standards or certification available to evaluate them	Lack of unified, structured information	R4
So right now, a lot of issues still depends on the supplier, so they are the one very actively promoting their products, instead of the government. So, it can be said that if you want more accurate information, contractor will contact supplier. However, it can be said that every different prefabrication manufacturer has their own unique design and construction methods. This will lead to incompatibility in terms of dimension and installation method.	A lot of information needs to be obtained from the supplier. Every supplier in the industry has their own design and construction methods, which may result in incompatibility of the components	Lack of unified, structured information	R5
I don't think there is currently any form of incentives in place. However, there are enforcement instead of incentives in place for certain projects to compel contractors to adhere to certain guidelines. For example, there is a clause that requires a certain percentage of local products to be used. There also certain government buildings that require the utilisation of a certain percentage of IBS components.	No incentive available for contractors, but contractor know government's enforcement on using certain percentage of IBS components in a government building project.	Lack of incentive	R5

4.2.1.5 Analysis Table for Objective 1

	R1	R2	R3	R4	R5
Category 1: Barriers of insufficient skill and knowledge	✓		✓	✓	✓
Industry stakeholders are not equipped with sufficient knowledge and skills		✓		✓	✓
Industry stakeholders are unwilling to learn or to adapt IBS systems		✓			
IBS knowledge are not covered well in Universiti programs					✓
Wages are not attractive enough to retain knowledgeable or skillful IBS practitioner	✓		✓	✓	✓
Category 2: Barriers of supply chain fragmentation					
IBS are treated as an alternative solution				✓	✓
Need many expertise and coordination from various parties.	✓	✓			
Contractor are not involved in the designing stage			✓		
Industry stakeholder reluctant to exchange information					✓
Category 3: Barriers of underdeveloped payment mechanism					
Payment mechanism are underdeveloped	✓	✓			✓
Contractors are expected to pay capital cost	✓		✓		✓
Payment process is not standardized, and based on relationship or negotiation.	✓	✓		✓	
Category 4: Barriers of lacking Incentive and directives from the government					
Lack of unified, structured information	✓	✓	✓	✓	✓
Lack of incentive	✓	✓	✓	✓	✓

4.2.1.6 Data Analysis for Objective 1

The findings from the interview question identified many barriers faced by the IBS practitioners in the IBS implementation process.

For category 1, barrier of poor skill and knowledge, the findings indicate that four out of five respondents (R1, R3, R4, R5) agreed that Industry stakeholders are not equipped with sufficient knowledge and expertise of IBS which therefore, created some difficulties during the construction process. Moreover, three out of five respondents (R2, R4, R5) claim that the industry stakeholders or elder generations find it difficult accept IBS practices that contracted with their current practice. One respondent (R2) stated IBS knowledge are not covered well in Universiti programs; whereas another respondent (R5) said that knowledgeable or skilful personnel are not willing to work in Malaysia due to unattractive wages. The findings are supported by the literature review, where Rahman and Omar (2006); Nawi et al., (2011); Jusoh et al., (2014) Abidin et al., (2014); Abdullah and Egbu (2014); Ariffin et al., (2018) imply that most local professionals and contractors are not equipped with sufficient technical knowledge and have very limited experience towards IBS.

The supply chain fragmentation (category 2) is also one the barriers that contractors have to cope with when using IBS systems in construction project. 2 respondents (R4, R5) imply that IBS construction method are often thought as an alternative solution. For instance, IBS was only being consider when there is labour shortage around the industry, and not being planned at the beginning. On the other hand, 2 respondents (R1, R2) think the reason the IBS supply chain is fragmented because it constantly need suggestions and input from other professionals in order to make a decision, and there is no one able to provide one-stop solution for IBS systems. Respondent 3 (R3) pointed that most of the IBS projects need to be redesigned or reworked because contractors or suppliers are not involved at the designing stage, which leads to extra cost and time for the manufacturer to convert all the traditional construction drawings to IBS standard or specification. The points provided by the respondents correspond with the literature review, as research from Latham (1994); Abadi (2005); Nawi et al., (2011); Kamar and Hamid (2011); Nawi et al., (2014) and Fauzi et al., (2018) implies that the fragmented and disconnected construction supply chain is one of the consequential causes of low IBS implementation.

In category 3, questions regarding barriers of payment mechanism were being asked. Three respondents (R1, R2, R5) stated that payment mechanisms in Malaysia are still underdeveloped, and is disadvantageous towards contractor. Findings stated that most projects still apply PAM contract, so contractors are only allowed to claim works done on site even though majority of the IBS works are being done at the factory. As a lot of works are being carried out in the factory, contractors are expected to pay the capital to the suppliers in order to start fabrication works. Three respondents (R1, R3, R4) reveal that supplier will often request deposits from the contractor in order to start the fabrication works. One respondent adds on that it's even worse if project was being held under keep in view (KIV). The contractors will have to withstand the delayed payments. Other than underdeveloped payment mechanism and expected to pay out capital, three respondent (R1, R2, R4) indicates that the payment process is not standardised, and contractors will have to negotiate with suppliers and developer about the terms of payment. Maintaining good relationship becomes important, as negotiation need both sides to come to an understanding in order to work. The statement of respondent has the support of literature review, as researchers such as Shukor et al., (2011); Jaafar and Radzi (2013); Jalil et al., (2015); Hung et al., (2015); Mohammad et al., (2017); Dzulkalnine et al., (2017) had revealed that that current payment mechanisms available were not applicable for IBS projects.

Category 4 is the Barriers of lacking directives and incentive from the government. The lack of unified, structure information from the government is mentioned by all respondents (R1, R2, R3, R4, R5). Findings show relatively less information from the government concerns the contractors. One respondent claim that more guidance and form of assistance need to come from the government to improve the readiness towards IBS system. Another respondent said that a lot of information are obtained from the supplier side. However, over relying on suppliers is also not optimum, as suppliers are unable to provide neutral information over their products or systems. Furthermore, one respondent claims that information regarding precast concrete system can be found on CIDB website, but most of the information is copied from Building Construction Authority (BCA) from Singapore, which may not be applicable to local standards. These findings are supported by the literature review, as Nawi et al. (2014), Kamar et al., (2009), Hamid et al., (2008) and Hussein (2007) indicate the construction industry is indeed lacking directives or unified, structure information from the government. On the other hand, the lack of incentive is also agreed by all respondents (R1, R2, R3, R4, R5), however, compare to other barriers that the respondents have mentioned, relatively less information regarding lack of

incentive is provided by the respondents. Perhaps the lack of elaboration is the best explanation that the IBS is indeed lacking incentive or promotions from the government. The points provided by the respondents correspond with the literature review, as Foo (2016) and Hadi et al., (2017) mentioned the industry lacks attractive incentive that can motivate contractors to enter the IBS industry.

4.2.2 Second Objective

Second Objective

The second objective is to ask respondents to determine the critical success factors of implementing IBS in construction project and explain why the chosen factor is indeed critical to the success of implementing IBS in projects. The data to be analyse are collected from questionnaire section C. Five categories have been listed out from the data collection process.

