BARRIERS IN THE IMPLEMENTATION OF IBS FORMWORK IN MALAYSIAN CONSTRUCTION INDUSTRY

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ABSTRAK

Pengunaan IBS di dalam Industri pembinaan di Malaysia semakin berkembang namun tidah bagi kotak acuan IBS.Penyelidikan ini memberi tumpuan kepada faktor-faktor penting dalam pelaksanaan penggunaan kotak acuan IBS dalam industri pembinaan Malaysia. Berdasarkan kajian penyelidikan terdahulu, ada lima (5) halangan utama dan kriteria mencabar yang diklasifikasikan sebagai kesukaran untuk kejayaan aplikasi sistem kerja IBS; isu-isu yang berkaitan dengan had teknikal produk, kos permulaan & halangan kewangan yang tinggi, bimbingan insentif & promosi kurang, kurang sokongan produk dan pendedahan kekurangan pada kerja IBS adalah penting sebagai dimensi utama untuk penggunaan sistem kerja IBS untuk berjaya. Objektif projek ini adalah untuk mengkaji amalan kerja IBS dalam industri pembinaan Malaysia, menentukan halangan dalam pelaksanaan IBS dalam industri pembinaan Malaysia dan untuk menunjukkan halangan utama dalam pelaksanaan kerja-kerja IBS dalam industri pembinaan Malaysia. Kajian kaji selidik telah dijalankan untuk mencapai matlamat. Responden terdiri daripada orang yang terlibat dalam projek pembinaan. Data telah diukur menggunakan Microsoft Excel dan kemudian dianalisis dengan menggunakan analisis frekuensi, indeks purata dan kedudukan. Sebagai kesimpulan, halangan pelaksanaan IBS di Malaysia telah dikenalpasti dan dibincangkan. Menurut kajian ini, batasan teknikal produk, kos awal & halangan kewangan yang tinggi dan kurangnya bimbingan insentif & promosi adalah faktor halangan utama dalam pelaksanaan IBS di Malaysia

ABSTRACT

Nowadays, in Malaysian construction industry, the use of IBS as a method of construction is develop rapidly, but not for this type of IBS; IBS formwork or prefabricated formwork. This research is to focal point the critical factors of implementation the used of Industrialized Building System (IBS) formwork or namely as pre-fabricated formwork system in the Malaysian construction industry. Based on the reviews of a previous research and related literature, this paper was identified five (5) main barriers and challenging criteria that classified as a difficulties to the success of IBS formwork system application; the issues related to product technical limitation, high initial cost & financial barriers, lack incentive & promotion guidance, less product support and lack exposure on IBS formwork were highlight as a key dimension for the uses of IBS formwork system to success. The objective of this paper is to investigate the practice of IBS formwork in Malaysian construction industry, determine barriers in implementation of IBS in Malaysian construction industry and to point out the main barriers in implementation of IBS formwork in Malaysian construction industry. Questionnaires survey was conducted in order to achieve the objectives. The respondents consisted of person who involved in construction project. The data were tabulated using Microsoft Excel and then analyzed using frequency analysis, average index and ranked. In conclusion, the barriers of IBS implementation in Malaysia has been identified and discussed. According to this research, product technical limitation, high initial cost & financial barriers and lack incentive & promotion guidance are the main barriers factor in IBS implementation in Malaysia.

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LIST OF SYMBOLS

IBS	Industrial Building System
CIDB	Construction Industry Development Board
EPU	Economic Planning Unit

LIST OF ABBREVIATIONS

IBS	Industrial Building System
CIDB	Construction Industry Development Board
EPU	Economic Planning Unit

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Formwork is an ancillary construction, used as a mould for a structure. Into this mould, fresh concrete is placed only to harden subsequently (Mishra, Gopal, 2012).

(Mishra, Gopal, 2012) also stated that the construction of formwork takes time and involves expenditure up to 20 to 25% of the cost of the structure or even more. Design of these temporary structures is made to economic expenditure. The operation of removing the formwork is known as stripping. Stripped formwork can be reused. Reusable forms are known as panel forms and non-usable are called stationary forms.

Timber is the most common material used for formwork. The disadvantage with timber formwork is that it will warp, swell and shrink. Application of water impermeable cost to the surface of wood mitigates these defects. To ensure the quality of finished concrete structures, box form should have the following characteristics:

- ✓ Formwork should be straight to resist deflection during concreting.
- ✓ Formwork form must have the strength to support the weight or pressure and vibration during concrete compaction process.
- ✓ To be installed correctly and properly according to size and level as determined.
- ✓ The connection shapes must be closely and securely so that it does not leak to prevent loss of concrete water.
- ✓ Pieces and parts are easy to unit lifted, installed and removed.

- ✓ Order of referral units trapped by concrete poured and easily opened and not damages the concrete.

- ✓ Surface of the slab and the internal divided units should be straight and flat with no impurities. This should be used each time the box.

The development of construction technology was increase day by day. The IBS technology was introduced in construction industry. The Industrialized Building Systems (IBS) is defined as a construction process which utilized techniques, products, components, or building systems that involves with prefabricated components and on-site installation (Zawawi, 2009). The IBS formwork that includes metal/steel, aluminium and plastic gained its popularity recently due to its flexibility of application in many projects, recyclable at many phase of construction; and can be used in different types of design structure (Baharuddin, Bahardin, Zaidi, Yusof, & Lokman, 2015). This factor is giving a significance impact towards the importance of IBS formwork system applied in the Malaysian construction industry.

The Construction Industry Development Board (CIDB) Malaysia in 2017 reported that, the implementation of IBS formwork was relatively lower as compared to the other components of IBS system. The study has shown that, issues related to high initial capital investment for pre-casters in purchasing new machinery, mould, transferring a foreign technology as well as highly wages of skilled workers; were reflected to the lower application of this system. Furthermore, lack of knowledge in IBS formwork technology among the Malaysian construction industry stakeholder has given a consequence in creating an understanding, awareness and readiness to applied IBS formwork system.

The CIDB Malaysia classified the IBS component into a few system namely precast concrete framing, panel and box systems, reusable formwork systems, steel framing systems, prefabricated systems, block work system and innovation. The formwork system provides extra advantages as a sustainable formwork which can provides better speeds of construction, lower life-cycle costs, almost indestructible and reducing the additional site work (Baharuddin,2015).On the other hand, the IBS formwork is one of the intelligent components introduced to reduce the chaining of various problems which comes from construction industry.

As a sustainable element technology, IBS formwork was full of benefits in fulfil the basic goal of construction; time, resources and quality .Nevertheless, the expectation in application of IBS formwork in construction industries sounds mushrooming seen contradictive. Even the CIDB of Malaysia actively promoting the use of IBS in construction, the application of IBS by the Malaysian stakeholder was lack and relatively below the target. The stakeholders are needs to align with the paradigm shift from conventional construction process into a lean construction method .Since, there is little research related to readiness factors of using IBS formwork system in Malaysia were raised by researchers; the research is tend to focus on the critical factors and its difficulties by using this system in the Malaysian construction sector.

1.2 Problem Statement

Research study need to identify the objectives of research from the problem statement. Based on Zawawi,2009 he stated that the level of IBS usage in local construction industry is only 15% in 2003 (CIDB,2003a) while in 2006 only 10% which is less than one third of completed construction project using at least one IBS product (CIDB,2007). Based on the Roadmap mid-term review, it is clearly stated that one of the most barrier is negative perception by the consumer & the practitioner

Besides, the existence of this IBS formwork seems to be one of the problem solving in reducing the used of conventional formwork which famous of additional site work and quiet waste based on time, cost and safety (Haron, 2015). Nevertheless, production of IBS formwork with full of advantages seems not glowing enough when their application still not rapidly embracing (Nawi, 2011).

The IBS or prefabricated formwork is known as one of the best alternative in completing the construction project nowadays. The existence of this IBS formwork seems to be one of the problem solving in reducing the used of conventional formwork which was exposed to the additional site work in nature as well as to the construction waste that finally affected the time, cost and safety (Nawi, Anuar, & Lee, 2013).

In respecting to this scenario, the study on identification of critical factor and its difficulties for applying IBS formwork; will assists the Malaysian government to overcome the shortcomings. This can provides an alternative solution to enhancing the uses of IBS formwork in the Malaysian construction industry.

1.3 Research Question

It is essential to develop research questions in order to help on focus the area research and the presentation of the report. Followings are some research questions that arise when conducting the research:

- ✓ What are the challenges and problems in construction industry?
- ✓ What are the issues in current development of IBS in Malaysian construction industry?
- ✓ What are acceptances of prefabricated or IBS steel formwork in Malaysian construction industry?
- ✓ What are the barriers to the implementation prefabricated or IBS steel formwork in Malaysian construction industry?
- ✓ What type of information to be collected?
- ✓ How to carry out the questionnaire?
- ✓ Who are the respondents?
- ✓ How to make use of the data collected?

1.4 Objective of Research

From the problem statement listed, we have decided the objective that we will achieve in this project. There are the objectives:

i. To investigate the practice of IBS formwork in Malaysian construction industry.

ii. To determine barriers in implementation of IBS formwork in Malaysian construction industry; and

iii. To point out the main barriers in implementation of IBS formwork in Malaysian construction industry

1.5 Scope of Study and Limitation

The scope of study is only focusing on the development of construction industry in Malaysia to achieve the objectives. Concentrating on construction industry in Malaysia could give a clearer sight of view of the overall development in local industry. Random sampling will be done in assigned area, whom practicing conventional construction method and IBS method. There are some limitations for this study:

i. The information and data taken only covers projects within 2005 until now.

ii. Area of data collection confines within state of Selangor because this state is the highest IBS formwork manufacture.

By review on previous researches that focus on the similar area of study, some of the barriers was highlighted and the input is obtained by questionnaires prepared based on it. The respondents are mainly consisted of contractors, consultants, developers, architects and quantity surveyors in Malaysia. This is to survey on the readiness of these construction players to embrace IBS and identify barriers in implementation of IBS formwork into the construction industry.

The analyses are based on respondent's data from questionnaires only. The analysis results do not represent the whole construction industry in Malaysia. However the discussion is based on comparison of the analyses data and information from literature studies. Conclusions were made according to objectives of the study.

1.6 Significant of Study

Malaysia had facing many challenge in construction industry and the main challenge listed are lack of innovation and technology in industry. Besides, motivation as the workforce is aging and shrinking as progressively fewer young enter the industry .In addition, the challenges facing our construction industry is the acute shortage of construction workers. This, together with the social problems associated with foreign workers, further aggravates the situation.

If this phenomenon persist, the industry will rapid to a very unhealthy condition, for example rely heavily on foreign workers, lack of technology and modernization in

construction techniques. Hence, the industrialization of building construction system and the evolution of construction technology are unavoidable and tenable.

The IBS system is well known in construction industry, year by year, the uses of IBS system is increase. Usually, they use precast concrete system, Steel-framed building and Roof Trusses and Block Work System. But steel formwork system is not widely used in Malaysian construction industry because of some factors.

The first phase of successive implementation of IBS formwork is the ability to find out the barriers that hinders the development of IBS formwork in Malaysia construction industry. This is very important because if the barriers of implementation of IBS formwork system are identified, it enables for finding out solutions by focusing effort to solve the problems.

