SELECTION OF METHOD IN CONSTRUCTION INDUSTRY BY USING AHP METHOD

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ABSTRAK

Kaedah dalam industri pembinaan sangat penting dalam industri pembinaan. Jenis kaedah yang digunakan dalam pembinaan boleh menjejaskan kualiti projek. Kaedah yang membincangkan dalam kajian ini adalah kaedah tradisional, reka bentuk dan pembinaan dan sistem bangunan perindustrian. Menurut (Sutt. J., 2011), dalam kaedah perolehan tradisional, pelanggan akan memasuki kontrak secara berasingan dengan arkitek dan kontraktor. Arkitek akan bertanggungjawab untuk kerja reka bentuk, manakala kontraktor akan bertanggungjawab untuk kerja pembinaan. Oleh itu, reka bentuk dan pembinaan adalah kontraktor menerima tanggungjawab untuk sesetengah atau semua reka bentuk dan sistem bangunan perindustrian adalah sistem pembinaan yang dibina menggunakan komponen pra-fabrikasi. Objektif kajian ini adalah untuk mengenalpasti kriteria dan kesesuaian untuk memilih kaedah penyampaian dalam pembinaan oleh kaedah Proses Hierarki Analitikal (AHP). Proses Hierarki Analisis (AHP) adalah untuk menentukan berat kepentingan parameter. Data itu menyimpulkan, kontraktor untuk Gred 7 sesuai untuk menggunakan kaedah sistem bangunan industri dan kaedah tradisional sesuai untuk kontraktor Gred 1.

KATA KUNCI | Kaedah Tradisional, Reka Bentuk dan Kaedah Membina, Sistem Bangunan Industri, Kontraktor, Proses Hierarki Analisis

ABSTRACT

Method in construction industry is very important in construction industry. The type of method used in construction may affect the quality of the project. The method that discuss in this research are traditional method, design and build and industrial building system. According to (Sutt. J., 2011), in the traditional procurement method, the client will enter into the contracts separately with architect and contractor. The architect will responsible for design work, while contractor will responsible for construction work. Hence, design and build is contractor accepts responsibility for some or all of the design and for industrial building system is construction system that is built using pre-fabricated components. The objectives of this study are to identify the criteria and suitability for selecting delivery method in construction by Analytical Hierarchy Process (AHP) method. Analytical Hierarchy Process (AHP) is to determine the weights of importance of the parameters. The data concluded, the contractor for Grade 7 is suitable to use industrial building system method and traditional method is suitable for the contractor Grade 1.

KEYWORDS | Traditional Method, Design and Build Method, Industrial Building System, Contractor, Analytical Hierarchy Process

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LIST OF ABBREVIATIONS

TM	Traditional Method
D&B	Design And Build
IBS	Industrial Building System
CIMP	Construction Industry Master Plan
CIDB	Construction Industry Development Board, Malaysia
CEI	Construction Engineering And Inspection
PWD	Public Work Department

CHAPTER 1

INTRODUCTION

1.1 Introduction

In this chapter include the background of study, problem statement, research objective, research question, scope of research and significance of research and operational of research. Chapter one also discuss the introduction about the method that most used in the construction industry. This chapter also explain the major of the problem when adopting the method in the construction industry that related with company of construction industry.

1.2 Background Of Study

Given the impact construction methods have on productivity, quality, and cost, their selection is a key decision for the proper development of a construction project, and it is one of the main factors affecting the productivity and efficiency of construction projects (H.R.Thomas, 1990). Construction methods are the means used to transform resources into constructed products (C.B.Tatum, 1988). According to (Illingworth, 1993), programming and management techniques are of little value for a project if construction methods are not the most optimal in terms of cost or are not safe to run.

Firstly, in this research there have a three method in a construction industry. The methods are traditional method, Design and Build (D&B), and Industrial Building System (IBS). Then, Traditional/conventional method also known as separated and co-operative system. The main characteristic of traditional method is design and construction works are separate and will responsible by different firm. In this type of system, architect will full responsible for design work of the project and design will be

done before tender process for contractor begins. Other than that, architect also will act as consultant of client in supervise the construction process and protect the interest of client (Masterman, 1992).

Furthermore, the main characteristic of Design and Build (D&B) method is one organization/firm is responsible for both design and construction work. Therefore, there have only one main contract between the client and main contractor for use as reference. This system seems to be popular in construction industry in nowadays because provide shorten project completion duration, high quality of end product and can early know about the project cost. Because contractor responsible for all aspect in project, therefore it convenience for client to estimate their total cost of the project. Design and build method also known as integrated procurement system (Masterman, 1992).

On the other hand, for Industrial Building System (IBS) is defining as a construction technique in which components are manufacturing in a control environment (on office or site), transport, position and assemble into a structure with minimal additional site work (Hamid, 2008). The Industrial Building System Centre becomes one-stop reference Centre regarding IBS for both government and private sector in order due to ensure the success of CIMP and IBS Roadmap 2011-2015 (CIDB, 2016). According to the IBS Manufacturers Directory by the (CIDB, 2008), majority IBS manufacturers are located in industrial areas such as Klang Valley, Seremban and Butterworth.

1.3 Problem Statement

According to (Mohd Nasrun Mohd Nawi, 2014) was highly critical of the sequential nature of construction processes which often acts as an effective barrier to using the skills and knowledge of all project partners effectively in the design and planning of the project. Such as mechanical and engineering design of construction professionals, as well as facility management expertise was needed during the early stage of a project. In addition, the gap between design and construction processes also contributes to major behavioural, cultural and organisational differences between project individuals and groups.

Some clients and contractor are less excited with the benefits offer by design and build contract because if compare to traditional method, clients have less control and influence to the design matters and inflexibility in makes change. While, contractor need to responsible for both design and construction of the project as different to traditional method which the client will assign different parties such as architect to performed design work. In addition, the number of projects procured under design and build method decreasing from March 2012 to March 2014 (CIDB, 2014).

Other than that, if the contractor need to responsible for both design and construction work they need to liability to all risk resulting from design and construction work in order to complete the project. It is very different to traditional method, which risk from design work will liability by architect (Ling T. M., 2014).

Many small contractors are reluctant to adopt IBS system and prefer to continue using the conventional method of construction. This is due to the fact that small contractors are already familiar with the conventional system and for them the technology suit well with small scale projects and therefore not willing to switch to mechanized based system (Ling T. M., 2014).

Furthermore small contractors lack financial backup and are not able to set up their own manufacturing plants as it involves very intensive capital investment. In this case, financial issues become the main obstacle for small contractors to move forward with the IBS system. Lack of knowledge in structural analysis and design of pre-fabricated components among civil engineers and those related to construction discourages further the implementation of IBS system (Ling T. M., 2014).

1.4 Research Objectives

There is objective of the research that are follows:

a) To identify the criteria for selecting delivery method in construction.

b) To identify the suitability method of delivery by Analytical Hierarchy Process (AHP) method.

1.5 Research Question

The question of the research is as following:

a) What is the criteria for selecting delivery method in construction.

b) What is the suitability method of delivery by Analytical Hierarchy Process (AHP) method.

1.6 Scope Of Research

This study are focuses on the method in the construction industry. The method is include the traditional, D&B and IBS method. Hereby, this research area is including fourteen states in Malaysia. Then, the respondents that include for this study is from private and public sector. This is because to know the comparison of the method that usually used in a construction industry for private and public sector in Malaysia.

1.7 Significance Study

To give an opinion about the best method in construction industry because of each method have their own advantages and disadvantages. Furthermore, the player in construction industry can exposure about each method especially the information about the methods is very important for the new player in construction industry.

1.8 Expected Result

The expected result when the research is finish is the researcher hope that the company and the player in construction industry can improve the performance to complete the project. So, the parties that involved in construction industry can prevent the problem occurred.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In the previous in Chapter 1, the overview of this study was explained about and problem in a traditional, design and build and industrial building system of the delivery method in a construction. Hence from the overview of this study is to explain about the advantages and disadvantages of each delivery method that related to this research. Then, its also explain about each grade of the contractor that define the price of the project with the common problem that faced by the contractor.

2.2 Malaysian Construction Industry

In Malaysia, the construction industry plays an important role to produce adequate, quality, and affordable home, facility and the infrastructure as a part of the development of the country (Chan, September 2011). Then, the attitude of the contractor and the other parties involved is effect the result of the project to be success. Therefore, construction is a process of creating and building infrastructure or a facility. Its also can influence the Gross Domestic product of the development country and it will begin with plan the design of the building, duration of the project and support that is continuously until the project will complete and ready to advertise such as housing to client or people.

The triple constraint whereas time, cost and quality is to have the best result and produce a positive impact for the company in a construction. On the other hand, delivery method is important to make sure the project is going well without many problem occur during construction. As we know Malaysian construction will keep on expanding, so it needs to change into the systematic and mechanized system, more worker that have an excellent skills and new technology that follows the global competition (A. Haron, 2005).

2.3 Delivery Method

According to (Frederick E.Gould, 2002) the term of delivery method is the owner's will approach to organize the project team and handle the construction process and design process. On the other hand, the owner's can choose any method that deliver the project on time, cost and all specifications is followed owner's needs. Hence, the common method of delivery method that usually used are traditional method, design and build and industrial building system. All the delivery method have their own advantages and disadvantages, so the owner's will have the rights that will pick which delivery he or she needs. Therefore, the owner's will weigh wisely which delivery is suitable with the specific project.

2.4 Conventional Method

Construction industry player has been widely practiced globally and locally in a traditional method (TM). Therefore, the process of the installation of the timber or plywood formwork and steel reinforcement for the building at site is by fabricating components that called as a conventional method (C. Lou, May 2012). On the other hand, in conventional method have two parts. For the first part is structural system that the frame is in cast in-situ such as column, slab and beam. Hence, cast in-situ process is going into four action which are install the steel reinforcement bar, erection of the timber of formwork and scaffolding, using of pouring fresh concrete and disassemble of formwork and scaffolding (Ali, 2012).