Category 1: Training & Education
Category 2: Organisation Culture & Communication Skills
Category 3: Site Process & Management
Category 4: Supply Chain & Procurement
Category 5: Information Technology

4.2.2.1 Category 1: Training & Education

Meaning Unit	Condensed Meaning Unit	Code	Respondent
Or we can say in another way, we really need continuous professional development (CPD). We need information from the professional bodies. It is because if the body can't provide neutral suggestions, we can only obtain information from the supplier's side, which may not be optimum for the situation. Supplier will tell you the good side of their products, technologies, but won't tell you the other side.	Continuous professional development (CPD) is important, contractor need to obtain information from professional bodies.	Continuous professional development	R1
We are still able to train, training is not that difficult. Because if we want to train the worker, they can learn really fast with our training. It will be better if we can directly acquire these skilled workers, but if not, we can also train them very fast, very straightforward. It's like a kid who plays Lego, the work doesn't need special skills to operate, not like building the technical work. They just need to install.	Training is important. Training worker isn't as difficult, very straight forward	Retrain existing employees	R1
Yes, for precast concrete systems, there are two main things that need to be retrain for the management team. Engineers need to be familiar with the design concept, and Architect must be familiar with modular system. They must learn the concept of standardization, repetition, design a component using minimum types of shape and size, height possible. Less different sizes, less different mould needed	Training is important, engineer and architecture need to be familiar with relevant knowledge	Retrain existing employees	R2
Training is definitely important. We train and retrain our existing construction workers. Training and retraining are the important factor for the successful implementation for the Precast system for the construction industry, because the method of construction changed from labour intensive to mechanise.	Train and retrain employees are important, because method of construction changed from labour intensive to mechanise	Retrain existing employees	R2

The Continuous professional development is an important process to upgrade all the professional or sub-professional, even supervisory work, because the world is changing. For example, just now we mentioned about digitalization construction, robotics, so these things require a lot of retraining.	The Continuous professional development is an important process to upgrade all the professional or sub-professional.	Continuous professional development	R2
We do have knowledge management practices. We have a manual, or SOP for different installation skills for different products, the procedures are written in sequences and upload to cloud server, and is shared around the office.	Knowledge is written down and shared around the company.	Knowledge Management	R3
Personally, I think training is the more practical approach. Both site workers and management team need to learn the basic knowledge, such as installation, safety aspect, how to hoist, how to make sure it is in the right position, accuracy those. Nowadays, many foreign labors are still used to cast in situ method construction, and not familiar with the installation method, so we need training. Sometimes suppliers will introduce installer, and the installer will have their team to train our site labors as well.	Training and basic knowledge is important for both site workers and management team.	Retrain existing employees	R3
As I said, the training is important for the management team because technology in the factory is important, like how to cast the concrete component, how to design the mould, the steel mould. These technologies may be common already around the world, for Malaysia, it is still considered advance.	Training is important for the management team. Management team needs to learn how the factory functions	Retrain existing employees	R4
Training site workers are still ok; methods are quite straightforward. Just teach them how to do the installations. Management team requires a lot more training, because if they don't have the knowledge, they won't be able to arrange the work task, especially in precast project, it requires a lot of intense planning and arrangement, so it is necessary to provide them training. Site worker is really straightforward, supplier come teach, initially maybe the workers are not familiar, but once they get used to it, it would become very easy, but management team is different, need to know a lot about the arrangements, sequences, where to position the panels, in this aspect they require more knowledge.	Training is important. Site workers are easy to train because it's mostly hoisting and installation works. But management team require more training, because management team need to know many things about the arrangement and sequences.	Retrain existing employees	R5

4.2.2.2 Category 2: Organisation culture and Communication Skills

Meaning Unit	Condensed Meaning Unit	Code	Respondent
I think good working collaboration is really important. A good relationship and collaboration among the project members from commencement till completion can ensure smooth running of the project.	Good working collaboration is important from commencement till completion	Good working collaboration with others	R1
I think to run a project; the powerful leadership will come first as we need to lead a team to execute the works. The leader needs think of the big picture, provide a very clear instruction and ensure everyone is running in the same direction.	A leader that is able to provide clear instruction is very important.	Leadership	R1
Apparently, based on the previous IBS projects that I was involved in, I learn that many people are unexperienced with IBS. Therefore, collaboration with others became really important. Error will occur if we lack communication, like misunderstanding, and cause the works need to be redo, and eventually generate some negative energy among the team, or even lead to project delays.	Collaboration is important because many industry stakeholders are still unfamiliar with IBS	Good working collaboration with others	R2
If the environment is full of arguments, all of us will be in a bad mood and generate many negative thoughts. So, the process will be affected. On the other hand, if we can provide more positive thoughts, encouragement during the process, all of us will be very comfortable and do the work peacefully. This is the culture which can highly promote the success of the project.	Encouragement and motivation are important. Positive culture will promote the success of project	Positive working culture and behaviour	R2

Good communication is important. For example, if we miscommunicate, we might mess the arrangement order, obstruct everything and highly affect the result. Good communication can build good relationship with the suppliers, which can be very rewarding. Good communication within a team can improve team working skills and lead to positive collaboration	Good communication is important because it can build good relationship with suppliers, improve team work skills	Establish effective communication channel	R3
Teamwork is important. No matter what we do, we need to constantly interact with each other. Good collaboration between parties is essential to IBS. The ability to collaborate well with others will improve the project delivery speed significantly.	Good collaboration between parties may improve the project delivery speed significantly	Good working collaboration with others	R3
Good working collaboration with others is important, people will be more willing to share their knowledge, skills, experience with you.	Good working collaboration can improve the willingness of sharing information.	Good working collaboration with others	R4
An inspirational leader is important in a project. The leader must be capable of inspiring people to work, inspire people to follow, to achieve the goals.	Inspiring leadership that are capable to inspire people is important	Leadership	R4
Designing, manufacturing, transporting, installing requires many collaborations between each party. If everybody is working well with each other, many problems can be solved efficiently.	Good working collaboration with others can solve many problems efficiently.	Good working collaboration with others	R5
Leadership is needed on every level. We send our employees to leadership training programs. Leaders that know how to lead, to motivate, to provide direction, make right decisions, is important for a team to perform. A leader must always have himself as a team player.	Leaders that know how to lead, to motivate, to provide direction, make right decisions, is important for a team to perform	Leadership	R5

4.2.2.3 Category 3: Site Management & Process

Meaning Unit	Condensed Meaning Unit	Code	Respondent
The scheduling needs to be accurate, the schedule should be pass to the supplier. The supplier will strictly follow the given schedule. It is also essential for site to be prepare; certain task needs to be carried out at the right timing. For instance, when the components are delivered to site, se have to ensure there are spaces to store the newly arrived components, and store it in a way that it can be ready to install the next day, then just keep repeating the sequence.	It is essential for site to be prepare and certain task needs to be carried out at the right timing.	Just in time project delivery method	R1
One of the most important aspect of IBS implementation is extensive planning and process coordination. The planning needs to start early. Proper planning helps foresee issues related to site management and transportation. Production of components from factory, and uploading to the truck is determined by the installation sequences at site. The first panel that needs to be installed at site should be the last panel to be loaded on the truck. It is an exhausting job, unless process coordination was carried out between contractor and suppliers.	Project planning needs to be initiated early. Proper planning helps foresee issues in advance in terms of site management and logistics.	Extensive Planning and Process Coordination	R1
Just like other businesses, repetitive and continuous projects are important for business to survive. China can be so successful is because, design and build give them control, so their capabilities are not regulated by the architecture's design. Instead, it's more like contractor control architecture's design. By deciding on how to do the precast system first, then only think how to do the designing works. This is why I think they are successful. What amazed me even more they will use the same set of drawings to construct a same building at different areas.	Repetitive and continuous projects are important for business to survive. Same set of drawings to construct a same building at different areas	Standardisation	R2

