SAFETY ASPECT IN INSTALLATION OF INDUSTRIALIZED BUILDING SYSTEM (IBS) FORMWORK IN MALAYSIAN CONSTRUCTION INDUSTRY

NUR IZZATI BINTI ADNAN

B. ENG (HONS.) CIVIL ENGINEERING

UNIVERSITY MALAYSIA PAHANG

UNIVERSITY MALAYSIA PAHANG

DECLARATION OF THESIS AND COPYRIGHT

Author's Full Name : NUR IZZATI BINTI ADNAN

Date of Birth : 06 MARCH 1992

Title : SAFETY ASPECT IN INSTALLATION OF INDUSTRIALIZED BUILDING SYSTEM (IBS) FORMWORK IN MALAYSIAN CONSTRUCTION INDUSTRY

Academic Session : 2017/2018

I declare that this thesis is classified as:

☐	CONFIDENTIAL	(Contains confidential information under the Official Secret Act 1997)*
☐	RESTRICTED	(Contains restricted information as specified by the organization where research was done)*
☑	OPEN ACCESS	I agree that my thesis to be published as online open access (Full Text)

I acknowledge that University Malaysia Pahang reserves the following rights:

1. The Thesis is the Property of University Malaysia Pahang
2. The Library of University Malaysia Pahang has the right to make copies of the thesis for the purpose of research only.
3. The Library has the right to make copies of the thesis for academic exchange.

Certified by:

_____	_____
(Student's Signature)	(Supervisor's Signature)
920306086380	ZAHRIZAN BIN ZAKARIA
New IC/Passport Number	Name of Supervisor
Date:	Date:

NOTE: * If the thesis is CONFIDENTIAL or RESTRICTED, please attach a thesis declaration letter.

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of the Bachelor Degree of Civil Engineering.

_____

(Supervisor's Signature)

Full Name :

Position :

Date :

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at University Malaysia Pahang or any other institutions.

_____

(Student's Signature)

Full Name : NUR IZZATI BINTI ADNAN

ID Number : AA14032

Date : 7 JUNE 2018

SAFETY ASPECT IN INSTALLATION OF INDUSTRIALIZED BUILDING SYSTEM (IBS) FORMWORK IN MALAYSIAN CONSTRUCTION INDUSTRY

NUR IZZATI BINTI ADNAN

Thesis submitted in fulfilment of the requirements
for the award of the
Bachelor Degree in Civil Engineering

Faculty of Civil Engineering and Earth Resources

UNIVERSITI MALAYSIA PAHANG

JUNE 2018

ACKNOWLEDGEMENT

First and foremost, I want to acknowledge and thank to ALLAH SWT with my deepest gratitude for the miracles He has performed in my life for the completion of Final Year Project (FYP). This FYP would have not been carried out successfully without the cooperation from many parties who contribute in preparing and completing this study.

I would like to express my sincere gratitude to my dedicated and understanding Supervisor's Mr. Zahrizan Bin Zakaria for the continuous support of my final year project and research, for this patient, motivation, enthusiasm and immense knowledge. His guidance helped me in all time of research and writing this thesis. I could not have imagined having a better advisor and mentor for my research.

Special thanks to all respondents who gives very good cooperation throughout in completing this final year project.

Last but not least, I would like to thank my family members and all my friends for providing support and friendship that I needed. Thank you for being supportive throughout my time here and for helping me to complete this study. Thank you very much once again for all people. The cooperation is kindly appreciated.

ABSTRAK

Teknologi Sistem Bangunan Perindustrian (IBS) yang baru muncul telah mencapai momentum sebagai campurtangan untuk meningkatkan keselamatan di kalangan pekerja. Aspek keselamatan yang sangat penting harus diterapkan pada mana-mana projek pembinaan bagi mencegah kemalangan yang akan mengakibatkan kecederaan dan juga kematian. Pemasangan komponen kotak acuan IBS tidak terkecuali daripada bahaya. Matlamat projek ini adalah untuk mengkaji proses kerja pemasangan kotak acuan IBS, untuk mengenalpasti aspek keselamatan dan tahap keselamatan, dan untuk mengenal pasti faktor-faktor untuk meningkatkan keselamatan pemasangan komponen IBS. Terdapat empat proses kerja pemasangan kotak acuan IBS termasuklah mengangkat, meletakkan, menstabilkan dan proses menanggalkan, dan aspek-aspek keselamatan yang berkaitan yang perlu dilaksanakan semasa proses telah dikenalpasti dalam kajian literatur. Penemuan ini mendedahkan enam faktor yang dikaitkan dengan peningkatan keselamatan tapak pembinaan IBS di Malaysia. Faktor-faktor tersebut ialah faktor bersifat sejarah, faktor psikologi, faktor teknikal, faktor prosedur, faktor organisasi dan faktor persekitaran. Struktur soal selidik telah direka dan diedarkan kepada responden dengan matlamat untuk menilai pemahaman dan kesedaran mengenai keselamatan dalam pemasangan IBS. Pandangan pengamal dalam pembinaan IBS termasuk kontraktor dan perunding telah diambil dan dikumpulkan melalui pendekatan kuantitatif. Borang soal selidik yang dipulangkan telah dianalisis dengan menggunakan indeks purata dan kaedah analisis frekuensi. Keputusan menunjukkan bahawa aspek keselamatan yang dipersetujui responden yang perlu dipatuhi adalah pekerja perlu dilengkapi Peralatan Perlindungan Peribadi. Hasilnya juga menunjukkan bahawa keselamatan berada pada tahap yang baik pada semua fasa proses pemasangan. Tambahan pula, dari analisis, faktor psikologi disenaraikan sebagai faktor yang paling penting yang menyumbang kepada meningkatkan keselamatan dalam pemasangan IBS. Faktor psikologi adalah termasuklah mengenai kesedaran diri dan pengaruh dari tingkah laku rakan sekerja. Kesimpulannya, aspek keselamatan amat penting. Bagi meningkatkan keselamatan dalam kerja IBS sehingga mencapai kemalangan sifar, pekerja terlatih dan mahir diperlukan untuk pembinaan IBS, oleh itu latihan yang betul adalah harus ditekankan.

ABSTRACT

Emerging technology of Industrial Building System (IBS) has gained momentum as an intervention to improve the safety among workers. Safety aspect is very important must apply to any construction project to prevent accidence that resulting injury and fatalities. Installation of component IBS formwork is not excluding from having hazard. The goals of this paper are to study the process installation of IBS formwork, to identify the safety aspect and level of safety, and to identify the factors for improving safety in installation of IBS formwork. A total four process installation of IBS formwork which is lifting, placing, bracing and stripping process, and the relevant safety aspect that has to be applied during the process were identified in literature review. The findings disclosed six factors linked to the safety improvement of IBS construction site in Malaysia. The factors were historical, psychological, technical, procedural, organisational and the environmental factors. Structures of questionnaire was designed and distributed to the respondents with aim to assess their understanding and awareness regarding to the safety in installation IBS formwork. The viewpoint of practitioners in IBS construction including contractors and consultants was captured and collected through the quantitative approach. Returned questionnaire were analyses with used average index, frequency analysis method and mean. Result has shown respondent strongly agreed safety aspect need to apply is workers equipped with Personal Protective Equipment (PPE). The results also indicate that the safety is in good level at all phases. Furthermore, from the analysis, a psychological factor ranked as most crucial factor contributing to safer in installation IBS formwork. The psychological factor included the self-awareness and influences from workmates behaviour and least is environmental factor. To conclude, safety aspect is needed to apply. In order to improve safety of IBS formwork until zero accidents, a well trained and skilled workers are required for IBS construction, thus proper training is permissible and should be emphasised.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Introduction

In general safety is related to any precaution to avoid any hazards that might be occurred in all circumstances. In construction industry, both in traditional method or in Industrialized Building System (IBS) strives to maintain and practicing safety aspect for every workers. The construction industry in Malaysia has been introduced with the IBS. Now, the construction industry that was once only use traditional methods have been moved to a more innovative method which is Industrialized Building System, where projects are mostly based more on the product based. IBS is a construction system that built using prefabricated components. A formwork is classified as one of the IBS components. Besides, the construction method of IBS is where the components are manufactured off-site or factory and once completed it will be delivered to construction sites for assembly and erection (S. S. Kamaruddin, 2013). The work process of IBS formworks has its own significance and deficiency to be compared with traditional method.

In construction industry, innovation of building system is considered necessary in order to cater to the increasing demand of industry products. 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). In order to improve the effectiveness and implementation of IBS in construction industry, the safety requirement during the process of work at site being considered. The safety in installation of IBS formwork component in building is included in this consideration.

Safety aspect in construction is a major importance and it has to apply to any construction project.

The IBS formwork that includes metal or steel, aluminium and plastic gained its popularity recently due to its flexibility of application in many projects, recyclables at many phase of construction and can be used in different types of design structure (Baharuddin, 2015). From that point, it giving a significance impact towards the importance of IBS formwork system applied in the Malaysian construction industry. The lack of knowledge in IBS formwork system among the Malaysian construction industry has giving consequences in creating problem in safety aspect and safety requirement.

IBS in Malaysia has begun in early 1960's when Ministry of Housing and Local Government of Malaysia visited several European countries and evaluate their housing development program (Thanoon *et. al.*, 2003). After their successful visit in 1964, the government had started first project on IBS aims to speed up the delivery time and built affordable and quality houses. About 22.7 acres of land along Jalan Pekeliling, Kuala Lumpur was dedicated to the project comprising seven blocks of 17 stories flat there are 3000 units of low-cost flat and 40 shops lot. Based on research in Malaysia Project Online, the IBS component (Steel formwork system) that has been used in buildings in Malaysia is Public Housing Project at Telipok, Sabah.

1.2 Background of Study

Industrialised building systems (IBS) is defined as the overall structural components of a building, including walls, floors, roofs, stairs, etc. that were built at the factory or at the project site with the supervision of the quality factor and reduced activity at the construction site (Trikha, 1999). IBS is a construction process that utilises techniques, products, components, or building systems which involve prefabricated components and on-site installation. From the structural classification, there are five IBS main groups identified as being used in this country, and these are:

i. Pre-cast Concrete Framing, Panel and Box Systems – pre-cast columns, beams, slabs, 3-D components (balconies, staircases, toilets, etc)
ii. Formwork Systems – tunnel forms, EPS-based forms, beams and columns moulding forms, permanent steel formworks
iii. Steel Framing Systems – steel beams and columns, portal frames, roof trusses
iv. Prefabricated Timber Framing Systems – timber frames, roof trusses, etc;
v. Block Work Systems – interlocking concrete masonry units (CMU), lightweight concrete blocks, etc.

Formwork in construction is the use of support structures and moulds to create structures out of concrete which is poured into the moulds. The IBS formwork system includes steel, aluminium and timber formwork system. CIDB Malaysia, in collaboration with various organizations representing the construction industry, has been urged to use innovative construction techniques, and to shift from the traditional practice of brick and mortar systems to an Industrialised Building System (IBS) of construction (Hamid, 2011). One of the technique is called as IBS formwork system which able to speed up the delivery time, and to build affordable and quality houses.

IBS formwork construction give lessens the problem of site wastages and the related environmental problem. There is three important phases to be looked out in categorised of IBS which are manufacturing, delivering and also the construction phase. Then, the most important element during the sequence of construction is the planning. During the manufacturing phase, the IBS components are usually done at the factory. All this phases includes considering the aspect of safety requirement that need to be applied by all workers (N. Nasir, 2012). The construction phase of formwork especially for high rise building is the most challenging stage as it involves with several activities.

IBS has been identified as a potential solution to improve the overall performance of a project including the safety aspect. It is a system which uses industrial production techniques either in the production of components or assembly

of the building or both. According to IBS Roadmap that published 2003, has outlined the utilisation of IBS components leads to a safer working environment at minimum work is a required on-site, cleaner site due to timely material delivery, systematic components storage, reduction of construction material and waste. In construction industry, both in traditional method or in IBS method strives to maintain and practicing safety aspect for every workers. The government is taking the leading role in persuading the construction industry to adopt a more systematic approach and methodology in construction. The effort which started in 1998 is a strategic change in the construction industry (Abd. R, 2006).

However, despite all advantages, health and safety is still an issue despite of all the steps taken by the government and other related agencies through enforcement of various rules, regulations, policies and Acts (N. Nasir, 2012). There are three basic laws that govern Health and Safety which are Factories and Machinery Act 1967, Occupational Safety and Health Act 1994 (Act 514) and Construction Industry Development Board (Act 520). There are also training/awareness and enforcement programmes created in order to put safety a priority such as Green Card under CIDB and Coupon System under DOSH. In order to materialise the Construction Industry Master Plan (2006-2015), which targets of zero number of accidents and fatality rates, it is important to examine all areas of construction and disclose methods that can improve it.

Nowadays statistics of accident in construction industry encourage researchers to find new way for improving or enhancing safety performance in construction industry. Field in IBS also not exceptionally involved in accidents and safety issues involving workers during the installation of IBS components. With such unpredictable figures reported, accidents in this industry have captured the attention and concerns from both governmental and non-governmental organizations (Gloria, 2011). Furthermore, both of direct and indirect cost of accident adds more expenses to construction projects that are because of improper safety performance in construction site. Malaysia, recorded a worrying increase in the numbers of accidents occurring at the construction sites by the Social Security Organization (SOCSO) indicating the number of permanent disabilities and fatalities from year 1996 to 2008 (D. Abang Abdullah, 2010).

Safety aspect in installation of IBS component which is formworks is discussed in this study. The construction phase is the most challenging stage as it involves several activities. The activities include the lifting, placing, bracing, connecting and grouting of the IBS components (M. Zaki, 2016). It differs from the traditional method as mostly the components and structures are large in size and they need to be cast on site. Therefore, the safety aspect of it may also differ. (N. Nasir, 2012). Hence, installation of IBS forrmwork really need a skilled workers because the procedure for installation is difference with traditional method and needed a speciality to do so follow the safety requirement. Installer must have a detailed safety procedure in their method of installation that meets all Department of Occupational Safety and Health (DOSH).

There are sum summary cases accidents involved with formwork. The cases are following in table 1.1

Table 1.1 Summary cases

Author	Summary Cases
(The Star Online, 2006)	Incident involving Steel Formwork killed Dr Liew Boon Borng and severely injured his wife and the driver on 30 December 2005. A mould fell onto his BMW from the 20th floor
(DOSH, 2006)	Negligence of three construction companies, led to the death of another Indonesian worker where a 32-storey of 100 units apartment was to be built.
(DOSH, 2013)	A 7 kg aluminium plate struck onto the victim's head. He died struck by aluminium formwork.
(DOSH, 2012)	Victim fell from a height of 16 metres while carrying out works of dismantling aluminium formworks.
(New Strait Times, 2016)	A woman was killed when a crane hook at a construction site fell on her car as she was driving along Jalan Raja Chulan, Bukit Bintang.

Most of the accidents near 99% are caused because of unsafe act, unsafe condition or both (J, 1986). In 2000–2009, SOCSO reported 656 555 accidents in all industries (6.5% of all accidents in industries) and 42775 accidents in the Malaysian construction industry. The data were retrieved from the hardcopy of annual reports for the years 2000–2009 in SOSCO's head office. Besides that, DOSH Ministry of Human Resources most recently recorded a worrying rise of accidents in the Construction Industry having severe and fatal accidents occurring every month in the year 2007 and 2008 (D. Abang Abdullah, 2010). Unfortunately, statistics of accidents occurred in the Malaysian construction sector have not been well organized especially in IBS field. The factual statistical data retrieved from the Department of Occupational Safety and Health (DOSH) cannot indicate the actual and absolute construction safety and health scenario in Malaysia (H. Chong, 2014). So that, it is important to identify the aspect that can be improved in order to enhance the safety performance of construction sites. Although IBS researchers have pointed that safety is one of the advantages associated with IBS construction, but there are times it can turn out to be disastrous.

1.3 Problem statement

A safety aspect is one of the problems that every site is facing. Every year, safety is become an issue that has no end and there will always have accidents happened at construction site. This has proven through numerous construction accidents which mostly includes involvement of cranes and fallen objects which take a big part in the IBS construction method (SOCSO, 2009). Accidents in IBS construction contributed by several causes such as lack of suitable planning, ignored some procedures in method statement, safety equipment that already provided did not utilize properly, poor attitude and lack of focus regarding to the safety during installation process. From previous researchers that study related to statistic of accidents it is noted that 50% of the construction workers in Malaysia are working under unsatisfactory conditions. The condition includes failure to wear safety hats and boots, construction sites failing to adhere to pre-requisite safety requirements, and using unauthorized heavy machinery (Bashir, 2009). Could it be possible these occurrences are due to the poor management of the sites or simply just the behaviour and common practices or cultures of the workers passed down at work?

Concerning in safety aspect during installation stages of IBS formwork seems not glowing enough. Therefore, construction workers and related person need to show their own initiative in order to taking care of their safety and concerning about the risk and factor that contribute to accidents.

Safety precautions need to be aware because even everything like training session, employer's responsibility and safe working environment already been looking out but still accidents occurred. It is essential for the contractor to take into consideration to all these matter in order to achieve success in the IBS project and also gained zero-accidents at construction site. Now, the questions arise on how to improve the safety aspect on the IBS construction method especially in installation of IBS formwork system component. Enabling factors may help fill this gap. Hence, IBS shall be rigorously implemented and called for the need on the enabling factors that foster a safer working environment to be addressed.

1.4 Research Objectives

From the problem statement listed, there are objective that will to achieve on this study are following:

i. To study the process of installation IBS formwork
ii. To identify the safety aspect and safety level in installation IBS formwork at site.
iii. To identify the factor improving safety in installation of IBS formwork

1.5 Scope of Study and Limitations

In order to achieve the objectives of this study, the scope of the research is only focusing on element of Industrialized Building System (IBS) method and safety requirement in constructions specific in IBS formwork system. This research is only targeted on Malaysia's construction industry and is not related with all other countries. Concentrating on construction industry in Malaysia could give a clearer sight of view of the overall development in local industry. The data collected in this

study are mainly from the companies' safety manuals documents study, case studies, previous researcher, questionnaire and interviews. Random sampling will be done in assigned area, whom practicing IBS method. There are some limitations aspects considered in this study which are:

i. This study is focus on IBS formwork system.
ii. This study is focus about safety process installation of formwork at the site.
iii. Area of data collection confines within state of Pahang and Selangor.