(Frederick E.Gould, 2002) stated this arrangement is the owner first hire a design professional, who needs to prepare a design, including a complete contract documents. The design professional is typically paid a fee that is either a percentage of the estimated construction cost or lump sum amount, or she or he is reimbursed for costs at an agreed-upon billing rate. With a complete set of documents available, the owner either conducts a competitive bid opening to obtain the lowest price from contractors to do the work or negotiates with a specific contractor. The contractor is then responsible for delivering the completed project in accordance with the dictates of the contract documents. The contractor may choose the subcontract much of the work or may have the forces in house to accomplish the task. That choice usually depends on the complexity of the project. This delivery method become more popular near the turn of 20th century in response to the increasing specialization of the various building professions and until recently it was the predominant mode of delivery.

During the construction process, the owner may hire the architect to administer the contract or may choose to have in-house employees do this task. Administering the contract consists of observing the work to monitor quality, carry out the change order process, certify payment to the contractor and ensure that the owner is receiving the product called for in the contract documents. If the owner hires the architect, he or she does so through an agency relationship that is the architect is bound by the legal rules of this relationship and as such is empowered to act in the owner's name. The contractor, on the other hand, is hired in a simple commercial simple contract and such as is charged with carrying out the terms of the construction contract. There is no contract between the architect and the contractor. The relationship is one in which the architect acts for the owner during any dealing with the contractor. Nor are there contract agreements between the architect/owner and the specialty subcontractor. The relationship exists only with the contractor who is solely responsible for subcontractor's performance (Frederick E.Gould, 2002).

2.4.1 Advantages

According to (Frederick E.Gould, 2002) the traditional method is a known quantity to owners, designers and constructors. This probably its greatest strength. For many years, the mode of delivery was the predominant one for the construction in the United States. The procedures and contractual rules of conduct have been worked out and are well understood. Many professionals prefer this well-defined relationship, which reduces their level of risk because it reduces uncertainty. Under the right circumstance, this means that a project is more likely to proceed smoothly from beginning to end.

The mood also contains considerable contractual protection for the owner. The allocation of risk for construction performance rests almost completely on the contractor and subcontractors. The owner is insulated from many of the risks of cost overruns, such as labour inefficiencies, nonperforming subs, inflation and other vagaries of the larger economic picture. In most instances, the owner knows the final cost at the beginning of construction, and the risks of cost overruns are borne by the contractor. However, the risk of cost increases depends to large extent on the accuracy and completeness of the contract documents. If they are unclear or not well done, the changes that must ensue can raise the owner's costs considerably (Frederick E.Gould, 2002).

Additionally, the traditional method provides the owner with all the benefits of open market competition. The open bidding procedure, in which the lowest bidder is the "winners", gives the owner the lowest price available in the marketplace and presumably the greatest economic efficiency (Frederick E.Gould, 2002).

Finally the owner does not have to be heavily involved in the construction process. He or she must be involved in the design process to make key decisions about whether or not to accept the design but once construction actually begins, the owner is represented by professionals empowered to act in his or her name and to make recommendations. Day to day interaction is no necessary (Frederick E.Gould, 2002).

2.4.2 Disadvantages

Several elements of disadvantage from traditional method is time consuming aspects of the development process. (Masterman, 1992) said one reason given for this is that the traditional system is a sequential process. The construction phase, for example, should not begin until the design is completed. However, the preparation and approval of drawings, and the mistakes and discrepancies found in the design documents are frequent causes of delay in the design phase (Chan D. W., "A Comparative Study of Causes of Time Overruns in Hong Kong Construction Projects"., 2004). As a result, whole development process is lengthened (Turner, 1990). Similarly, when the design team permits the client to postpone the briefing decisions until the later stages, this results in key time delays – again causing the whole project to be delayed (Chan, "An Evaluation of Construction Time Performance in the Building Industry", 2004)

In many cases, project designs and bills of quantities are not prepared before the contractor is selected due to the lack of design information available (Masterman, 1992). Far from saving time overall, therefore, this inevitably results in delays in the construction phase due to unclear drawings and specifications, which prevents contractors planning for the resources required for the work (Chan, "An Evaluation of Construction Time Performance in the Building Industry", 2004). Another implication of a reduced design period is an increase in variations later. Variations are not only a source of annoyance in terms of time and cost (Chan, "An Evaluation of Construction Time Performance in the Building Industry", 2004) but are "a time-consuming and expensive undertaking" (Hovet, 2004). They also always lead to poor on-time performance (Chan, "An Evaluation of Construction Time Performance in the Building Industry", 2004).

Secondly, an associated issue concerns cost uncertainty. Because of the long period of time taken to design, document and tender, there are inevitably significant changes in the market forces, tender prices, interest and inflation rates (Turner, 1990). Price fluctuations in construction materials have also been found to be particularly significant in economically unstable countries (Akpan, 2001). For most projects, however, variations that occur during the construction phase have the most significant and inevitable effect on final cost (Akpan, 2001). The variations result in many extra claims (Morledge, 2002) and are often "very expensive". "Scope growth" during the

construction phase has been identified as a particular problem, with the majority of cost increase being derived from this source (Akpan, 2001).

Next, according to (Frederick E.Gould, 2002) all parties work autonomously in this mode. The designer designs the project based on the owner's instructions. The general contractor prices and schedules the project based on the construction documents alone. This approach provides little opportunity for interaction and team building among the participants and can lead to major breakdowns relationships (Frederick E.Gould, 2002). For example, when the contract must be interpreted, the parties involved view the situation from fundamentally different perspectives. A firm fixed-price contract can considerably exacerbate the problem because the contractor had to competitively bid for the job and thus interprets details as cost-effectively as possible. The owner and the designer, on the other hand, want to receive the most for their money. Such differences in interpretation lead to conflicts that can quickly escalate, creating adversarial relationship.

Unforeseen conditions on a job can also be a source of conflict and may lead to changes in the contract. A through design process and complete set of drawings attempt to minimize these conditions. Conducting additional soil borings or opening up walls in renovation work can help to properly identify actual conditions and avoid future conflicts. Unfortunately, no every condition can be identified and when unforeseen conditions or events occur the contract may have to be renegotiated. This takes away any advantage to the owner in terms of know costs when construction begins (Frederick E.Gould, 2002).

2.5 Design and Build Method

The need for a more integrated design and build process, faster project delivery with a consortium taking sole responsibility over the project, usually on a lump sum fixed price coupled with the adversarial nature of the traditional procurement systems which separates the design and construction teams has led to the popularity of the D&B procurement system (E.W.M. Lam, May 2008). D&B procurement is recognized as an ideal substitute in many public projects and private in many countries (E.W.M. Lam, May 2008). Refer to (Songer, Nov/Dec 1998) and (E.W.M. Lam, May 2008) define D&B as alternative procurement approaches which promote a single entity or consortium who takes sole responsibility over the project, usually on a lump sum fixed price.

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D&B became popular in Malaysia in the 1980s and 1990s with the Public Work Department (PWD) taking the lead role. A typical D&B project implement process would involve the end-user initially identifying a project and applying to secure a budget. Once approved, PWD would manage to implement the project on behalf of the end user government agency until completion. To facilitate the implementation process three documents are:

i. D&B Condition of Contracts
ii. Guidelines for Management of Design and Build Projects
iii. Guidelines for Project Brief Preparation to outline the framework of the project management process.

Not with standing, several researchers (Aziz, September 2009), (F. Hassan, 2009) and (Hassan, 2009) revealed that weakness in DB project management approach are persisting. This includes cost and time overruns and quality problems emanating from the culmination of unfamiliarity with the DB process problems and flaws within the project management process.

2.5.1 Advantages

One major reason for choosing a design and build arrangement is to benefit from the good communication that can occur between the design team and the construction team. Many of the largest design and build companies specialize in particular areas and have developed a smooth flow between design and construction phases of the project. This collaboration allows the project be easily fast racked, cutting down on overall schedule for the project (Frederick E.Gould, 2002).

Good communication between the designer and the construction professionals also allows construction input early in the design phase. Such input includes constructability analyses, value engineering and subcontractor pricing. Cost estimating, scheduling, long lead item identification, and ordering all become part of the overall project planning (Frederick E.Gould, 2002).

In general, this arrangement allows easier incorporation of changes due to scope or unforeseen conditions since their coordination occurs within the same contractual entity. The owner is less heavily involved and sits outside the direct day-to-day communication between designer and constructor. This keeps owner staffing to a minimum and puts the full responsibility for good communication, problem solving and project delivery on the design and build team (Frederick E.Gould, 2002).

2.5.2 Disadvantages

Although it is possible to give the owner a fixed, firm price before the project begins, this generally does not happen in a design/build arrangement. Because the firm is hired before the design has started, any real pricing is not possible. Instead, an owner usually enters this arrangement with a conceptual budget but without the guarantee of a firm price. Firming up the price too soon puts the design and build team in the position of making the scope fit the price, which carries the risk of sacrificing quality to protect profit. If the project is fast-tracked, the owner may not have a good idea about the final price until part of the project, such as the foundation is complete (Frederick E.Gould, 2002).

The owner's ability to remain marginally involve can be both an advantage and disadvantage. When design and build Company has an organization that is efficient at performing the work, the project can move very fast. If the owner does not stay consistently involved throughout the process, he or she may have to make decision without fully understanding the issues. Once a project develops a rhythm, it is difficult to change that rhythm. If the owner is not moving to the same rhythm, the project may take a direction that he or she does not want but is not aware of until too late (Frederick E.Gould, 2002).

Another disadvantage is the lack of checks and balances. In the traditional arrangement, the designer prepares a complete set of contract documents, which is then used to measure and evaluate the performance of the contractor in the field. The owner often hires the designer to oversee the work of the contractor and to ensure that deficient work is identified and corrected. But in the design and build arrangement the designer works for the same company as the builder.

Similarly, during construction the builder sometimes uncovers certain design deficiencies, errors or missions. The designer is contract bound by contract to correct these deficiencies without additional costs to the owner. In design and build the design and construction professionals are put in position of critiquing their co-workers and perhaps affecting their bottom line by that critique. The owner must rely more heavily on the quality and ethics of the firm since most of the checks and balances will likely take place behind the company's door (Frederick E.Gould, 2002).

2.6 Industrial Building System

An Industrialised Building System (IBS) is a construction system that is built using pre-fabricated components. The manufacturing of the components is systematically done using machine, formworks and other forms of mechanical equipment. The components are manufactured off-site and once completed will be delivered to construction sites for assembly and erection. IBS can be defined as a construction system which components are manufactured in a factory, on or off-site, positioned and assemble into structures with minimal additional site work (CIDB, 2003).