1.7 Research Methodology

The research methodology has been carried out to fulfil the objectives of the study which include the method of data collection such as documents study, case study, preparation of questionnaires and data collection. The research procedures are as shown in Figure 3.1in chapter 3.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In order to face the challenges of the construction industry, designers and contractors should be sensitive to the use of the latest technologies. Lately the government through the body CIDB (Construction Industry Development Board) seriously promote the use of Industrialised Building System (IBS) in the construction sector. IBS is believed to provide a construction system that promises better quality, fast and cost effective (Nawi, 2011; Nawi, 2014a).Sector-based building industry or IBS (Industrialised Building System) is still considered relatively new in Malaysia, although this system has long been used in developed countries such as in Europe. IBS is a system that has been proposed in several European countries after the World War 2 as a solution to provide the sudden high demands on houses and other infrastructures. This technique is applied in order to reduce the dependence on number of workers and to reduce time consuming (Maryam , 2010).

IBS is a construction process that it utilizes the advanced techniques, products, components, or building systems which involve prefabricated component and on-site installation. This industrialization process consists of many different approaches; it begins with the organizational process with continuous production to imply a steady flow of demand, and then integration between different stages during the production such as designs, workforce allocation and quality checking (Nawi, Mydin, Elias, Shaharanee, & Yusoff, 2014).

2.2 Definition of IBS

Generally, IBS (also known as offsite manufacturing in the UK construction industry) is defined from two perspectives, namely, system and process of construction. Parid (1997) defined IBS as a system which uses industrialized techniques either in the production of components or assembly of a building, or both. Similarly, Trikha (1999) classified IBS as "a system in which concrete components prefabricated at sites or in factories are assembled to form structures under strict quality control and minimum in situ construction activity."

In early literature, Dietz (1971) defined IBS as "a total integration of all subsystem and components into overall process fully utilizing industrialized production, transportation and assembly techniques".

Warszawski (1999) described IBS as "a set of interrelated element that act together to enable the designated performance of the building". At the same time Trikha (1999) added that IBS is a "system in which concrete components prefabricated at site or in factory are assembly to form the structure with minimum in situ construction

Rahman (2006) defined IBS as "a construction system that is built using pre-fabricated components. The manufacturing of the components is systematically done using machine, formworks and other forms of mechanical equipment. The components are manufactured offsite and once completed will be delivered to construction sites for assembly and erection

Almost all the definition of IBS mentioned the prefabrication, off-site production and mass production of building components as a main characteristic of IBS. The scope of IBS focuses the construction of buildings rather than civil structure or engineering projects. For the purpose of this research, IBS is best defined according to CIDB Malaysia (2013) is a term used in Malaysia for a technique of construction where by components are manufactured in a controlled environment, either at site or off site, placed and assembled into construction works

2.3 History of IBS in Malaysia

IBS began in early 1960's when Ministry of Housing and Local Government of Malaysia visited several European countries and evaluate their housing development program (Thanoon, W.A.M., Peng, L.W., AbdulKadir, M.R., Jaafar, M.S. and Salit, M.S. , 2003) . After their successful visit in the year 1964, the government had launched pilot project on IBS to speed up the delivery time and built affordable and quality houses. Nearly, 22.7 acres of land along Jalan Pekeliling was dedicated to the project comprising 7 blocks of 17 stories flat (3000 unit of low-cost flat and 40 shop lot. This project is taken by Gammon/Larsen Nielsen using Danish System of large panel of pre-fabricated system. In 1965, the government of Malaysia launched second project, a 6 block of 17 story flats and 3 blocks of 18 stories flat at Jalan Rifle Range. The project was awarded to Hochtief/Chee Seng using French Estoit System (Din, 1984). Between 1981 and 1993, PKNS a state government development agency acquired pre -cast concrete technology from Praton Haus International based on Germany to build low cost house and high cost bungalow in Selangor (CIDB, 2003.)

In Malaysia construction industry today, the use of IBS as a method of construction is evolving. More local manufacture is established themselves in the market. As a result precast, steel frame and other IBS were used as hybrid construction to build national landmark such as Bukit Jalil Sport Complex, LRT and PETRONAS Twin Tower. It was reported that at least 21 of various manufacturers and suppliers of IBS are actively promoting their system in Malaysia (Thanoon, W.A.M., Peng, L.W., AbdulKadir, M.R., Jaafar, M.S. and Salit, M.S. , 2003). IBS move to next step of the development through the establishment of IBS Centre initiated by CIDB at Jalan Chan Sow Lin, Cheras, Kuala Lumpur. The obligation to implement IBS strategies and activities from this centre serves concurrent both to improve performance and quality in construction, also to minimize the dependency of unskilled foreign labours flooding the construction market.

2.4 Development IBS in Malaysia

Figure 2.1 is a chart of technological development in our country the development of IBS. Here we can see a series of Road Map has been carried out and the program will run expectations MIIE 2011 April. In this MIIE exhibition, we can see

many new products introduced for the purposes of IBS and the contractor and customer knowledge, and community out there.

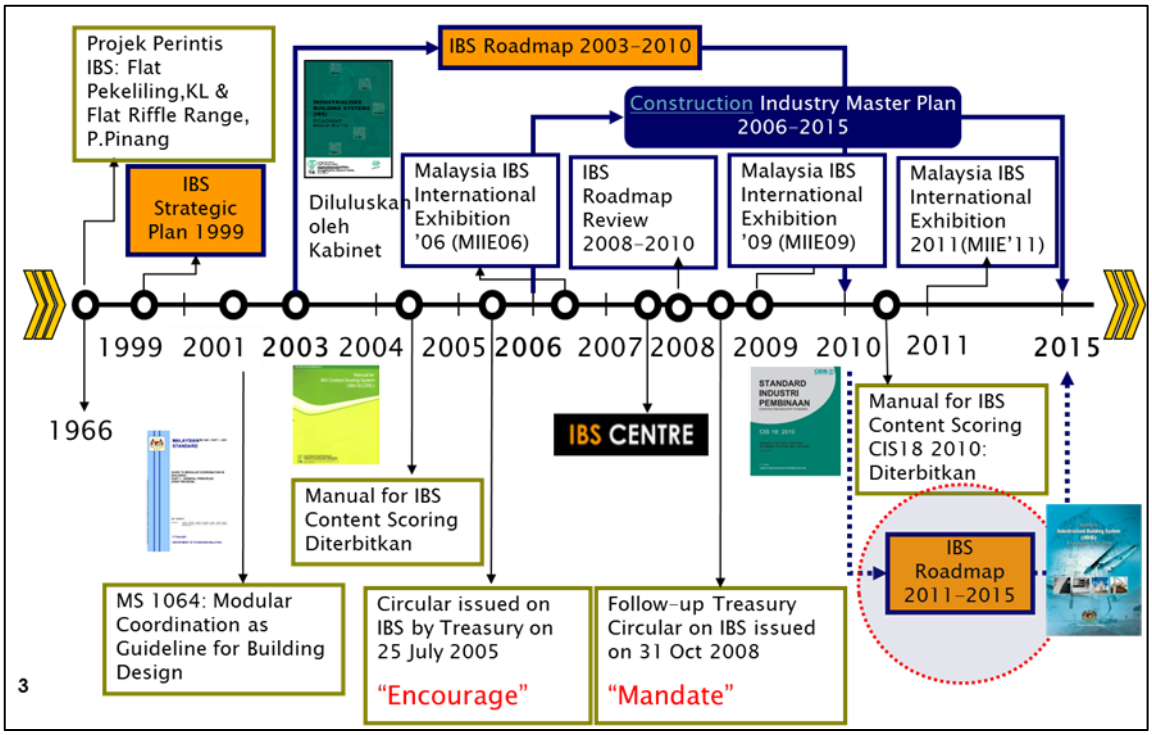

Figure 2.1 Developments of IBS in Malaysia

Sources: Wsuzana (2011)

2.5 Classification of IBS Type

In Malaysia, CIDB (2003) has classified IBS into five categories, which are pre-cast concrete framing panel and box system, steel formwork systems, steel frame system, timber frame system and block work system. IBS is a construction process that utilizes techniques, products, components or building systems which involved prefabricated components and on-site installation. From the structural classification, there are five IBS main groups that are used in Malaysia as shown at following sub-section, which mainly based on classification by CIDB with some modification to it. But for this thesis only focus on prefabricated formwork system which typically made from steel.

2.5.1 Steel Formwork System

This system categorized as an IBS because the process of construction is carried out using a systematic and mechanized method that is by using reusable steel formwork panels. The system allows the rapid on-site placement of cast in situ concrete to form beams, columns, slabs and walls. The system is better preferred for the construction of walls instead of column and beam due to many repetitive of similar wall components in wall frame buildings. Steel formwork components are normally available in standard panel sizes and stiffened using built in stiffeners or tie rods to resist lateral concrete pressure during concreting. It offers faster speed of erection, comparatively lower cost and simplicity in equipment. It also provides good accuracy and smooth internal finishing that eliminate the need of plastering.

Formwork system (box mold) is defined as the mold wood, steel or other materials which are mixed concrete at the construction site will be cast into it while waiting for the concrete to harden. (Azman, 2012). According to JT Grundy, box mould (Formwork) is sometimes known as a cover board or vertical pieces to form the still wet concrete during placing of concrete work. The component also some of the most concrete finishing strong. The mould constructed must not have a significant effect on the economy, strength, firmness and rigidity. Generally, there are two types of mould box (formwork) that are commonly used that kind of permanent and temporary. Box mould (formwork) is a type of permanent mold box (formwork) that will be left after the completion of the concrete work.

Type box mould (formwork) while waiting for the building was used in the concrete hardens. Appearance at the end of the concrete surface and the development work of the mold box (formwork) of this type is based on the frequency of use of the system

Identified as one of the least prefabricated types of the IBS, it generally involves concrete at the construction site and high quality control. These products provide a high quality finish, faster construction and demand relatively less labour and materials. This includes the "tunnel form", the "lilt-up" beam system, "moulding form" columns and a permanent steel mould.

Figure 2.2 Steel Formwork

2.6 Characteristic of IBS

2.6.1 Advantages

According to CIDB (2003), compares to conventional construction method, the industrialized building system has the following advantages:

i. Less construction time

IBS requires less construction time because casting of precast element at factory and foundation work at site can occur simultaneously and the work at site is only the erection of IBS components. This leads to earlier occupation of the building.

ii. Cost savings

The formwork of IBS components are made of steel, aluminium or other materials that allows for repetitive use and this leads to considerable cost savings.

iii. Saving in labour

When the IBS components are produced in factory, higher degree of utilisation of machine is permitted and the use of labour will be reduced and lead to saving in labour cost.

iv. Less labour at site

The use of IBS will reduce the construction process at site and consequently reduce the number of labour required at site.

v. Optimized use of material

The utilization of machine during the production of IBS components lead to higher degree of precision and accuracy in the production and consequently reduce material wastage.

vi. Higher quality and better finishes

An IBS component have higher quality and better finishes due to the careful selection of materials, use of advanced technology, better and strict quality assurance control since production in factory is under sheltered environment. vii. Construction operation less affected by weather Faster project completion due to rapid all weather construction. The effects of weather on construction operation are less due to the fabrication of IBS components is done in factory while at site is only erection of the components.

vii. Flexibility

IBS provides flexibility in the design of precast element so that different systems may produce their own unique prefabrication construction methods. ix. Increase site safety and neatness Utilization of IBS components leads to less construction process especially wet work at site. This will lead to the neater site condition and increase safety.

viii. Environmental friendly

The use of IBS will decrease the using of timber formwork on construction projects.