We have a term for our planning process, its known as erecting floor cycle. The sequences of panel marking, erecting, concreting and mechanical and electrical are all listed out attentively by one team. For instance, the detailed plan will systematically label the components that should be delivered to site on which day, so it will be easier for workers to manage or install the components.	The sequences of panel marking, erecting, concreting and M&E are listed out attentively, so it will be easier for workers to manage or install the components.	Extensive Planning and Process Coordination	R2
A machinery such as tower crane, is vital to component installation. We need to study and conduct a proper site, labour and resource planning much better than conventional construction. Choosing the appropriate tower crane of 20 or 40 tons to carry out the work is important. Lifting panels is a big part of IBS construction. It needs competent personnel, close supervising and planning, failure to use proper machinery means the construction works will be delayed.	Choosing the proper machinery is important for the success of the project	Invest in heavy machineries	R2
Now imagine, you custom made an adjustable steel mould to cater different product shape or size, and every time after casting, you will have to adjust the mould constantly to cast different products. It will use a lot of time and human power. If is just length, it's easy, if it's too complex in terms of shape, many time and people will be use to adjust the mould, It's not really practical. Standardization is more advantageous than adjustable mould. One mould, every day cast the same thing. If I need to fabricate another type of panel, I will just fabricate another mould, dedicate for that panel, adjust every day is not efficient, and might damage the mould. That's why standardization is important.	Standardization is more advantageous than adjustable mould, as adjusting mould need time and manpower, so its not efficient to keep adjust the moulds.	Standardisation	R3

If the planning was miscommunicated or didn't provide a very clear direction, it will lead to project delay. Very detail planning and frequent communication is needed. Even the sequences of loading process at factory and unloading process at site needed to be careful. The last piece to install should be lastly loaded to the truck, once arrive to site, the last piece would be unloaded first and the first piece would be place on top and be ready for installation. All components also needed a mark, call panel marking. The marking will indicate the location to install, use at where. There are two methods of doing this. One is by using crayon, or uses QR code. The code is attached to the precast item. Every item will have their own QR code. It considers as digital construction as well.	Very detail planning and frequent communication is needed. The sequences of work need to be very clear; each panel have its own marking that indicate where and how to install.	Extensive Planning and Process Coordination	R3
Design freeze for super structure elements is very critical. We cannot accommodate design changes during the production or installation process. We will always remind the client and consultants that they must let us know early if there are design changes. Minor changes are allowed; we have ways; such as trimming, recasting, epoxy, to modify the panel. If the changes are too great, we will have to charge variation order, because we might need to fabricate a new mould, or hack those already fabricated.	Design freeze for super structure elements is important, as contractors may be unable to modify design changes during the production and assembling process.	Implement design freeze policy	R3
Contractors can try to negotiate or request clients to see they can simplify the design thereby reducing the types of mould needed for the project. Based on my past experience, there's a project that has almost 100 different type of dimension for it. We discuss with the client saying that the storage and handling would be very complex. So, we negotiate, some dimensions that are close, if the difference is just between 5mm to 10mm, we just standardize into one kind. If those are just in small quantity, just use cast in situ on site.	Standardisation is important and contractors can try to negotiate or request clients to see they can simplify the design thereby reducing the types of mould needed for the project	Standardisation	R4

Just in time delivery method is important because projects that uses precast system, sequencing is important. The panel fabricate at factory once can be delivered to site in time, is an important purpose of using IBS. The supplier side will have a system coordinator that we keep frequent communication with the contractor. Contractor will also study like when is the traffic congested and choose the right time, right route to deliver the panels. Usually, contractor is in charge of coordinating with site, factory, and supplier, and the supplier will coordinate with the transporter.	Just in time delivery method is important because the panel fabricate at factory can be delivered to site on time. Contractors will even study the traffic route to ensure timely deliveries of panel.	Just in time project delivery method	R4
Process coordination is important, especially between factory and project site. The factory must be flexible to fabricate based on the construction process. When works at site is called to halt, the fabrication works at factory shall also be stopped. Proper coordination can prevent double handling and storage problems. Transportation process also needs to be plan in advance, to avoid problems of panel transportation, and also to ensure the panels are in good condition during transportation.	Process coordination is important, can prevent double handling and storage problems.	Extensive Planning and Process Coordination	R4
There's a practice among architectures, that architectures will ask the dimensions of the supplier's mould, and design the projects based on the supplier's available mould. For instance, staircases are almost identical in many projects. So they will ask for the design. It can save a lot of money from the need to reopen a new mould.	Architectures will ask the dimensions of the supplier's mould, and design the project based of the given dimension.	Standardisation	R5
Just in time method is very important. For conventional projects, today's problem can only be solved tomorrow, but IBS projects is tomorrow's problem solve today. It's because precast projects are often repetitive, site workers can improve continuously, problems can foresee early. Moreover, it's also important to outline the transportation route to site to avoid delivery delays	Just in time method is very important, because precast projects are often repetitive, site workers can improve continuously, problems can foresee early	Just in time project delivery method	R5

4.2.2.4 Category 4: Supply Chain & Procurement

Meaning Unit	Condensed Meaning Unit	Code	Respondent
Using Design and Build can help implementing IBS in projects. Because contractors have more control on design aspect, and can propose the use of IBS systems. More IBS benefits can be attained if it is decided to use at the planning stage.	Design and Build (D&B) can help implementing IBS in projects because contractors can propose the use of IBS systems	Design & Build Procurement Method	R1
Design and Build can help. D&B can help because in an IBS project, the design part is the most important and takes a lot of time, effort and resources. If design and construction is combined together, it gives more responsibility to the contractor. It is best to be certain of using IBS in early stage, because transforming conventional design to IBS design can take a lot of time. Combining D&B and IBS could really speed up the project delivery time.	Design and Build (D&B) can help it gives more responsibility to the contractor. It is best to be certain of using IBS at early stage, because transforming design from conventional drawings to IBS drawings is time-consuming.	Design & Build Procurement Method	R2
It is known that contractors have no say at the beginning in a traditional method of procurement. Design & Build can help by giving more responsibility to contractors, contractors can propose to client, as well as start work at site earlier. Combining the use of D&B and IBS might be costly. IBS construction normally cannot compete with conventional construction methods in terms of cost.	Design and Build (D&B) can help it gives more responsibility to the contractor. Contractor can propose the use of IBS, as well as start work early	Design & Build Procurement Method	R3