In Malaysia, Industrialised Building System (IBS) was first introduced almost 50 years ago with the completion of the Tunku Abdul Rahman Public Housing Estate; or commonly known as the Pekeliling Flats at Jalan Pekeliling, Kuala Lumpur. Despite many years have passed, the adoption of IBS in the construction sector is still low and represents only 15% of construction projects used IBS in Malaysia (Shaari, 2003). IBS Mid - Term Review in 2007 indicated that approximately only 10% of the complete projects used IBS in the year 2006 as compared to forecasting IBS usage of 50 % in 2006 and 70% in the year 2008 as projected in the roadmap (Hamid Z A, 2008). In contrast, other developed countries such as Finland, Sweden, Japan, Germany, and even Singapore have been successfully implemented IBS and it is very much preferred construction method due to its numerous benefits (CIDB, 2011).

The process of IBS construction started with the manufacturing of component off-site or mass production on the site, once completed, the components will be delivered to the construction site for assembly and erection (Hamid Z A, 2008). (CIDB, 2011) has divided IBS into six (6) major classification based on structural aspects. IBS has been classified into precast concrete framing, panel and box system, steel formwork systems, steel framing systems, prefabricated timber framing systems, blockwork systems and innovative product systems.

Table 2.1: Classification of IBS

Classification	Types
Pre-cast Concrete Framing, Panel and Box Systems	Pre-cast concrete elements such as pre-cast concrete columns, beams, slabs, walls, "3-D" components, lightweight pre-cast concrete and permanent concrete formworks.
Steel Formwork Systems	Tunnel forms, tilt-up systems, beams and columns moulding forms and permanent steel formworks (metal decks).
Steel Framing Systems	Light steel trusses (cold-formed channels) and steel portal frame systems.
Prefabricated Timber Framing Systems	Timber building frames and timber roof trusses.
Blockwork Systems	Interlocking concrete masonry units (CMU) and lightweight concrete blocks.
Innovative product systems	Solid drywall system and sandwich panel system.

(CIDB, 2011)

2.6.1 Industrialised Building System History In Malaysia

The IBS is not a new thing in the construction sector; the concept was introduced in as early as 1624, when the wood panel houses were brought from England to North America. The pyramids of Egypt were using the IBS concept where blocks are divided into smaller and more manageable sizes for easy transportation (H.R. Thomas, 1994). The turning point of constructions using the IBS was in the United Kingdom, particularly in the construction of the Crystal Palace which was built in 1851 (Figure 2.1). Frame components used were glass, wood and steel windows. Based on the SPI Survey, the construction of this building took only four months to complete (C.H. Oglesby, 1989).

In 1963, the Malaysian government sent architects from the Public Works Department (PWD) to several European countries to explore the concepts of development in these countries in further detail. At the same time, the Ministry of Housing and Local Government focused on housing development projects to improve the quality of life at that time. Representatives from Malaysia also visited Western nations such as Germany, Denmark and France for information on the construction industry (P.F. Kaming, 1997).

Figure 2.1: The Crystal Palace, London.

(C.H. Oglesby, 1989)

Nowadays there are numerous mega-projects that deploy the Industrialised Building System and among these are the Petronas Twin Towers (Figure 2.2) Bukit Jalil Sports Complex and The Malaysian Light Rail Transit (Figure 2.3). Although this system had been introduced since nearly four decades ago in Malaysia, yet its applications are still at low levels. Enhancements of the infrastructure in the country allow the system to continue to expand in the future (P.F. Kaming G. H., 1998).

Figure 2.2: Petronas Twin Tower.

(P.F. Kaming G. H., 1998)

Following the success of their visits, the government started major projects using the IBS system in 1964. Their main objective was to accelerate the completion of the projects on time besides being able to construct affordable housing units of substantial quality. Projects along the Jalan Pekeliling, Kuala Lumpur which were as wide as 22.7 acres included the construction of 7 blocks of flats of 17- storeys each encompassing 3,000 low-cost flats and 40 shop lots (Figure 2.4). The project took two years and three months to complete, costing a total of RM 2.5 million for casting (P.F. Kaming P. O., 1997).

Figure 2.3: Light Rail Transit (left) and Bukit Jalil Sport Complex (right).

(P.F. Kaming G. H., 1998)

The system can only be used for buildings with simple and easy designs. The use of the IBS in construction is getting better by the day. As reported, there are at least 21 different manufacturers and suppliers that are promoting their components in Malaysia. An IBS Centre has also been established in Jalan Chan Sow Lin, Cheras, Kuala Lumpur. These are the authorities who are responsible for implementing strategies and introducing breakthroughs in the IBS technology to improve its performance and quality in the construction industry as well as to reduce dependencies on foreign labour, avoiding the flooding of the local construction market with a foreign workforce (P.F. Kaming G. H., 1998).

Figure 2.4: Jalan Pekeliling Flat, Kuala Lumpur.

(P.F. Kaming G. H., 1998)

2.6.2 Advantages

According to (M.A. Othuman Mydin, 2014):

- **Cleaner, neater and safer construction sites**

  IBS construction sites have proven to be tidier and better organised as compared to the traditional construction sites which are often wet and dirty. Usages of IBS components can reduce wet work at construction sites. Wastage of time and materials on temporary works such as timber formworks and props, which are common in conventional constructions are reduced greatly when the MATEC Web of Conferences construction emphasises more on IBS components. This prompts construction sites to be neater, reduces involved risks related to health and well-being besides promoting a safer working environment.

- **Able to uphold the sustainability of the environment**

  Completion datelines of IBS projects are not that volatile due to the rapid construction rates. In addition, construction operations are not affected because the fabrications of the IBS components are done at factories and in a controlled environment.

- **Cost reduction**

  IBS construction methods are cheaper than the traditional method. Savings are made possible when fewer workers are employed as costs can be reduced in terms of wages. The IBS is also considered as one of the cheaper options when considering the overall cost incurred for the construction of a building project. This has brought about the phenomenon where the IBS is now beneficial for the constructions of small shops, offices and simple house designs. It helps if these have easy and repetitive designs. Construction using prefabricated materials can also considerably reduce the usage of scaffoldings and other temporary supports compared to in-situ systems.

- **Reduced Labour**

  The construction sector in Malaysia is very much dependent on foreign labour from neighbouring countries like Indonesia, Bangladesh and Vietnam. With the implementation of the IBS system, this dependency can be drastically reduced for the benefit of the local economy. The IBS is able to reduce the number of workers for example concreter, carpenters, bar benders, plasterer and more. Now, the task can be replaced by a group of IBS component installer which at most, may only consist of at least 5 individuals in each project. When the IBS components are produced at factories using complex machineries, it can minimise the requirement of labour and this will lead to savings in terms of labour costs. The usage of IBS will also reduce the required construction site areas and thus contribute to lower budgets.

- **High and controlled quality of end products**

  The IBS offer improvements on quality, productivity and efficiency due to the components being factory-produced. It could also reduce the possibilities of poor workmanship and lack of quality control. IBS components have superior quality and better surface finishes compared to that of the traditional method. It provides high quality surface finishes where the joint sections are the only parts to be grouted, eliminating the requirement of plastering. The construction is done in shaded and environmental protected environments which emphasise on critical elements such as material curing processes. Temperature control would be able to evade crack problems on the concrete structures.

- **Faster completion time**

  IBS construction projects are able to reduce the construction time periods and this can save valuable time and help to reduce monetary losses. This is because the constructions of prefabricated components are concurrent constructions which can proceed even when the foundations of the construction sites are under survey or when they are involved in earthwork. The installations of IBS components will be made on the sites only after that. This phenomenon helps in reducing the risks of project delays and unnecessary expenditures. IBS element productions are not affected by weather conditions. Instead, the use of large panel structures would be able to accelerate structural-related tasks such as painting, electrical wiring and plumbing.

2.6.3 Disadvantages

According to (M.A. Othuman Mydin, 2014):

- **High capital costs**

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

- **Problem of joints between components**

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

- **Sophisticated plants and skilled operators**

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

- **Site accessibility**

  Site facility and accessibility is one of the most important factors in the implementation of the IBS. The IBS requires adequate access to transport all IBS components of the plants up to the construction sites. It is possible for complications to arise at the construction sites. An example is the delay in the installation of the components due to transportation woes which could result in a delay in the overall construction. The installation task would then have to be performed later.

2.6.4 Issues of The Implementation of Industrial Building System (IBS)

The issues against the IBS implementation can be grouped into technical issues and human issues (Pan, 2012). The issues as discussed by several scholars are summarized in Table 2.2:

No.	Technical	Human
1	Lack of knowledge among designers (Omar, 2006).	The need of mindset change with proper education (Kamar, 2007).
2	Poor quality products, Lack of technical knowhow, low off-site manufacturing of construction components to guarantee quality, mechanization and standardization (Kamar, 2007).	Bad perception of IBS due historical failure (Qays, 2010).
3	Insufficient incentives, sheer cost investment, low components standardization (Hashim, 2011).	The fragmentation and diversity in construction industry sector make it is difficult to organize IBS planning stage

		(Qays, 2010).
4	The availability of cheap foreign labour (Hashim, 2011).	To enabling the workforce/human capacity to appreciate change (Nadim, 2010).
5	Inflexibility of IBS components, the weakness of connection and jointing system (Qays, 2010).	Lack knowledge & exposure to IBS Technology (Omar, 2006).
6	Poor quality control and lack of technical experience caused several defects (Idrus, 2008).	Lack of integration among relevant player (CIDB, 2011).

Table 2.2: Issues of implementation of IBS

2.7 Contractor

A contractor is someone who enters into a binding agreement to perform a certain service or provide a certain product in exchange for valuable consideration, monetary, goods, services, even barter arrangements. In the building trades, a contractor is one who is engaged in the construction or building related services for a client. The construction site is overseen by a "Prime", General, or Specialty contractor, who may perform the work with employees, subcontractors or any combination (Wikipedia, 2001-2006).

2.8 Common Problem Faced by Contractor

Some of the problems unfortunately only surface after commencement of a project and if not expected, can pose real problems to unsuspecting employers and contractors. A few of the several potential problems are mentioned below (Tan, 1997).

The unsuspecting employer may find that he still has to engage his own consultants for technical guidance and preparation of material setting out the employer's requirements. The unsuspecting contractor may find that his costs and effort for tendering would be quite high especially if he is unsuccessful in the tender exercise.