By review on previous research that focus on the similar study, some of the safety aspect, safety attributes and factor to improve safety issues was highlighted and the input is obtained by questionnaires prepared based on it. Hence, the prospective respondents are main contractors, site supervisor and site staff in Malaysia. Contractors are targeted as they have hands on experiences to deal with the construction progress. This is to survey on the awareness and knowledge of these contractors about the safety aspect in construction industry.

The analysis is 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 analysis data and information from literatures studies. Conclusion was made according to objectives of the study.

1.6 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, preparations of questionnaires and data collection. This process started from the topic selection followed by identifying issues and research problem, objectives of the studies, scopes, literature review, data collection, data analysis, conclusion and recommendation and finally the thesis write up.

After topic has been selected, the issues and problem statement been indentified to prove the relevance of the topic selection. The statements of the problem include the clear description of the study issues and also the potential

methods to solve the problem of accidents happened during construction work. This happened due to the lack of consideration of safety and risk evaluation in IBS construction.

Literature review done based on previous researches, thesis, journals, books and other publications. It is a description of the literature relevant to a particular field or topic. Besides, content in literature review is an overview about the prevailing theories and hypotheses. In this literature review, all the information is about the on previous or historical finding which is related to the study which is safety aspect in IBS formwork.

To achieve the objective of the research, the following steps were carrying out:

i. A preliminary research was made on the factors that affect safety aspect.
ii. Site visit, interview with the contractors. This is done to collect data and to understand the safety procedures and level of safety in construction industry.
iii. The questionnaires were formulated after the preliminary interviews and literature review was obtained.
iv. The questionnaire was collected but the incomplete questionnaire will be excluded.
v. The questionnaire was collected needed to analyse and obtaining the overall data.

The research procedures are as shown in Figure 1.1.

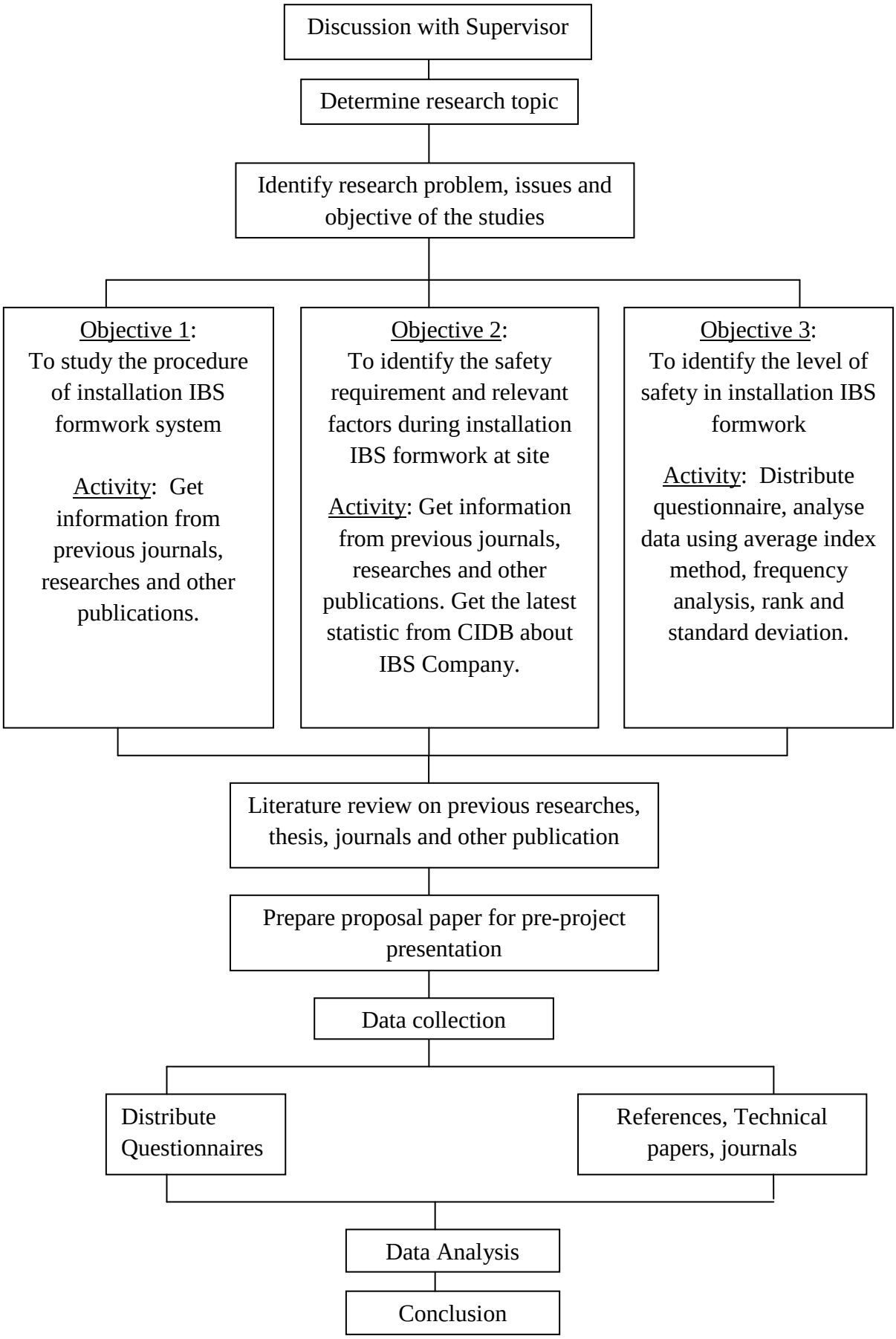

Figure 1.1 Research flow chart

1.7 Significant of Study

The construction industry now is facing challenges in four aspects; time, cost, quality and safety. Actually, safety is one of the most important factors in construction industry where it will affect the time, cost and quality of any construction project. By identifying the safety aspect and safety procedure in IBS formwork, we will acknowledge all workers and contractor about importance of safety and how near risk in life.

Besides, this study will help to measure the safety in Industrialized Building System (IBS). Other than that, the compliance of the safety regulations coupled with the knowledge of safety provides advantages to the construction companies. The effective safety attribution in construction companies will reduce risk of death and practice zero accidents happen. It decreases of accidents and the project can be completed with high quality within the given time. A good practice of safety during the installation stage could avoid the accidence in construction industry.

Thus, this paper will first identify the procedure of installation IBS formwork according to the importance various aspect from the point of view of the contractors and his operations teams. At the end, conclusion will be made about the level of safety based on the information from respondents and identify the relevant factors towards safety improvement in installation of component IBS.

1.8 Expected Outcome

At the end of this study, workers must be knowledgeable and high self awareness in order to have a safe construction site. They must put safety as a priority. The crucial safety factors during the construction and installation stage need to be identified in order to produce a better quality of the formwork system in building hence, improve the safety aspect. The objective of the research in the end will be achieved so that contractors have knowledgeable and in gaining zero-accidence at site as requested by all construction parties.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

IBS is a construction process that it utilize the advanced techniques, products, components or building system which involve prefabricate component and on-site installation. This industrialization process consists of many different approaches. It begins with the organizational process with continues 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 (M. Nawi, 2014).

2.1.1 Industrialized Building System (IBS)

There are several terms used which are interchangeable with IBS. These terms are interchangeable when describing the characteristics of industrialized building. Nonetheless, the terminology used brings the same meaning which is the components are manufacture offsite in a controlled environment which wastage and quality can be controlled. IBS is stand for Industrialized Building System. In general, the construction methods can be classified into four categories which is cast in situ, conventional method, composite method and fully fabricated (Badir And Razali, 1998).

In general there are several categories of IBS definitions according to few researchers. In early literature, Parid (1997) defined IBS as a system which uses industrialized techniques either in the production of components or assembly of a building, or both.

According to Lessing et al (2005), IBS as an integrated manufacturing and construction process with well planned organization for efficient management, preparation and control over resources used, activities and results supported by the used of highly developed components.

CIDB (2003), has outlined IBS is define as a construction system which components are manufactured in a factory or off site, positioned and assembled into structure with minimal additional site work.

Trikha (1999), IBS as a system in which concrete component prefabricated at site or in factory assembled to form the structure with minimum in situ construction. At the same time, Warszawski (1999) said, IBS also defined as a set of interrelated element that act together to enable the designated performance of the building.

Besides, Esa And Nurudin (1998), IBS is a continuum beginning from utilizing craftsmen for every aspect of construction to a system that make use of manufacturing production in order to minimize resource wastage and enhance value end users.

Another definition that clarified by Junid (1986), IBS as process by which components of building are conceived, planned and fabricated, transported and erected at site. The system includes balanced combination between software and hardware components. The software element includes system design, which is complex process of studying the requirement of the end user, market analysis and the development of standardized components. Finally, Dietz (1971), has defined IBS as total integration of all subsystem and components into overall process fully utilizing industrialized productions, transportation and assembly techniques.

Almost all the definitions of IBS mentioned about the prefabrication off-site production and mass production of building components as a main characteristics of IBS. Hence, from my reading it can say that Industrialized Building System (IBS) is a process whereby the pre-cast concrete elements are concrete products that are manufactured or at site and cured in a plant environment and then transported to a job site for installation to be assemble together to form a building.

Besides, it is interesting to note that the term "Industrialized Building System" (IBS) is often misinterpreted as systems limited only for construction of building. In fact, IBS covers all types of structures as the word "building" actually relates to "construction" (Shaari and Elias, 2003).

2.1.2 History of Industrialized Building System (IBS) in Malaysia

IBS is a technique of construction, which introduced by CIDB was succeed and applied the prefabricated technology into the construction industry in Malaysia. IBS is define as a construction system in which components are manufactured in a factory, on or off site, positioned and assembled into structure with minimal additional site work (CIDB, 2003). Dietz, A.G.H (1971) earlier defined IBS as total integration of all subsystem and components into overall process fully utilising industrialised production, transportation and assembly techniques.

The benefits of IBS systems are to reduce the construction time, convenience for site management, better productivity, better quality control, reduced wastages of materials, etc. In order to having an industrialised construction industry and achieving Open Building by the year 2010, CIDB has introduced IBS Roadmap 2003-2010 in order to achieve the aim. There have 5-M strategy in IBS Roadmap 2003-2010, there are manpower, materials-components-machines, management-processes-methods, monetary and marketing.

In the late 60s, IBS has been used in Malaysia. The first IBS project was a construct 7 blocks of 17 storeys flats, which involved 3000 units of low-cost flat and 40 units of shop lot along Jalan Pekeliling, Kuala Lumpur in the year 1964. This project was using the Danish System of large panels in a pre-fabricated system in which undertaken by Gammon/ Larsen Nielsen. After this, the government had launched a second project in the year 1965. The project was using French Estoit System that undertaken by Hochtief Chee Seng. The project was a construct 6 blocks of 17 storeys flats and 3 blocks of 18 storeys flats at Jalan Rifle Range.

There are many factors pros and cons need to be consider as to whether or not the pre-fabrication will be more economical or efficiency than the conventional

construction method, which is cast in-situ. According to Nicolas S.Y. Yeung (2015), pre-fabrication will contribute to improved build ability and associated efficiency gains in terms of time, cost, quality, safety and environmental targets.

In order to make the installation procedures successful, meeting is the most important issue needs to be carrying out with all the parties involved like Employer, Consultant, Contractor, employees, labours, etc before installations. The discussion during meeting should included the site access for deliver the pre-fabricated components to site, components' size and weight, installation procedures, storage issues, etc. It is important that the Employer and other parties to understand the installation procedures and function for the final output.

The delivery trucks should have a clear access to the site and can lift those components to the site safely without cause any damage of the works around the site. In addition, the site area mush be accommodate for the components handling and storages. Upon the components delivered to site, the site must be able for crane to move around the product to the selected location without coming in close with other works.

2.1.3 Sequence of Construction for IBS Method

IBS method is different from the conventional construction method. Known for its benefits in terms of shorter construction time, saving in labour, material saving, better quality control, immunity to weather changes and the cost factor, IBS method illustrates a different approach to the construction method commonly used. It offers an alternative to the existing conventional building system.

Among one of the most important characteristics of IBS method is IBS components are prefabricated offsite. According to Chew and Michael (1986), prefabrication system of construction means breaking a whole housing unit into different components such as the floors, walls, columns, beams, roofs, etc. and having these components separately prefabricated or manufactured in modules or standard

dimensions in a factory. Figure 2.1 show sequence of activities of IBS construction method.

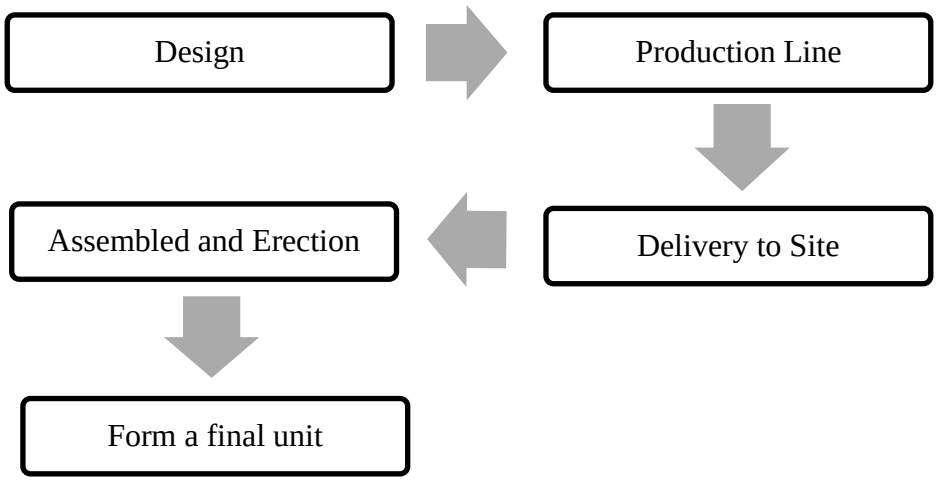

Figure 2.1 Sequence of activities for IBS construction method

2.2 Classification of Industrialized Building System (IBS)

There are various classification components of IBS. Just as the definitions, IBS has a various different classification which is based on material, process and system. Table 2.1 shows the classification of IBS. This section will focus on the classification system established buildings in Malaysia.

Table 2.1 Comparison of industrialized construction classification

Classification	Sub-categories	Author
Mazjub's Building System Classification	• Panel system • Box system • Frame system	(Majzub, 1977)
Industrialized System Classification (Razali-Badir's Classification)	• Conventional building system • Cast in situ formwork system • Table or tunnel formwork • Prefabricated system • Composition system	(Badir et. al, 2002)

Warszawski's Building System Classification 1	• Timber • Steel • Cast in situ concrete • Precast concrete	(Warszawski,1999)
IBS Classification (CIDB)	• Panel and box systems • Steel formwork systems • Steel framing systems • Prefabricated timber framing system • Block work system	(Shaari, S.N. Ismail, 2002), (CIDB, 2003), (Chung,2006)
IBS Classification (UTM)	• Pre-cast concrete-framed building • Pre-cast concrete wall system Reinforced concrete building with pre-cast concrete slab • Steel formwork system • Steel-framed building and roof trusses	(Rahman & Omar,2006)

For further exploration of and discussion between researchers in this field, a generic classification for IBS can be derived as the followings:

- Frame System (pre-cast or steel)
- Panellised System
- Onsite fabrication
- Sub-assembly and components
- Block work system

Table2.2 Types of building system in Malaysia (Majzub, 1977)

Building System			
Composite Building	Prefabricated system	Cast in situ system with Steel or Aluminium as Formwork	Conventional Column, Beam-Slab, Frame, System with Timber and Plywood as Formwork

Source: Majzub (1977)

However, Majzub (1977) have a different concept to the classification system of the building. He explain that the relative weight of the components necessary to use a basis for classification of buildings which constitute the system architecture, system and system panel box as shown in Table 2.2. Weight factors include the effects of transmission 'n' capacity component and also impact on the production of components and its erection on site. This classification is not suitable in Malaysia as it was found not enough to incorporate with system building thriving lately.

Besides, IBS Survey (2003) listed out five categories of IBS classifications and they are listed as follows:

i. Formwork Systems

Considered as one of the “low-level” or the “least prefabricated” IBS, as they generally involve site casting and are therefore subject to structural quality control, the products offer high quality finishes, and fast construction with less site labour and material requirement. These include tunnel forms, tilt-up systems, beams and columns moulding forms, and permanent steel formworks (metal decks).

ii. Pre-cast Concrete Framing, Panel and Box Systems

The most common group of IBS products is the pre-cast concrete elements pre-cast concrete columns, beams, slabs, walls, “3-D” components (e.g.

balconies, staircases, toilets, lift chambers, refuse chambers), lightweight pre-cast concrete, as well as permanent concrete formworks.

iii. Steel Framing Systems

Commonly used with pre-cast concrete slabs, steels columns and beams, steel framing systems have always been the popular choice and used extensively in the fast-track construction of skyscrapers. Recent development in this type of IBS includes the increased usage of light steel trusses consisting of cost-effective profiled cold-formed channels and steel portal frame systems as alternatives to the heavier traditional hot rolled sections.

iv. Prefabricated Timber Framing Systems

Among the products listed in this category are timbers building frames and timber roof trusses. While the latter are more popular, timber building frame systems also have it own niche market; offering interesting designs from simple dwelling units to buildings requiring high aesthetical values such as chalets for resorts.

v. Block work Systems

The construction method of using conventional bricks has been revolutionised by the development and usage of interlocking concrete masonry units (CMU) and lightweight concrete blocks. The tedious and time-consuming traditional brick-laying tasks are greatly simplified by the usage of these effective alternative solutions.