Once a project is awarded, forming a consortium with the supplier may make the communication go a lot smoother since profit and risk are being shared by both sides. Like I said just now, for IBS projects, the industry now really much depends on the expertise of the suppliers. Even consultants have to ask supplier for advice. Choosing a right supplier is so important. Sometimes rather than choosing a supplier based on the lowest price, we would also consider the service or other values that the supplier can put on the table. Going for the lowest price is not always the answer.	Forming a consortium with the supplier may make the communication go a lot smoother, as the industry now really much depends on the expertise of the suppliers.	Forming Consortium with other Organisations	R4
I will choose Design & Build (D&B) over others. I'm not familiar with other methods. I know through D&B, contractors can promote the use of IBS easier, but it still depends on the client. D&B can also reduce drawing mistakes. In a conventional method, mistakes made at the drawing stage may not be discovered until item was about to installed on site.	Contractors can propose the use of IBS systems using D&B procurement. D&B can also reduce drawing mistakes	Design & Build Procurement Method	R5

4.2.2.5 Category 5: Information Technology

Meaning Unit	Condensed Meaning Unit	Code	Respondent
Designing software like AutoCAD are useful. If we compared with the old times in Malaysia, it really changed dramatically. In the old times, if we needed to find the discrepancy from the drawings, we needed to find it one by one. But with the help of IT, we can find it very fast.	Utilizing BIM can find discrepancy from drawings easily	Utilize BIM to improve designing process	R1
The use of Information and Communication Technology is really helpful. It provides more platforms for different parties to communicate and transmit the message. This is the era of technology, so it is critical. It can be very helpful in many perspectives.	ICT provide more platform for different parties to communicate	Utilize ICT to improve communication process	R1
Implementing IT in designing works is important. Our company uses Building Information Modelling (BIM). There's a lot of shop drawings to process in a precast concrete project, and by using BIM, it can prevent clashes, and there is software that can automatically generate the quantities, like how many concretes, how many bars, all these, so it's very useful for IBS projects	Utilizing BIM can detect clashes, and can automatically generate the quantities needed for the project	Utilize BIM to improve designing process	R2
Information and Communication Technology is useful. For formal communication you have email, for more casual ones you have WhatsApp or Telegram, feedback response is almost immediate, which is vital for today's society.	ICT is able to receive feedback promptly.	Utilize ICT to improve communication process	R2

Precast nowadays are getting more complex, now we have to consider the M& E services, connection detail. It's good to invest a bit money buy some good software, is very helpful. Users can also zoom in or zoom out on the drawings to look better at the details.	Projects are getting more complex so utilizing BIM can be helpful	Utilize BIM to improve designing process	R3
Information communication technology is useful, our company uses cloud computing to share information, and it is by far way more efficient than transferring through WhatsApp or other communication channels. Staff can even access important info when they are not in office, no hard drive required, can transferred huge file size.	ICT is very convenient for workers to share, transfer, or store information.	Utilize ICT to improve communication process	R3
For IT, I think it's already implemented in precast projects long time ago. I think Building Information Modeling (BIM) is important. Even nowadays they have many software such as TEKLA concrete. Once you import the design, they will automatically generate a very detail shop drawing, like such as need how many steel bars or hook needed to put inside the components. It is a software that emphasize on the details, but it requires input from the users. For instance, I want to draw a beam, beneath two steel bar, upper side two steel bar, and the beam join to column, it can be illustrate clearly using the software.	BIM is convenient because it can automatically generate a very detail shop drawing and the quantities as well	Utilize BIM to improve designing process	R4
Information and Communication Technology is also useful, sharing information promptly increases work efficiency, keeping various parties updated.	ICT can share information promptly, increase work efficiency, and keep various parties updated.	Utilize ICT to improve communication process	R4

There's difference between precast and conventional drawings, for precast projects, one panel means one shop drawing. It could be just in A4 size. Everything requires a lot of detail. Even the hook radius how much will also be demonstrated, very accurate. Manually drawing it not possible nor efficient, it heavily depends on software drawings. Also, because the precast system is very detailed, so before you go into these factory or product for pre-casting, they will be thousands of drawings, shop drawings, it will be a nightmare to manage so many shop drawings without a designing software.	BIM is useful to generate shop drawings. One project may have thousands of shop drawings, which is impossible to manage or draw manually without the help of BIM	Utilize BIM to improve designing process	R5
Rather than just using Information and Communication Technology to sending message, drawings and whatnot, I think what matters is IT communications gives more accessibilities to other, and can build relationship with consultants or suppliers. When communication is good, supply chain will improve.	Other than the basic functions that ICT can offer; it can also build relationship with other stakeholders easily	Utilize ICT to improve communication process	R5

4.2.2.6 Analysis Table for Objective 2

	R1	R2	R3	R4	R5	
1. Continuous professional development	✓	✓				**2**
2. Knowledge Management			✓			**1**
3. Retrain existing employees	✓	✓	✓	✓	✓	**5**
4. Positive working culture and behaviour		✓				**1**
5. Good Leadership	✓			✓	✓	**3**
6. Top-Down Commitment						**0**
7. Establish effective communication channel			✓			**1**
8. Good working collaboration with others	✓	✓	✓	✓	✓	**5**
9. Extensive Planning and Process Coordination	✓	✓	✓	✓		**4**
10. Just in time project delivery method	✓			✓	✓	**3**
11. Invest in heavy machineries		✓				**1**
12. Standardization		✓	✓	✓	✓	**4**
13. Implement design freeze policy			✓			**1**
14. Partnering with other organisations to improve project delivery						**0**
15. Forming consortium with other organisations				✓		**1**
16. Design & Build procurement method	✓	✓	✓		✓	**4**
17. Integrated Project Delivery						**0**
18. Utilize IT to improve designing process	✓	✓	✓	✓	✓	**5**
19. Utilize IT to improve communication process	✓	✓	✓	✓	✓	**5**
	9	**10**	**10**	**9**	**8**	**46**

4.2.2.7 Findings Analysis for Objective 2

19 factors were listed out for the respondents to choose and explain why the selected factor is critical to the success of implementing IBS system in construction projects. A table is generated to demonstrate the chosen factors by the respondents.

For the first category, retrain existing staff is chosen by all five respondents. It's interesting to see that two out of five respondents mentioned that retraining site workers is more efficient than hiring new IBS skill workers, as the training process should be quite straightforward. One respondent said that retraining existing staff was vital as the method of construction changed from labour intensive to more machinery based. On the other hand, 2 respondents said that management team training is also important, as they need to know a lot about the knowledge of arrangements, sequences, concept of standardization and repetition. Continuous professional development is chosen by two respondents, as involving staff in Continuous professional development is an important process to upgrade all the professional. Knowledge management is only chosen by one respondent. The respondent think knowledge sharing around the office is important to successful IBS implementation.