Also, a contractor's perception of liability assumed for design could be much wider than anticipated (Tan, 1997).

No.	Author	Problem
1	(Murali Sambasivan & Yau Wen Soon, 2005)	The problem of delays in the construction industry is a global phenomenon and the construction industry in Malaysia is no exception.
2	(Nuhu Braimah & Issaka Ndekugri, 2008)	Delays and disruption to contractor's progress are a major source of claims and disputes in the construction industry. The matters often in dispute concern the dichotomy in responsibility for delays (projects owner or his contractors) partly because of the multifarious nature of the potential sources of delays and disruption. With increased project complexity and requirements coupled with multiple parties all subject to their performance exigencies, the resolution of such claims and disputes has become a matter of the greatest difficulty.
3	(K.C. Iyer & K.N. Jha, 2005)	The factor adversely affecting the cost performances of project are conflict among project participants, ignorance and lack of knowledge, presence of poor project specific attributes and non existence of cooperation, hostile socio economic and climatic condition, reluctance in timely

		decision , aggressive competition at tender stage and short bid preparation time.
4	(M.S. Mohd Danuri, M.E. Che Munaaim,H.Abdul Rahman & M.Hanid, 2006)	Late and non-payment will cause severe cash flow problems especially to contractors.
5	(Abdul Rahman Ayub & Janidah Eman, 2006)	Some common types of problem faced by bumiputera contractors in Malaysia construction industry are shown as follows: i. Lack of expertise and experiences ii. Over-optimistic estimation in tender bids iv. Material price escalation v. Financial Problems vi. Materials supply networking vii. Lack of skilled workers viii. Lack of construction materials and machineries ix. Inefficient and ineffective planning and management x. Communication problems
6	(Abdul Rahman Ayub & Janidah Eman, 2006)	Delays or late deliveries, sub-standard workmanship and materials, poor safety management on sites and cost over-run of government's projects are

		some the issues that been seriously discussed by the government.
7	(Abdul Rahman Ayub & Janidah Eman, 2006)	Failures to perform to the quality expectations.
8	(Mansfeild NR, Ugwu OO & Doran T, 1994)	Delays causes are financing of and payment for completed works, poor contract management, changes in site condition and shortages in materials.
9	(Odeyinka HA & Yusif A, 1997)	Delay via project participants and extraneous factors.
10	(Wellington Didibhuku Thwala & Mpendulo Mvubu, 2008)	Financial constraints, late payment by clients, relationships between emerging contractors and suppliers and difficulties when running a business.

Table 2.3: The problem faced by contractor

2.9 Summary

In this chapter, for the definition of the traditional method, design and build method and industrial building system method were discussed. On the other hand, each method have their own advantages and disadvantages. From the advantages and disadvantages we can decide which method is better to used in construction industry. Next, the problem of the contractor is identified and can be relate with the advantages and disadvantages of each method that can be pick which method is suitable for the each grade of the contractor.

CHAPTER 3

METHODOLOGY

3.1 Introduction

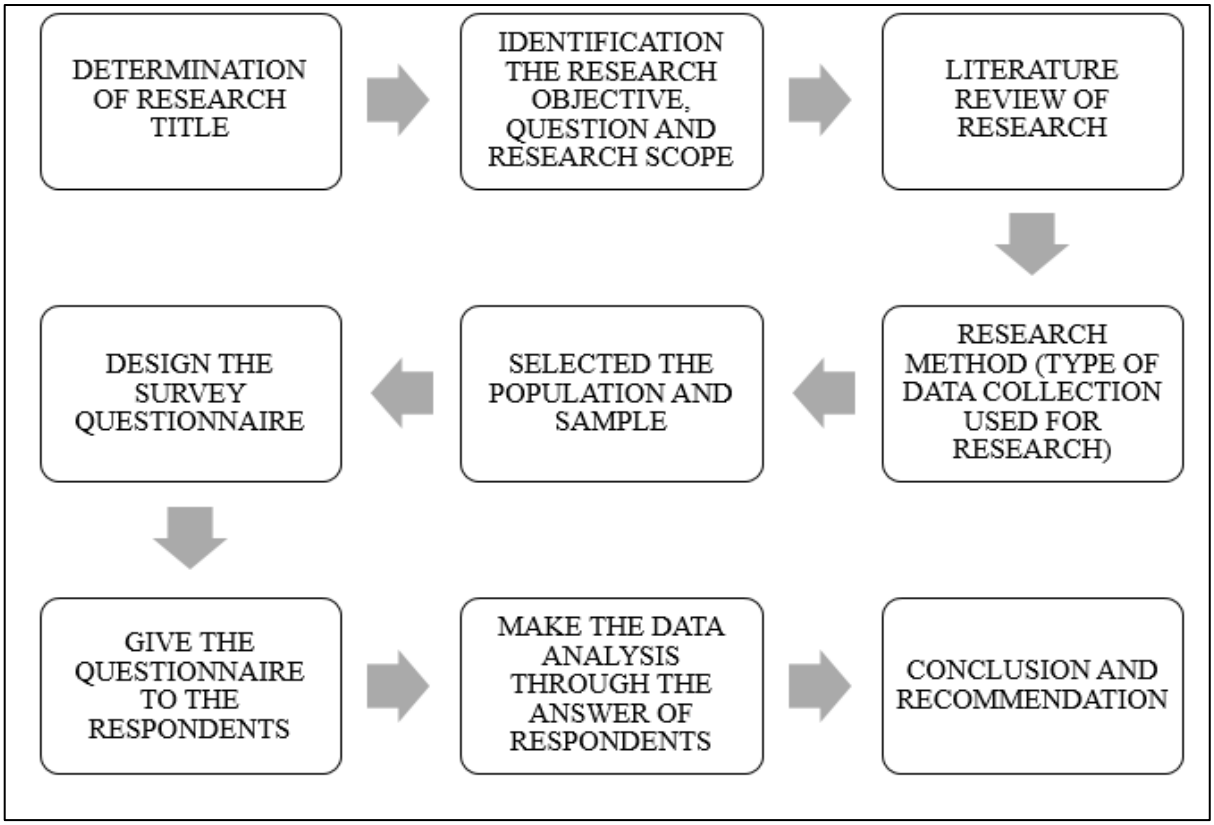
The target in this chapter is to know the research methodology that used in this research. It explain the research design and to describe how to interpret the data and analyse to achieve the research objective by using Analytic Hierarchy Process (AHP) and Expert Choice software. The research objective that stated in the Chapter 1 is:

a) To identify the criteria for selecting delivery method in construction.

b) To identify the suitability method of delivery by Analytical Hierarchy Process (AHP) method.

3.2 Research Process

Figure 3.1: The flow of research process



(Ling T. M., 2014)

3.3 Literature Review

The literature review is doing by reading of the related books, journals, thesis, magazine, newspaper and the other resources which can be obtained from the internet, pamphlet, and browser. Most of the sources of the literature review can be found in the library. The reason why the researched use this literature review is to know what different among the past research, the method the past research used and others (Chua, 2016).

This research was conducted by distributing a set of the questionnaire to the professional parties in construction industry. They are including public and private company and contractor. This is because they are really experiences with the method in the construction industry which are better to used during construction.

The advantage of using questionnaire form are the data information required can be obtained directly from questionnaire and require little time duration to answer questionnaire form in more convenient to the respondent due to limited time they have and a lot of work to do. This is because all require answers needed need to be organized in the form and the respondent just need to tick the appropriate answer. Therefore the questionnaire survey is the most effective method to be applied in order to obtain the data collection (Rahman, November 2009).

Before examining the method used in this study, it is important to observe and to know the background of the study. This is in order to know about comparisons between designs & build contract and conventional contract, to identify the common problems faced by the contractor and to rank the problems among contractors to achieve the objectives. According to Burgess, 2001 said that the selection of suitable question is important because it is a key aspect that needs to be addressed. Hence, the method that will using in the questionnaire is Analytical Hierarchy Process (AHP) that is pair wise comparison method.

Through this approach, literature review is enough to have understanding about the topic of selection method in construction industry. The first part in literature review is about the method and the procurement that will use in the construction industry. The second part is explanation about the problem that always being faced by the contractor that will effect the method that they are used. The literature review give the understanding information and know the detail about the topic.

3.4 Analytical Hierarchy Process (AHP)

Once the criteria have been chosen and the model has been given its structure, the second, essential step is to determine the weights of importance of the parameters. Often this is determined on the basis of the shared opinion of an appropriate interest group (Singh, 2009). The group usually consists of experts in the field and future method users. The analytic hierarchy process (AHP) is very frequently used to determine the shared opinion of the group (Chang, Chiang, & Chou, 2007) as it is one of the most frequently used methods for multiple-criteria decision-making. AHP allows the experts to make decisions concerning complex content by simplifying the natural decision-making process on the basis of pairwise comparisons between two parameters (Chandratilake & Dias, 2013). The AHP method for ascribing weights to parameters using the model for assessing building sustainability was executed in the following order (Bhatt & Macwan, 2012):

- The problem was defined and modelled in a hierarchical structure.
- The group of experts to carry out the comparisons was formed.
- Judgements were made between parameters on a scale of 1–9, as proposed by Saaty (Saaty & Vargas, 1980), by each expert individually.
- The pairwise comparisons of individual experts were entered into a matrix.
- The consistency ratio was calculated to establish whether the judgements of experts were sufficiently consistent.
- Individual judgements were aggregated into a group judgement using the geometric mean method to derive local weights of parameters.
- Local weights of parameters were derived according to Saaty's eigen vector method (Saaty & Vargas, 1980).
- Global weights of parameters were calculated from the hierarchical structure.

The questionnaire consisted of pairwise comparisons of the individual parameters on the same hierarchy level within a group of parameters. Each parameter also contained a short description to explain the content. The descriptions were of comparable length and quality. When allocating judgments in pairwise comparisons experts used the number scale 1–9, as proposed by Saaty (Saaty & Vargas, 1980).

Table 3.1: Explanation of numerical value in allocating judgements

Intensity of Importance	Definition	Explanation
1	Equally preferred	Parameters *i* and *j* are equally important
2	Equally to moderately	
3	Moderately preferred	Parameter *i* is moderately more important than *j*.
4	Moderate to strongly	
5	Strongly preferred	Parameter *i* is much more important than *j*.
6	Strongly to very strongly	
7	Very strongly preferred	Parameter *i* is proved to be more important than *j*.
8	Very strongly to extremely	
9	Extremely preferred	Parameter *i* is absolutely more important than *j*.