2.3 Definition of formwork

Formwork can be defined as used to form concrete into structural shapes which are beam, column, slabs, and etc. Besides, formworks is a structure which is usually temporary but can be a whole part permanent used to contain poured concrete to mould it into required dimensions and support until it s able to support itself (Industry Resources Formwork, 2006). According to Brooks (2008), formwork can be made using moulds out of steel, wood, aluminium and prefabricated forms. This study

only focuses on steel formwork systems. The inside surface is coated with a bond breaker (plastic or oil) to keep the concrete from sticking to the mould. A good formwork should satisfy the safety in construction site.

There are some requirements that satisfying the formwork is a good condition. There are including a strong enough to withstand all types of dead loads and live loads, the joints in the formwork is tight against leakage of cement grout, construction of formwork is permit removal of various parts in desired sequences without damage to the concrete, how safety can be improved for the site and how good concrete quality can be achieved.

2.3.1 Classification of Formworks System

From the structural classification, there are five IBS main groups that are used in Malaysia as shown previous at sub-section which mainly based on classification by CIDB.

i. 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 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. Then, this system is preferred better for the construction of walls instead of beam and column due to many repetitive of similar wall components in wall frame buildings. It offers faster speed erection, comparatively lower cost and simplicity in equipment.

ii. Tunnel Formwork

This tunnel formwork is a mechanized system for cellular structures and known as a modern method of construction (MMC). Used widely in the construction of cellular structures that consists of high degree of repetition. The construction process are 24-hour construction cycle can be achieved and the buildability of in-situ concrete is improved by using tunnel

formwork system. Tunnel formwork can produce strong and durable in-situ cellular structures.

iii. Aluminium formwork

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

iv. Timber formwork

It consists of timber building frames and timber roof trusses. Although the latter is more common, timber building frame systems also offer interesting designs from simple dwelling units to buildings such as chalets for resorts.

2.4 Categorise of Formwork

Ravishnkar (2015) noted that, formwork can be categorising into three which is conventional, Modern-Day Formworks and Engineered/Pre-fabricated formworks.

i. Conventional Formwork

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.

ii. Modern-Day Formworks

This formwork system is 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.

v. Engineered/Pre-fabricated Formworks

This 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.). The two major advantages of formwork systems, compared to traditional timber formwork, are speed of construction and lower life-cycle costs (barring major force, the frame is almost indestructible, while the covering if made of wood; may have to be replaced after a few – or a few dozen – uses, but if the covering is made with steel or aluminium the form can achieve up to two thousand uses depending on care and the applications).

2.5 Prefabricated Formwork

Prefabrication formwork system offer the contractor the ability to assemble components for almost any size or shape form, the need very little on-site skilled labor, the ability to reuse forms (The Aberdeen Group, 1966).

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

Material that typically used for prefabricated is steel aluminium and plastic. Steel formwork is stronger, durable and has longer life than timber formwork and their reuses are more in number.

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 plastic (GRP) and vacuum formed plastics are used when complicated concrete shapes are required such example waffle floors. Although vacuum formed plastics will always need support; GRP can be fabricated with integral bearers making itself supporting. Besides, 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).

2.5.1 Types of Pre-fabricated Formwork

There are different types of formwork available for different purposes. Generally, the formwork 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 verticals lifts. After each casting the forms are removed and raised to forms the next lift until the required height has been reached. These forms are widely used in the constructions of industrial chimneys, silos, high rise towers and building cores.

Figure 2.2 Climbing Formwork

ii. 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. The can be of two types participating and non-participating. The material used for these forms must be durable and 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.

Figure 2.3 Permanent Formwork

iii. Table Formwork

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.

Figure 2.4 Table Formwork

iv. Tunnel Formwork

The tunnel formwork is a room sized structural sized steel fabricated form which is used to cast the Reinforced Cement Concrete (RCC) 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.

Figure 2.5 Tunnel Formwork

2.6 Activity in Formwork Construction

The activities that involve during formwork construction are assembly and erection, propping and centering, concrete placement and stripping and dismantling.

2.7 Formwork Installation Process

Regarding CIDB (2005), every installation of component in IBS is unique; the procedure might be difference, hard and can be complex. So that, before starting the process of installation, the knowledge in safety procedure is required and become major important to achieve a high level of quantity and customer satisfaction.

There have own initiative in every company to develop a method statement and way in installing formwork. To make installation run smoothly, it is best to have experienced workers plants should take the initiative and train employees, developing them into highly skilled installers. This goes to foreman, welders, crane operators and the whole crew that involved during the process of installation. The safety procedures need to be developed. If the procedures are kept simple and consistent, installation workers can achieve efficient, safe and thoroughly effective installation while improving their track records each time (CIDB, 2005). Figure below shows the process component installation of formwork system.

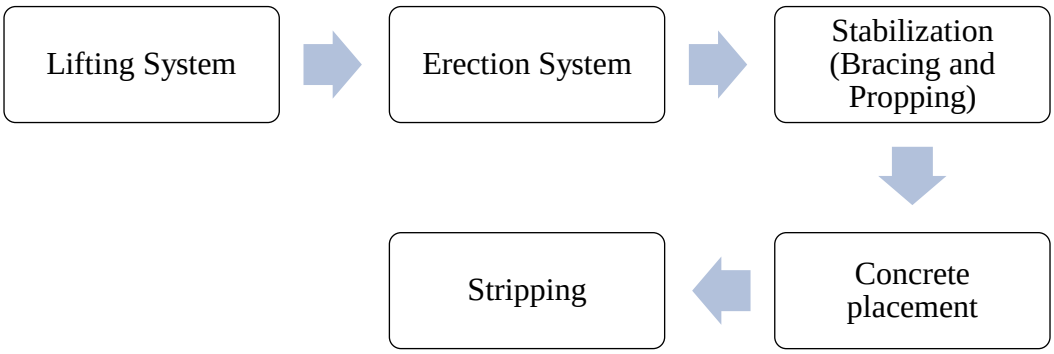

Figure 2.6 Process component installation of formwork system.

2.7.1 Lifting System

To lifting a formwork, the material been used is consists of wire ropes, chains employing spreader bars, hooks shackle and lifting plates. All the hardware should have annual certification to verify the capacity and safe working loads generally is required. DOSH have strict regulations on lifting systems. The four chains (one in each corner) needed and should be fitted to lift boxes. Crane-lifted loads is slung and secured so that the load (or any part of it) cannot fall. Tare mass of wall, lift or column forms should be provided on site with formwork documentation and made available for inspection by all interested parties. To get the safe working load mass is clearly marked on bins. The process lifting boxes only run when have certified engineer-designed to appropriate for the material being lifted.

Then, Specifically-designed lifting boxes is used to lift smaller components (e.g. spigots, U-heads, base plates and couplers). The boxes should have enclosed sides or robust mesh (with openings less than the minimum size of materials being lifted). In the same time, materials should not be stacked higher than the side of the box unless they are adequately secured, but at no time should the box become top heavy, formwork frames should either be strapped together or lifting slings should be wrapped around the load and loads of joists or bearers should be strapped together before lifting. After that, the formply loads should be strapped together and lifted in a flat position to ensure the loads are supported with dunnage, the load is uniformly distributed over the supporting surface (Formwork Code Practice, 2006).

Slings attached to lugs or holes cut into part of the load are often used to lift bins, and wall, lift or column forms (instead of wrapping the lifting slings around the load). Information verifying the structural adequacy of the lifting points should be available. The certification should be provided by an engineer who should verify the structural adequacy of the lifting lug and means of attachment to the load (usually welded or bolted to the load).

2.7.2 Placing (Erection System)

During the placing of component, the principles of maximum potential fall distance and gap width at the working level should be applied. IBS formwork systems are often lighter weight and require less physical effort than traditional systems because they are often constructed from aluminium instead of steel and they eliminate the need for tasks such as repetitive hammering. However, because of their lighter weight, modular systems may be more susceptible to falling over during the erection of the system, due to factors such as wind loading. To effectively control this issue the formwork system should be progressively braced in accordance with the suppliers instructions during its erection.

2.7.2.1 Working platform

During the erection of component formwork units, the use of temporary working platforms, together with the frame metalwork and bracing are important for fall protection. AS/NW 1576 Scaffolding requires that temporary working platforms must be at least 450 mm wide (2 planks). Cleats can be used to prevent planks from slipping off the frames. A temporary working platform as well as a system to prevent or arrest falls should be provided when erecting above the first frame or a temporary catch platform should be provided below the work area. Catch platforms should only be adopted as a risk control measure based on a documented risk assessment. Where temporary catch platforms are provided as a fall arrest measure they should be constructed no further than one frame (of the standard 1.8 m height) with end fittings, below the work or fall risk area. Then, walkway systems is important during the process installation and must be in place along the upper level of formwork all

walkway systems must be properly positioned, spaced and fastened as per manufacturer's specifications and all applicable safety regulations.. Besides, scaffold brackets useful that attach with the manufacturer are recommended connectors (Formwork Code Practice, 2006).

2.7.3 Stabilizing (bracing and propping)

In installation and assembly of formwork, bracing is required to stabilize them against loads such as wind, seismic movement, eccentric dead loads, incomplete connections and possible impact from construction equipments. Bracing will be special requirements when involved for wall and column formworks. The formwork should be designed to withstand wind loading prior to, during and after the concrete pour. The bracing and forms should not be removed from the cast element until it can safely withstand potential impact loads and wind loads. The props used for centering may be of steel or timber post. Pillars made up of brick masonry in mud mortar are also sometimes used as props.

Bracing should already be stored at the site and readily available when needed. Lateral support can be provided to vertical elements in a variety of ways including horizontal and angled braces and structural connections to other parts of the building. A bracing element must be verified and signed off by an engineer. The bracing element must also be able to resist both tensile and compressive loads that may be applied by the wind. Anchors for braces should preferably be cast-in type anchors or 'through-bolts' that extend through both sides of the anchoring medium. At the ground, bracing must be positioned to ensure that the unit remains in the proper location. Most bracing can be adjusted by turnbuckles, by changing its position or by other adjusting methods. Bracing should not be removed until the formworks units are within the acceptable placement tolerance and the permanent connections have been made.

2.7.4 Concrete Placement

Before concrete been placed, the formwork should be cleaned of all rubbish particularly the sawdust savings & chippings etc. Then, the face of formwork in contact with conc. shall be cleaned & treated with release agent like raw linseed oil or soft soap solution as to prevent the concrete getting struck to the formwork. During vibration process, worker should be instruct and do not use vibrator to move concrete. Do not vibrate further than one-foot into the previous lift. Avoid vibrator contact with wall ties. External vibrators must not be attached to formwork unless it was designed for their use.

2.7.5 Stripping

Prior to commencement of the stripping operation, a competent person, from the principal contractor such example project engineer is to provide written certification that formwork can be removed. This certification should be based on an engineer's specifications for the building, the strength of the concrete mix and the time period that has elapsed since the pour. An engineer will also be required to have input into the stripping safe work method statement to ensure the concrete element will not fail and must have provided details on the structural engineering drawings as required by AS3600 - Concrete structures. Be certain that concrete has sufficiently set to carry its own weight and any imposed loads prior to stripping formwork. When gang-forming, secure the lifting mechanism prior to removal of ties, anchors and/or bracing.

2.8 Safety in General

Safety is one of the important things that must be implemented when commence any construction activities. The safety and health are no valid to the workers only as it is require for any individuals that enter the construction site where hazard and accident risk exist. The first step to implement safety and health in

construction site is preparing general safety policy and revise a written with respect to the safety and health at work of the employees and the organization.

In this section, safety aspect during the installation of component formwork will identify. There are several step that can be applied to controlled hazard and risk at site that have been arrange in hierarchy that is elimination, substitution, engineering control, management control and personal protective equipment. This safety and health precaution can be one of the factors in successfully carrying the project operation. Besides, the safety officer is the key man that has to be in charge in implement the safety and policy by giving out the guidelines, procedure and corrective action during working or any others activities involving the project site. Other than that, the worker should follow the safety aspect to ensure that accidents not happen at site.

Besides, general safety at site also needs to be aware among all the workers to prevent any risk that might accident happen. Any components and items that might to be considered are such as safety signage should be placed in work site area. Then, employer must provide with adequate safe and clear access around the site. Furthermore, there are some aspects that really need to be considered which is monitor on arrangements, including safety and health inspection by audits, implement performance of on-going hazard identification and risk assessments, and provision and maintenance of welfare facilities and Personal Protection Equipment (PPE). Regarding to this research studies about safety aspect in installation of IBS formwork, training should be provided to workers so that they have skilled to do a work. Tool box meeting also no exception should implement. All these are critical issues at work area.

The workers will provide with Personal Protection Equipment (PPE) as part of effort to protect worker when do the construction. PPE such as safety shoes, gloves, safety helmet, and etc should be provided and be used correctly. To offering protection from falling while work in height area, safety harness must be used. Most of accidents happen are caused because of unsafe act, unsafe condition or both (J, 1986). Construction workers in Malaysia are working under unsatisfactory conditions and the condition includes failure to wear safety (Bashir, 2009).

2.8.1 Hazards

The following are the main hazard areas in formwork operations.

i. Falls – They are the major hazard because they are potentially fatal. Cramped work areas, inadequate access, failure to install guardrails, failure to use fall arrest systems, tools or material left underfoot, and surfaces slippery from form oil can all lead to falls. Ladders are also frequently involved in falls. All workers in Ontario who may be exposed to a fall hazard and who may use a fall protection system must have working at heights training that has been approved by the Chief Prevention Officer.

ii. Materials handling – The activity most frequently connected with injury. Improper or excessive materials handling can result in sprains, strains, and overexertion in shoulders, arms, and back, as well as bruises, abrasions, and crushed fingers.

iii. Struck by – Another common cause of injury. Rebar, formwork panels, concrete buckets, and other material hoisted overhead can strike workers. Struck-by injuries can also be caused by hammers, pry bars, stakes, wedges, and material such as joists and panels during stripping.

iv. Electrical contact – Power tools, extension cords, and temporary supply and wiring systems, used under less-than-ideal conditions – mud, ground water, wet excavations, and fresh concrete – can lead to ground faults, shortcircuits, and shock hazards. Ground fault circuit interrupters are legally required for portable tools used outdoors or in wet locations

v. Collapses – Even with advanced methods of design and installation, there is always the risk that formwork, slabforms, wall forms, and

other large components can come loose, slip out of place, or fall over, striking or crushing workers underneath.

vi. Environmental conditions – Ice, snow, and rain create slippery conditions. Wind can be a major hazard. Handling sheets of plywood becomes more difficult, panels may require more bracing, and hoisting gets harder, especially with large panels or tables.

2.8.2 Factor in Improving Safety in Installation Formwork

According to Sawacha (1999) and Langford (2000), the factors that are linked to the level of site safety are following:

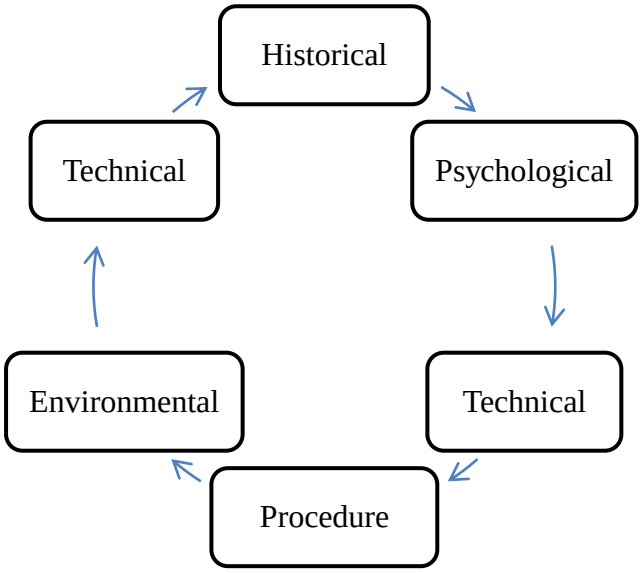

Figure 3.7 Factor safety in Construction

2.8.1.1 Historical factor

The historical factor is assessed by the background and characteristics of the individual, such as age and experience. The older and experience a worker gets, the more aware and alert he is towards safety at construction site (Sawacha, 1999). The same task done at a younger age will be analysed and handled differently when doing

it at a later age. Due to this ability to adjust, one can continue with a highly skilled activity. The factor can be used to investigate whether IBS workers are employed based on age and experience. This is important especially when IBS is using large a big equipments.

2.8.1.2 Psychological factor

On the other hand, the psychological factor is assessed by the safety behaviour of fellow workers on site including supervisors. These are such factors as the effect of the Malaysian Health & Safety at Work Act of 1974, influence of training levels, propensity to accept danger or risk taking, skill levels, supervisor carefulness, worker carelessness and others (Langford, 2000). Psychological factors will help a worker to behave in safe manners since the lack of psychological awareness has been proven to be among the largest causes of construction accidents.

2.8.1.3 Technical factor

Nevertheless, education and training is still important to maintain a good safety performance record. This is include in a technical factor that be considered. A firm is obliged to provide sufficient, adequate and continuous training to all workers (Nunez, 2011). The training scheme must be supplemented with job-specific information if necessary. The training (both basic and specific) increases the workers' skills to behave safely in the workplace. As a result, organisations with better-trained workers will have a larger stock of safety human capital.

2.8.1.4 Procedural factor

Procedural factor is assessed by the provision of training and handling of safety equipment on site and how the operation of equipments is correctly managed on site. Some of the procedures that can enhance the firm's safety effort is through the active monitoring system. It includes procedures for examining the physical conditions of the workplace and installations (Nunez, 2011). This can also be

reviewed as an important role and responsibility of a supervisor. However, the question remains whether this factor is suitable within the context of IBS construction or will it be a matter of interference to the sequence of construction work. Organisational factors were considered as items such as group interactions/interrelationships, trade union involvement, safety policy and safety propaganda and others. These have been labelled as "organisational and risk management systems". According to Leather (1983) noted that, considered these items as "organisational changes within a feedback loop". Effective project management can be seen to be dependent upon the project manager's competency and authority (Jaselskis, 1991).