For the second category, the respondents all agreed that establishing good working collaboration is important and contributes to the successful implementation of IBS. R1 stated that good working collaboration is important from project commencement till completion because it helps the project go smoothly. R2 explain that many people from different parties are actually still unexperienced with IBS. This situation makes good working collaboration very important, as we need different ideas or knowledge from each other, and any miscommunication or misunderstanding may lead to redo works, or even project delays. R3 stated that Good collaboration between parties will improve the project delivery speed significantly. R4 shows that good working collaboration may lead to other parties more willingly to share their information. R5 stated that good working collaboration is needed on designing, manufacturing, transporting, and installing processes, and many problems can be solved with ease if collaboration between parties is good. Powerful leadership is selected by three respondents (R1, R4, R5). R1 indicates that powerful leadership is needed to influence the workers, provide clear instructions and ensure everyone is moving in the same direction. R4 also make similar comments, saying that leadership is needed to inspire people to accept IBS working methods. R5 stated that a competent leader that is able to make right decisions is important because it can promote good working collaboration between on site and management teams. Effective communicational channel is only selected by R3 as one of the critical success

factors. R3 explains that any form of miscommunication may have minor or major consequences. R3 also add on that good communication channel may build good relationship with the suppliers, or improve team working and lead to positive collaboration. Positive working culture and behaviour is only selected by R2 as a critical success factor to implement IBS systems. R2 explain that a negative working culture will demotivate the use of IBS systems. Encouragement or motivations will promote positive working culture, and people will be more willingly to adapt into new system or technologies. The factors that are not chosen by any of the respondents in this category is 'Top-Down Commitment'. It might be because IBS projects are rare in Malaysia, therefore the upper management did not feel the need to commit into IBS projects. Moreover, it is more difficult for IBS systems to maintain competitiveness compared to conventional method.

For the third category, four out of five respondents chose extensive planning and process coordination as an important aspect of IBS implementation. R1 claims that proper planning helps foresee issues regarding site management and logistics in advance. R2 stated that a detailed planning process that list out all the sequences of work can make workers manage or install the components with ease. R3 indicated that very detail planning and frequent communication is needed in IBS projects, and extensive planning can be even improved with the helped of digital construction. Furthermore, R4 stated that proper coordination can prevent double handling and storage problems. Three out of five respondents (R1, R4, R5) select Just in time project delivery method as critical factors of implementing IBS in construction projects. R1 stated that it is essential to practice Just in time project delivery, as it can ensure the materials or components delivered to project site on the actual day of use of just the day before, thereby reducing space needed for storing the items. R4 also make similar comments that Just in time delivery method is important because it ensure the materials or components delivered to site when it is needed. R4 also added that in order for Just in time project delivery to work, contractors should also conduct studies regarding traffic so logistics can choose the right time, right route to deliver the panels. R5 indicate that Just-in-time delivery method is important because it improves site performance continuously by foreseeing the problems early. R5 also stated that it's critical to outline the transportation route to site to avoid any delays. Four out of five respondents (R2, R3, R4, R5) acknowledge the importance of standardization. R2 said the reason that he thinks standardization is important is because the cost of mould would be greatly reduced if it can achieve repetitive usage. R3 stated that standardization of components is more advantageous than flexible moulds, as adjusting the mould constantly to cast different products will use a lot of time and human power. R4 indicate by standardizing the components, the

storage and handling works will be direct and simple, thereby increase efficiency. R5 also agree that standardization is critical to the IBS industry, and explain that one of the standardization practices among the industry is architect will ask the dimensions of the supplier's mould, and then design the projects based on the given dimension. One respondent (R2) choses invest in heavy machineries as critical success factor of IBS. The respondent indicates that the use of machinery such as tower crane is vital to assemble the panels. R2 add on that lifting panels is big art on IBS construction, and choosing the right crane to be used is important. Failure to use proper machinery means the project delivery will be delayed. The author thinks the reason no other respondents choose this is because not all IBS system requires heavy machineries, and since modular systems are not used in Malaysia, it is unnecessary for local contractors to invest in a 40, 50-ton crane yet. Moving on, R3 select implementing design freeze principle as one of the critical success factors. R3 explain that design freeze the super structure elements is important because design changes cannot be accommodated during the fabrication and installation process. Minor changes are allowed as there are ways to trim or recast the components. But if the changes are too great, contractors will have to charge variation order.

For the fourth category, the findings show four out of five respondents choses design and build (D&B) procurement as an important factor to successful IBS implementation. R1 point out that D&B procurement allows contractor to have more control on design aspect, and can propose the use of IBS systems. R2 explain that the design part is the most important and takes the most time, effort and resources. If design process and construction process is combined together, it gives more responsibility and control to the contractor, and can ensure early use of IBS systems. R3 also explain that D&B procurement gives contractor more responsibility, and contractor can propose the use of IBS system more conveniently. R5 stated that D&B procurement can reduce drawing mistakes, because it bypasses the need of transforming conventional drawings into IBS drawings if the client decided early to construct the project using IBS method. Only 1 respondent (R4) stated that forming a consortium with the supplier is important towards the implementation of IBS, as the industry now really much depends on the expertise of the suppliers. Partnering with other organisations to improve project delivery and Integrated Project Delivery. It may be because partnering approach is not common and the concept of profit and risk sharing is not perceived as a favourable method. Throughout the interview, it was also mentioned by the respondents that integrated project delivery method was commonly practice in Singapore, but not here in Malaysia.

For the fifth category, the findings show that all five respondents agreed that utilizing Information Technology to improve designing process and communication process are both

important in the implementation of IBS in projects. R1 point out that designing soft wares are extremely helpful in finding discrepancy between drawings. R2 stated that designing software such as BIM can help managing shop drawings effectively, as it is possible that one project to have thousands of shop drawings. The designing software can help detect clashes, and automatically generate quantities needed for the project. R3 highlighted that designing software is helpful because it offers functions such as zoom in or zoom out to look better at the details. R4 explain the use of BIM is important, because certain software can automatically illustrate a very detail shop drawing once the design details is import inside the software. R5 also explain the same suggestions as other respondents, saying BIM can help illustrate very detail drawings, and can manage large amount of shop drawings effectively. On the other hand, findings also show that all five respondents agreed that using Information technology to improve communication process is important towards IBS implementation. R1 and R4 point out that ICT can share information promptly, keep various parties updated, and increases work efficiency. R2 said feedback response are almost immediate using ICT, which can be really helpful. R3 said cloud computing can share information effectively, transferring huge file between each other, and staff can even access important info when they are not in office. R5 add on that ICT can improve supply chain because it provides more accessibilities to others, and can build relationship with other stakeholders easily.

CHAPTER 5
DISCUSSION

5.1 Introduction

This chapter will describe the significance of findings. The author will also interpret the findings based on the author's understanding.

5.2 Barriers of Implementing IBS in construction projects

This study shows that there are four barriers of implementing IBS in construction projects. The four barriers are namely: poor skill & knowledge, supply chain fragmentation, underdeveloped payment mechanism, and lack of incentives and directives from the government. The barriers can affect the various stakeholders if it remains unsolved. The barriers will be a very challenging situation for local companies to implement IBS systems in their business. The industry players still preferred conventional labour-intensive method rather than IBS systems. The barriers also serve as a challenge for the local companies to compete with international competitors that are stronger in terms of financial capability, technology or specialization.

Throughout the findings, it indicates that most local contractors or local professionals lack technical knowledge and experience in the IBS. This situation of insufficient knowledge and experience will cause unnecessary delay or lead to unforeseen risks. Other than the professionals, the skill level of local workers are not great as well as most site workers are so used to conventional working methods. According to Rahman and Omar (2006), the role of the contractor is shifted from builder to an assembler, therefore there is a need for contractors to be equipped technologically with IBS knowledge and skill. The author agrees with Rahman and Omar (2006), but also thinks that professionals such architect and engineer also need to allocate time and resources to pick up the IBS knowledge and skill, as the professionals or consultants are the one that can advocate the use of IBS systems for the clients. The author also agrees with Rahman and Omar (2006); Abdullah and Egbu (2014), that IBS subjects should be incorporate into Universiti syllabus.