(Saaty & Vargas, 1980).

In the AHP method all judgements are recorded in a matrix of pairwise comparisons $A = (a_{ij})_{n\times n}$ in which the dimension of matrix n means that we compared n parameters. The element of the matrix a_{ij} denotes a pairwise comparison of parameter *i* with parameter *j*, we gave the inverse comparison (comparing parameter *j* with parameter *i*). So the reciprocal value:

$$a_{ij} = 1/a_{ij} \tag{1}$$

We can employ the eigenvector method to derive the parameter weights from the matrix of pairwise comparisons *A*, which means that we must solve the equation:

$$Aw = \lambda_{max} w \tag{2}$$

where λ_{max} is the maximal eigenvalue of matrix *A*. For every matrix of pairwise comparisons *A* we must also calculate the consistency ratio, which measures the level of inconsistency between pairwise comparisons:

$$CR = \frac{CI}{RI} \tag{3}$$

where $CI = \frac{\lambda_{\max} - \mathrm{n}}{\mathrm{n}-1}$ is the consistency index, *n* is the size of matrix *A* and *RI* is the average consistency index. We assumed that if $CR \leq 0.15$, then the inconsistency level of matrix *A* is still acceptable.

In the case of group decision making where m is the number of decision makers, we aggregate the individual judgments into one joint judgment ${a_{ij}}^{group}$ applying the geometric mean method:

$${a_{ij}}^{group} = \sqrt[m]{\prod_{k=1}^{m} {a_{ij}}^{k}} \tag{4}$$

where $a_{ij}{}^{k}$, k = 1, ..., m are the individual judgements of m decision makers. (Saaty, 2014) showed that the geometric mean method Equation (4) is the only appropriate method for aggregating individual judgments into group judgments as it satisfies some necessary axiomatic conditions like preserving reciprocity. For the analysis of the acquired data is need to be follow (CR $\leq$ 0.15). Its will be mean that the result will be acceptable.

3.5 Expert Choice

The Expert Choice software is a multi-objective decision support tool based on the Analytic Hierarchy Process (AHP), a mathematical theory first developed at the Wharton School of the University of Pennsylvania by one of Expert Choice's founders. The AHP is a powerful and comprehensive methodology designed to facilitate sound decision making by using both empirical data as well as subjective judgments of the decision-maker(s) (M.Barfod, 2014).

The AHP assists with the decision making process by providing decision-makers with a structure to organize and evaluate the importance of various objectives and the preferences of alternative solutions to a decision (M.Barfod, 2014). Following are the steps used in AHP and Expert Choice (M.Barfod, 2014) :

- Brainstorm and structure a decision problem as a hierarchical model.
- Set the type and mode of pair wise comparisons or data grid functions.
- Group enable the model.
- Import data to Expert Choice from external databases.
- If applicable, pair wise compare the alternatives for their preference with respect to the objectives, or assess them using one of the following: ratings or step functions, utility curves, or entering priorities directly.
- Pair wise compare the objectives and sub-objectives for their importance to the decision.
- Synthesize to determine the best alternative.
- Perform sensitivity analysis.
- Export data to external databases.

- To perform resource allocations using Expert Choice's 'Resource Aligner' to optimize alternative projects subject to budgetary and other constraints.

Expert Choice has a unique method of using pair wise comparisons to derive priorities that can more accurately reflect perceptions and values than most other ways. Expert Choice synthesizes or combines the priorities that are derived for each facet of the problem to obtain the overall priorities of the alternatives. By performing "what-if" and sensitivity analyses, it can quickly be determined how a change in the importance of an objective would affect the alternatives of choice (M.Barfod, 2014).

If the results of the decision model differ from the decision-makers' intuition it is possible to modify the model and/or judgments until the model incorporates this intuition. Then the model results will either change to conform to the "gut" feeling, or the intuition will change based upon the modelling. In the former case, not only the "gut" feeling will be verified, but a detailed justification will be available if one is required. In the latter case, the decision-makers will have learned something and avoided a costly mistake (M.Barfod, 2014).

Expert Choice provides for the synthesis of different peoples' judgments. Expert Choice is also useful for forecasting, assessing risk and uncertainty, and deriving probability distributions (M.Barfod, 2014).

3.5.1 Model Functions

Figure 3.2 shows the 'Model View' window consisting of three panes that contains a completed model (M.Barfod, 2014).

Figure 3.2: Model view

(M.Barfod, 2014)

The 'Tree View' pane displays the hierarchical listing of the objectives and sub-objectives. This is where the objectives and sub-objectives are entered. Each element in the 'TreeView' is normally referred to as a 'Node'. The 'Alternatives' pane displays the active alternatives. Alternatives can be added to the model from this pane or from the 'Data Grid'. The 'Information document' pane displays information about the highlighted objective or alternative in either the 'Tree View' or 'Alternatives' pane (M.Barfod, 2014).

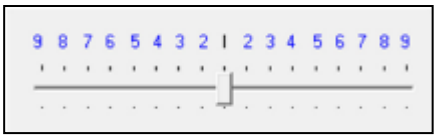
3.5.2 Pairwise Comparison

One of the major strengths of the AHP and Expert Choice is the use of pair wise comparisons to derive ratio scale priorities, as opposed to using traditional approaches of "assigning weights" which can also be difficult to justify. Once the model is built, the next step is to evaluate the elements by making pair wise comparisons. A pair wise comparison is the process of comparing the relative importance, preference, or likelihood of two elements objectives with respect to another element the goal in the level above. The user will make pair wise comparisons throughout the model to establish priorities (M.Barfod, 2014).

3.5.2.1 Numerical Judgements

The ‘Numerical Comparisons’ window is divided into two sections. Numerical judgments are made in the top pane. Two elements are compared with respect to their parent using a numerical scale. The slider bar is used to indicate which judgment is preferred and the strength of that preference. The two opposing sides of the scale represent each element being compared (M.Barfod, 2014).

Figure 3.3: Numerical scale for judgement



(M.Barfod, 2014)

The numerical equivalents of the judgments are displayed in the comparison matrix as numbers from 1 to 9. If the row element (on the left) is preferred, then the judgment is displayed in black. If the column element is preferred, then the judgment is "inverted" and displayed in red. When enough judgments have been made to calculate priorities, they will also be displayed as bar graphs that overlay the row elements (M.Barfod, 2014).

Judgments can be made any of the following ways:

- Drag the slider bar with the mouse
- Click on a number above the bar

To invert a judgment to select the other element in the comparison the ‘Invert’ button can be clicked to select the other side of the comparison scale. The judgments can also be entered directly in the comparison matrix (M.Barfod, 2014).

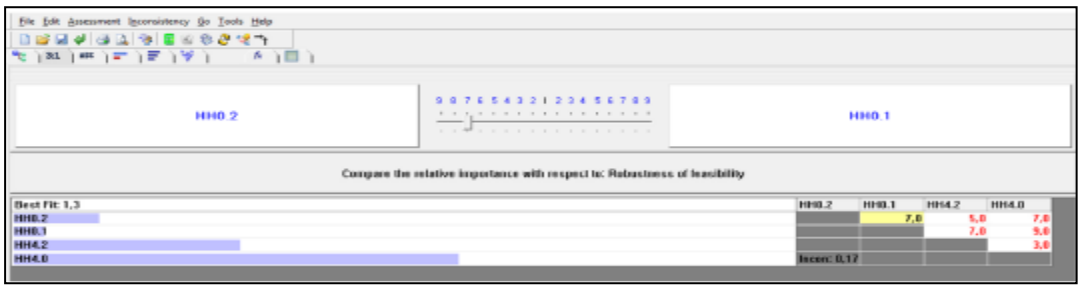
3.5.3 Inconsistency

The inconsistency measure is useful for identifying possible errors in judgments as well as actual inconsistencies in the judgments themselves; this is accessed from the priorities with respect to window. In general, the inconsistency ratio should be less than 0.1 or so to be considered reasonably consistent. The priorities with respect to window also shows how many missing judgments are in the set of elements being compared (M.Barfod, 2014).

After the judgments have been entered, it is possible to request suggestions for reducing the inconsistency. This can be done from any comparison mode (M.Barfod, 2014).

- Select 'Inconsistency, 1st' from the menu to identify the most inconsistent judgment.
- Select Inconsistency, Best Fit.

Figure 3.4: Inconsistency check



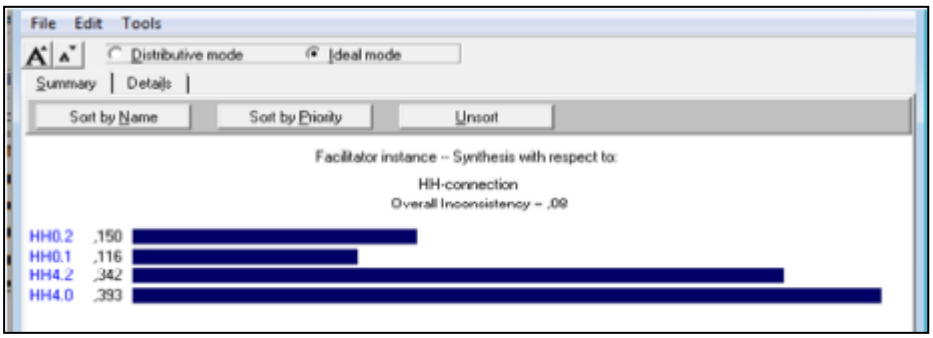
(M.Barfod, 2014)

Figure 3.4 shows the 'Best Fit', where the judgment between HH0.2 and HH0.1 should be 'Equal' as indicated by the 'Best Fit' indicator of 1,3 located above the matrix. Note that a judgment of very strong (7) has been entered. It is also possible to identify the 2nd, 3rd,…, and 9th inconsistency in the matrix and find the 'Best Fit' (M.Barfod, 2014).

3.5.4 Obtaining The Results

A synthesis can be done for either the entire model or a portion of the model. From the 'Model View', the 'Synthesize, With Respect to Goal' is selected. The synthesis window will then appear, showing the results (see Figure 3.5). Note the 'Ideal' and 'Distributive' buttons (M.Barfod, 2014).