2.6.2 Disadvantages

Due to existence of constraints of IBS where management and skill different from traditional construction, the practioners will not choose to use IBS unless is required by client (Kamar et al., 2012). Hence, it I apparent that client plays an important role to determine the use of IBS. Below is constraint of IBS based on CIDB 2003

i. High capital costs

Initial capital costs are usually high. At this stage this includes all costs from the construction of factories, the casting of beds and the acquisition of support machineries which are usually very expensive. Besides that, in some IBS there is a tremendous demand for export labour. Therefore, extra costs are required to train the unskilled or semi-skilled labour.

ii. Problem of joints between components

Malaysia is a country with an equatorial climate. Such countries often experience heavy rainfall during the monsoon seasons every year. This leads to the problem of leakages which is a major problem faced by buildings constructed using IBS applications. When a leakage manifests, other complications may follow and these includes dampness, corrosion and so on.

iii. Sophisticated plants and skilled operators

In the IBS system, extensive usage of sophisticated plants and machineries are involved. These are operated and maintained by skilled operators. If there are any damages to the plants or on the machines, a significant impact will be resulted upon the production of IBS components.

iv. Site accessibility

Site facility and accessibility is one of the most important factors in the implementation of the IBS. The IBS requires adequate access to transport all IBS components of the plants up to the construction sites. It is possible for complications to arise at the construction sites. An example is the delay in the installation of the

components due to transportation woes which could result in a delay in the overall construction. The installation task would then have to be performed later.

v. Large Working Area

Construction projects using the IBS require large work areas for the plants, trailers, tower cranes and storage for the IBS components. In addition, most construction sites, especially those in cities are often crowded and cannot provide the required area.

2.7 Definition of Formwork

(Industri Resources Formwork, 2006) state the formwork is best described as a structure which is usually temporary but can be whole or part permanent, it is used to contain poured concrete to mould it into required dimensions and support until it is able to support itself. Formwork also can be defined used to form concrete into structural shapes (beams, columns, slabs, shells) for building. Formwork can be of timber, steel, plastic, or fiberglass. The inside surface is coated with a bond breaker (plastic or oil) to keep the concrete from sticking to the mold.

There are many different types of formwork used in construction, usually differing according to what the building requirements and challenges are. (Brooks, 2008) described the formwork is used by creating moulds out of wood, steel, aluminum or prefabricated forms into which the concrete is poured. This is then allowed to harden and set after which it is stripped, or in the case of stay-in-place formwork it is left as part of the structure.

Requirements of a good formwork system are depending on how formwork can be erected and de-shuttered fast, how good concrete quality and surface finish can be achieved, what is the optimum stock of formwork required for the size of work force, the specified time schedule and flow of materials, what is the overall cost savings that can be achieved using the right type of formwork and how safety can be improved for the site personnel.

2.8 Categories of Formwork

Basically formworks are categories into three which are conventional, Modern-Day Formworks and Engineered/Pre-fabricated Formworks (Ravishnkar, 2015)

Conventional formwork is the formwork is built on site out of timber and plywood or moisture-resistant particleboard. It is easy to produce but time-consuming for larger structures, and the plywood facing has a relatively short lifespan. It is still used extensively where the labour costs are lower than the costs for procuring reusable formwork. It is also the most flexible type of formwork, so even where other systems are in use, complicated sections may use it.

Figure 2.3 Conventional Formwork Using Timber

Modern-Day Formworks is formwork systems are mostly modular, which are designed for speed and efficiency. They are designed to provide increased accuracy and minimize waste in construction and most have enhanced health and safety features built-in. The main types of formwork systems in use now are; Table form/flying form, System column formwork, Horizontal panel, Slip form and Tunnel form.

Engineered or Pre-fabricated Formworks is formwork is built out of prefabricated modules with a metal frame (usually steel or aluminium) and covered on

the application (concrete) side with material having the wanted surface structure (steel, aluminium, timber, etc.).

2.9 IBS Formwork

Prefabricated forming systems offer the contractor the ability to assemble components for almost any size or shape form; the need for very little on-site skilled labor; the ability to reuse forms either as a large section or as individual units. (The Aberdeen Group, 1966)

Engineered or Pre-fabricated Formworks is formwork built out of prefabricated modules with a metal frame (usually steel or aluminium) and covered on the application (concrete) side with material having the wanted surface structure (steel, aluminium, timber, etc.). (Ravishnkar, 2015)

Material that typically used for prefabricated formwork is steel or aluminium and plastic. Steel formwork are stronger, durable and have longer life than timber formwork and their reuses are more in number .Steel forms can be installed and dismantled with greater ease and speed. Besides, the quality of exposed concrete surface by using steel forms is good and such surfaces need no further treatment. Steel formwork does not absorb moisture from concrete and does not shrink or warp. (Ravishnkar, 2015)

Aluminium formworks are often used in pre-fabricated formwork that is put together on site. Aluminium is strong and light, and consequently fewer supports and ties are required. The lighter sections will deflect more, but this can be avoided by simply following the manufacturer's recommendations. (Ravishnkar, 2015).

Plastic formwork is glass reinforced plastics (GRP) and vacuum formed plastics are used when complicated concrete shapes are required (e.g. waffle floors).Although vacuum formed plastics will always need support; GRP can be fabricated with integral bearers making itself supporting. Like steel, plastic formwork can be re-used many times, as long as care is taken not to scour the surface whilst vibrating the concrete. (Ravishnkar, 2015)

2.10 Type of IBS Formwork

There are different types of formwork available for different purposes. Generally, the formworks for vertical concreting are called wall forms and those for horizontal concreting are called slab or floor forms.

i. Climbing Formwork

Method of casting walls consists of a climbing formwork; the climbing of which may be manual or crane assisted. It employs a common set of forms used in a repetitive manner for casting walls in set vertical lifts. After each casting the forms are removed and raised to form the next lift until the required height has been reached. These forms are widely used in the construction of industrial chimneys, silos, high rise towers & building cores, bridge piers & pylons, airport control towers, telecommunication, towers etc.

ii. Sliding Formwork or Slip Forming

Slip form means a continuously moving form, moving with such a speed that concrete when exposed has already achieved enough strength to support the vertical pressure from concrete still in the form as well as to withstand lateral pressure caused by wind .Thus, the slip form concreting technique is a rapid and economical construction method that can be applied with great advantage to many types of construction projects such as chimneys, silos, water towers, bridge-columns, lift shaft cores and shaft lining. The technique is based on movable forms which are gradually lifted by hydraulic jacks. It is a continuous process where wet concrete is added to wet concrete. Reinforcing steel and/or post tensioned cables are continuously fixed as the normal slipping speed is 3 to 6 meters per 24 hours. The slip form construction is designed for each project depending on the structure of the project

iii. Permanent Formwork

Permanent form or stay-in-place formwork is one in which the form is left as an integral part of the structure. Permanent formwork can also be utilized as the facing materials of in situ reinforced concrete. They can be of two types—participating and non-participating. The material used for these forms must be durable and of sufficient strength. Commonly used materials include polyvinyl chloride (PVC), galvanized

coiled sheet steel, fabricated steel, carbon/epoxy thin shell. The high initial cost of design and installation, lack of familiarity for installation and maintenance and more specified form design are some of the barriers to the use of this form. However, there are various advantages like low cost of transportation and installation, precise form design, maximum flexibility, greater durability with reduced long term maintenance and versatility.

iv. Special Forms

These are those forms that are specially designed and manufactured for a particular kind of construction. The need for a special formwork may arise due to several factors such as;

a. When the contract demands the highest class of dimensional tolerance to be followed

b. Where the form work shape required becomes uneconomical or impracticable for site fabrication

c. Where the formwork is required to be self-contained i.e. self-propelled.

d. Where rate of concreting, admixtures or types of concrete are such that concrete pressure developed within forms and stresses in the forms demand special attention where a substantial number of re-uses is envisaged

v. Table Form

This is a special formwork designed for use in casting large repetitive floor slabs in medium to high-rise structures. The main objective of reducing the time required re-erecting, striking and re-erecting slab formwork. A system which can be put as an entire unit, removed, hoisted and repositioned without any dismantling.

vi. Tunnel Form

The tunnel formwork is a room sized structural steel fabricated form which is used to cast the Reinforced Cement Concrete (RCC) walls and floor slabs of a building as a monolithic structure in a continuous pour. The forms are then heated using hot air blowers for accelerated curing of the concrete. This system is most economical when

the structure consists of large number of identical units. There exist two versions of this type of formwork. They are:

a. The half tunnel formwork used to cast only one wall and slab simultaneously.

b. The full tunnel formwork used to cast two walls and a slab simultaneously

The sequence of construction involves placing of reinforcement, electrical and sanitary conduits along with the tunnel forms. Concrete is then poured and the open side of the forms is covered and hot air blowers placed inside. The forms are removed the next day and placed on the next site using cranes. The optimum use of tunnel form is in multiunit shear wall structure with identical floor layout at each level.

vii. Ganged Panel Form

The increasing pace in the construction of multi-storey and massive concrete structures, and the parallel progress in development of cranes and other mechanical methods of transporting forms have made the use of ganged prefabricated forms for the concreting of large sections of high walls very common. Ranging up to 30x50 ft, their size is limited only by the mechanics of handling. Large panels can be assembled flat on the ground where it is easier to work. Delay and lost motion are avoided in stripping because the gang forms are stripped as a unit.

2.11 Barriers and Challenging Criteria

Based on Baharuddin (2015), the implementation of pre-fabricated or IBS formwork is known as one of the best alternative in completing the construction project nowadays. The existence of this pre-fabricated formwork seems to be one of the problem solving in reducing the used of conventional formwork which famous of additional site work and quiet waste based on time, cost and safety (Haron, 2015).

Nevertheless, production of pre-fabricated formwork with full of advantages seems not glowing enough when their application still not rapidly embracing (Nawi, 2011). Based on the study conducted by (Azman, 2010b), the adoption of the IBS formwork system still lack as there is only twelve (12) number of IBS manufacturers in 2009 which operate in three states mainly in Klang Valley. In fact, the implementation

of this system will facilitate the Malaysian stakeholders especially the contractors in a way to reduce a harmful effect to the environment by achieving the sustainable agenda.

Currently, the take up of IBS formwork was below than the target of IBS used as stated in IBS Roadmap 2003-2010 (CIDB, 2007) and the participation of contractors to involved in the IBS project is currently poor (Baharuddin, 2015). With regards on that scenario, the identification of barriers and challenging criteria is vital in way to overcome the shortcomings.

In general, a barriers and challenging criteria is defined as the element which contribute the ineffective result and achievement towards successful of building construction with considering of time, quality and cost. According to study been done by Baharuddin (2015), there are ten (10) numbers of barriers and critical factors found in their study which ranked as follow:

Table 2.1 Barriers and Critical Factors of IBS Formwork

No	**Barriers and Critical Factors of IBS Formwork**
1	Lack of Skills, Knowledgeable Manpower and Exposure on IBS Technology
2	High Initial Cost & Financial Barriers
3	Lack of Knowledge & Awareness
4	Lack of Incentives, Promotion & Guidance
5	Lack of Enforcement for Government Policy
6	Readiness Among Stakeholders
7	Manufacturing Capabilities Readiness Among Stakeholders
8	Lack of Involvement from Small Contractor
9	Supply Chain and Procurement
10	Transportation Cost

He added, based on the critical review on literature, there are several barriers and critical factors in adoption of IBS Formwork in construction industry. It shows that most of the scholars Haron (2009); Kamar (2009a); Ministry of Finance (2008); Nawi (2011), Nawi (2015) are strongly agreed that most of barriers and critical factors should be overcome in order to ensure the successful of IBS formwork implementation.