2.8.1.5 Organisational factors

Organisational factors are beyond than just the role of a project manager but include trust and communication skill from top management to the bottom management. The importance of trust in safety research was demonstrated by Alinaitwe (2006), where they have figured out that the relationship between safety leadership and safety citizenship behaviour was subjected by safety-specific trust in management.

2.8.1.6 Environmental factors

The environmental factors are the factors that relate to the site conditions, the interrelationships between the construction groups, such as inter and intra group co-operation, control and supervision of work activities, site tidiness, influence of site planning and also worker safety observance. This can also be investigated through the management and leadership style of an organisation Sawacha, (1999) and Langford (2000).

2.9 Safety Aspects in Component Installation

Safety aspect during installation process of IBS formwork system, it can see from activity when do the installation. Nasyairi Mat Nasir (2012) noted that, the most important aspect of safety for IBS construction is transportation of component, placing, bracing and connection and joining of components. These studies are involved with formwork component that focused on several activities. That activity is lifting system, stabilizing bracing or propping, and the last connection component welding or grouting. Other than that, also practice general safety aspect current in site construction. Never forget about crane because it is main machinery that use during the process.

2.9.1 Safety Aspects in Lifting

Hazard is become serious during the lifting process component formwork in construction. This process is a critical activity when involved in high risk building or activity. Workers must be aware of safety and put it as individual priority. When working at heights, ensure all safety equipment is used properly at all times no matter how long the task may take and used safety harness (CIDB, 2005). Safety harness might reduce the risk worker to fall and get injured.

Worker in construction site can lead to danger from component falling or move from crane while lifting. It can make critical injured and can lead to death if workers fall during process. Worker should not sit near or in blind spot of crane during the lifting of component formwork. They should be aware because if they do careless, accident might happen. Besides, factor weather also need to be consider during the activity and should be stop immediately when windy day and heavy rain. Steel formwork is lightweight so it can be risk the component might fall.

CIDB strictly noted that lifting equipment should be in serviceable conditions. Before starting the lifting process, all the material and heavy machine should firstly be checked and maintain. Ensure that the Personal Protective Equipment (PPE) is in

suitable to be used and good condition. Other than that, equipment such as walkie talkie must be in good condition and understand the hand gesture or signal between rigger and operator. Ensure hooks, safety latch, slings fully secured and ensure to follow Standard Operation Procedure (SOP) (CIDB, 2006).

2.9.2 Safety Aspects in Placing

IBS formwork systems are often lighter weight and require less physical effort than traditional systems. However, because of their lighter weight, it may be more susceptible to falling over during the erection of the system, due to factors such as wind loading. To effectively control this issue the formwork system should be progressively braced in accordance with the suppliers instructions during its erection. Be certain that all wall ties are in place and secured as per manufacturer's recommendations. Do not weld, bend or otherwise alter wall ties as it may seriously reduce their strength. Erection process is a placing a component of formwork in a right alignment and position. If work and placing the component in a high place, worker must use suitable safety equipment such as safety harness. According to some company safety regulations, the use of safety harness is obligatory if workplace exceeds 1.8 meter in height. Same as lifting process, all the PPE must be suitable to be used and workers applied it. Besides, other material like walking platforms must be in safety installed as per applicable safety standards to ensure there is no risk worker falling to the floor.

During the erection stage, working platform should be installed properly to protect form fall. A temporary working platform as well as a system to prevent or arrest falls. During the installation of working platform, worker must wear all the safety equipment and follow all the safety method statement. Inspect all components thoroughly and if you find weakened equipment, reinforce it immediately. Work at height is unavoidable in most formwork activity, and special safeguards shall be implemented and use safety equipments to avoid accidents by falling from height. All criteria shall be checked and all requirements satisfied as in the Code of Practice for Safely Working at Height (2009).

2.9.3 Safety Aspects in Stabilizing (Bracing and Propping)

Bracing and propping are used for stabilizing the formwork. Aligners (alignment devices, plumbing struts) are considered only as alignment devices with no provisions for withstanding concrete pressure or any portion thereof. Maintain formwork during pour to ensure that aligners are not supporting or stabilizing concrete pressures. Braces used to withstand concrete pressure must be designed by a qualified formwork designer. The process of installation bracing and propping must be done by workers that have skilled and already attending a training that related to safety working in construction site. Inspection should be done by Engineer immediately after braces has been install for correctness of spacing and proper attachment device. Supervising by safety officer also need to check whether the installation is followed as per requirement as method statement. Before removing braces, assure that the concrete has attained sufficient strength to safely support the imposed load at support locations (Formwork Code of Practice, 2006). Other than that, during propping activities should does in correct method to ensure it safe patching that component formwork. All propping equipment to be placed and used appropriately follows the method statement and also inspected.

2.9.4 Safety aspect in stripping formwork

According to Formwork Code of Practice (2006), stripping formwork can be one of the most hazardous phases of IBS construction. While falling objects are the primary hazard, there may also be fall hazards as a result of floor collapse and manual tasks hazards from a person working in awkward postures, repetitive handling of materials and limited task variety. Formwork stripping is probably the most hazardous operation. Hazards can be reduces by planning and providing safety training personnel properly (Heaney, 2016). As with formwork erection, the stripping operation must be carried out in an orderly, progressive manner. A safe work method statement for the stripping operation should be prepared and provided to those who will be involved in this high risk activity. There must identify the work that is high risk construction work, state hazards relating to the high risk construction work and risks to health and safety associated with those hazards and describe the measures to

be implemented to control the risks. As for example, because of their lighter weight, it may be more susceptible to falling over during the stripping work. Previously, there have incident that a steel formwork fall into a car and had caused a death. Because of that, workers should be careful in handling stripping formwork activities to prevent the forms may fall to the floor, road or etc.

Workers should follow manufacturer's recommended field procedures - generally, reverse the order of procedures used in erection of formwork. Use extreme caution for all formwork to assure that no panel, walkway bracket, brace or any other form component is unfastened prematurely. Assure that all disconnects have been made and the bond of the formwork to concrete has been broken prior to lifting of gang form (Formwork Code of Practice, 2006).

2.10 Summary

In this chapter already discussed the information related to this aim of this study. The various definition of IBS also been discussed according to differences researchers. The definition of formwork itself been discussed that become focused in this study. It can conclude that formwork used to form concrete into structural shapes which are beam, column, slabs, and etc. Besides, formworks is a structure which is usually temporary but can be a whole part permanent used to contain poured concrete to mould it. Even though IBS formwork is rarely used in construction industry in Malaysia, once we using it, all the safety aspect must be aware and have major considered.

There are some requirements that satisfying the formwork is a good condition. There are including a strong enough to withstand all types of dead loads and live loads, the joints in the formwork is tight against leakage of cement grout, construction of formwork is permit removal of various parts in desired sequences without damage to the concrete, how safety can be improved for the site. IBS System has a great potential to grow in Malaysia. Besides, IBS has been identified as a potential solution to improve the overall performance of a project including the safety aspect. There are five classification of formwork which is steel formwork system, tunnel formwork

system, aluminium formwork system and timber formwork system. Then, the typical formwork material used is aluminium, steel and plastic. Installation of IBS forrmwork really need a skilled workers and a speciality to do so follow the safety requirement. This is to ensure the increase statistic of accidents in construction Malaysian industry.

There are four main stages for installation process used formwork method. There are challenging stages for this method starting with lifting system, placing of the component, stabilizing of formwork component either bracing or propping, and lastly is stripping process. Overall stages needed a skilled worker for operation and put safety as priority. Other than that, installer must have a detailed safety procedure in their method of statement for installation that meets all the Department of Occupational Safety and Health (DOSH). General safety such hazard must be aware and always keep in mind about the small incident might risk to workers and resulting in injury or death. Workers should be always wearing PPE and understanding the blind spot near the jobsite also always aware of the surroundings. All the safety aspects need to follow in every each of stage during the installation process. Furthermore, there are factor that linked to the safety especially in site area. The safety factor is included historical, psychological, technical, procedure, environmental and technical. These entire factors had assessed the different affect to the individual.

This thesis is more focused about research on the safety aspect in installation IBS formwork in Malaysian construction industry. The installation stages are included lifting system, placing system (erection), stabilizing system and stripping system. The safety aspect during each of four stages is highlighted in this study.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This section, research methodology will explain and focus on the method the objectives of this study to be achieved. Thus, it also will organize the suitable methodology to ensure the effectiveness of the study process. The study was carried out based on the literature review and questionnaire survey. Moreover, data collection from the questionnaire survey being analysed using a certain method and their results are presented.

Methodology is planned by stages according to their priorities and function. The process will be including five stages. The stages are including preliminary stage, reviewing stage, collecting data and information, analysing data and make conclusion recommendation.

3.2 Literature Review

In effort to achieve the aims and objectives of this study, literature review is the first stage in this research which is to analyze, summarize, evaluate, clarify, integrate, and recognize of the information of the journals, articles, and books that related with this research. By getting knowledge through literature review, once can understand more in detailed about the current scenario of IBS and construction industry. From there, the problems that are still remained which are open for further research can also be identified (Nawi et al., 2012)

3.3 Interview

Interview is one of the most popular and simple method to achieve objective of this study. Interviews were being to person who involve in construction mostly process in IBS formwork. It include person who in-charge in work when do the process installation and experienced with IBS formwork such as supplier, manufacturer and others.

3.4 Questionnaire Survey

Questionnaire survey is one of the most popular and simplest methods in order to achieve the objectives of this study. A questionnaire is defined as a formal set of question or statement designed together the information from respondents that will accomplish the goals of the research project (Redzuan, 2006). The questionnaire designed need to meet the objectives and aim of the study, the nature of the problem and the alternatives appropriate for its investigation (Stephen Isaac, 1971). A design is a strategy for constructing the research structure using concise notation that summarize a complex design structure efficiently, to show all of the major parts of the research project the background problems theoretical frameworks, hypothesis, research questions, methodology work together to try to address the centre research objectives (King et al, 1994). Three fundamental considered before design the question:

i. What is the purpose of the survey?
ii. What kind of question the survey developed to answer?
iii. What sort of results consider from the questionnaires?

90 sets of the survey questionnaire will be distributed to the targeted respondents. About the sets of the survey questionnaire it will be distributed to contractors, clients, architect and developer in construction industry. In the process of data validation, the answers obtained from the questionnaires will be checked for accuracy and suitability for this research purpose.

3.4.1 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 the in construction projects, safety aspect in installation IBS formwork, and factor safety in installation stage. Respondents were suggested to attach their business cards or company stamp to the questionnaire forms. The information gathered was as follows:

The questionnaire was structure into four sections:

i. Questionnaires cover the general information's and instructions to the participants.
ii. Section A : Respondent's and company's background
iii. Section B : Safety aspect in installation IBS formwork
iv. Section C : : Factor in improving safety in installation IBS formwork

3.4.2 Data Collection

Data collection is most the critical part of the study to make sure the accuracy of the data will be determined the success or failure of the research. Respondents for the questionnaire in this research are consisted of contractors, consultants, developers and architects in Malaysia.

Handing out questionnaire is an approach to identify the safety requirement and relevant factor and safety level during installation IBS formworks within Selangor and Kuantan. 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:

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

3.4.3 Data Sampling

The sampling technique used in this survey is random sampling (Hamzah et al., 2010). The respondents are chosen from the contractors companies. Due to the limitation not all the companies will be involved in this study. The targeted companies are which is involved in Industrialized Building System construction.

3.5 Methods of Analysis

The information and data gathered through questionnaire were compiled and processed using average index method in relation to the objectives and scope of study. Two statistical methods were applied, namely descriptive statistic and inferential statistics. Result from the findings will be presented in the form of graphs, histogram and pie chart for easier understanding.

3.5.1 Average Index

In average index analysis, the results further summarized to obtain the level of importance in evaluating the factors, which involve in the survey on safety level in installation IBS formwork. The questionnaires are based on two point scale only which is very good and poor. The average index is being calculated based on the formula by Al Hammed et .al, 1996 as below:

$$\textbf{Average Index (A.I)} = \frac{\sum aixi}{\sum xi}$$

Where,

ai = constant expressing the weight given i

xi = variable expressing the frequency of response for i = 1,2,...n

The overall of agreement by the respondents to the safety which influences the safety aspect in installation IBS component are summarized based on the classification of the rating scale. A scale of 2 categories has been used for the average index method in order to show priority. The scales of the categories are:

Table 3.1 Modification level of agreement and evaluation for average index analysis

Average Index	**Level of Agreement**
1.0 ≤ average index < 1.5	Strongly Disagree
. 1.5 ≤ average index < 2.5	Disagree
2.5 ≤ average index < 3.5	Slightly Agree
3.5 ≤ average index < 4.5	Agree
4.5 ≤ average index < 5.0	Strongly Agree

Source: Abd Majid & R. McCaffer (1997)

3.5.2 Frequency Analysis

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

3.5.3 Rank

Rank is actually to 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.

3.6 Comments

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.

3.7 Conclusion

The results of the research reveal that ensuring adequate data from the research based on the questionnaire given. These methods emphasise that successful research were implemented with ease, and getting the information that this study aims. There are three different analysis of the data collection required in the research such as the average method, rank method and comments method analysis. Therefore, the research will be achieved the target of the research and "the right thing right". Lastly the researches of this study are to identify relevant factor and level of safety installation of IBS components in Malaysia. The expected from this study is to make people have awareness about the safety.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter is continuation of the previous chapter and will use the data collected according to the arrangement identified in the questionnaire to describe the overall analysis. The data will analyze and the results will be shown by pie charts, histograms and tables. The data collected from questionnaires are distributes by using email and Google form method to secure a higher return rate than other distribution method. The questionnaires were distributed into a different part which enables the analysis to be done systematically and reflects a logical result.

4.2 Questionnaires Analysis

As stated in the previous chapter, the questionnaire form is divided into three sections, A, B and C. Each section been asked to respondents in multiple choice, tick and multiple choice with scale from one to five. Section A is about profile and background of respondents. In section B, the question is about identifying the safety aspect and safety level during the installation process. Then, in section C the question is about safety factor improving safety in the installation of IBS Formwork. The sample questionnaire can be referred in Appendix.

There were about ninety (90) set of questionnaire form were distributed to the targeted respondents consists of contractor, consultants, engineer, manufacturer and developer. Out of the total 90 questionnaire form sent out, only 50 respond were

received. Table 4.1 below shows the percentage of respondent that has been summarized.

Table 4.1 Respondent's Rate

Number of Questionnaire form send out	Number of Returned Questionnaire form	Percentage of Response Rate (%)
90	50	55

4.3 Section A: Respondent Background and Information

Respondent information was made to get the information of the respondent to fulfil the researcher target which is people who involve in construction field only. It is in the section A of the questionnaire and the compulsory information include the respondents profile, position, experiences and also how many accidents happen during installation of IBS Formwork.

4.3.1 Respondent Position

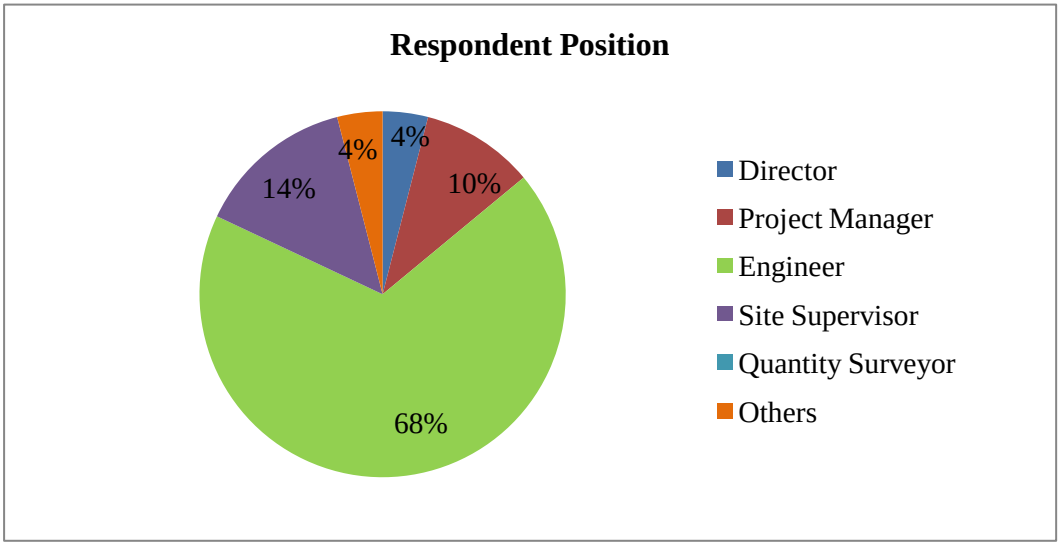

Figure 4.1 Composition of respondents by position

Figure 4.1 shows the composition of respondents by position. From the total returned questionnaires, 68% out of 50 were from Engineer and represents the largest group of response in this research. Then, this followed by Site Supervisor with 14% and Project Manager 10% of 50 respondents. Director and group of others (safety officer, QAQC) shared a same response which is 4%.

This group of respondents is the frontline of the people who in contact with the construction projects. This shows that all the returned questionnaires form are answered by a group of professional that involved directly in the construction industry and useful to this research.