Figure 3.5: The results view



(M.Barfod, 2014)

The 'Ideal synthesis mode' assigns the full weight of each covering objective to the best (highest priority) alternative for each covering objective. The other alternatives receive weights under each covering objective proportionate to their priority relative to the best alternative under each covering objective (M.Barfod, 2014).

The weights or priorities for all the alternatives are then normalised so they sum to 1. When using the ideal synthesis mode, the addition or removal of alternatives that are not best on any covering objective will not impact the relative priorities ranks of other alternatives. The ideal mode should be used when selecting one alternative from many and when the priorities of the alternatives not selected are not of interest (M.Barfod, 2014).

The 'Distributive mode' distributes the weight of each covering objective to the alternatives in direct proportion to the alternative priorities under each covering objective. When using the distributive synthesis mode, the addition or removal of an alternative results in a re-adjustment of the priorities of the other alternatives such that their ratios and ranks can change (M.Barfod, 2014).

The distributive mode should be used when measuring under conditions of scarcity – for example when forecasting outcomes whose probabilities must add to 1, or when looking at elections where votes cast for one candidate may alter the rank of another candidate. Because each synthesis mode combines priorities differently, it can be noticed that each mode may yield different, although normally very similar (M.Barfod, 2014).

3.6 Sensitivity Analyses Of Graphs

Sensitivity analyses from the 'Goal' node will show the sensitivity of the alternatives with respect to all the objectives below the goal. It can also be performed from the nodes under the goal if the model has more than three levels to show the sensitivity of the alternatives with respect to an objective or subobjective. When performing a sensitivity analysis it is possible to vary the priorities of the objectives and observe how the priorities of the alternatives would change. There are five types of sensitivity analysis embedded within Expert Choice (M.Barfod, 2014).

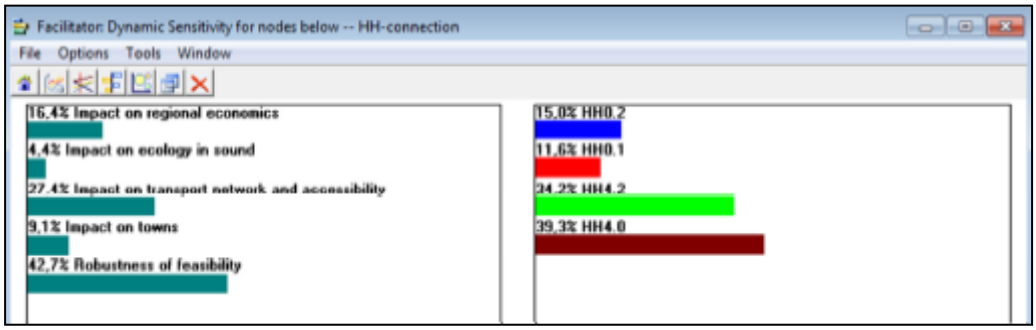
- Dynamic
- Performance
- Gradient
- Head to head
- Two-dimensional (2D plot)

The different types of sensitivity analyses can be opened at once or each one separately. Each graph has its own unique menu commands and each sensitivity analysis can be compared to a "what-if" analysis because the results are temporary (M.Barfod, 2014).

3.6.1 Dynamic Sensitivity

'Dynamic Sensitivity' analysis is used to dynamically change the priorities of the objectives to determine how these changes affect the priorities of the alternative choices. By dragging the objective's priorities back and forth in the left column, the priorities of the alternatives will change in the right column. If a decision-maker thinks an objective might be more or less important than originally indicated, the decision-maker can drag that objective's bar to the right or left to increase or decrease the objective's priority and see the impact on the alternatives. Figure 3.6 shows a Dynamic sensitivity graph (M.Barfod, 2014).

Figure 3.6: Dynamic sensitivity graph

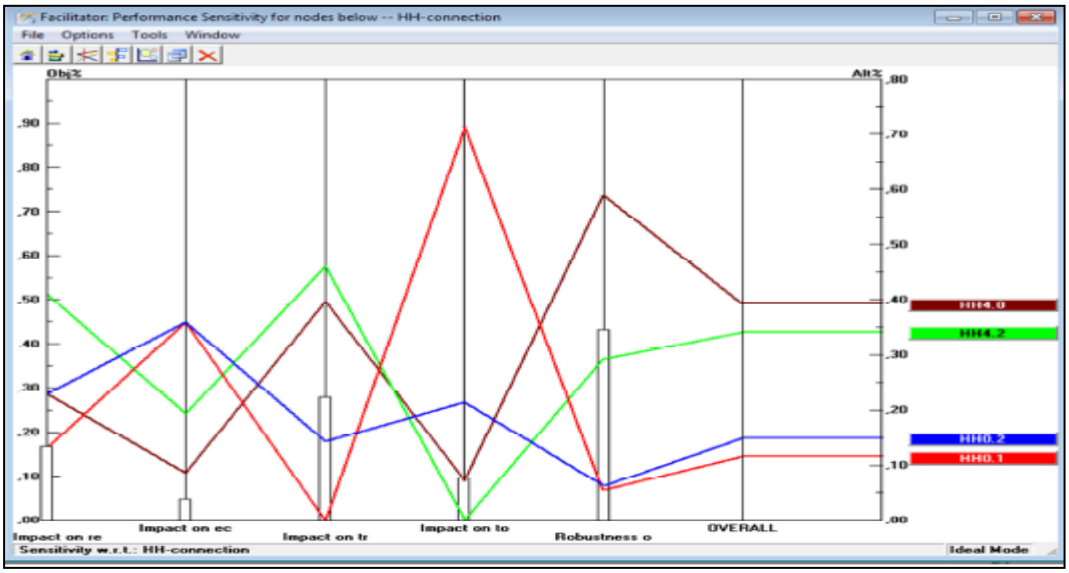


(M.Barfod, 2014)

3.6.2 Performance Sensitivity

The 'performance sensitivity' analysis, displayed in Figure 3.7, shows how the alternatives were prioritised relative to other alternatives with respect to each objective as well as overall (M.Barfod, 2014).

Figure 3.7: Performance sensitivity graph



(M.Barfod, 2014)

To see how the best alternative performs compared to the second, third and fourth alternatives, read the overall priority from the intersection of the right y-axis and the overall priority for each alternative (M.Barfod, 2014).

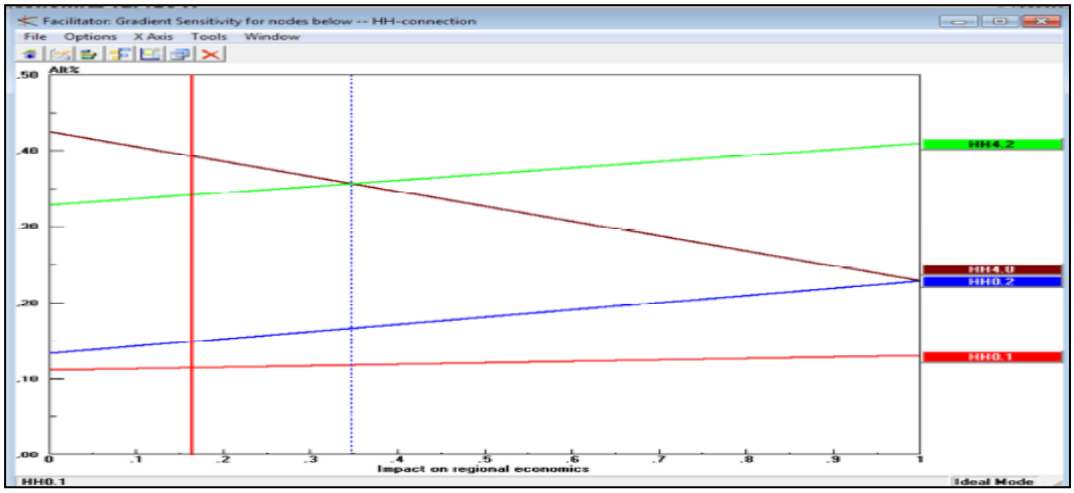
In the case example, HH4.0 is approximately 0.39, HH4.2 is approximately 0.34 and so on. Note that the priorities for the alternatives sum to one. To read each objective's priority (based on the decision-makers' pair wise comparisons), the left y-axis should be used. For example 'Robustness' is about 0.43 while 'Impact on towns' is about 0.09 and so on (M.Barfod, 2014).

To read the alternative priorities with respect to each objective, read from the right y-axis. In the case example, using 'Robustness', HH4.0 has a priority of approximately 0.59, while HH4.2 is about 0.30 and so on. The graph is also dynamic, so the relationship between the alternatives and their objectives can temporally be altered by dragging any one of the objective bars up or down (M.Barfod, 2014).

3.6.3 Gradient Sensitivity

The ‘gradient sensitivity’ graph shows the alternatives' priorities with respect to one objective at a time. By choosing the menu command ‘X Axis’, the user has the ability to select which objective appears on the x-axis. The red vertical line indicates the objective's priority (based on the decision-maker’s pair wise comparisons). To indicate where an objective's priority changes the red bar can be dragged to either the left or right. This is shown as a blue dashed vertical line (M.Barfod, 2014).

Figure 3.8: Gradient sensitivity graph



(M.Barfod, 2014)

In Figure 3.8 it can be seen that increasing the priority of ‘Impact on regional economics’ from 0.17 to 0.35 changes the choice of the alternative with respect to ‘Impact on regional economics’. When viewing a gradient graph the user should look for cross-over points of the alternatives (M.Barfod, 2014).