According to Haron (2009) stated that is required to overcome the barriers and critical factors for IBS formwork implementation as to support the government target in increasing the percentage of using IBS components. According to Baharuddin et al

(2015), stated that, there are five (5) numbers of most critical factors found in Malaysian Construction Industry

2.11.1 Lack of Skills, Knowledgeable Manpower and Exposure to IBS Technology

Currently, most of the stakeholders unaware the existence of IBS formwork systems and the usage of the IBS formwork systems in their construction projects is zero. The lack of skills, knowledgeable manpower and exposure to IBS technology among the stakeholders leads to the low popularity of the IBS formwork systems usage, compared to the conventional formwork method. As a result, the IBS formwork systems remain unfamiliar and unknown in the construction industry. According to Haron et al (2009), stated that for the fully prefabricated construction project, it will require high precision and exactness quality. However, most of the Malaysia labor forces still lack of skilled worker in IBS implementation.

On the other hand, Kamar (2009a) also stated that the implementation of IBS system requires tremendous effort to change existing construction practices and to train the personnel with specializing skills such as assembly and coordination. He added, this implementation will cause the contractors with noticeable difficulties and often fails to reinvent their current roles to suit with IBS project. In addition, the learning syllabus on the IBS formwork systems in the local universities mostly not being implemented (Abdullah & Egbu, 2010).

2.11.2 Lack of Knowledge and Awareness

According to Baharuddin et al (2015), Lack of Knowledge and Awareness is the most significant difficulties in implementation of IBS formwork system. According to Nawi (2015) lack of awareness program to understand client needs and giving correct information on IBS has contributing to a lack of interest from the client and decision makers.

As a result, IBS is often misinterpreted as high risk process and not contributing to any benefit to the building owner. Besides that, small contractors are already familiar with the conventional systems and unwilling to switch to the new mechanized based system since the technology was complex and complicated. Meanwhile, according to Baharuddin (2015), the majority of the stakeholders did not aware with the terms and

application of IBS formwork itself due to less information by the responsible parties. Meanwhile, based on observation the majority of them are using reusable formwork which is part of IBS formwork system. It shows that, there is still have a gap between the industry and responsible parties in that particular reason.

2.11.3 High Initial Cost and Financial Barriers

Based on CIDB (2006) found in CIDB (2007), the work and installation of Industrialized Building Systems requires high initial cost and would be financial barriers for the stakeholders. They also stress out that IBS is seen as an expensive, risky and difficult solution for contractors who normally aim for a higher marginal profit by cutting cost. The formwork of IBS components are mostly made of materials that can be used repetitively (ie: steel or aluminium) and this reduces the construction cost but high in initial cost. The initial cost to invest in the IBS construction is higher as it requires specified machine to cast the components (Guang, 2014)

Referrers to study by Haron (2009) revealed that construction by using IBS is more expensive due to the fierce competition by builders which is sticking to the traditional building construction method. Additionally, most of the IBS construction also requires a specialized equipment and machinery (Nawi, 2011). He also added research and development centre, support service, and testing labs are also needed by IBS Company as a tool for developing and sustain the IBS implementation. Therefore all these facilities should be supported by continual funding as such only companies which are strong and stable in the context of financial aspect could survive in the industry (CIDB, 2007a). Furthermore, the uncompetitive industry due to lack of open collaboration which is the contractors in Malaysia are obligate to close system and getting supply from the same manufacture throughout the construction and it already stressed by (Chung & Kadir, 2007).

In the other hand, with refer to the Nawi (2011), it is impossible for contractor to win the tender using IBS price if at the same time other companies were biding to use conventional price for ordinary construction method". According to Baharuddin (2015), the consensus of the scholars Nawi (2011); Nazrol (2015), Haron (2009); Chung & Kadir (2007); Rahman & Omar (2006); Thanoon (2003) and Nawi (2013) was strongly agreed that the factors of high cost and financial barriers would bring a huge

implication as to IBS implementation agenda. He added as to emphasize the IBS implementation; a government through responsible authority which is CIDB, Economic Planning Unit (EPU) and others should produce a special policy and strategic planning as to increase a supply chain in the construction industry with compliment of great incentive, promotion and others encouragement policy

2.11.4 Lack of Inventive and Promotion

According to Haron (2009), IBS formwork system is still not being widely implemented due to lack of stimulus factors. According to Mirza (2010), currently the implementation of IBS formwork system is not being fully supported and guided by the Government. It was agreed by Zawawi (2009) which revealed that the government through responsible authority should increase a pull and push factor as well as increasing the incentives and promotion towards IBS implementation activities.

According to Baharuddin (2015), although the current incentive through a reduce remittance by a foreign worker was execute; it is still insufficient (Haron et al, 2009). Moreover, the decision makers both in public and private sectors most are not using IBS system. It has been proved that by (CIDB, 2015) through the launching of CITP 2016-2020 document which stated only 24% project in both private and public sectors instead of 70% are using IBS implementation. Therefore, it shows that stakeholders are unacquainted with the current scenario.

Cited by Nawi (2011), the lack of incentives and promotion, guidance, and seriousness has reflected the population of stakeholders which adopting IBS formwork system. Currently only twenty seven (27) nos. manufacturer was registered as IBS formwork manufacturer to supply for East and West Malaysia (Haron, 2009). Based on Baharuddin (2015), he reported the consensus of scholars agreed that the government should consider the new methodology and steps in promoting the IBS adoption (Nawi, 2011); (Nazrol, 2015); (Kamar, 2009a); (Haron , 2009), (Abdullah, 2010); (Chung & Kadir, 2007); (Nawi, 2013); (Thanoon, 2003).

2.11.5 Lack of Enforcement of Government Policy

According to Baharuddin (2015), there is still lack of enforcement for government policy since there is no a specific IBS building regulation or standard

guidelines for contract documents or procurement systems in terms of tendering, design, construction and operation of a project. It was agreed by Kamar, (2009a) that highlight lack of structured information will not only affect construction professionals because of misunderstanding and misinterpreting regulations but also for authorities in terms of project approval.

Currently, Malaysian Government already highlighted the used of IBS system in construction which focusing on affordable housing project and government building project was increase from 30% to 50% on 2005 as one of the initial moved in application of IBS system facing the modern and globalization era (CIDB, 2007). Nevertheless, in 2008 the governments via Ministry of Finance has upgrade a new condition of the used for component in IBS system not less than 70% for government project and 50% for private sector (Ministry of Finance, 2008) as to support a current agenda. The addition requirement implies by the government which for the RM 50 million project and above to use at least 70% of IBS components should be enforce by responsible party or through government bodies such PWD or others. However, the enforcement for private project is still uncontrolled.

2.12 Summary

IBS system has a great potential to grow in Malaysia if we viewed positively. To ensure the successful of implementation of building industrialization, they must give the commitment and cooperation between the public and private sectors.

Also, the Malaysia‟s construction workforce is aging and shrinking as progressively fewer young enter the industry. This phenomenon prompts the industry to rely heavily on foreign workers. If, the demand for labour remains the same and the supply decrease, construction cost will increase and eventually pass on this cost to the home buyers. Hence, the industrialization of building construction method and the evolution of construction technology are inevitable and plausible.

This section has focused on barrier of implementation of one part of IBS which is pre-fabricated system. The common barrier was listed based on previous and other researcher to determine what is the major barrier among Malaysian.

There are two types of IBS formwork existing in Malaysia: modular formwork and engineered formwork. The typical material used for pre-fabricated formwork is aluminium, steel and plastic. These IBS represent most of the IBS that exist worldwide. Quality, speed of construction, and cost savings are the main advantages of these systems. These factors are very important in implementing the Ninth Malaysia Plan. The main disadvantages of the IBS in Malaysia are that they are highly capital intensive and there is a need for experts at the construction site for some of them. The main reason to recommend the use of IBS in Malaysia is that the raw materials used in the IBS have to be produced locally in order to overcome the shortages that are being faced by the IBS construction industry.

Below is the summarization about the critical factor and issue that previous researcher mentioned on their thesis study. The highest factor to lead the barrier in the implementation of IBS formwork is lack of skills, knowledgeable manpower and exposure on IBS technology, followed by Lack of Knowledge & Awareness.

Table 2.2 Summarization about Critical Factor and Issue from Previous Researcher

Authors / Critical Factors/ Issue	Nawi et-al (2011)	Rahman & Omar (2006)	Kamar et-al (2010)	Haron (2009)	Abdullah M.R (2010)	Kamar et-al (2009)	MoF (2008)	Nawi et-al (2005)	CIDB (2011)	Chung & Kadir (2007)	Zawawi (2009)	Thanoon et-al (2003)	Nawi (2015)	**Total**
Lack of Skills, Knowledgeable Manpower and Exposure on IBS Technology	√	√	√	√	√	√	√	√			√	√	√	**11**
Lack of Knowledge & Awareness	√	√	√	√	√	√	√				√		√	**9**
Lack of Incentives, Promotion & Guidance	√	√	√	√		√				√	√	√		**8**
High Initial Cost & Financial Barriers	√	√		√		√	√	√		√	√	√	√	**10**
Transportation Cost								√		√	√			**3**
Lack of Enforcement for Government Policy	√			√		√	√		√	√		√		**7**
Readiness Among Stakeholders		√	√	√		√		√			√		√	**7**
Lack of Involvement from Small Contractor	√	√				√						√	√	**5**
Manufacturing Capabilities Readiness Among Stakeholders	√		√	√		√		√			√			**6**
Supply Chain and Procurement	√		√				√						√	**4**

CHAPTER 3

METHODOLOGY

3.1 Introduction

In making any assessment, the first thing that is needed is clarity about the study and the research objectives. Once the research and researchers understand research objectives can focus your research and be able to understand precisely the study needs to be done. The proper planning and detail study to the flow of the research methodology is crucial in order serves as a guide in order to achieve the objectives and scopes of the study. This chapter shall further discuss in detail the research procedures, from how the data is collected till how it is processed and analysed to achieve the objectives and scopes of the study

This chapter aims at elaborating the methodological process that used to carry out the research based on the objectives of the study. This is including the literature review and also the preparation of questionnaire in order to obtain the input that are required.

3.2 Research Methodology

This section of study would focus on the method of study to be carried out to achieve the objective of this report. Therefore, every measure taken must be appropriate and relevant to the related topic of study. Three approaches have been throughout this study to gather reliable and relevant data. The approaches are:

a. Literature review

b. Handing out of questionnaire

c. Reviewing the effective strategic formulation method

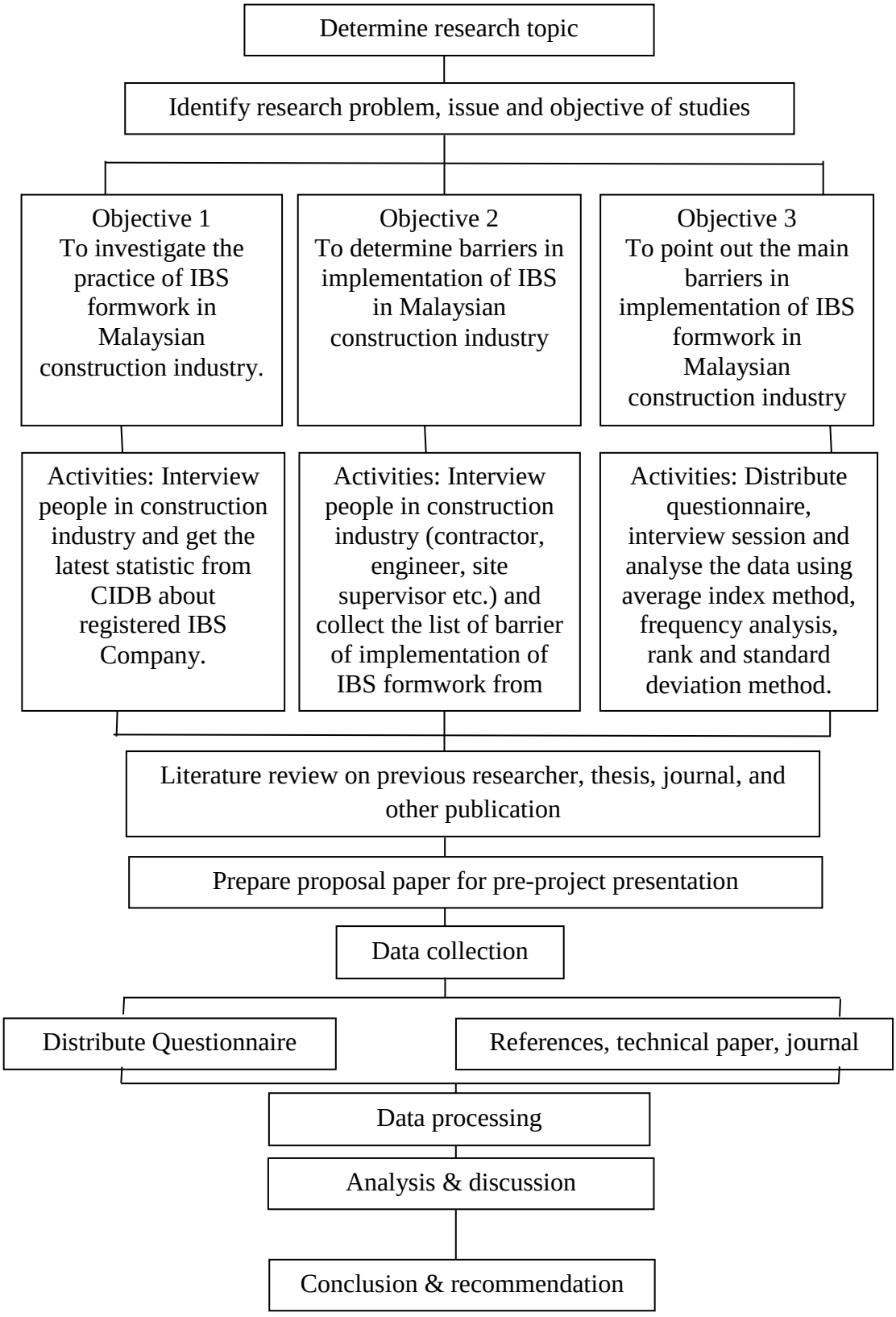

Figure 3.1 Research Flowchart

3.3 Questionnaire

Questionnaire is a set of pre-formulated and written questions that the researchers would like to ask to respondents and record their answers. Questionnaire can be an efficient data collection tool when the researcher knows exactly on the information that is needed and how to measure the variables of interest. Thus, all questions should be clear, understandable and obtain no ambiguity. Data validation was conducted after the questionnaires had been collected. In the process of data validation, the answers obtained from the questionnaires will be checked for accuracy and suitability for this research purpose.

3.3.1 Sampling of Data

There were about 100 copies of questionnaires distributed to the targeted respondents. Respondents for the questionnaire in this research are consisted of contractors, consultants, developers, architects and quantity surveyors in Malaysia.

Handing out questionnaire is an approach to determine the current barriers of the implementation of prefabricated formwork system that have been practiced among the construction players in Malaysia. It was designed to gather and verify the information from literature review. The method of distribution and collection of the questionnaire survey encompass the following:

- ✓ By mail and returned via mail through stamped self-addressed envelope
- ✓ By conforming through telephone calls and dispatching the questionnaire.
- ✓ By hand distributions for selected respondents

3.3.2 Design of Questionnaire

Questionnaire is an effective way designed to gather and verify the information which from literature studies. However, the limitation of questionnaire is that it is subjected to the willingness and cooperation of the respondent in completing the questionnaire. Therefore, it is necessary to design the questionnaire as straight-forward as possible to obtain information related to the objectives of the study. Another

important criterion when designing the questionnaire is the time to complete it. It should be designed to be completed in the shortest time possible for the convenience of the respondent as the workload of the respondents is usually heavy.

The questionnaire consisted of three parts – general information of respondent, a survey on their experience and readiness adapting IBS in construction projects, barriers of adapting pre-fabricated formwork in construction industry and lastly ways to enhance implementation of prefabricated formwork.

Section A: General information of the respondent

- ✓ Name of respondent
- ✓ Profession
- ✓ Position
- ✓ Working Experience

Section B: Experience and readiness adapting prefabricated formwork in construction projects

- ✓ Experience with Industrialized Building System (IBS) type
- ✓ Experience with Industrialized Building System (IBS) formwork
- ✓ What type of formwork respondent had experience
- ✓ Readiness of using prefabricated formwork in building projects

Section C: Barriers in the implementation of using IBS Formwork & way to enhance

- ✓ Product Technical limitation
- ✓ High Initial Cost & Financial Barriers
- ✓ Lack incentive & promotion guidance
- ✓ Less product support
- ✓ Lack exposure on IBS

3.4 Method Analysis

There were about 100 copies of questionnaires distributed to the targeted respondents. Respondents for the questionnaire in this research are consisted of contractors, consultants, developers, architects and quantity surveyors in Malaysia.

3.4.1 Average Index

Average index is being calculated based on the formula of:

$$\text{Average Index} = \sum a_i x_i / \sum x_i \quad \textbf{3.1}$$

Where,

a = constant, weighing factor for i,

x = frequency of respondent

i = 1, 2, 3… n

A scale of 5 categories has been used for the average index method in order to show priority. The scales of 5 categories are:

1	Least Agreed	1.00 to 1.50
2	…	1.50 to 2.50
3	Moderate	2.50 to 3.50
4	…	2.50 to 4.50
5	Mostly Agreed	4.50 to 5.00

3.4.2 Frequency Analysis

The collected raw data are required to be separated in a table of frequency to show the distribution of each data collected

3.4.3 Rank

Rank shows relative position or ordering when comparing the issues in the same category. Rank is based on the average index. Higher rank with low rank numbers unless mentioned otherwise are generally have more importance or influences in terms when come to comparison and vice versa. It is very useful in order to highlighted and list out of its importance

3.4.4 Standard Deviation

In this research, standard deviation is used as a measure of the variability or dispersion the data set from frequency analysis. A low standard deviation indicates that the data points tend to be very close to the same value (the mean); while high standard deviation indicates that the data are spread out over a large range of values. It is used to verify the pattern and distribution of the collected data that assist in when doing analyses in respected category

3.4.5 Comment

Comments come in situational which are classification of the analysed data that based on the average indexes, ranks, and standard deviations of the data. It turns the numbers in the analyses to more meaningful phrases that could be interpreted easier by others

3.5 Summary of Chapter

This chapter describes in detail the flow of the study from the initial stage to the end in achieving the objectives. The choices of the methods used is highly depends on the study. For this study, questionnaire survey is used to gather the data of the study and percentage analysis are used to analyse the data collected

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CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter focuses on analysing the results gathered from the respondents through interview and questionnaire. Since time allocated for the distribution and collection of the questionnaire is very limited, the distribution of questionnaire is limited to the respondents within the coverage of the researcher only.

The data collected were converted into more meaningful, useful and informative formats that are in the form of tables and figures. The data also were expressed according to the suitability of the analysis itself. The questionnaires were distributed into different parts enables the analysis be done systematically and reflects a logical result.

4.2 Distribution and Return Questionnaires

There were about 100 copies of questionnaires were distributed to the targeted respondents consisted of architects, contractors, developers, consultants and quantity surveyors and those who related to construction field. By the cut-off date, the researcher managed to collect back 45 useable questionnaires out of 60 returns back of respondent from the respondents. This constitute of a sum of 45% response rate. According to Fellows et al (1997), the normal expected useable response rate is ranging from 25 % to 35%. Therefore, the total response received is considered sufficient for the purpose of this research.

The return percentage of the distributed questionnaire is 45% useable respondent from 100 respondents. In this research, the data collected by using email and

Google form method secure a higher return rate than other distribution method. Questionnaires were sent by email to respondents who worked in the construction industry. Besides that, the researcher also makes a few interviews by call and didn't manage to visit the company due to some problem; limited and the distance from one to another place is far, but the objective was achieved. However, distribution of questionnaire by email and by call was shown the highest response rate than the other method.

4.3 Question Structure

The sample of the questionnaire can be referred in Appendix A. The questionnaire is divided into three sections; Section A, B & C as described in Chapter 3. The analysis mainly focused into three parts as discussed as follows:

4.4 Respondent Information

Respondent general information was made to get the information of the respondent to fulfil the researcher target which is people who involve in construction field only. The information that compulsory to know is profession and the experiences of the respondent in construction field so that the answer from questionnaire is relevance.

4.4.1 Respondent Position

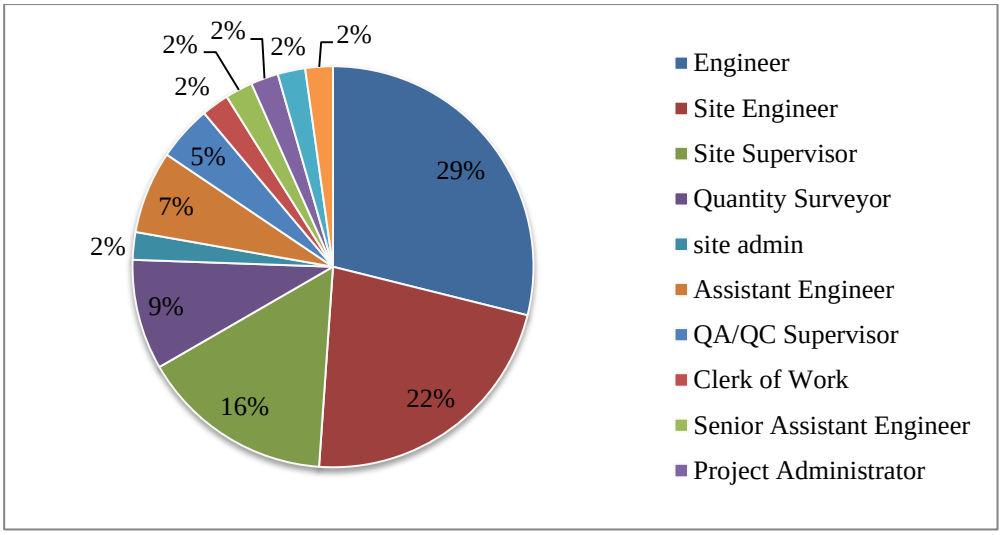

Figure 4.1 Current Positions of Respondents in Construction Industry

Figure 4.1 shows the returned questionnaires of the different types of respondents in the construction industry. 29% out of 45 useable questionnaires were from engineer, which represent the largest groups of response in this research followed by site engineer with 22% and site supervisor 16% of 45 respondents. An engineer, site engineer and site supervisor are part of position in construction field. This group of respondents is the frontline of the people who in contact with the design stage of the construction projects. The other position of respondent mostly related in construction site too, so their opinions are very useful and provides true insights to this research.

4.4.2 Respondent Experience in Construction Industry

Figure 4.2 illustrates experience of the respondent in construction. The pie chart shown 80% respondents have 1-4 years. 13% respondents have 5-10 years and the other 7% of 60 respondent shows more than 10 years working experience in construction industry.