4.3.2 Types of Organization

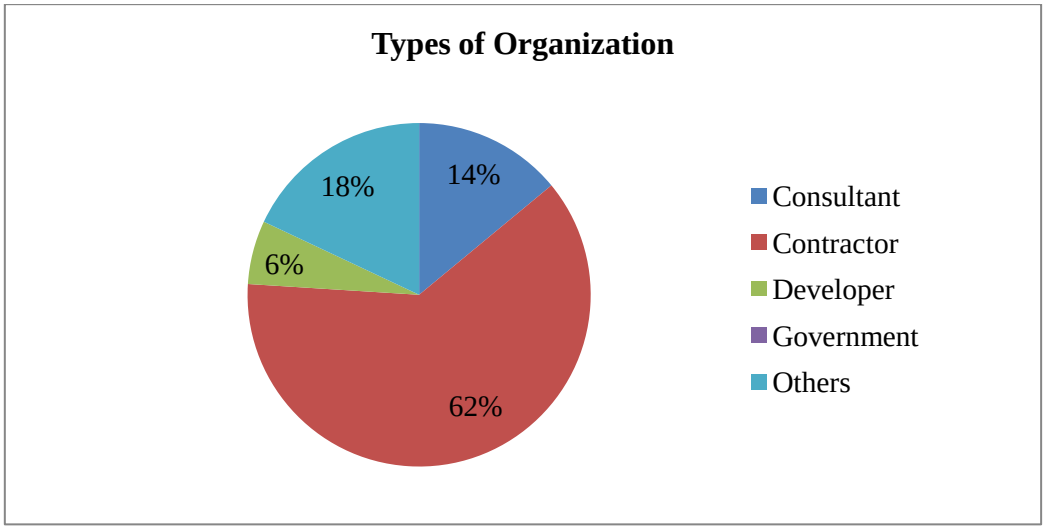

Figure 4.2 Types of Organization of Respondent

Figure 4.2 shows the different types of organization that response in this questionnaire. The percentage of response from Contractor is the highest with 62%. Next, response from others which consists of Formwork Supplier and Manufactures with 18% and Consultant with 14%. The lowest responses are from the Developer with 6% only.

4.3.3 Respondent Experience

The question is to identify their experiences in Industrialized Building System (IBS) Formwork in construction project. Then, next question is to examine what types of IBS Formwork they had experienced and followed by the question of number of respondent experience in construction project using IBS Formwork that have involved.

4.3.3.1 Respondent Experiences with Industrialized Building System (IBS) Formwork

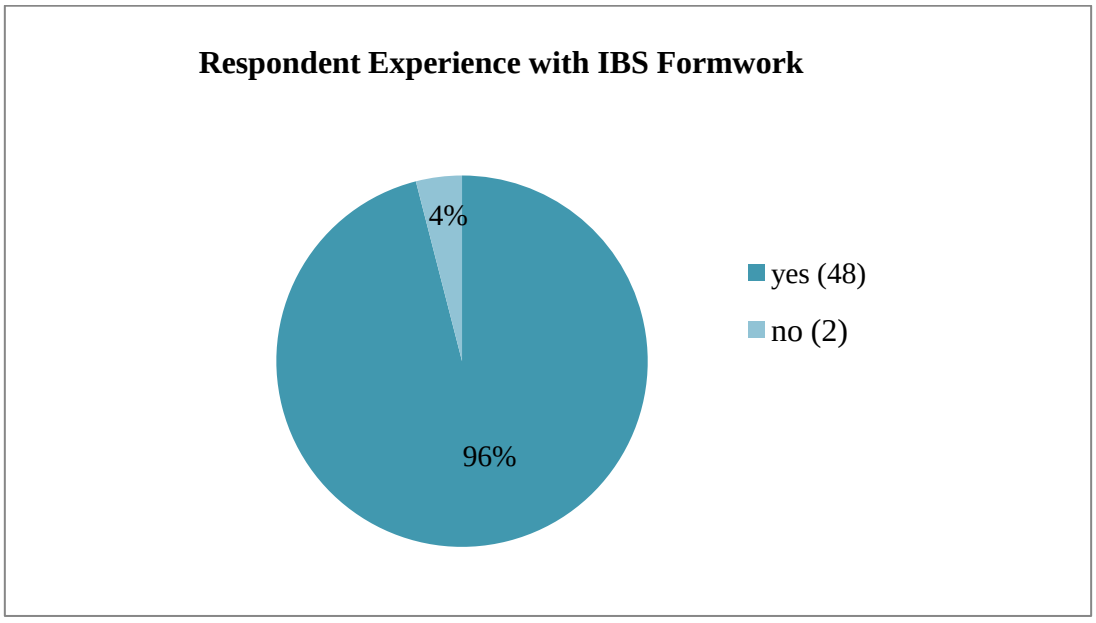

Figure 4.3 Percentages of Respondent Experiences with IBS Formwork

Figure 4.3 shows the percentage of experiences respondent in Industrialized Building System (IBS) Formwork in construction project. The results show that about 48 out of 50 encounter with IBS Formwork with 96%. Another 4% of the respondents do not having experienced with IBS Formwork.

4.3.3.2 Experiences Analysis Respondent Experiences with Types of IBS Formwork

The researcher want to know what type of IBS Formwork that respondents used, so 90% respondent earlier that experienced have answer next question which is type they had experienced. The result was shown in figure 4.4 below.

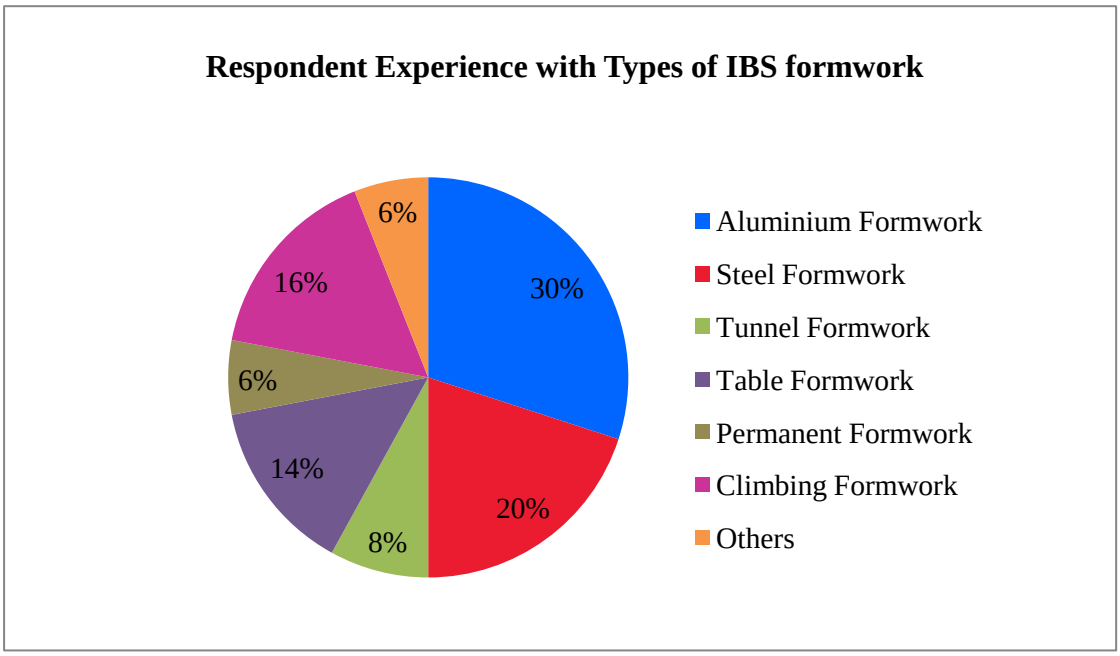

Figure 4.5 Respondent Experiences with Types of IBS Formwork

Based on data analysis as shown on graphic bar chart at Figure 4.5, the highest type of IBS Formwork respondent deal is Aluminium formwork with 30% out of 50 responses. The others type (slip forms, special forms) and permanent type of formwork is the lesser used by respondent.

4.3.3.3 Analysis Number of Year Respondent Experience Using IBS Formwork

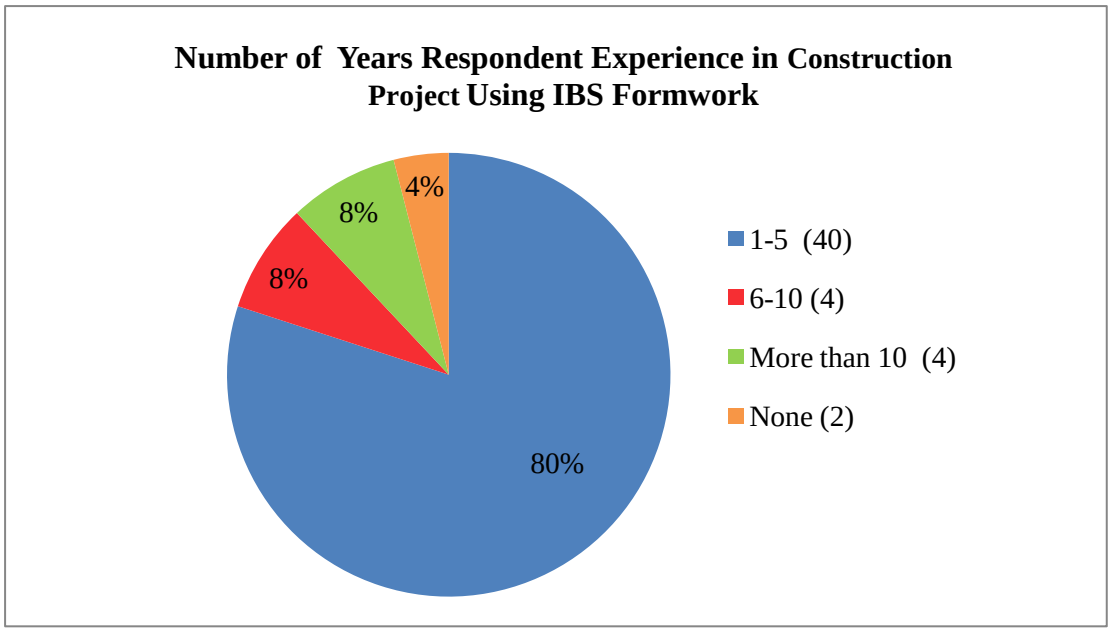

Figure 4.6 Number of Construction Project Using IBS Formwork

Figure 4.5 shows the number of construction project using IBS Formwork that respondent has involved. From the 50 respondent, 40 of them are having one to five (1-5) years working experience in construction project using IBS Formwork with 80% and represent the highest value.

Next, 8 out of 50 respondents having six to ten (6-10) years working experience of construction project and more than 10 years working experiences, each of them with 8%. The lowest value is respondent with none experiences with 4%. These experiences acquired indirectly helps to proven the precise of the data obtained from the respondents because this study really needs a person's experiences besides knowledge.

4.3.3.4 Respondent's Site Experiences in Accidents

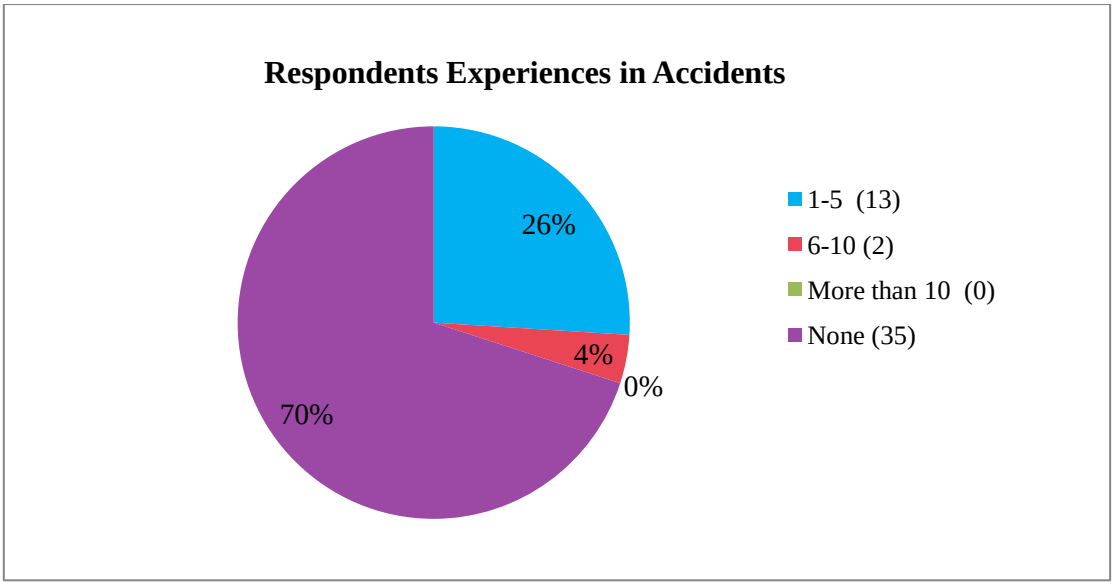

Figure 4.7 Respondent Experiences Involved in Accident

From figure 4.6 shows the experience of accidents happens during involvement in construction used IBS Formwork. The results shows, majority of respondents not experience with accident during installation process of IBS Formwork with 70% which means 35 out of 50. Only 26% of the respondents have one to five (1-5) years of experiences involved in accidents and 4% has six to ten (6-10) years of experiences involved in accidents. Majority of respondents have not experienced with accidents and it eventually shows that the accidents during uses of IBS Formwork still can be decreases.

4.3.4 Discussion

Taken as a whole, this section involved respondent purposes do helps in finding the appropriate answer to this study. Respondents consists of Engineer is the highest person involved, followed by Site Supervisor, Project Manager, Director, Safety and Health Officer, and QAQC Engineer. Then, from the organization, Contractor is the most responses to this research and the lowest is from Developer. Respondents show their experiences in handling construction projects as well as giving their opinions and share their experiences in answering all the questions asked.

The results shows, the highest type of IBS Formwork respondent deal is Aluminium formwork. The lesser is permanent formwork and the others type of formwork. Besides, majority respondents do not having experienced and involved with accidents during installation process of IBS formwork. Only certain respondents who had answered this questionnaire experienced with accidents. This indicates safety can be increase and gaining zero accidents at site.

4.4 Section B: Safety Aspect and Analysis of Safety Level

Activities in installation of IBS formwork have been reviewed via literature and related to the typical IBS activities found in construction sites. The process were further categorised into four phases which is lifting, placing, bracing and stripping. Then, from the phases, the relevant safety aspect and requirement that should be applied is determined by calculated Average Index Value. The result shows in Table 4.2.

Table 4.2 Safety Aspect in Installation IBS formwork

Safety Aspect		Frequency					Rank
		1	2	3	4	5	
Aspect 1: Safety Aspect During Lifting Process							
1.	Material and heavy machine be checked and maintain.			13	23	14	14
2.	The process are under supervision of Formwork Supervisor			8	29	36	13
3.	Workers used/wear all the Personal Protection Equipment (PPE)			2	23	25	2
4.	The installation process were stopped when heavy weather			4	24	22	6
5.	Using appropriate equipment with safe working method statement			6	27	17	11
Aspect 2:Safety Aspect During Erection/Placing Process							
1.	Workers used/wear all the Personal Protection Equipment (PPE)			2	22	26	1
2.	Erection process are under supervision of Formwork Supervisor			9	31	10	14
3.	Working platform used and has			2	26	22	5

	installed properly to prevent falls						
4.	Worker equipped with safety harness while working at high place			4	20	26	3
5.	The process are using safe working method statement			2	30	18	8
Aspect 3: Safety Aspect Bracing and Propping Process							
1.	Components and material be checked before it used			8	29	13	13
2.	Workers used/wear all the Personal Protection Equipment (PPE)			3	24	23	5
3.	Installation process bracing and propping be done by skilled workers			17	19	14	15
4.	The process are using safe working method statement			4	27	19	9
5.	Inspection done after braces has been install			3	31	16	10
Aspect 4: Safety Aspect During Stripping Process							
1.	Safety measures has been conducted to control the risk formwork susceptible to falling over during the work			3	23	24	4
2.	Workers are used/wear all the Personal Protection Equipment (PPE)			2	24	24	3
3.	Stripping process are under supervision of Formwork Supervisor			8	27	15	12
4.	Stripping operation be carried out in an orderly and progressive manner			2	35	13	11
5.	The process are using safe working method statement			2	29	19	7

4.4.1 Safety aspect during Lifting Process

Lifting process is one of the critical activities in installation process using IBS formwork. Analysis that has being made is shown in Table 4.3 below.