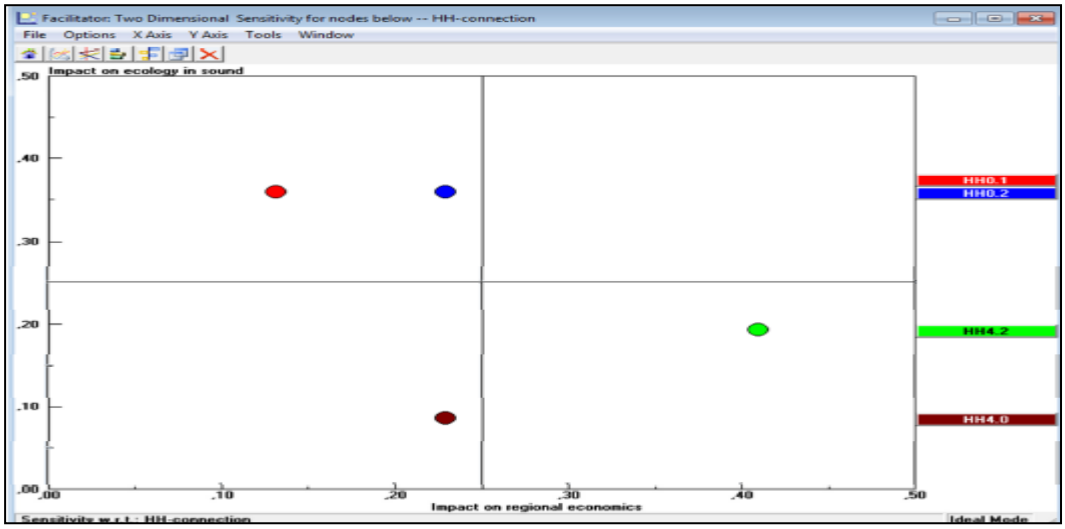
3.6.4 Two-Dimensional Sensitivity

The graph in Figure 3.9 shows the alternatives' priorities with respect to two objectives at a time. By clicking the menu commands "X Axis" and "Y Axis" you have the ability to change the objectives being displayed (M.Barfod, 2014).

The area of the 2D plot is divided into quadrants. The most favorable alternatives with respect to the objectives on the two axes will be shown in the upper right quadrant (the closer to the upper right corner, the better the alternative). The least favorable alternatives will be shown in the lower left quadrant (the closer to the lower left corner, the less favorable the alternative) (M.Barfod, 2014).

Alternatives located in the upper left and lower right quadrants indicate key tradeoffs where there is conflict between the two selected objectives (M.Barfod, 2014).

Figure 3.9: Two-dimensional graph



(M.Barfod, 2014)

3.7 Questionnaire Review

Questionnaire survey is one of the most popular and simplest methods in order to achieve the objectives of this study. Questionnaire is defines 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 objective and aim of the study. The design decisions depend on the purposes of the study, the nature of the problem, and the alternatives appropriate for its investigation (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 center research objective (King et al., 1994).Three fundamental considered before design the question:

- What is the purpose of the survey?
- What kind of question the survey developed to answer?
- What sorts of results consider from the questionnaires?

3.7.1 Section A: General Information of The Respondent

Section A is to obtain the information on the background of the respondents. The questionnaire includes the following:

- The name of the respondent's company.
- The position of the respondent in construction industry.
- The experiences of the respondent in construction industry.
- The organization of the respondent.

3.7.2 Section B: To Identify The Criteria And The Suitability Method By Analytical Hierarchy Process (AHP) Method.

This section is to identify the criteria and the suitability method of delivery in construction industry. The respondent were asked to rank the suitability method for each grade of the contractor. The questionnaire contains of nine (9) scale for each question. The rank that will respondent tick is will be measure the suitable method for each grade of the contractor in construction industry.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter is about the analysis that develop from the questionnaire survey. It contribute the information detail, objective and questionnaire that the respondent accomplished. All the information will enter into the Expert Choice software and will be generate to know the result. Findings from the data analysis are highlights in tabulation were appropriate and are expected to help toward achieving the research objectives.

4.2 Questionnaire Analysis

In the previous in chapter 3, the questionnaire forms are divided into two sections. For the first section are questionnaire cover the general information and instructions to the respondents. In section A, the Respondent's Background and in section B, the questionnaire. The questionnaire were distributed to the respondent about 35 questionnaire paper but were received only in 30 respondents only.

4.3 Section A: Demographic Respondent Analysis

Demographic analysis will show the percentage of respondent in this study. It includes the name of the company, gender, position, experience in construction industry and organization of the company. The background of the respondents is important to ensure quality data obtained.

4.3.1 Name Of Company

Table 4.1 shows the name of the company of respondents have work in construction industry.

NAME OF COMPANY
JKR BARAT DAYA, PENANG.
FADZILL CONSTRUCTION SDN. BHD.
SYARIKAT RAZNIK CONSTRUCTION SDN. BHD.
HAZWA ENTERPRISE
RD TECHNOLOGY SDN. BHD.
HATCH CONSTRUCTION SDN. BHD.
GERBANG NUSAJAYA SDN. BHD.
FOCUSPLUS SDN. BHD.
WBC SDN. BHD.
WCT SDN. BHD.
KERJAYA PROSPEK SDN. BHD.
KARYA CITARASA SDN. BHD.

MK MUTIARA SDN.BHD.
TEKNIK PADU BINA SDN BHD
SERI VILLA SDN. BHD.
MIINT DESIGN SDN. BHD.
PROSPECTIVE HOME BUILDERS SDN. BHD.
KEJURUTERAAN INDAH MAJU SDN. BHD.
HATI NURANI SDN. BHD.
MEGAH TIMUR BINA SDN BHD
NAS ENGINEERING SDN.BHD.
CELESTA JAYA SDN. BHD.
MRF BINA SDN. BHD.
RAFA SEPAKAT SDN. BHD.
TUNAS SUBUR SDN. BHD.
PEMBINAAN TAMAN SEROJA SDN. BHD.
TOTAL = 26 of different name of the company

Table 4.1: List of the company

4.3.2 Gender Of Respondents

Gender of respondents of the survey as shown in Figure 4.1.

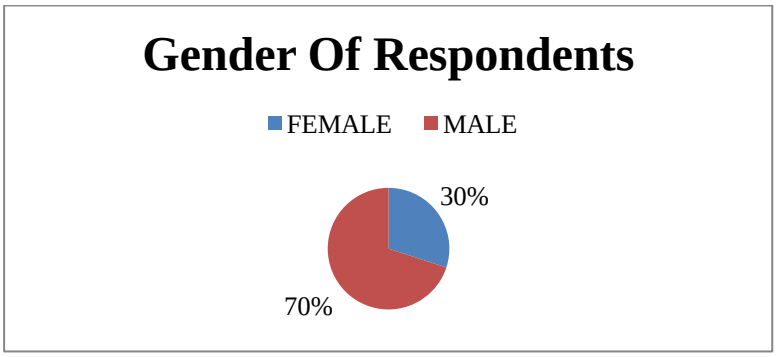


Figure 4.1: Respondents by gender

From Figure 4.1 illustrates the respondents by gender. From the total 30 responses received, 21 responses (70%) received from male and 9 responses (30%) received from female.

4.3.3 Position In Company

Position in company of the is classified to four categories as shown in Figure 4.2.

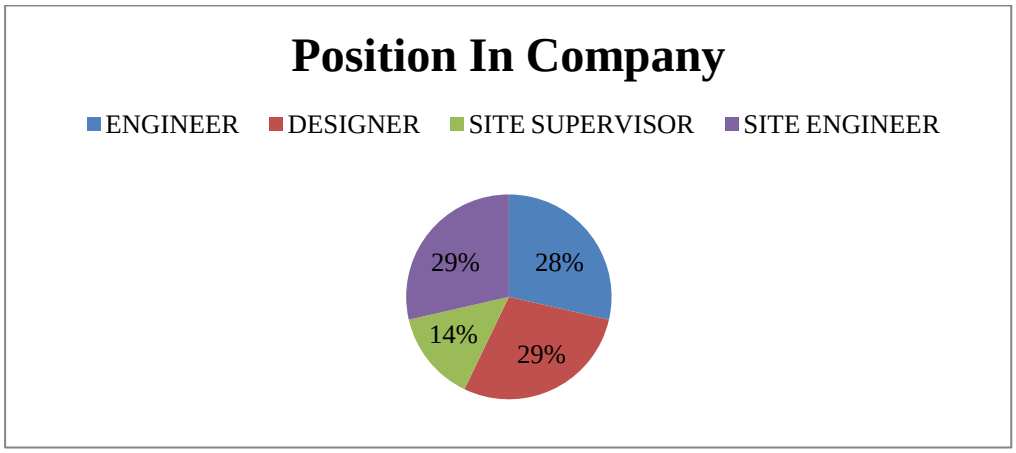


Figure 4.2: Respondents by position

From Figure 4.2 illustrates the composition of respondents by profession. From the total 30 responses received, 8 responses (29%) received from site engineer and and designer, 8 responses (28%) from engineer and 4 responses (14%) received from site engineer.

4.3.4 Respondent Experiences In Construction Industry

Respondent experiences in construction industry as shown in Figure 4.3.

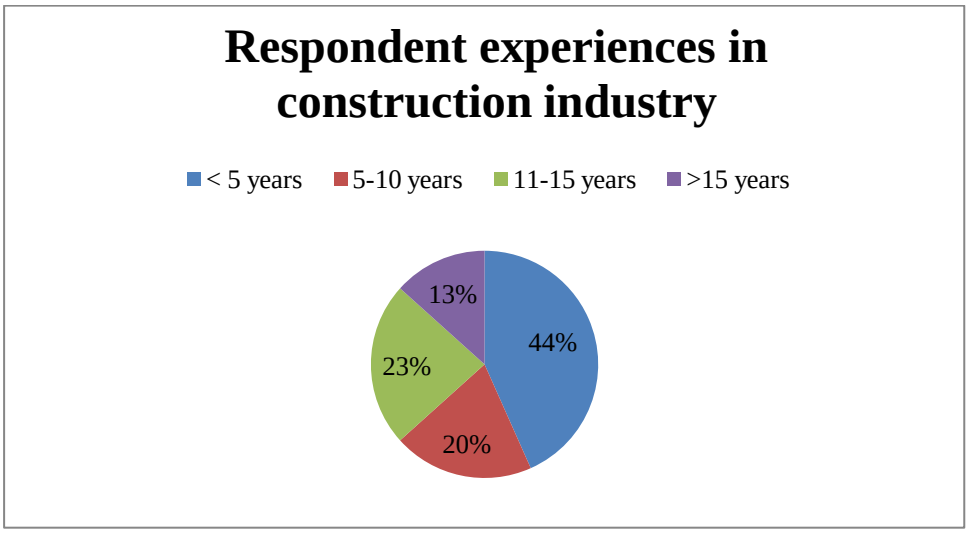


Figure 4.3: Respondent experiences in construction industry

From Figure 4.3 illustrates the respondent experiences in construction industry. From the total 30 responses received, 13 responses (44%) received from less than 5 years experiences, 6 responses (20%) received from the 5-10 years experiences, 7 responses (23%) received from the 11-15 years experiences and 4 responses (13%) received from more than 15 years.