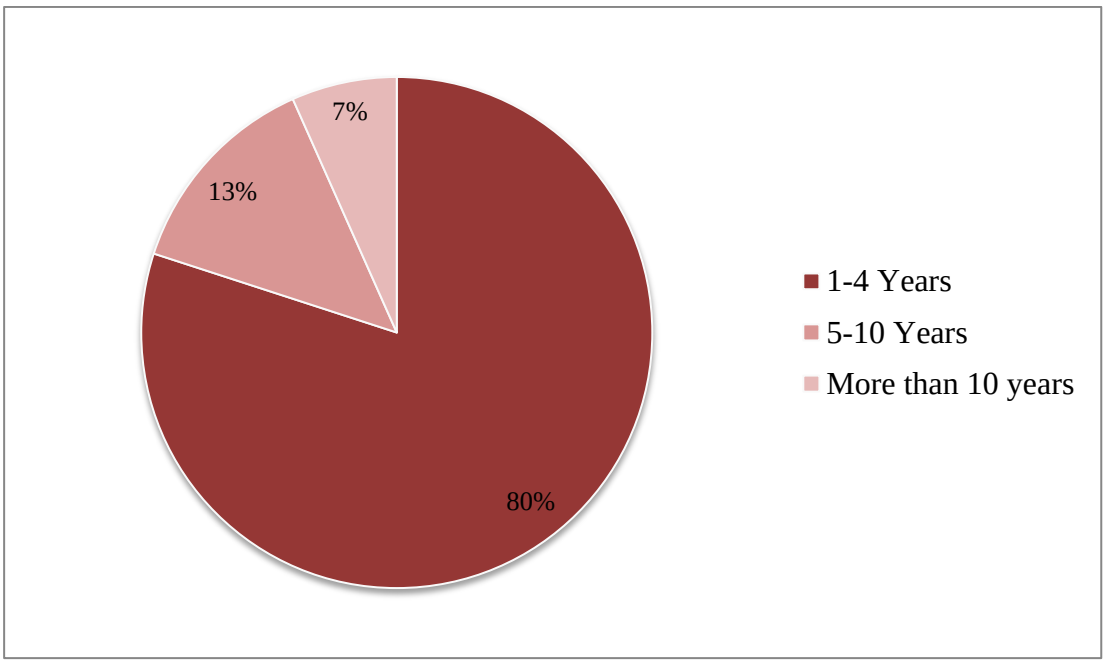

Figure 4.2 Respondent Experiences in Construction Industry

4.5 The practice of IBS formwork in Malaysian construction industry

First objective of this thesis is to investigate the practise of IBS formwork in Malaysian construction industry. To fulfil this objective the questionnaire are listing the question about respondent practice in all type of IBS. After knowing the percentage of

the respondents practise IBS, then the researcher want to know the readiness of respondent if Malaysia is widely using IBS formwork in every construction project.

4.5.1 Experiences with Industrialized Building System (IBS)

The first question is to identify their experiences in Industrial Building System (IBS). Meanwhile the second question is to examine what type of IBS they had experienced. From the questionnaires survey analysis, the result shows that about 60% (17 over 45 respondents) encounter with IBS in their work. There are 40% of the respondents do not having experienced with IBS. The result was shown in figure 4.3 below. The researcher want to know what type of IBS respondent used, so 60% respondent that experienced with IBS have answer next question which is what type of IBS they had experience. There were five type of IBS; Precast Concrete, Steel Framing System, Pre-fabricated Formwork (IBS Formwork), Pre-fabricated Timber Forming System and Block Work System. .

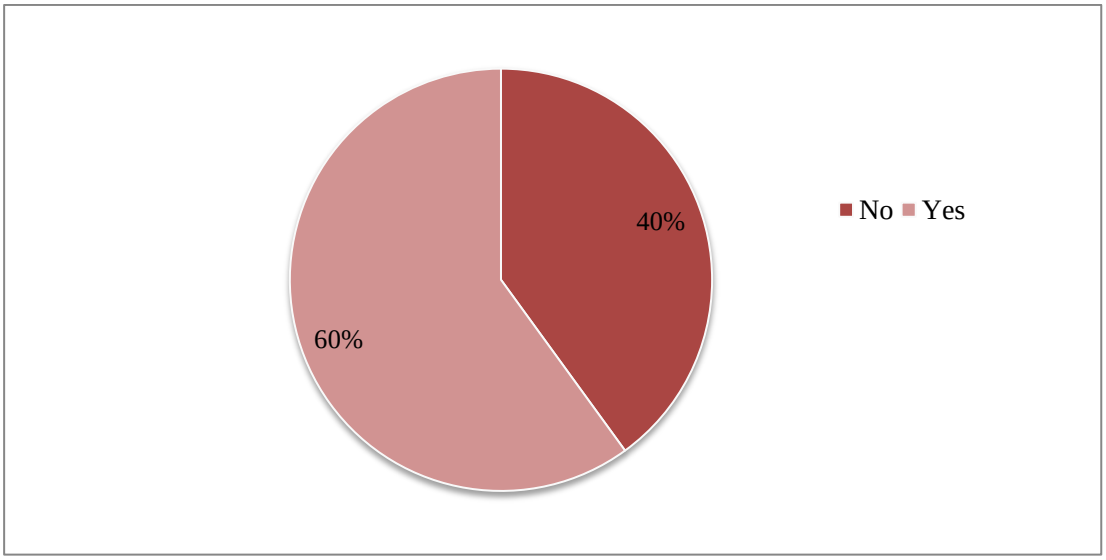

Figure 4.3 Percentage of respondent experiences with of IBS

Based on bar graph in figure 4.4 the highest type of IBS respondent involved is precast concrete which is 30% followed by IBS formwork which is 25% and prefabricated timber forming system shows the least uses of respondent among theme.

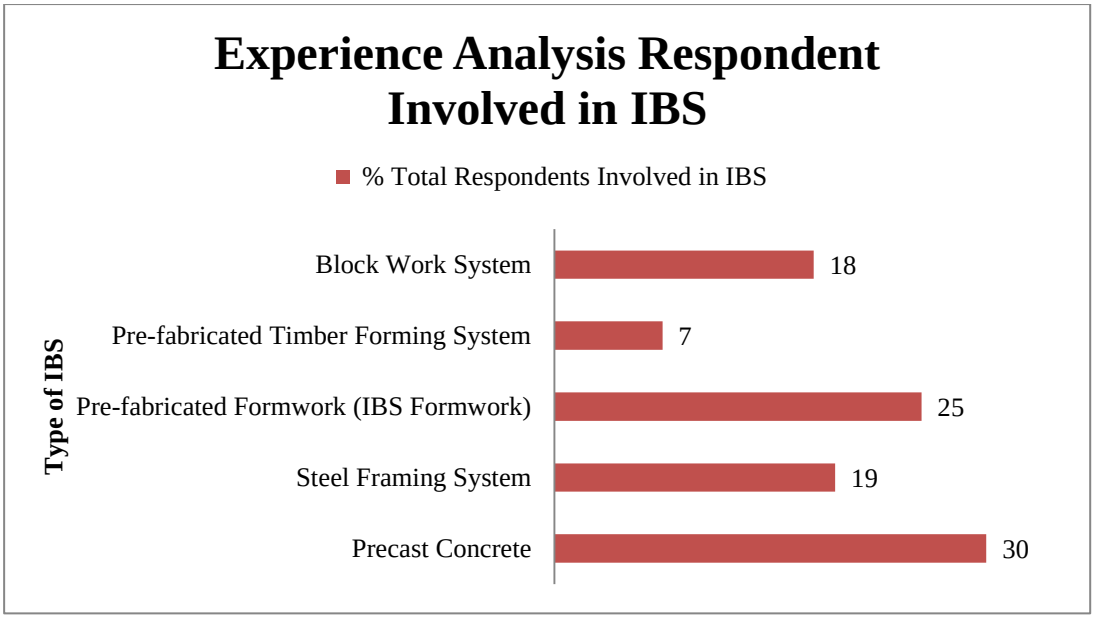

Figure 4.4 Respondent experiences with types of IBS

4.5.2 Experience with IBS Formwork

The researcher wants to know about experience of respondent that involved in IBS formwork, so the next analysis is what type of IBS Formwork they experienced.

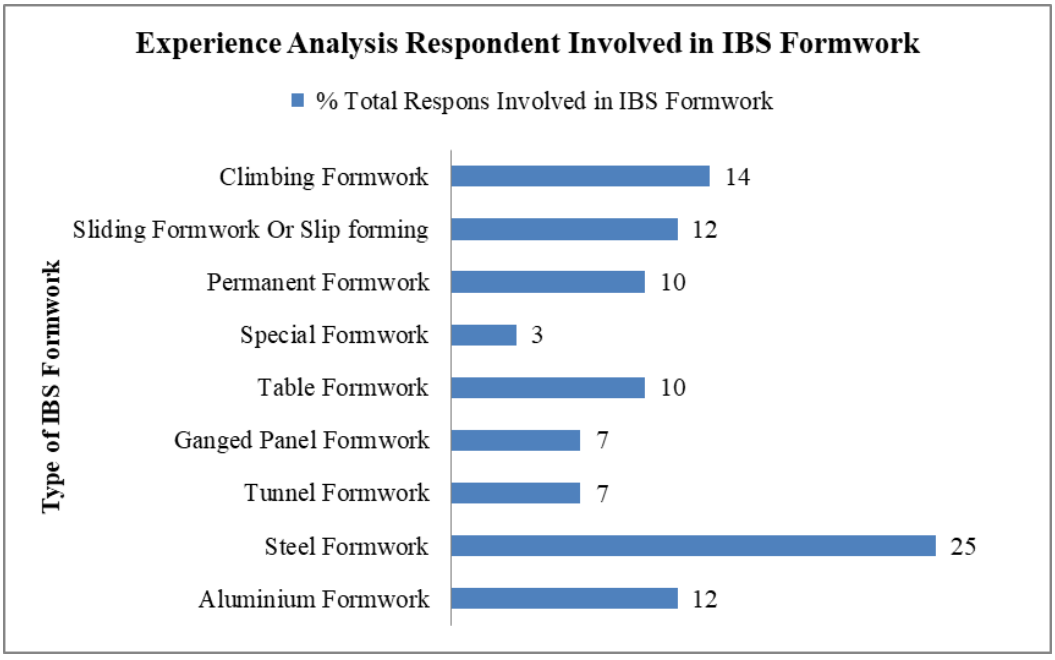

Figure 4.5 Respondent experiences with types of IBS Formwork

Based on data analysis shown on graphic bar chart at figure 4.4, the highest type of IBS formwork respondent deal is steel formwork, 25%. The other types of IBS formwork are shown lesser used from respondent.

4.5.3 Readiness of Respondent Using IBS Formwork in Construction

These question types are asked to analyse the readiness of respondent using IBS formwork in construction. So from the pie chart below shown the 71% respondent are said yes for using IBS formwork in construction and the rest 29% respondent are not sure or don't have any idea about the uses of IBS formwork in construction.