Table 4.3 Safety aspect during Lifting Process of IBS Formwork

Safety Aspect		**Frequency**					**Average Index (A.I)**	**Rank**
		1	**2**	**3**	**4**	**5**		
No.	**Aspect 1: Safety Aspect During Lifting Process**							
1.	Material and heavy machine be			13	23	14	4.02	5

	checked and maintain.							
2.	The process are under supervision of Formwork Supervisor			8	29	36	4.10	4
3.	Workers used/wear all the Personal Protection Equipment (PPE)			2	23	25	4.46	1
4.	The installation process were stopped when heavy weather			4	24	22	4.36	2
5.	Using appropriate equipment with safe working method statement			6	27	17	4.22	3

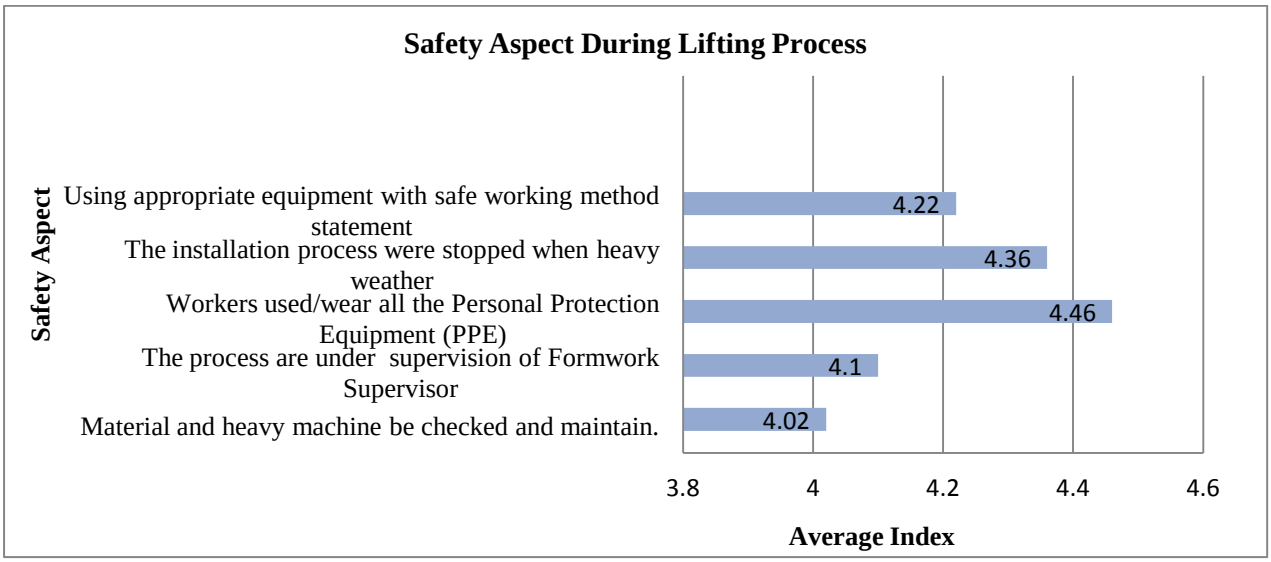

Figure 4.8 Safety Aspects during Lifting Process

Figure 4.8 shows the result of safety aspect during lifting process installation of IBS formwork. Workers must wear all the Personal Protection Equipment (PPE) with Average Index (A.I) of 4.46. Therefore, company constructions in Malaysia should provide PPE to their workers as to ensure they cover their body from any harm. Secondly with 4.36 of A.I shows during ongoing process of lifting process, have should be stopped when heavy weather. Next, with 54 of A.I shows using appropriate equipment with safe working method statement. This is important to ensure nothing failure during the process. This equipment to ensure they cover their body from any harm. Then, followed by 49% frequency which is lifting process should be under supervision of Formwork Supervisor.

Moreover, material and heavy machine be checked and maintain concerning in safety aspect during lifting process with 4.10 of A.I. This is to prevent any risk accident happen during the process. Lastly, with 4.02 A.I which is lifting process supposed be under supervision of Formwork Supervisor. Workers can immediately inform if there is problem during process. Additionally, by strictly following the procedures, risk hazard can be reduced.

4.4.2 Safety Aspect during Placing Process

The second phase of installation formwork is placing process. Analysis is being made about important safety aspect in placing process as shown in Table 4.4.

Table 4.4 Safety Aspect during Placing Process

No.	Aspect 2: Safety Aspect during Placing Process							
1.	Workers used/wear all the Personal Protection Equipment (PPE)			2	22	26	4.48	1
2.	Process are under supervision of Formwork Supervisor			9	31	10	4.02	5
3.	Working platform used and has installed properly to prevent falls			2	26	22	4.40	3
4.	Worker equipped with safety harness while working at high place			4	20	26	4.44	2
5.	The process are using safe working method statement			2	30	18	4.32	4

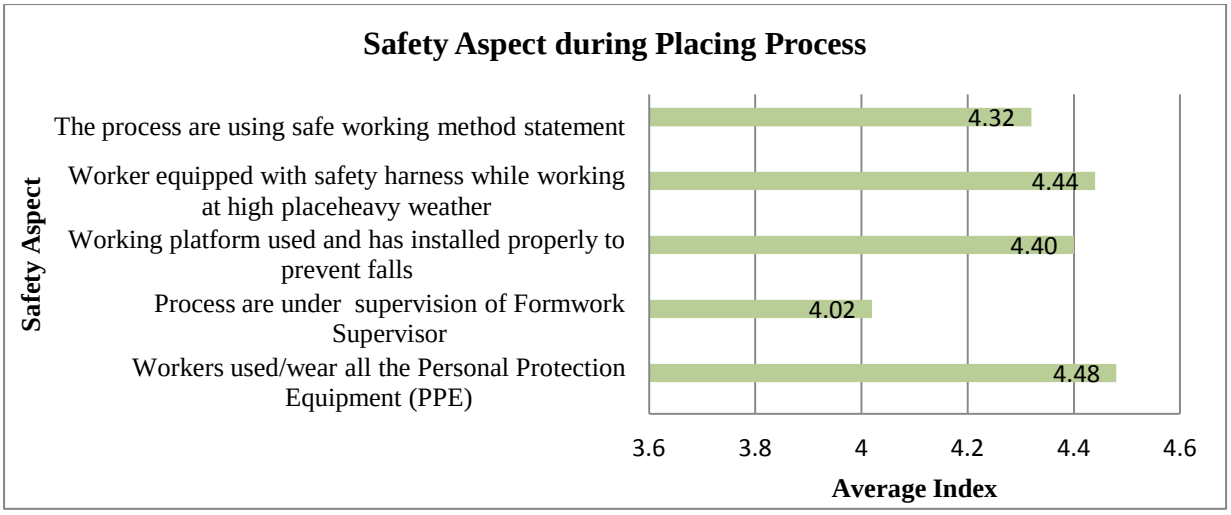

Figure 4.9 Safety Aspects during Placing Process

Figure 4.9 shows the result of safety aspect during placing process installation of IBS formwork. The most important safety aspect during placing is process is workers must wear all the Personal Protection Equipment (PPE) with Average Index (A.I) of 4.48. Therefore, company constructions in Malaysia should provide PPE to their workers as to ensure they cover their body from any harm. Secondly, with 4.4.of A.I, workers equipped with safety harness while working at height. Working at height carries more risk than working at ground level. A person could fall and caused injury.

On the other hand, with 4.40 of A.I, working platform used and should be installed properly to prevent falls. Thus, risk hazard can be reduced. Next, placing process is followed safe working method statement with 4.32 of A.I. Construction companies should provide the document of method statement and requirement needed in placing process of IBS formwork. Similarly with lifting process, during the placing process also supposed are under supervision of Formwork Supervisor. This method has less concerning with 4.02 of A.I.

4.4.3 Safety Aspect during Bracing and Propping Process

The third phase of installation process is bracing and propping. This process is depends on position of components such as if need to install in second floor, it used propping. Analysis being made by arranging Average Index and Ranking as the important safety aspect as shown in Table 4.5.

Table 4.5 Safety Aspect Bracing and Propping Process

No.	Aspect 3: Safety Aspect Bracing and Propping Process							
1.	Components and material be checked before it used			8	29	13	4.10	4
2.	Workers used/wear all the Personal Protection Equipment (PPE)			3	24	23	4.40	1
3.	Installation process bracing and propping be done by skilled workers			17	19	14	3.94	5
4.	The process are using safe working method statement			4	27	19	4.30	2
5.	Inspection done after braces has been install			3	31	16	4.26	3

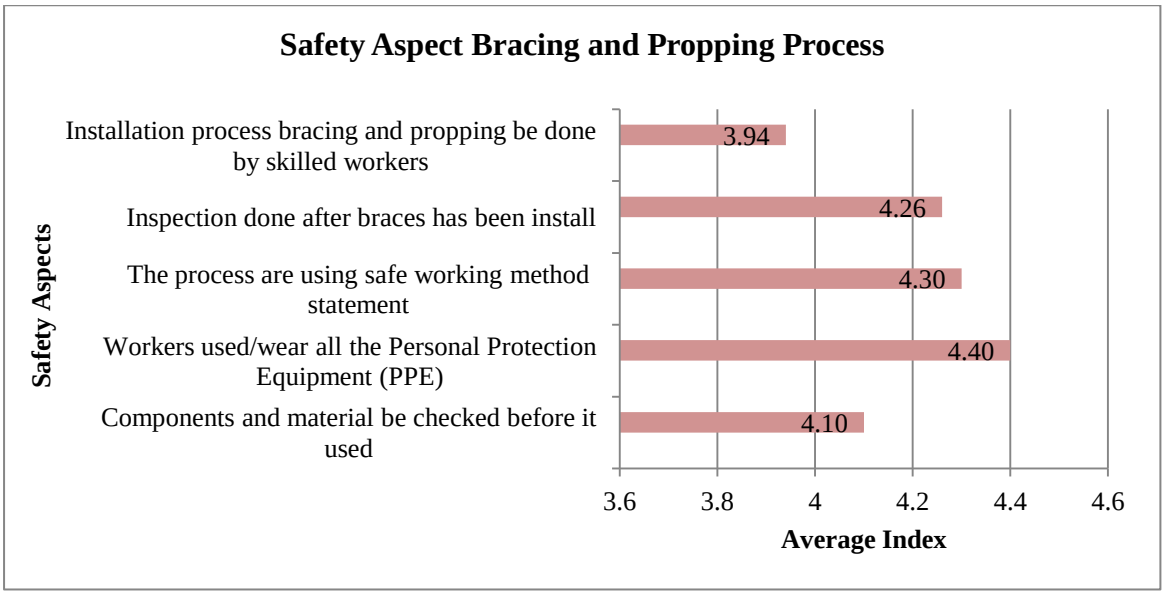

Figure 4.10 Safety Aspect Bracing and Propping Process

Figure 4.10 shows the result of safety aspect bracing or propping process installation of IBS formwork. Workers used/wear all the Personal Protection Equipment (PPE) is most concerning safety aspect in bracing process with 4.40 of Average Index (A.I). It can include items such as safety helmets, gloves, safety boots, and safety harness.

Secondly with 4.30 of A.I show the process is using safe working method statement. This method to prevent failure and the process can run smoothly. This

method important because bracing process is needed to provide stability of structures so, it must be securely fixed.

Next, with 4.26 of A.I which inspection has done after braces have been installing. Then it was followed by components and material be checked before it used with 4.10 of A.I. Lastly; other concerning safety aspect during bracing process is Installation process bracing and propping be done by skilled workers. It is important to ensure the workers have enough skilled to conduct the process.

4.4.4 Safety Aspect during Stripping Process

The last phase is stripping process. Stripping formwork can be one of the most hazardous phases. Analysis about the most important aspect that should be concern is shown in Table 4.6.

Table 4.6 Safety Aspect during Stripping Process

No.	Aspect 4: Safety Aspect during Stripping Process							
1.	Safety measures has been conducted to control the risk formwork susceptible to falling over during the work			3	23	24	4.42	2
2.	Workers are used/wear all the Personal Protection Equipment (PPE)			2	24	24	4.44	1
3.	Stripping process are under supervision of Formwork Supervisor			8	27	15	4.14	5
4.	Stripping operation be carried out in an orderly and progressive manner			2	35	13	4.22	4
5.	The process are using safe working method statement			2	29	19	4.34	3

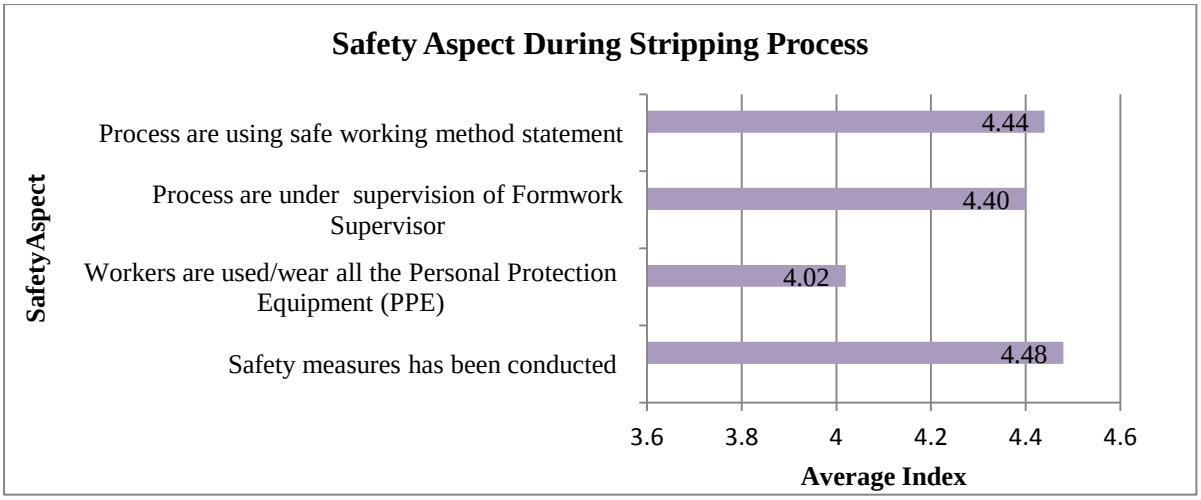

Figure 4.11 Safety Aspect during Stripping Process

Figure 4.11 shows the result of safety aspect during stripping process in installation of IBS formwork. The result indicate is safety measures been conducted to control the risk formwork susceptible to falling over during the work with 4.48 of Average Index (A.I). Stripping formwork can be one of the most hazardous phases because of their lighter weight. Secondly, 4.44 of A.I shows safe work method statement for the stripping operation should be prepared and used in this high risk activity. This, hazard can be reduced.

Similar in the lifting and placing process, stripping process also should under supervision of Formwork Supervisor with 4.40 of A.I. With the supervision, it can eventually measures and control the risk at construction site. Lastly; other concerning safety aspect during stripping process is workers must wear all the Personal Protection Equipment (PPE) with 4.02 A.I. PPE will protect against safety risk at work. It can include items such as safety helmets, gloves, safety boots, and safety harness.

Table 4.7 Five Vital Safety Aspects in Installation IBS formwork

No.	**Five Vital Safety Aspect**	**Installation Phase**	**Overall Ranking**
1	Workers used/wear all the Personal Protection Equipment (PPE)	Placing	1
2	Workers used/wear all the Personal Protection Equipment (PPE)	Lifting	2
3	Worker equipped with safety harness while working at high place	Placing	3

4	Workers are used/wear all the Personal Protection Equipment (PPE)	Stripping	3
5	Safety measures has been conducted to control the risk formwork susceptible to falling over during the work	Stripping	4
6	Workers used/wear all the Personal Protection Equipment (PPE)	Bracing	5
7	Working platform used and has installed properly to prevent falls	Placing	5

Table 4.7 shows the analysis of five vital safety aspects in installation IBS formwork. The most important five vital safety aspects in installation of IBS formwork is workers must wear all the Personal Protection Equipment (PPE). Majority respondents have agreed the variable is important to be applied in all phases which is placing with 4.48 of Average Index (A.I) and lifting with 4.46. Bracing and stripping with shared same value with 4.44. Another variable that include in five vital important safety aspect is safety measures has been conducted to control the risk formwork susceptible to falling over during the work with 4.42 of A.I.

4.4.5 Discussion

Analysis is being made by arranging the Average Index value and ranking from the highest value until the lowest value. The respondents identify variables that they perceived by responding to a scale from 1(strongly disagree) to 5 (strongly agree). The Average Index has been calculated and the ranking of these aspects determine the most critical safety aspect that should be applied in installation of IBS formwork in Malaysian construction industry.

Overall from the analysis, the important safety aspect is during placing process which is workers should wear all the Personal Protection Equipment (PPE). Majority respondents agreed that variable is important during all phases which is placing, lifting, bracing and stripping. PPE is purpose as protection against health and safety hazards. It designed to protect many parts of the body. According to (CIDB, 2005), worker should use suitable PPE. Thus, it can reduce hazards.

In placing process it demonstrated respondents agreed that worker equipped with safety harness while working at high place is vital safety aspect. Work at height is unavoidable in most formwork activity, and special safeguards shall be implemented and use safety equipments to avoid accidents by falling from height. All criteria shall be checked and all requirements satisfied as in the Code of Practice for Safely Working at Height 2009.

Another variable is in stripping process which safety measures have been conducted to control the risk formwork susceptible to falling over during the work. Formwork stripping is probably the most hazardous operation. A safe work method statement for the stripping operation should be prepared and provided Hazards can be reduces by planning and providing safety training personnel properly (Heaney, R. , 2006). The least is placing process where respondents agreed working platform used and has installed properly to prevent falls. A temporary working platform as well as a system to prevent or arrest falls so it is important to be installed properly. According to Code of Practice for Safely Working at Height (2009), all criteria shall be checked to prevent from hazards.

Overall, it can be seen the most safety aspect is workers must wear all the PPE as majority it important in all phases during installation process. Installation of IBS formwork can be practiced by the player who expert in this major sector. This method may not risk if all the safety aspect is applied. The safety requirements need to be applied to make sure there are no hazards to their employees that can affect the reputation of the company.

4.4.6 Analysis Safety Level in Installation of IBS formwork

Analysis level of safety is being made by classified and arranging the ranking of each safety aspect in each phases. The researcher use preference index by ask a person by completing questionnaires that requires them to indicate the level of agreement of evaluation of each variables during the installation of IBS formwork. The Average Index value of each variable has been calculated to interpret their level of safety. The result is shown in Table 4.8.

Table 4.8 Safety Level during Lifting Process

Safety Aspect		Frequency					Average Index (A.I)	Rank
		1	2	3	4	5		
No.	**Aspect 1: Lifting Process**							
1.	Material and heavy machine be checked and maintain.			13	23	14	4.02	5
2.	The process are under supervision of Formwork Supervisor			8	29	36	4.10	4
3.	Workers used/wear all the Personal Protection Equipment (PPE)			2	23	25	4.46	1
4.	The installation process were stopped when heavy weather			4	24	22	4.36	2
5.	Using appropriate equipment with safe working method statement			6	27	17	4.22	3

From the analysis, it shows level of agreement of evaluation for safety level during lifting process in rank Good level because majority respondents agree safety aspect are important during lifting process. Table 4.8 shows, the majority respondent agreed on workers wear all the Personal Protection Equipment (PPE) with Average Index (A.I) 4.46. Secondly, with A.I 4.36 is the installation process were stopped when heavy weather. A.I for using appropriate equipment with safe working method statement is 4.22. Next, respondent agreed lifting process is under supervision of Formwork Supervisor. Lastly is, material and heavy machine be checked and maintain with 4.02 of A.I.