Another barrier of implementing IBS in construction is the fragmented supply chain. The findings show that the reasons of fragmented supply chain are due to the need of involvement, expertise and coordination from various parties; Industry stakeholder reluctant to exchange information; Contractor are not involved in the designing stage; and IBS are treated as an after solution. There are various authors that recommend innovative procurement systems that may minimise fragmentations in the conventional procurement method. For instance, Nawi et al.,

(2014) indicates an approach towards integrated team practice can be practice to minimise fragmentation, while Ariffin et al., (2018) recommends integrated project delivery or partnering approach can improve the supply chain. However, the author thinks the innovative procurement approach are still not widely trust by the industry stakeholders, because the industry lacks the experience to practice innovative procurement systems. On the other hand, pricings are usually the contractor's main priority, and contractor may be unable to offer repeat business opportunities to same partner or supplier. Without a regular partner, or supplier, it can be difficult to implement innovative procurement system. The author thinks what the contractor can do at this current stage is to develop good relationship with different industry parties and enhance communication skills to improve overall project performance, as it seems like a more pragmatic way to cut down fragmentations.

Furthermore, underdeveloped payment mechanism is also one of the barriers that contractor have to cope with when implementing IBS in construction projects. The findings show that contractors are bother by the non-existent of IBS standard regulations or contract documents suitable for IBS projects. Other than that, contractors are expected to pay capital cost to the manufacturers, but only be able to claim back the cost once there is progress on site. Moreover, since payment processes are not standardized, the contractors will have to negotiate with manufacturers and developers regarding the payment terms. According to Jaafar and Radzi (2003), there is a need to develop a procurement system with payment mechanism that is fair to the contractor. The author agrees with Jaafar and Radzi (2003), that a distinct set of procurement system and payment mechanism dedicated for IBS projects should be developed and promoted, as it will definitely expedite the IBS implementation process. The author thinks what the contractor can do at this current stage is to negotiate with the developer that certain percentage of product aspect should be constitute as part of the initial payment, thereby easing the issue of delayed payments. However, a written agreement needs to be signed by both parties to be legally enforceable, so the author also thinks contractors should realize the importance of relationship in negotiation.

Lastly, the lack of incentive and directive from the government is also barrier to the successful implementation of IBS. The findings show that the respondents all agree the incentive are inadequate, has no direct effect meaning to the contractors. One respondent also indicates that the current policy is developed in favour of larger stakeholders such as developer who are viewed to be the main driving force of IBS implementation. Moreover, the respondents argued that they are usually unaware of the announcement or directive by the governments. Without the directives, the contractors will be worried about the effects or hidden risk that they

are unable to foresee. It seems like there is a mismatch between the IBS target set by the government and the current industry's readiness to adopt IBS systems. Hence, the author thinks the government should formulate a new strategy which will benefit the project stakeholder in IBS implementation. On top of that, the government should also impose a reduction of company's tax for a company that involved in IBS project. Tax benefits are expected to motivate industry players to adopt IBS systems more willingly. One of the respondents suggest that the government should imitate the strategies of other countries that adopt IBS successfully. The respondent said that Singapore has a green award initiative called the "Green and gracious builders award". The award recognizes the conscious effort of contractors in implementing gracious practices that helped to develop a more positive image of the industry. The contractors who received this award will be consider priorly to tender for future projects. More job opportunities can also be a form of motivation for the contractor parties. Through this initiative, it promotes the use of IBS systems, allows contractor to be more competitive and reputable.

5.3 The critical success factors of Implementing IBS in construction projects

The purpose of determining critical success factors will give an organization a competitive edge and is the bottom line of success in fulfilling the responsibility of a project management companies. This in turn will give rise to satisfied investors and make the project management company prosper. Throughout the study of literature review, there are 5 different key areas that is defined as important to achieved in order to implement IBS in construction projects. The five key areas are training & education; organisation culture & communication; site process & management; supply chain & procurement; and information technologies.

Knowledge was highlighted as the first step on understanding how to change; training and education on new skills; and the process of learning new tools, behaviours and processes (Tamrin, Nawi & Nifa, 2016). The beginning of a transformation often begins with obtaining knowledge because it is very important for the success of the transformation. The result of the interviews shows the respondents agree that to train the management team and site workers with relevant knowledge contributes as a success factor of implementing IBS in construction projects. If it is to compare the level of a skilled worker between conventional construction methods, IBS is definitely more demanding. A well-trained workforce is very crucial as IBS methods requires new skill sets which is very different from the traditional method of construction. The combination of technical and management knowledge must be fulfilled by contractors to implement IBS in projects successfully.

Collaboration is a repetitive process whereby two or more people or organisations work collectively to achieve their shared goals. Under key area Organisation Culture & Communication Skills, good working collaboration with others is agreed by all respondents. Good working collaboration in a project from commencement till completion enhances information sharing, storing, and management; solve problems efficiently, and may improve the project delivery process. The author agrees with the findings, that to implement IBS system in a project successfully depends highly on the quality of competent human and entities or organization that are able to collaborate with each other effectively.

The other factor that was agreed by the respondents under key area Organisation Culture & Communication Skills is powerful leadership. The result of the interviews indicates that the role of leader should be capable of leading a team to execute works, provide clear instructions, inspiring or motivate the workers, and knowing how to make the right decision. Great leadership often leads to great integration and project coordination. The author thinks other than the features mentioned in the findings, a good leader should also be able to create a culture of accountability. When mistake occurs in a project, the leader's response should not be pointing fingers or blaming workers, but should focus on solving problems and learning from mistakes. A culture of accountability also helps building trust between employees and owners.

Moving on, Extensive planning & process coordination is deemed as one if the critical success factors by all respondents. The results from the interviews indicates that project planning needs to be initiated early as it helps foresee problems regarding site management and logistics in advance. Many aspects will need to be taken into consideration during planning and scheduling activity for an IBS project. Minor details such as the sequences of loading and unloading to panels from transportation trucks should also be taken care of. During the installation phase, during the installation phase, contractors should also identify the ground conditions, size of the site and the best routes and time to the project site before installation works can begin. Certain situations where access to site is restricted, the building itself may have to be designed. On the other hand, it is important to coordinate properly with the manufacturers. Fabrication process should strictly follow the process on site. Proper coordination can prevent double handling and storage problems. The finding has shown the planning process for an IBS project needs to be attentive to details, which can be very different from a conventional project. The author believes traditional planning and scheduling practices would not be able to handle IBS projects and extensive planning and process coordination should be carry out in order to ensure successful IBS project implementation.