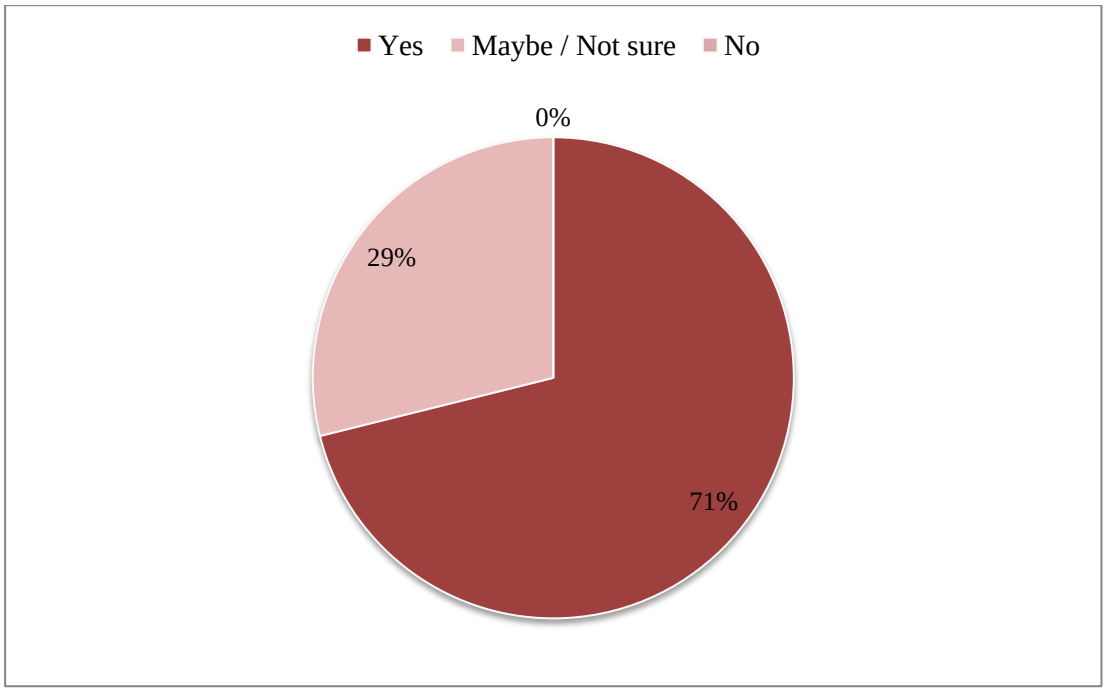

Figure 4.6 Readiness of Respondent Using IBS Formwork in construction

4.6 Barriers in the Implementation of IBS in Construction Industry

For this research, the barriers of adapting IBS in construction industry were divided into five categories as shown in Table 4.1. The researcher use likert scale method to measure respondent opinions. It functions by having a person complete a questionnaire that requires them to indicate the extent to which they agree or disagree with a series of statements.

Table 4.1 listed out the main barriers of adopting IBS in construction industry. According to the data analysis, the conventional system is more flexible when it comes to a complex design of structure (Prefabrication of element inflexible) most influential barriers in the implementation of IBS formwork. Because of inflexibility of formwork and limited uses, so it is lead to lack involvement from small contractor which ranked in number 2 of barriers in the implementation of IBS formwork.

Table 4.1 Barrier in the implementation of IBS formwork

Score		Frequency Analysis					Average Index	Standard Deviation	Rank
		1	2	3	4	5			
Factor 1 : Exposure on IBS formwork in Malaysia									
1	Lack of Exposure on IBS Technology in Malaysia	3	6	16	10	10	3.42	1.16	15
2	Lack of knowledge about advantages using IBS formwork	5	3	14	15	8	3.40	1.19	16
3	Lack of skill labour (contractor)	5	2	10	18	10	3.60	1.21	13
4	Lack of training (contractor)	2	1	10	21	11	3.84	0.98	5
Factor 2 : Incentives, Promotion & Guidance									
1	Lack of enforcement for government policy	2	2	10	16	15	3.89	1.07	3
2	Lack of standard design (manufacturer)	3	2	9	18	13	3.80	1.12	7
3	Lack of market demand (developer/ client/contractor)	5	2	9	16	13	3.67	1.26	12
4	Poor Industry marketing strategies (supplier/manufacturer)	1	3	12	19	10	3.76	0.96	9
Factor 3 : High Initial Cost & Financial Barriers									
1	High of transportation cost	1	3	10	18	13	3.87	0.99	4
2	Lack of standard design (manufacturer)	1	4	12	17	11	3.73	1.02	10
3	High capital expenditure (supplier)	2	3	11	19	10	3.71	1.04	11
4	Cost to change IBS system is high	2	4	9	15	15	3.82	1.13	6
Factor 4 : Product Support									
1	Lack Involvement from Small Contractor	4	0	7	17	17	3.96	1.17	2
2	High capital expenditure (supplier)	1	3	10	22	9	3.78	0.93	8
3	Compatibility and demand	1	1	13	18	12	3.87	0.92	4
4	Manufacturer not keen to proceed with IBS concept	1	4	18	16	6	3.49	0.92	14
Factor 5 : Product Technical limitation									
1	Very poorly on modification, against brickwork construction (e.g.: wall element using wall formwork)	2	1	13	13	16	3.89	1.07	3
2	The conventional system is more flexible when it comes to a complex design of structure (Prefabrication of element inflexible)	1	2	8	16	18	4.07	0.99	1
3	Limited size and shape of formwork	2	2	11	16	14	3.84	1.07	5
4	Lack of adjustable and easy to handle formwork	1	4	18	22	0	3.36	0.74	17

Figure 4.7 and 4.8 listed out the five most influential barriers and five least influential barriers respectively. From the figure, it is shown that the conventional system is more flexible when it comes to a complex design of structure are likely to have more influences to the barriers of IBS implementation in the construction industry. On the other hand, lack of adjustable and easy to handle formwork of IBS formwork are likely have less influences to the barriers of IBS implementation in the construction industry.

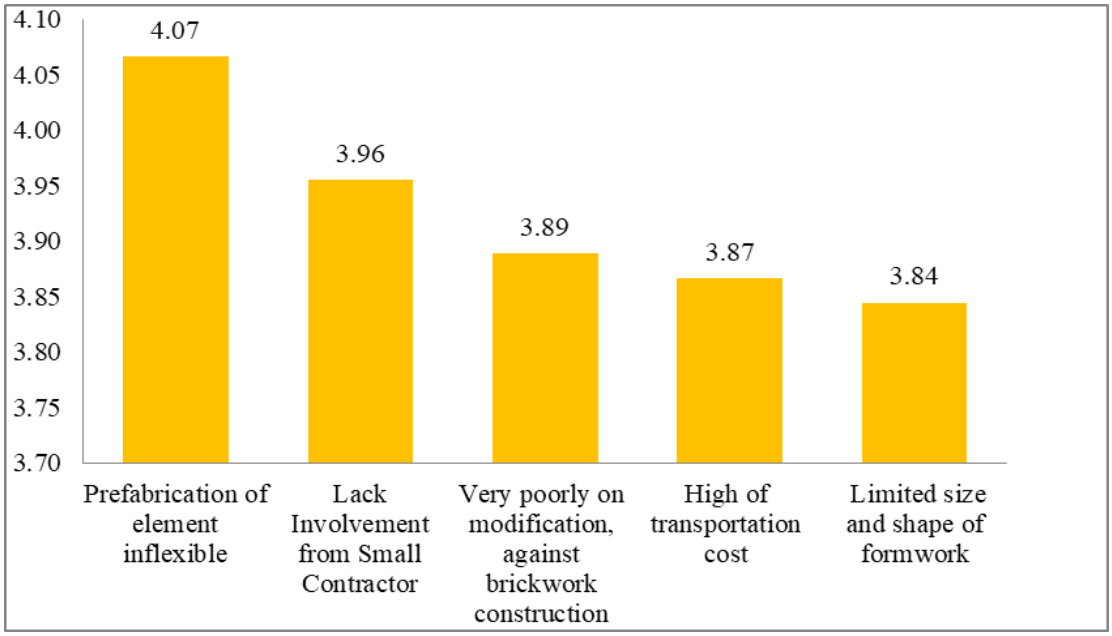

Figure 4.7 Top 5 most influential barriers the implementation of IBS Formwork

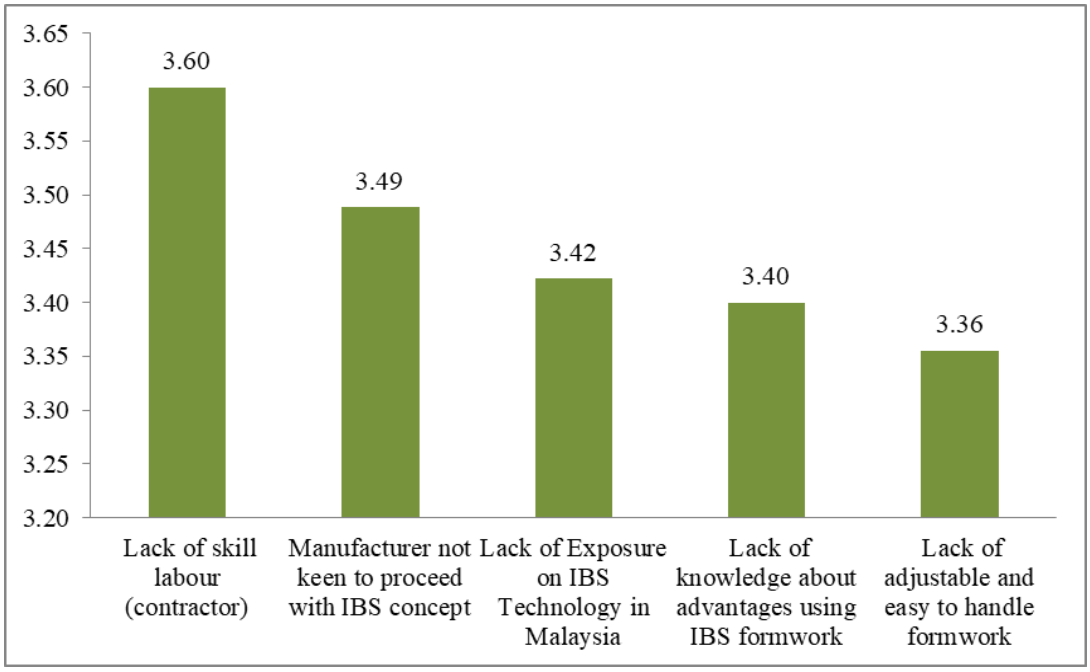

Figure 4.8 Top 5 Less Influential Barriers the Implementation of IBS Formwork

Table 4.2 shows the list of barriers factor in the application of IBS formwork in construction industry. In these categories, the most identifiable category which have average index of 3.79 is product technical limitation. The least influential barriers factors are the exposure on IBS formwork which is 3.57. Financial barriers and lack of promotion of IBS formwork is share same ranked which ranked second. The last ranked is lack of exposure on IBS formwork

Table 4.2 Barriers Factor In the Application of IBS Formwork in Construction Industry

Barriers Factor	**Average Index**	**Rank**
Product Technical limitation	3.79	1
High Initial Cost & Financial Barriers	3.78	2
Lack incentive & promotion guidance	3.78	2
Less product support	3.77	3
Lack exposure on IBS Formwork	3.57	4

4.7 Ways to Enhance Implementation of IBS Formwork

Table 4.3 shows some of the possible ways to enhance implementation of IBS. The main barrier was shown as product technical limitation, so the respondent agrees to standardise the size and shape of formwork to be more practical and efficient. Besides, with increasing formwork technology that easily to handle and adjustable in any design requirement can reduce the barriers of product technical limitation. Train local workers in IBS technology are ranked in no 2 of ways to enhance the practise of IBS formwork.