Table 4.9 Safety Level during Placing Process

No.	Aspect 2: Placing Process							
1.	Workers used/wear all the Personal Protection Equipment (PPE)			2	22	26	4.48	1
2.	Erection process are under supervision of Formwork Supervisor			9	31	10	4.02	5
3.	Working platform used and has installed properly to prevent falls			2	26	22	4.40	3

4.	Worker equipped with safety harness while working at high place			4	20	26	4.44	2
5.	The process are using safe working method statement			2	30	18	4.32	4

Table 4.9 shows the analysis of safety level for safety aspect during placing process. From the analysis, safety level during placing process is in rank Good level as the highest of A.I value presented most respondent agreed with 25.8. The highest ranking of safety aspect is workers wear all the PPE during installation process with 4.48 of A.I. Secondly, respondent agreed workers equipped with safety harness while working at height is important with 4.44 of A.I value. Working at height more risk compare to working at ground. It exposed to hazards. Then, A.I for working platform is used and has installed properly to prevent falls is 4.40. Followed by next safety aspect is the process are using safe working method statement with 4.30 of A.I value. Although this aspect is in ranking number four, the level of safety is still in good ranked. Last is placing process is under supervision of Formwork Supervisor with A.I value of 4.02.

Table 4.10 Safety Level Bracing and Propping Process

No.	**Aspect 3: Bracing and Propping Process**							
1.	Components and material be checked before it used			8	29	13	4.10	4
2.	Workers used/wear all the Personal Protection Equipment (PPE)			3	24	23	4.40	1
3.	Installation process bracing and propping be done by skilled workers			17	19	14	3.94	5
4.	The process are using safe working method statement			4	27	19	4.30	2
5.	Inspection done after braces has been install			3	31	16	4.26	3

From Table 4.10, shows respondent agreed level of safety for safety aspect during bracing and propping process in Good level as the highest of A.I value presented most respondent agreed it is important. The Average Index (A.I) value of

workers wears all the Personal Protection Equipment (PPE) is 4.40. It represents the highest rank in safety aspect during bracing process. Secondly, with A.I of 4.30 is process are using safe working method statement. A.I for inspection done after braces has been install is 4.26. This method important because bracing needed to provide stability of structures during the installation process. Through the level of agreement of evaluation for safety level, safety aspect of components and material is checked before it used has lesser response with 4.10 of A.I. Lastly, installation process bracing and propping be done by skilled workers with 3,94 of A.I value. Surprisingly it is the lowest response because this process should be involved with competent person.

Table 4.11 Safety Level during Stripping Process

No.	Aspect 4: Stripping Process							
1.	Safety measures has been conducted to control the risk formwork susceptible to falling over during the work			3	23	24	4.42	2
2.	Workers are used/wear all the Personal Protection Equipment (PPE)			2	24	24	4.44	1
3.	Stripping process are under supervision of Formwork Supervisor			8	27	15	4.14	5
4.	Stripping operation is carried out in an orderly and progressive manner			2	35	13	4.22	4
5.	The process are using safe working method statement			2	29	19	4.34	3

Table 4.11 show the analysis of safety level during stripping process in level Good level. It is presented as the highest rank. The highest ranking is workers wear all the Personal Protection Equipment (PPE) with 4.44 of Average Index value (A.I). Followed by safety measures have been conducted to control the risk formwork susceptible to falling over during the work with 4.42 of A.I value. Value of A.I for process is using safe working method statement is 4.34. Next, stripping operation is carried out in an orderly and progressive manner with A.I of 4.22. The last safety

aspect is tripping process are under supervision of Formwork Supervisor with 4.14 of A.I value.

4.4.7 Discussion

From the result, safe lifting components method is one of the main processes during the IBS Formwork installation process. There are some requirements need to be applied to make sure all the process are smooth, closely related with the first steps of installation process. The players need to comply all the construction issued by the authorities to sustain the safety at site. The value of highest A.I represents safety level is in Good level. Majority respondents agreed to the level of evaluation in this safety level. It means all the legislation and safety procedures directed by CIDB and Department of Safety and Health (DOSH) are practicable at site construction. Systematic planning for the lifting process is essential to ensure that the IBS component is carried out in a safe manner and efficiently. Improper planning leads to unsafe technique and it may cause an accident (Adilah Arma Shaari, 2016). Besides, during lifting process respondent agree must use appropriate equipment with safe working method statement. Moreover, the operator must be highly qualified and competent person. Workers should also wear all the Personal Protection Equipment (PPE) where this regulations also been stated in CIDB (2005).

Next step is placing process. From this result, conclusion can be drawn that, most of the respondents answered the entire question and agreed hence analysed as safety level in placing process is in Good level. The placing process is strongly related to the safety aspect and requirements of workers at construction site to ensure the placing of building structure (Formwork Code of Practice, 2006). When working at height for the placing process, workers should ensure to wear a safety equipment to prevent from falls.

Followed by next process, bracing is needed to provide stability of structures during the installation process. Bracing must be securely fixed and should have an adequate safe bearing at each end (Leicester, 2013). Respondent agreed it is important to inspect installed braces immediately after installation for correctness of spacing and

proper attachment device. In addition, according (N. Nasir, 2012), some of the safety aspect and requirements like systematic planning and performed by a competent or skilled person should be noticed while handling bracing process.

Finally, stripping process is the last method for installation of formwork. Majority respondents agreed stripping process during installation process is important. Not surprisingly, it is the highest of A.I compare to other lifting, placing and bracing process. Safety measures important to be conducted to control the risk formwork susceptible to falling over during the work (Formwork Code of Practice, 2006). During the stripping process, the workers need to wear safety equipment to protect against safety risk at work. According to (CIDB, 2005), worker should use suitable PPE. Another safety aspect requirement is the process need to follow safe working method statement hence; the operation must be carried out in an orderly and progressive manner (Formwork Code of Practice, 2006). Targeting zero accidents on construction sites is a good policy and therefore safety should be managed properly due to strong humanitarian, financial and legal reasons (N. Nasir, 2012),

4.5 Section C: Factor Improving Safety in Installation of IBS Formwork

Several factors were collected through literature reviews as bases for determining the factors of safety in installation of IBS Formwork. The factors have been categorised under six main categories which are historical, technical, procedural, organisational, psychological and environmental factors (refer the Table 4.12).

Table 4.12 Factors Improving Safety in Installation of IBS Formwork.

FACTOR		Frequency					Average Index (A.I)	Rank
		1	2	3	4	5		
No.	**FACTOR 1: HISTORICAL**							
1.	Workers are educated in IBS field.	2	6	24	14	4	3.24	17
2.	Experience workers less involves in accidents.		6	11	25	8	3.7	16
3.	Older workers are more sensitive to safety issues.	3	8	21	14	4	3.16	18
4.	Only skilled labours for IBS	1	2	12	23	12	3.86	13

	construction.							
No.	**FACTOR 2: TECHNICAL**							
1.	IBS components are transported under safety officer supervision.			19	22	9	3.8	15
2.	Only experienced workforces are duty to operate machine for installation.			5	33	12	4.14	7
3.	Workers are given adequate training and explanation before operating machine and installation process.			4	22	24	4.40	3
4.	Worker equipped with safety harness while working at higher place.			5	18	27	4.44	2
No.	**FACTOR 3: PROCEDURAL**							
1.	Installation of IBS component requires more safety procedure and equipment.		1	7	20	22	4.26	5
2.	Workers are trained on using safety kit and the Personal Protection Equipment (PPE).			6	21	23	4.34	4
3.	Delay of inspection leads to unsafe behaviour.	2		11	19	18	4.02	10
4.	The process are using safe working method statement			4	25	21	4.34	4
5.	Contract of Employment should impose punishable offense for failure to use safety equipment.		1	10	22	17	4.1	8
No.	**FACTOR 4: ORGANISATIONAL**							
1.	Project management pays attention to safety only after accidents have occurred.	13	12	7	12	6	2.72	20
2.	Project management encourages safety efforts.		1	11	29	9	3.92	12
3.	Management is open to discussing safety issues.		1	12	30	7	3.86	14
4.	Safety information like ‘Tool Box Meeting’ implements to give awareness.			5	18	27	4.44	2
No.	**FACTOR 5: PSYCHOLOGICAL**							
1.	Adequate safety training is provided for all workers at all levels.			4	19	27	4.46	1
2.	Site supervisor is much involved on site regarding		1	15	19	15	3.96	12

	safety.							
3.	I have been pressured to put production before safety.	14	8	9	13	6	2.78	19
4.	I am aware of safety and put it as my individual priority.			3	26	15	4.12	6
No.	**FACTOR 6: ENVIRONMENTAL**							
1.	Design stage has included safe working conditions for IBS construction.			10	30	10	4.00	11
2.	Proper planning for machinery and equipment impact the safety aspect in installation/construction of IBS.			5	36	9	4.08	9
3.	Storage is important for IBS components.			5	34	11	4.12	6

According to Table 4.12, most respondent agreed that adequate safety training is provided for all workers at all level is the main factor safety in installation of IBS formwork with 4.46 of Average Index (A.I). On the other hand, project management pays attention to safety only after accidents have occurred has fewer responses when respondent strongly not agreed which in ranked number 20 with 2.72 of A.I.

4.5.1 Analysis Ten Vital Factors for Improving Safety of IBS Formwork

From the variables that have been categorised in the above analyses, the next step identifies the variables (refer to Table 4.13) that can be considered as the vital factors improving safety in the installation of IBS Formwork. There are thirteen variables fell into the 10 top-ranking factors because of the same Average Index (A.I) of some variables.

The main factor is from the psychological factors category which is adequate safety training is provided for all workers at all levels with 4.46 of Average Index (A.I). Lack of training can result in accidents or near misses occurring. Most crucial improvement factor of safety is followed by worker equipped with safety harness while working at higher place with 4.44 of A.I and shared the same value with factor safety information like ‘Tool Box Meeting’ implements to give awareness.

Next, this research has also found that training is an important factor in improving the safety of IBS construction, especially training that is provided before operating machines with 4.40 of A.I. This was followed by process are using safe working method statement with 4.34, installation of IBS component requires more safety procedure and equipment with 4.26 of A.I

Table 4.13 Ten Vital Factors for Improving Safety of IBS Formwork

No.	Ten Vital Factor	Factor Category	Ranking	Average Index (A.I)
1	Adequate safety training is provided for all workers at all levels.	Psychological Factor	1	4.46
2	Worker equipped with safety harness while working at higher place.	Technical Factor	2	4.44
3	Safety information like 'Tool Box Meeting' implements to give awareness.	Organisational Factor	2	4.44
4	Workers are given adequate training and explanation before operating machine and installation process.	Technical Factor	3	4.40
5	The process are using safe working method statement	Technical Factor	4	4.34
6	Workers are trained on using safety kit and the Personal Protection Equipment (PPE).	Procedural Factor	4	4.34
7	Installation of IBS component requires more safety procedure and equipment.	Procedural Factor	5	4.26
8	Only experienced workforces are duty to operate machine for installation.	Technical Factor	6	4.12
9	I am aware of safety and put it as my individual priority.	Psychological Factor	7	4.14
10	Storage is important for IBS components.	Environmental factor	7	4.14
11	Contract of Employment should impose punishable offense for failure to use safety equipment.	Procedural Factor	8	4.10
12	Proper planning for machinery and equipment impact the safety	Environmental factor	9	4.08

	aspect in installation of IBS.			
13	Delay of inspection leads to unsafe behaviour.	Procedural Factor	10	4.02

Then, with A.I 4.12, factor can improving safety is only experienced and skilled workforces are duty to operate machine for installation process. Installation IBS formwork involves many equipments and heavy machines such as crane when it come working at height place.

Next, other crucial factor is also from psychological factors category which is self awareness of safety and putting it as an individual priority with 4.14. Surprisingly this variable in ranging number seven even listed in top ten vital factors. This is important because no one is capable of providing safety for us if we are not aware of this issue ourselves. This was followed by storage is important for IBS components and proper planning for machinery and equipments as the important aspects in IBS construction with 4.10 and 4.08 of A.I value. The last one with 4.02 of A.I which illustrated that delay of inspection leads to unsafe behaviour.

Table 4.14 Factors for improving safety of IBS Formwork

Factor of Safety	**Average Index**	**Category Rank**
Psychological	4.24	1
Technical	4.20	2
Environmental	4.07	3
Procedural	3.80	4
Organisational	3.74	5
Historical Factor	3.50	6

Based on the analysis, table 4.14 shows the list of factors for improving safety of IBS Formwork. In these ranking categories, the most identifiable category which has Average Index with 4.24 is psychological factor. Then, these followed by technical factor with 4.20, environmental factor with 4.07, procedural with 3.80 and organisational with A.I of 3.74. The least is historical factor with 3.50 of A.I. Overall. it shows psychological can be categorised the most vital factors in improving safety in installation of IBS formwork.

4.5.2 Discussion

According to the analysis on vital factors for safety of IBS Formwork, all the factors are relevant to improve safety of IBS formwork. From six factors, the highest factor that agreed by respondents in improving safety is psychological factor which is adequate safety training is provided for all workers at all levels. Psychological factor as the effect of the Malaysian Health & Safety at Work Act of 1974 influence of training levels, propensity to accept danger or risk taking, skill levels, supervisor carefulness, worker carelessness and others (Sawacha, E., 2000). Training is important because this is an opportunity to expand the knowledge base of all workers. Lack of training can result in accidents or near misses occurring (N. Nasir, 2012).

Most crucial improvement factor of safety is followed by technical factor which is worker equipped with safety harness while working at higher place. According (Yuen, 2017), in his case studies of accidents involving accidents working at height, he stated not using the relevant Personal Protective Equipment (PPE) such as a safety harness is a reason workers resulting in accidents and injuries. Its proven neglecting of wearing safety equipment exposed to risk of accidents. Working at height carries more risk than working at ground level. However, if workers follow safety guidelines, they can accomplish what they need to at height without risk to themselves. With the same ranked is from organisational factor which is safety information like 'Tool Box Meeting' implements to give awareness. A safety talk is a hands-on way to remind workers that health and safety are important on the job. It can help workers recognize and control hazards on the project.

This was followed by installation process are using safe working method statement which is from technical factor and workers are trained on using safety kit and PPE which is this variable from procedural factor. Installer must have a detailed safety procedure in their method of installation that meets all Department of Occupational Safety and Health (DOSH) as outlined in CIDB that published 2005.

It also illustrated other vital factor agreed by respondents is from procedural factor which is installation of IBS component requires more safety procedure and equipment. Numerous associated with the improper practicing safety in the IBS

construction concept leads to the greatest risk including fatalities (M. Zaki, 2016). So, it shows that any construction or process that related to IBS required a safety procedure and method satetment to prevent risk and hazrads.

Next, this research has also found that training is an important and provided before operating machines. A firm is obliged to provide sufficient and continuous training to all workers, only experienced and skilled workforces are duty to operate machine for installation process (Nunez, 2011). Installation IBS formwork involves many equipments and heavy machines such as crane when it come working at height place.

Furthermore, other crucial factor is also from psychological factors category which is self awareness of safety and putting it as an individual priority. This is important because no one is capable of providing safety for us if we are not aware of this issue ourselves. Moreover, this helps workers to understand and be transparent to other factors influencing safety improvement when they are highly aware about safety. Psychological factors will help a worker to behave in safe manners since the lack of psychological awareness has been proven to be among the largest causes of construction accidents (N. Nasir, 2012).

The results above also shown that planning layout for an IBS construction site is an important aspect. This can be seen within the top ten vital factors, which include the variables of storage for IBS components and proper planning for machinery and equipments as the important aspects in IBS construction. Materials are mainly stored in storage rooms, covered storage yards and open air storage spaces (Tang, 2003). According to (William R. Mincks, 2011) concede that, systematic storage of material on the construction site is crucial and increase safety of the materials.

Contract of Employment should impose punishable offense for failure to use safety equipment. This variable are from procedural factor includes in top ten vital factors improving safety in installation of IBS formwork. This can also be reviewed as an important role and responsibility of a Safety Officer and Supervisor (Nunez, 2011). It also stated in the Provision and Use of Work Equipment Regulations 1998 that

these regulations deal with minimum standards for the use of machines and equipment with regard to suitability, maintenance and inspection.

It is also illustrated that delay of inspection leads to unsafe behaviour. This variable is from procedural factor. This can be related to the responsibility of the Safety Officer. Most safety officer takes lightly their jobs and only pays attention when accidents have occurred. According to (N. Nasir, 2012), the delay in inspection also leads the workers to unsafe behaviour because they would want to finish their work as fast as possible and ignore the safety elements. However, the question remains whether this factor is suitable within the context of IBS construction or will it be a matter of interference to the sequence of construction work (Nunez, 2011).

4.6 Summary

This research firstly to study the process in installation of IBS formwork. The process has been view via literature. There are four phases highlighted during the installation of IBS formwork as to achieve first objective. The process consists of lifting, placing, bracing and stripping process. Then safety aspect was identified reference to the each phase of installation process. Through the finding, analysis been made about the level of safety during the installation process. From the result, it shows safety level during installation of IBS formwork is in Good level. . It reaches to the level where majorities understand their role in safety aspects, particularly in IBS formwork. It proven that respondents still have awareness regarding the This data analysis calculated based on Average Index value to arranging the ranking stage by stage to evaluate the level of safety. Its proven workers still practice the safety aspect and requirement during installation of IBS formwork to prevent any accidents happen that resulting in fatalities and injury. Level of agreement of evaluation used to analyze the safety level is achieved by responses from the respondent in the questionnaire as objective number two that stated in chapter 1.