Furthermore, the concept of standardisation is also perceived as one of the critical success factors by the respondents. Standardization increase efficiency by simplifying the communication process, reduced project costs by process simplification, shorter time to manage business processes and better use of human resources. The results from respondent show that standardisation of components is more efficient than an adjustable mould that can fabricate different shape and sizes of components. Adjusting a mould may need a low of time and man power, which is not recommended. Moreover, the respondents also elaborate a few practices that may promote standardisation practices. For instance, contractors are known to negotiate with client to see if the designs size and shapes can be simplified, and architect will ask the dimensions of the supplier's mould, and then design the projects based on the given dimension. However, the author thinks that it will challenging to apply the standardisation concept in Malaysia, because, it is not common for Malaysians to accept repetitive design. Perhaps the government should come out with more directives regarding standardisation, such as by finalizing the standard dimensions of the components first, then only proceed to project designing stage.

Under the fifth key area supply chain & procurement, the findings showed using design and build procurement method is the best-case scenario for utilizing IBS system. Design and build procurement method can allow the contractor to have more control over the whole project flow. One significant advantage of design and build procurement method is the drawing works can be carried out concurrently while the earth-work or pilling works are being carried out on site. The process still requires consultation with project owners or clients to finalize the design works. By going straight towards producing IBS drawings helps to phase out redundant works in conventional method, especially during the superstructure stage. Another significant advantage of implementing IBS in projects using design and build procurement, as it is easier for contractors to propose the use of IBS systems. It is best that IBS is selected as the construction method at the early stage of the project in order to attain the maximum benefit from IBS. The benefits would not be noticeable if IBS is to be used as an alternative solution, or introduced after the designing, manufacture or assembly stage.

Information technology (IT) has proven to be a key enabler in product design aspect of implementing IBS in construction industry. Similarly, an advance and more complex construction project such as modular houses can only be illustrated and developed using an extensive and modern IT software. Results from findings demonstrated that it is important to utilize information technology to improve designing process. The designing software are extremely helpful in managing shop drawings and finding discrepancy or clashes between

drawings, as it is possible that one project to have thousands of shop drawings. Moreover, the designing software can also automatically illustrate a very detail shop drawing, or generate the quantities needed for the project once the design details is import inside the software. The computer technology and system accessible nowadays can help contribute to a well-planned and systematic IBS system.

Meanwhile, findings also show that all five respondents agreed that using Information technology to improve communication process is important towards IBS implementation. The role of IT software may form communication between project team and manufacturers and also act as a medium for quality control of overall project deliveries by sharing information promptly, keep various parties updated, and increases work efficiency. The communication channel allows effective 'feedback-respond' activities between all the project stakeholders. Errors can be detected more early thus avoiding problems during the manufacturing and assembly phase. The ease of communicating with each other also allows industry stakeholders to build relationship with each other effortlessly. On the other hand, there are also results mentioning the role of cloud computing can share information effectively, transferring huge file between each other, and staff can even access important info when they are not in office.

Throughout the results, the author realizes that even though the respondents mentioned that IT was an important factor in the implementation of IBS system in projects, respondents only use BIM software to generate or manage drawings, and not use for information sharing and communication, which contradict with the studies of Nawi et al. (2014), as the researchers indicate the developments of BIM software initially are targeted to solve the common practice of information sharing and communication. The prefer communication method used by the respondents are still mainly ICT such as E-mail, Telegram, ow WhatsApp. Perhaps the practice of using BIM to share or communicate with each other is still not a common practice in Malaysia, as different stakeholders may use different types of software, which make information sharing not as convenient as IT that are dedicated for communication.

CHAPTER 6
CONCLUSION

6.1 Introduction

This chapter will include the summary of research, limitations of study, and recommendations for future research.

6.2 Conclusion

This study is carried out for the purpose of identifying the barriers the contractor has to cope with when implementing IBS in construction projects, and also to determine the critical success factors of implementing IBS in construction projects.

The first objective of the research is to identify the barriers that contractors have to face when implementing IBS. Among all the barriers, lack of sufficient knowledge and incentive seemed to outshine other barriers. It is helpful to identify the barriers, as it may help the contractors to be better prepare for facing the barriers that may encounter while implementing IBS in projects. Through this research, one can know what challenges to expect when IBS comes into consideration.

The second objective of the research is to determines different key areas that should be focused upon the implementation of IBS, in order to guide on what contractors should do to overall ease the implementation process. The key areas are: training & education; organisational culture & communication; site process & management; supply chain & procurement; and information technology. It is beneficial to identify what type of key area can enhance IBS implementation as in overall. Through this research, one can decide to invest time, money and energy into the right aspects when IBS comes into consideration or application. The results from both of the studies can be utilized for further research on IBS implementation.

6.3 Limitations of research

Based on findings obtained and discussion made, there is a clear indication on need and room for improvement for this study. There are multiple limitation factors in conducting this study. It might be due to IBS is still consider a rare trade around Malaysia, so there are not a lot of respondents have myriad of experience and knowledge that can provide relevant information. Furthermore, initially this study was hope to target a sample size of ten interviewees, but at the end, the sample size was narrowed down to five respondents. As this study was conducted by sole researcher only with one supervisor, the amount of work that can

be done has a limit or capacity. If there were additional time or manpower, then it could probably produce a more perceptive and credible study.

6.4 Recommendations

In concluding this research study, the author hopes the future academic researchers who are concern with the issues of implementing IBS in construction projects to carry out a research study on how to overcome the barriers of implementing IBS in projects, which are not covered in this research study. Furthermore, other researchers can also try to explore this topic from other industry stakeholder's perspective. Lastly, this study recommends the future academic researchers to utilize the quantitative approach or mixed method approach for future similar studies, in order to collect more responses on the barriers and critical success factors of implementing IBS in construction projects.

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APPENDICIES
APPENDIX A: Questionnaire

A STUDY ON CRITICAL SUCCESS FACTORS OF IMPLEMENTING INDUSTRIALISED BUILDING SYSTEM IN MALAYSIA

CONSENT FORM FOR QUESTIONNAIRE SURVEY OF MEBH15109 PROJECT

Research team contacts

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Description

This project is being undertaken as part of Mater of Project Management programme. The purpose of this project is to identify the barriers that contractors have to cope with when implementing IBS in their construction projects, and to determine the critical success factors of implementing IBS. The research team requests your assistance because your input will be important to provide us with as understanding of the industry practice and key factors for implementing IBS in construction projects.

Participation

Your participation in this project is voluntary. If you do agree to participate, you can withdraw from participation at any time during the project without comment and penalty. Your decision to participate will in no way impact upon your current or future relationship with UTAR. Your participation will involve as an interviewee for approximately 90 minutes

Confidentiality

All comments and responses are anonymous and will be treated confidentiality, and would not be shared publicly.

Question/ Further information about the project

Please contact the researcher team members named above to have any questions answered or if you required further information about the project.

Statement of consent

By participating in the interview, you are indicating that you:

- Have read and understood the information document regarding this project.
- Have had any questions answered to your satisfaction.
- Understand that if you have any additional questions, you can contact the research team.
- Understand you are free to withdraw at any time, without comment or penalty.
- Agree to participate in this project.

Section A: Respondent's Profile

Please fill in all the fields and tick (√) in the appropriate box.