Table 4.3 Table of Ways to Enhance Barriers in the Practise of IBS Formwork

Score	Frequency					Average index	Std Dev	Rank
	1	2	3	4	5			
Education awareness on IBS through courses and seminars	1	1	7	14	22	4.22	0.95	5
Train local workers in IBS knowledge	1	0	3	18	23	4.38	0.81	2
Getting the design process right	1	0	7	21	16	4.13	0.84	7
Educate the contractor available to apply IBS	1	2	4	16	22	4.24	0.96	4
Proof of cost and time savings	1	0	8	16	20	4.20	0.89	6
More research and development initiative	1	1	7	15	21	4.20	0.94	6
Promote designers to design in IBS	2	0	6	16	21	4.20	0.99	6
Promote formation of other suppliers to avoid monopoly	1	1	4	19	20	4.24	0.88	4
Standardise sizes and shapes of formwork	1	6	11	13	14	3.73	1.12	1
Increase formwork technology that easily to handle and adjustable in any design requirement	1	1	6	14	23	4.27	0.94	3
Requires information sharing/database on tools & machines	1	1	9	17	17	4.07	0.94	8

4.8 Discussion

Based on Baharuddin (2015), the implementation of IBS formwork is known as one of the best alternative in completing the construction project nowadays. The existence of this IBS formwork seems to be one of the problem solving in reducing the used of conventional formwork which famous of additional site work and quiet waste based on time, cost and safety (Haron, 2015). Nevertheless, production of IBS formwork with full of advantages seems not glowing enough when their application still

not rapidly embracing (Nawi, 2011). Followings are some discussion raised based on the analysis of the study.

4.8.1 Barriers of implementing IBS to various parties in construction

The main objective of this research is to list out the main barriers in the implementation of IBS formwork since formwork is very important in producing concrete structure which allows contractors to cast the main parts of a building which are required to be strong and support the structure. However, the practice of this type of IBS is not fully used in our construction industry.

Based on result the main barriers are product technical limitation. The IBS formwork not suitable for all construction, for example projects that used IBS formwork to cast the house building, so it is very poorly on modification. That why the highest uses of IBS formwork is high rise building or project that do not having modification or renovation. Moreover, the conventional system is more flexible when it comes to a complex design of structure and so that the contractor tend to choose conventional method . But, from the reading of the researcher, almost all prefabricated systems are designed for light as well as heavy construction. Contractors can bid almost any type of work; straight, battered, curved or cut-up. Prefab forms may be set in any combination, horizontally and vertically, to any wall height. In a prefab system the contractor can remove and replace forms at any point. This simplifies erection and stripping, which can be started at any location. To allow for a casting pocket, a panel is simply removed and replaced.

The other problem rising based on this research is high initial cost & financial barriers. IBS construction requires high skills and trained workers to commit high quality end product. For installation of IBS Formwork , they used trained workers and this will led the extra cost while the contractor tend to use conventional method as to gain profit from labour cost. In addition the formwork of IBS components are mostly made of materials that can be used repetitively (ie: steel or aluminium) and this reduces the construction cost but high in initial cost. The initial cost to invest in the IBS construction is higher as it requires specified machine to cast the components (Guang, 2014).

According to the CIDB (2017), the majority of IBS manufacturers are located in industrial areas (like Klang Valley, Seremban or Butterworth). This situation will indirectly increase the component of logistics and transportation costs in a construction project budget if it is located far away in rural areas, especially in the northern and east coast regions of Malaysia (Chung, 2006 and Nawi, 2005). Given this situation, the unfortunate contractor will have to incur extra logistics and transportation expenses in getting the IBS components delivered to such a site. This has been identified as one of the major hindrances in the adoption of IBS in the Malaysian construction industry.

The other barriers that point out in this research is market reception of new material will dictate IBS utilisation. The manufacturer needs to provide various standard shape and sizes of IBS formwork in way easy to achieve client desire without additional costing.

4.8.2 The Ways of Implementing IBS

Based on the research and views of experienced people involved in the IBS construction system, the following recommendations which can function as a guide, and simultaneously making the IBS implementation more known to the public (as clients) in general and the developers, contractors and consultants in particular for improvements are proposed:

a. Manufacturer should provide various standard shape and sizes of IBS formwork in way easy to achieve client desire without additional costing.

b. Local contractor is encouraged to adopt the latest technology construction works. What is regarded as an important initiative is exposing the contractors to not be afraid to try and use the new technology

c. Clients, consultants and contractors need to build a strong foundation and communication between themselves in conducting new construction projects, especially those which apply the Industrialized Building System (IBS).

CHAPTER 5

CONCLUSION

5.1 Introduction

This aim of the research is to examine and study the barriers and point out the main barriers in current development of IBS formwork in Malaysian construction industry. The purpose of this chapter is to conclude all the findings derived from the study. All the three objectives set for the research have been successfully achieved and the findings are summarized based on the objectives of the research as follows:

5.1.1 Objective 1: To investigate the practice of IBS formwork in Malaysian construction industry.

This objective is to investigate the practise of IBS formwork in Malaysian construction industry and identify the readiness of the construction players to adapt IBS in their construction project. From the findings, the level of respondent practise IBS formwork is above average level only. The highest type of IBS formwork used is steel formwork. For overall readiness using fully IBS formwork in the construction is at highest level. This is the good starting to develop more IBS formwork uses in the future.

5.1.2 Objective 2: To determine barriers in implementation of IBS formwork in Malaysian construction industry.

In this research, the barriers of adopting IBS formwork in Malaysian construction industry were listed in chapter 2 and for the questionnaire purpose, the researcher listed out 5 main factor of development IBS formwork to analysis. They are; exposure on IBS formwork in Malaysia, incentives, promotion & guidance, high initial cost & financial barriers, product support and product technical limitation. Based on 5

factors, the researcher were list out the barriers in each factor. The barrier was shows in questionnaire form in Appendix.

5.1.3 Objective 3: To point out the main barriers in implementation of IBS formwork in Malaysian construction industry.

The barriers of adopting IBS formwork in Malaysian construction industry are mainly due to product technical limitation. The local contractors rather choose the conventional method due to flexibility when it's come to complex design structure. Besides, the other barriers using IBS formwork is the structure or building will poorly on modification or renovation. High initial cost also led to difficulties of IBS formwork in the Malaysian Construction Industry. Lack of involvement from a small scale contractor and transportation cost were highlight as a key driven on the less usage of IBS formwork in Malaysia too. This variable are require for further investigation in order to confirm its validity. Therefore, an analysis of this empirical literature review will help to shape a framework or structuring model for enhancing the uses of IBS formwork system among stakeholder in Malaysia

5.1 Recommendations

This finding of the study gives an effective strategy to implement IBS in the current state of the construction industry. However, there are still some areas in the IBS management that can be look into to conduct a research which can be look into for further studies and further improvement can be made.

While the researcher runs this project, there are several limitations that have to face. The first restriction is the researcher cannot go to all listed company for interview session because the distance from one to another place is far, but the researcher managed to collect data by other method which is by call interview. Other than that, the respondent return back questionnaire form is not fully can be used .It is happen when they do not read properly the questionnaire and simply answer the question. End up only 45 useable respondents can be used over 60 return questionnaire form. The following recommendation can be considered and used as reference for future study purposes.

1. Implementation plan of IBS by introducing policy and guidelines for effective implementation.

2. Investigation on design integration issues in IBS and conventional project

3. Continuous improvement that on the aspect of improving the strategy of implementing IBS.

4. Malaysian people mind-set about IBS needs to change. Most of the Malaysian thinks the IBS product is low in quality due to lower price. Lot of alternative can be made in order to change it. Just need to be consistent and take a long time.

5. Manufacturer should provide various standard shape and sizes of IBS formwork in way easy to achieve client desire without additional costing.

The purpose of these surveys is to gather information on implementation and application of IBS formwork in Malaysia. IBS features potential construction system for the future with emphasis on quality, higher productivity, and environmental friendly and less labour intensive. The selection and practise of IBS promises to elevate every level of the construction industry to new heights and image of professionalism. IBS should be seen as the modern methods of construction where modern and systematic methods of design, production planning and mechanized methods of manufacturing and erection are applied.

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APPENDIX A
QUESTIONAIRE SAMPLE

"Barriers in the Implementation of IBS Formwork System in Malaysian Construction Industry"

These questionnaire are be made to investigate the practice of IBS formwork in Malaysian construction industry and to determine the main barrier in the implementation of IBS formwork system in Malaysian construction industry.

Section A: General Information

Name : ……
Profession : ……
Working experience : ……

Section B: The practice of IBS formwork in Malaysian construction industry

1. Did you have experienced with Industrialized Building System (IBS) in construction project?
   a. YES
   b. NO

   If YES, Please tick (√) all those you are on

Precast Concrete	☐
Steel Framing System	☐
Pre-fabricated Formwork (IBS Formwork)	☐
Pre-fabricated Timber Forming System	☐
Block Work System	☐

2. Did you have experienced with Industrialized Building System (IBS) FORMWORK in construction project?
   a. YES
   b. NO

   If YES, Please tick (√) all those you are on

Aluminium Formwork	☐
Steel Formwork	☐
Tunnel Formwork	☐
Ganged Panel Formwork	☐
Table Formwork	☐
Special Formwork	☐

Permanent Formwork	
Sliding Formwork Or Slip forming	
Climbing Formwork	

Others: ……

3. If Malaysia is widely using IBS FORMWORK in every construction project, do you ready to using IBS formwork in building project?
   a. Yes b. Not sure c. No

Section C: Barriers in the implementation of using IBS Formwork

The following item describe the factor that lead to barriers in the implementation of IBS formwork and way to overcome the barriers factor. Indicate your agreement and disagreement with the following statement by circling your response using this scale.

1	2	3	4	5
Not Agreed	Least Agreed	Moderate	Agreed	Mostly Agreed

Factor 1 : Exposure on IBS formwork in Malaysia		**Scale**				
Barriers	Lack of Exposure on IBS Technology in Malaysia	1	2	3	4	5
	Lack of knowledge about advantages using IBS formwork	1	2	3	4	5
	Lack of skill labour (contractor)	1	2	3	4	5
	Lack of training (contractor)	1	2	3	4	5
Ways to enhance	Education awareness on IBS through courses and seminars	1	2	3	4	5
	Train local workers in IBS knowledge	1	2	3	4	5
Factor 2 : Incentives, Promotion & Guidance		**Scale**				
Barriers	Lack of enforcement for government policy	1	2	3	4	5
	Lack of standard design (manufacturer)	1	2	3	4	5
	Lack of market demand (developer/ client/contractor)	1	2	3	4	5
	Poor Industry marketing strategies (supplier/manufacturer)	1	2	3	4	5
Ways to enhance	Getting the design process right	1	2	3	4	5
	Educate the contractor available to apply IBS	1	2	3	4	5
Factor 3 : High Initial Cost & Financial Barriers		**Scale**				
Barriers	High of transportation cost	1	2	3	4	5
	Lack of standard design (manufacturer)	1	2	3	4	5
	High capital expenditure (supplier)	1	2	3	4	5
	Cost to change IBS system is high	1	2	3	4	5
Ways to enhance	Proof of cost and time savings	1	2	3	4	5
	More research and development initiative	1	2	3	4	5

Factor 4 : Product Support		Scale				
Barriers	Lack Involvement from Small Contractor	1	2	3	4	5
	High capital expenditure (supplier)	1	2	3	4	5
	Compatibility and demand	1	2	3	4	5
	Manufacturer not keen to proceed with IBS concept	1	2	3	4	5
Ways to enhance	Promote designers to design in IBS	1	2	3	4	5
	Promote formation of other suppliers to avoid monopoly	1	2	3	4	5
Factor 5 : Product Technical limitation		**Scale**				
Barriers	Very poorly on modification, against brickwork construction (e.g.: wall element using wall formwork)	1	2	3	4	5
	The conventional system is more flexible when it comes to a complex design of structure (Prefabrication of element inflexible)	1	2	3	4	5
	Limited size and shape of formwork	1	2	3	4	5
	Lack of adjustable and easy to handle formwork	1	2	3	4	5
Ways to enhance	Standardise sizes and shapes of formwork	1	2	3	4	5
	Increase formwork technology that easily to handle and adjustable in any design requirement	1	2	3	4	5
	Requires information sharing/database on tools & machines	1	2	3	4	5
Comment :						

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