Furthermore, based on the research and views of experienced people involved in the IBS construction system focusing in formwork, installation of IBS formwork should be practiced by the player who expert in this major sector. This method may not risk if all the safety aspect is applied. The safety requirements need to be applied

to make sure there are no hazards to their employees that can affect the reputation of the company. In this research, safety aspect is been identified regarding based on the all four phases of installation process which is lifting, placing, bracing and stripping. According to analysis, respondent are agreed workers must wear all the Personal Protection Equipment (PPE) are the most vital safety aspect during installation of IBS formwork with highest Average Index value 4.45. It is practicable in every stage of process installation. Although IBS researchers have pointed that safety is one of the advantages associated with IBS construction, but there are times it can turn out to be disastrous. Therefore, workers should consider using PPE during the installation process to improve the safety

Furthermore, training is important that it will provide knowledge before starting to work at site and to prevent results in accidents. Thus, it can reduce and prevent hazards. This has proven in the results to identify the factor in improving safety in installation of IBS formwork. There are six factors that been highlighted but the most vital factors is psychological factor which is adequate safety training is provided for all workers at all levels. It is agreed by experienced respondents that involve with this research. The experiences from the respondent acquired indirectly help to proven the precise data obtained because this research really needs a person experience besides knowledge. So, from the questionnaire factor improving safety during installation process is been achieved. It also illustrated self awareness of safety should be put as an individual priority. Safety should be first in mind when involved in construction.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Introduction

In this final chapter, elaboration on investigation study is made based on literature reviews. The conclusion is being made to ensure every objective is achieved. Recommendations will be listed out regarding this research. Suggestion and recommendation are provided based on the given solution, so this study made would offer awareness certain parties. The achievement in these three objectives will be discussed from the outcome of the study obtained.

5.2 Conclusion for the Objectives

The three objectives of the study are achieved. The conclusion that can be made is as follows:

5.2.1 Objectives 1: To study the procedure in installation of IBS formwork.

The first objective of this study is to study the process in installation of IBS formwork. In this research, the process of installation then be identified and were listed out in chapter 2 and presented for questionnaire purpose. In this study, there are four general process have been highlighted which consists of lifting, placing, bracing, and stripping process.

5.2.2 Objectives 2: To identify the safety aspect and safety level in installation of IBS formwork.

In this research, safety aspects regarding to IBS Formwork have been reviewed via literature. Then, the researcher listed out the safety aspect in questionnaire based on the phases during the lifting, placing, bracing and stripping process. According to analysis, respondent are agreed workers must wear all the Personal Protection Equipment (PPE) are the most vital safety aspect during installation of IBS formwork with highest Average Index value 4.45. It is practicable in every stage of process installation. Result is in table below.

Table 5.1 Analysis Five Vital Safety Aspect in Installation IBS formwork

No.	**Five Vital Safety Aspect**	**Installation Phase**	**Average Index**	**Overall Ranking**
1	Workers wear all the Personal Protection Equipment (PPE)	Placing	4.48	1
2	Workers wear all the Personal Protection Equipment (PPE)	Lifting	4.46	2
3	Worker equipped with safety harness while working at high place	Placing	4.44	3
4	Workers are wear all the Personal Protection Equipment (PPE)	Stripping	4.44	3
5	Safety measures has been conducted to control the risk formwork susceptible to falling over during the work	Stripping	4.42	4
6	Workers wear all the Personal Protection Equipment (PPE)	Bracing	4.40	5
7	Working platform used and has installed properly to prevent falls	Placing	4.40	5

Analysis of safety level is being made by classified the ranking of each variable of safety aspect during installation process. The researcher use preference index by ask a person by completing questionnaires that requires them to indicate the level of agreement of evaluation. The analysis is determined as shown in table 5.2 below:

No.	Safety Aspect During Lifting Process	Rank
1.	Workers used all the Personal Protection Equipment (PPE)	1
2.	The installation process were stopped when heavy weather	2
3.	Using appropriate equipment with safe working method statement	3
4.	The process are under supervision of Formwork Supervisor	4
5.	Using appropriate equipment with safe working method statement	5

No.	Safety Aspect During Erection/Placing Process	Rank
1.	Workers used all the Personal Protection Equipment (PPE)	1
2.	Worker equipped with safety harness while working at height	2
3.	Working platform used and has installed properly to prevent falls	3
4.	The process are using safe working method statement	4
5.	Erection process are under supervision of Formwork Supervisor	5

No.	Safety Aspect Bracing and Propping Process	Rank
1.	Workers used all the Personal Protection Equipment (PPE)	1
2.	The process are using safe working method statement	2
3.	Inspection done after braces has been install	3
4.	Components and material be checked before it used	4
5.	Installation process bracing and propping be done by skilled workers	5

No.	Safety Aspect During Stripping Process	Rank
1.	Workers are used all the Personal Protection Equipment (PPE)	1
2.	Safety measures has been conducted to control the risk formwork susceptible to falling over during the work	2
3.	The process are using safe working method statement	3

4.	Stripping operation is carried out in an orderly and progressive manner	4
5.	Stripping process are under supervision of Formwork Supervisor	5

Overall, from the analysis, the safety level in installation process is in Good level. It reaches to the level where majorities understand their role in safety aspects, particularly in IBS formwork. It proven that respondents (employees) still have awareness regarding the safety.

5.2.3 Objectives 3: To identify the factor in improving safety in installation of IBS formwork.

For this objective, the researcher listed out six main category factors to analysis. The vital factors improving safety in the installation of IBS Formwork have been analyzed through index as follows:

Table 5.2 Analysis Five Vital Factor in Improving Safety in Installation of IBS formwork

No.	Ten Vital Factor	Factor Category	Rank	Average Index
1	Adequate safety training is provided for all workers at all levels.	Psychological Factor	1	4.46
2	Worker equipped with safety harness while working at higher place.	Technical Factor	2	4.44
3	Safety information like ‘Tool Box Meeting’ implements to give awareness.	Organisational Factor	2	4.44

4	Workers are given adequate training and explanation before operating machine and installation process.	Technical Factor	3	4.40
5	The process are using safe working method statement	Technical Factor	4	4.34
6	Workers are trained on using safety kit and the Personal Protection Equipment (PPE).	Procedural Factor	4	4.34
7	Installation of IBS component requires more safety procedure and equipment.	Procedural Factor	5	4.26

From analysis, there are seven variables fell into the five top-ranking factors because of the same Average Index (A.I) of some variables. Based on that, all the factors are improving safety in installation of IBS formwork. Overall, from six factors, the most of the vital factors to improve safety in installation process can be categorised as psychological factor which is adequate safety training is provided for all workers at all levels. Training given to workers may increase their self awareness.

5.3 Conclusion

From the findings, it can be conclude that safety level in installation of IBS formwork is in rank very good. Workers still practice all the safety aspect and requirement during the installation process at construction site. Even though the safety level in ranking very good, effort to improve the safety is still needed to achieved zero accidents at construction site as well as maintaining the ranking and can widely practicing the IBS formwork in Malaysian construction industry.

Uses of IBS can be healthy for the construction companies in Malaysia when safety aspect and requirement is applied. Safety aspect and requirements need to be

applied to make sure there are no hazards to their employees that can affect the reputation of the company. The respond highest average index disclosed that the safety training is important for all workers at all levels. This is the most vital factor that improving of safety in installation of IBS formwork. Construction Company must prioritize about provided training before involved in construction especially in Industrialized Building System. Training is important because this is an opportunity to expand the knowledge base of all workers. Lack of training can result in accidents or near misses occurring. Workers must be knowledgeable and high self awareness in order to have a safe construction site. They must put safety as a priority.

5.4 Recommendations

There are several suggestions and recommendation can be adopted from this study. A suggestions and recommendations have been identified on how to improve the safety of installation IBS formwork. There are, allow only certified installers to involve in IBS construction. IBS Company should have an organisational safety policy for the proper administration of safety. Besides, conduct weekly formal safety meetings at the project level to know the progress of work. Then, always post safety signs and posters at the job site. This is Safety Officer responsible to do their job to give awareness to workers although this should be their self responsibility to put safety as priority. Other than that, conduct weekly safety inspections from Government Safety bodies. Not to forget, management can reward workers for their safe behaviour.

At the same time it can improve the level of safety in site. The employees must ensure all high-risk work is planned effectively. Particular consideration must be given to employees who are known to have a history of bad background on their health from example back trouble, hemia or other health problems that could affect their manual handling capability. The contractor is deemed to accept responsibility for the protection of IBS component from the starting project till the project finish. Then, other suggestion is the employer should provide safety file that contains all the types of equipment, first aid and PPE provided, and all the related items with safety at site.

REFERENCES

(2008). Retrieved from Industry Resources Formwork.

(2010, June 10). Retrieved from http://civilresourcess.blogspot.my/2010/06/formwork.html

Brooks, R. G. (2008). The use of Formwork in Construction.

S. S. Kamaruddin, M. F. Mohammad, R. Mahbub, and K. Ahmad. Industrialised Building System Readiness Formwork (2013). Procedia-Soc. Behaviour. Sci. 105, 106.

M. Zaki, W. M. (2016). Safety in IBS Construction. *12* (3), 2367-2373.

A. Rahim, A. H. (2008). *Causes of Accidents At Construction Sites*. Malaysian Journal of Civil Engineering , *20* (202), 242-259.

K. Anuar, M. K. (2011). *Industrialized Building System (IBS)*: Revisiting Issues of Definition and Classification. *1* (June), 120-132.

Bashir, A. A. (2009). *Simulation safety management of IBS construction.* Declaration of Thesis Undergraduate Project Paper and Copyright .

Yuen, C. Y. (Apr 21, 2017). *Case Studies of Accidents Involving working at Heights.* National Work at Heights Safety Taskforce Workplace Safety and Health Council.

D. Abang Abdullah, G. W. (2010). *An Analysis of Accidents Statistics in Malaysian Construction Sector*. International Conference on E-business, Management and Economics , 3, 1-4.

H. Chong, T. L. (2014). *Accidents in Malaysian construction industry: Statistical data and court cases.* International Journal of Occupational Safety and Ergonomics , 20 (3), 503-513.

Sawacha, E., Naoum, S., and Fong, D. (1999). *Factors Affecting Safety Performance on Construction Sites*. International Journal of Project Management, Vol. 17, No. 5, pp 309-315.

Langford, D., Rowlinson, S., and Sawacha, E. (2000). *Safety Behaviour and Safety Management: Its Influence On The Attitudes of Workers In The UK Construction Industry*. Blackwell Science Ltd, Engineering, Construction and Architectural Management, pp 133-140.

Heaney, R. (2016). Formwork Code of Practice. 402-408.

Code of Practice for Working Safely at Heights. (2009). Revised 2013, WSH Council, Singapore, 69 p.

Maamor, N. Y. (2009). *Safety aspect in installation industrialized building system (IBS) component.* (November).

N. Nasir, Z. I. (2012). *Enabling Factors Towards Safety Improvement for Industrialised Building System (IBS).* International Journal of Architectural and Environmental Engineering , 6 (12), 1115-1120.

Workplace Health and Safety. Queensland. (2006). Formwork. Code of Practice 2006.

Mohd Faiz Mohammad Zaki, W. Z. (2016). *Safety in IBS Construction:* -. Arau, Perlis, Malaysia : lobal Journal of Pure and Applied Mathematics.ISSN 0973-1768 Volume 12, Number 3 (2016), pp. 2367–2373.

Nunez, I. and Villanueva, M. (2011). *Safety Capital: The Management Of Organizational Knowledge On Occupational Health And Safety*, Journal of Workplace Learning, Vol. 23 Iss: 1, pp.56 – 71.

M. Nawi, M. M. (2014). *Suitability of IBS Formwork System in Malaysian Construction Industry.* Australian Journal of Basic and Applied Sciences , 8 (April), 231-238.

Adilah Arma Shaari, M. F., W. Muhammad et al. (2016). *Safety of Precast Concrete Installation for Industrialised Building System Construction.* International Journal of Applied Engineering Research ISSN 0973-4562 Volume 11, Number 13 (2016) pp 7929-7932.

Workplace Health and Safety. (2006). Formwork. Code of Practice 2006.

A. Charehzi, A. A. (2012). *Enhancement of safety performance at construction site.* International Journal of Advances in Engineering & Technology , 5 (1), 303-312.

K. Anuar, M. K. (2011). *Industrialized Building System (IBS*): Revisiting Issues of Definition and Classification. *1* (June), 120-132.

D. Yakubu, I. B. (2013). *Evaluation of Safety and Health Performance on Construction Sites*. (Kuala Lumpur). (2), 100-109.

Nicolas S.Y. Yeung, A. P. (2015). An Overview of the Construction Industry Private sector.

William R. Mincks, H. Johnston. (2011). *Construction Jobsite Management*. (3rd Edition)

APPENDIX

APPENDIX A: QUESTIONNAIRE FORM

"Safety Aspect in Installation of Industrialised Building System (IBS) Formwork"

*These questionnaire are be made to identify the safety aspect and analyse the level of s*afety *in installation of IBS formwork system in Malaysian construction industry.*

Section A: Respondent's Information

1. What is your position in the company?

☐	Director
☐	Project Manager
☐	Engineer
☐	Site Supervisor
☐	Quantity Surveyor
☐	Others, please specify: ……

2. Type of Company

☐	Consultant
☐	Contractor
☐	Developer
☐	Government
☐	Others, please specify: ……

3. 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	

4. 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	
Table Formwork	
Permanent Formwork	
Climbing Formwork	

Others, please specify……

5. Number of year the company have involved in the construction using IBS Formwork

	1-5 Years
	6-10 Years
	11-20 Years
	>20 Years

6. Number of year construction project using IBS Formwork that you have involved.

	1-5 Years
	6-10 Years
	>10 Years
	None

7. During your involvement in construction using IBS formwork, how many accidents ever happen?

	1-5
	>10
	6-10
	None

Section B

The following item describe the safety aspect that lead in installation of IBS formwork in Malaysian construction industry. Indicate your level of agreement and disagreement with the following statement by ticking your response using this scale.

1	2	3	4	5
Strongly Disagree/Very Poor	Disagree/Poor	Slightly Agree/Satisfactory	Practicable/ Good	Strongly Agree/Very Good

Aspect 1: Safety Aspect During Lifting Process		**Scale**				
No.	**Safety Aspect**	**1**	**2**	**3**	**4**	**5**
1.	Material and heavy machine be checked and maintain.					
2.	The process are under supervision of Formwork Supervisor					
3.	Workers used/wear all the Personal Protection Equipment (PPE)					
4.	The installation process were stopped when heavy weather					
5.	Using appropriate equipment with safe working method statement					
Aspect 2: Safety Aspect During Erection/Placing Process		**Scale**				
No.	**Safety Aspect**	**1**	**2**	**3**	**4**	**5**
1.	Workers used/wear all the Personal Protection Equipment (PPE)					
2.	Erection process are under supervision of Formwork Supervisor					
3.	Working platform used and has installed properly to prevent falls					
4.	Worker equipped with safety harness while working at high place					
5.	The process are using safe working method statement					
Aspect 3: Safety Aspect Bracing and Propping Process		**Scale**				
No.	**Safety Aspect**	**1**	**2**	**3**	**4**	**5**
1.	Components and material be checked before it used					
2.	Workers used/wear all the Personal Protection Equipment (PPE)					
3.	Installation process bracing and propping be done by skilled workers					
4.	The process are using safe working method statement					
5.	Inspection done after braces has been install					

Aspect 4: Safety Aspect During Stripping Process		Scale				
No.	**Safety Aspect**	**1**	**2**	**3**	**4**	**5**
1.	Safety measures has been conducted to control the risk formwork susceptible to falling over during the work					
2.	Workers are used/wear all the Personal Protection Equipment (PPE)					
3.	Stripping process are under supervision of Formwork Supervisor					
4.	Stripping operation be carried out in an orderly and progressive manner					
5.	The process are using safe working method statement					

Section C

The following item describe factor of safety in installation of IBS Formwork in Malaysian construction industry. Indicate your level of agreement and disagreement with the following statement by ticking your response using this scale.

1	2	3	4	5
Strongly Disagree/Very Poor	Disagree/Poor	Slightly Agree/Satisfactory	Practicable/ Good	Strongly Agree/Very Good

FACTOR 1:		Scale				
No.	**HISTORICAL**	**1**	**2**	**3**	**4**	**5**
1.	Workers are educated in IBS field.					
2.	Experience workers less involves in accidents.					
3.	Older workers are more sensitive to safety issues.					
4.	Only skilled labours for IBS construction.					
FACTOR 2:		**Scale**				
No.	**TECHNICAL**	**1**	**2**	**3**	**4**	**5**
1.	IBS components are transported under safety officer supervision.					
2.	Only experienced workforces are duty to operate machine for installation.					
3.	Workers are given adequate training and explanation before operating machine and installation process.					
4.	Worker equipped with safety harness while working at higher place.					
FACTOR 3:		**Scale**				
No.	**PROCEDURAL**	**1**	**2**	**3**	**4**	**5**

1.	Installation of IBS component requires more safety procedure and equipment.					
2.	Workers are trained on using safety kit and the Personal Protection Equipment (PPE).					
3.	Delay of inspection leads to unsafe behaviour.					
4.	The process are using safe working method statement					
5.	Contract of Employment should impose punishable offense for failure to use safety equipment.					
FACTOR 4:		**Scale**				
No.	**ORGANISATIONAL**	**1**	**2**	**3**	**4**	**5**
1.	Project management pays attention to safety only after accidents have occurred.					
2.	Project management encourages safety efforts.					
3.	Management is open to discussing safety issues.					
4.	Safety information like 'Tool Box Meeting' implements to give awareness.					
FACTOR 5:		**Scale**				
	PSYCHOLOGICAL	**1**	**2**	**3**	**4**	**5**
1.	Adequate safety training is provided for all workers at all levels.					
2.	Site supervisor is much involved on site regarding safety.					
3.	I have been pressured to put production before safety.					
4.	I am aware of safety and put it as my individual priority.					
FACTOR 6:		**Scale**				
	ENVIRONMENTAL	**1**	**2**	**3**	**4**	
1.	Design stage has included safe working conditions for IBS construction.					
2.	Proper planning for machinery and equipment impact the safety aspect in installation/construction of IBS.					
3.	Storage is important for IBS components.					

ANY COMMENTS AND RECOMMENDATIONS:

.....
.....
.....