1. Name: _____

2. Company's name: _____

3. Job Position: _____

3. How long have you been working in the construction industry?

☐ 1-5 years ☐ 11-15 years

☐ 6-10 years ☐ More than 15 years

4. How many IBS projects have you been involved in?

☐ 1-5 projects ☐ 11-15 projects

☐ 6-10 projects ☐ More than 15 projects

5. What is the largest IBS project that you have been involved before?

☐ Less than RM10 million ☐ RM30-40 million

☐ RM10-20 million ☐ RM40-50 million

☐ RM20-30 million ☐ More than RM50 million

Section B: To identify the barriers that contractors have to cope with when implementing IBS in their construction projects.

I. The adoption of IBS system by construction industry stakeholders are still relatively low in Malaysia due to the following reasons:

- Poor Skill and Knowledge
- Supply Chain Fragmentation
- Payment Mechanism
- Lack of Incentive and information

II. Respondents will be asked to explain how IBS contractors cope with the barriers of adopting IBS in construction projects.

1. Insufficient Skill and Knowledge

Insufficient technical knowledge and limited experience regarding IBS systems among the industry players serves as a barrier and it causes unnecessary delay in the development process. Do you think the industry stakeholders have sufficient knowledge or skill regarding IBS? What are the reasons behind insufficient skill and knowledge?

2. Supply Chain Fragmentation

Supply chain is defined as the network between a company and its suppliers to produce and distribute a specific product to its final buyer. This network may comprise various types of activities, people, entities, information, and resources. Fragmentation refers to the isolation of too many professionals. The increasing number of organisation and professions involved in the process of constructing a project is caused by the growing demand for project specialisations, differentiation as well as the project size and complexity. Do you think the supply chain of IBS project is fragmented? How is the supply chain fragmented?

3. Underdeveloped Payment Mechanism

The underdeveloped payment mechanism and contract documents are not fully trusted by the industry stakeholders, and there are no known detailed IBS guideline/standard regulation/contract documents dedicated for IBS projects. Moreover, payments are expected to be made from contractor to manufacturer once the fabrication process starts. Additionally, the common payment practice in Malaysia is the S-curve method, which payment is made based on progress, which leads to payments made from client towards contractor for IBS projects are also based on progress, which may be unfavourable for contractors. Do you agree that the payment mechanism is underdeveloped?

4. Lack of Incentive and Directives from the Government

Studies show that there are not a lot of reliable sources, or any feasible, structured, unified information available for IBS contractors to refer to, and also the lack of incentive support from the government is also perceived as a barrier by the industry players. Are there any form of incentives or directives from the government available for the contractor?

Section C: Critical Success Factors of Implementing IBS in Malaysia

I. Critical Success Factors (CSF) are defined as satisfactory results of certain areas which will ensure successful performance for the organisation, individual or department. In other words, things must go right in a few key areas for the business to flourish. It is advantageous to determine the key success area within the company. Each area has different roles/task so it is imperative to personalized their very own key success factors. CSF helps to develop a range of key areas to focus on. The organisation can then allocate their valuable resources into the areas which really make the distinction between success and failure.

II. The key areas that contribute as a success factor are: Training & Education, Organisation Culture & Communication Skills, Cost Management, Site Process and Management, Supply Chain & Procurement, and Information Technology.

III. Respondents are asked to determine the factors from the key areas that contributes as a success factor of adopting IBS in Malaysia, and explain why or how the chosen factor is a critical success factor. Respondents may choose more than one factor from the key areas.

IV. Respondents are encouraged to refer the note section behind for clearer definition.

I. Which one of the following factors do you think contributes as a success factor in terms of Training & Education?

A. Assign site labours or management team to IBS training program.
B. Practice knowledge management (1) so that IBS knowledge are captured, transferred, shared in order to enhance organisation performance
C. Practice Continuous Professional Development (CPD) (2) in order to improve professional knowledge.

II. Which one of the following factors do you think contributes as a success factor in terms of Organisation Culture & Communication Skills?

A. Positive working culture and behaviour
B. Powerful leadership
C. Top-Down commitment (3)
D. Good working collaboration between internal and external parties
E. Effective communication channel between internal and external parties

III. Which one of the following factors do you think contributes as a success factor in terms of Site Process and Management?

A. Extensive planning and scheduling (4)
B. Just in time project delivery method (5)
C. Invest in heavy machineries
D. Standardisation of IBS components to increase efficiency and communication process
E. Implement design freeze principle to mitigate design changes (6)

IV. Which one of the following factors do you think contributes as a success factor in the key area Supply Chain & Procurement?

A. Partnering with other organisations to improve project delivery (7)
B. Forming consortium with other organisations (8)
C. Design & Build procurement method
D. Integrated Project Delivery (9)

V. Do you think information technology plays a huge role in the successful adoption of IBS systems?

A. Implement IT to improve designing process
B. Implement IT to improve communication process

Notes for Section C:

1. **Knowledge management**

   Knowledge management is defined as any form of practice, process that is able to identified, captured, transferred, shared, available knowledge to enhance organisation performance and learning opportunities.

2. **Continuous Professional Development (CPD)**

   Continuous Professional Development (CPD) is defined as a life-long learning process that maintains, enhances, or increase the knowledge and skills of professionals in order to ensure their knowledge and ability are pertinent to the society needs. Professional bodies such as Board of Engineer or Board of Architects are responsible to ensure current issues are being address and the level of knowledge acquired among the professionals are relevant. The initiatives of CPD organize by professional boards can be in the form of trainings, conference, short courses, technology transfer and seminars.

3. **Top-Down commitment**

   Top-down commitment refers to the commitment from project manager towards their workers, which includes active modelling and motivating desired behaviours and value, involving in learning system and implement change efforts.

4. **Extensive planning and scheduling**

   Refers to the planning and scheduling for all stages of work, including initial works, manufacturing process at a factory, transportation works to site location, installation and finishing works. A well-planned schedule could also ensure all parties to comprehensively understand their own job task

5. **Just in time project delivery method**

   Just in time (JIT)is a form of logistic management, and is defined as a philosophy of manufacturing that strives to eliminate waste as well as aiming for continuous improvement. For instance, materials or panels can be delivered to site when it is needed, or a day before the site need it, thereby reducing inventory.

6. **Implement design freeze principle to restrict design changes**

   Later design changes during the construction phase are not favourable, difficult to implement, and affects the production schedule. The concept of a design freeze principle is to help mitigate effects of any late design changes.

7. **Partnering with other organisations to improve project delivery**

   Partnering involves an agreement among the parties in order to achieve mutual objective, continuous improvement and problem resolutions. Partnering can incorporate all relevant construction parties from design till construction stage in order to overcome obstacles.

8. **To form an IBS consortium**

   A consortium is an association of two or more individuals or organisations with the objective of participating in a common activity, such as pooling their resources or responding to a tender in order to achieve a common goal. A consortium is formed by contract, and within the consortium, each party retain their separate legal status and consortium's control over each party is only limited to the activities involved in the joint endeavour, particularly the divisions of profits

9. **Integrated Project Delivery**

   Integrated Project Delivery (IPD) is a business structure for designing, implementing and transmitting the building works by incorporating, integrating, assembling a productive team of project players such as project owners, architect, engineer, main contractor, sub-contractor, manufacturer, supplier and others. All construction parties participating in a project using IPD method were all incorporated with Building Information Modelling (BIM) software to share information and execute works from design stage till completion stage.