4.3.5 Organization Of The Company

Respondent experiences in construction industry of the is classified to four categories as shown in Figure 4.4.

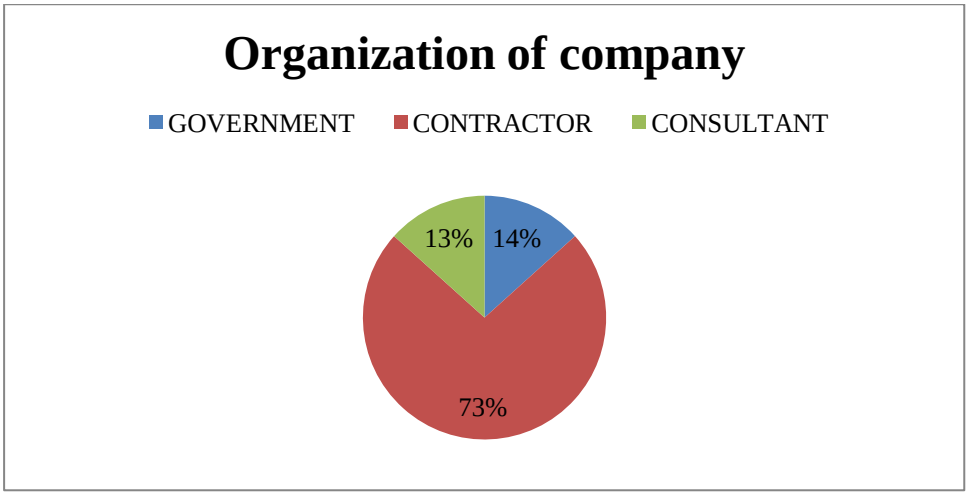


Figure 4.4: Organization of company

From Figure 4.4 illustrates the organization of the company. From the total 30 responses received, 4 responses (13%) received from the government, 4 responses (14%) received from the consultant and 22 responses (73%) from the contractor.

4.4 Section B: To Identify The Criteria And The Suitability Method By Analytical Hierarchy Process (AHP) Method.

The questionnare is analyzed by using Expert Choice software for 30 respondents. Then, 25 of respondents have been rejected because the inconsistency value is failed. Furthermore, the other 5 respondents result have been chose the lowest value of the inconsistency that will be produce more accurate result.

4.4.1 Priorities Respect To Selection Of Method In Construction Industry

As the Figure 4.5 shows the result of selection of method in construction industry that usually used in construction industry in Malaysia and according to (Saaty, 2014) the result is acceptable if the value of inconsistency is less than 0.15.

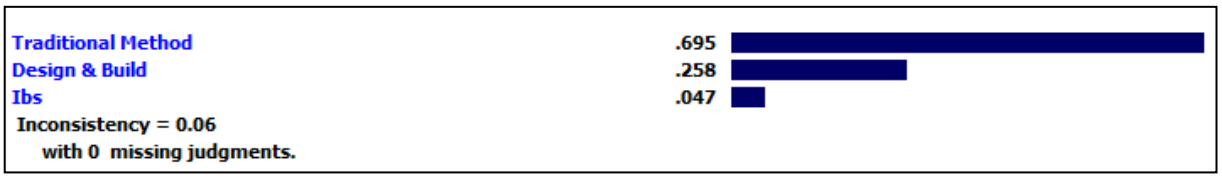


Figure 4.5: Priorities of selection of construction method

This result supports the current thinking that the contractors prefer to choose conventional building system rather than proposing IBS system since shifting of building system from conventional to IBS is not motivated by cost factors. Furthermore, most contractors have been exposed and trained in conventional building system for decades and there is an abundance of cheap foreign workers in Malaysia (S. M. Sapuan, 2008). Then, according to (Rahman & Omar, 2006), lack of knowledge and exposure to IBS technology is one of the factors that contribute to poor structural analysis and design of prefabricated components, thus its led to improper assembly due to difficulties during installation. Lack of knowledge of IBS in the industry is one of the reasons on delay of IBS take-up (Blismas & Wakefield, 2009).

4.4.2 Priorities Respect To Selection Of Method In Construction Industry For Traditional Method

As the Figure 4.6 shows the result of selection of method in construction industry for traditional method for each grade among the contractors in Malaysia and the value for inconsistency is 0.04 that is the result is acceptable.

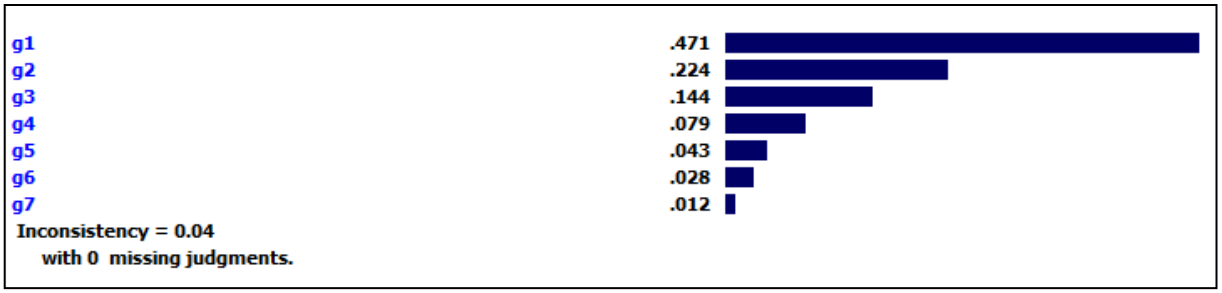


Figure 4.6: Priorities of selection in construction method for each grade of contractors in traditional method

According to (Hamid, 2010) many small contractors are reluctant to adopt IBS system and prefer to continue using the conventional method of construction. This is due to the fact that contractors are already familiar with the conventional system and for them the technology suit well with small scale projects and therefore not willing to switch to mechanised based system. Hence, small contractors lack financial backup and not able to set up their own manufacturing plants as it involves very intensive capital investment. On the other hand, the contractors need to cover the amortised cost of setting up a prefabrication yard, as well as the variable costs of manufacturing components and of their on-site assembly. Some contractors in Malaysia suffered from poor productivity and financial performance to be involved in IBS (CIDB, 2011).

4.4.3 Priorities Respect To Selection Of Method In Construction Industry For Design And Build Method

As the Figure 4.7 shows the result of selection of method in construction industry for design and build method for each grade among the contractors in Malaysia and the result is acceptable with the value for inconsistency is 0.13.

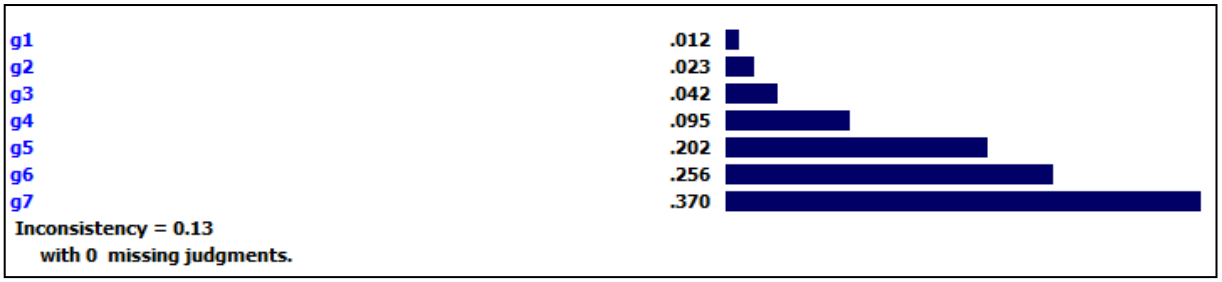


Figure 4.7: Priorities of selection in construction method for each grade of contractors in design and build method

The advent of design-build project delivery has raised concerns by some that small firms maybe unable to participate on design-build teams, particularly as the design-build team lead or prime contractor, due to the increased functional scope and scale of many design-build contracts, more stringent qualification requirements, and or higher bonding requirements. Then, early contractor involvement that enables construction engineering considerations to be incorporated into the design phase and enhances the constructability of the engineered project plans (F.Report, 2008).

4.4.4 Priorities Respect To Selection Of Method In Construction Industry For Indusrial Building System Method

As the Figure 4.8 shows the result of selection of method in construction industry for industrial building system method for each grade among the contractors in Malaysia and the result is acceptable with the value for inconsistency is 0.09.

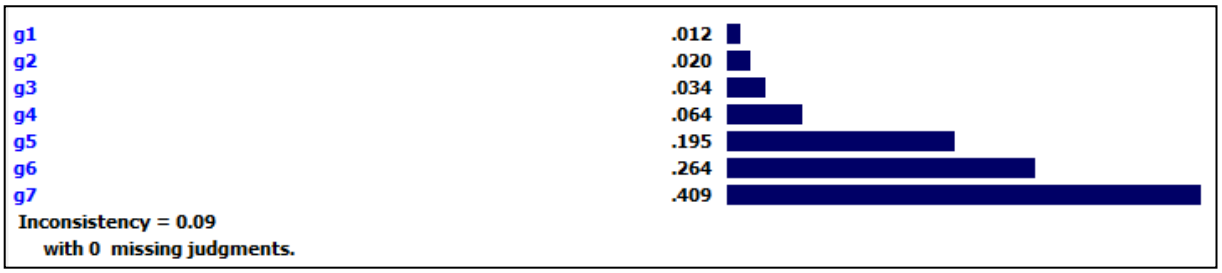


Figure 4.8: Priorities of selection in construction method for each grade of contractors in industrial building system method

According to (Hamid, 2012) the Malaysian G7 contractors, IBS offers significant savings in labour and material cost, as the number of labour force required in IBS is far lower than those required in traditional method. It is however, necessary to

emphasise that the workers still need to be imparted training and skill appropriate to IBS. It is expected such trained skilled worker in IBS would be much more quality conscious then the unskilled labour doing manual jobs in conventional construction. IBS also alleviates the issue of skills shortages in the construction industry since all the construction elements are fabricated at factory. IBS eliminate extensive use of carpentry work, bricklaying, bar bending and manual job at site.

4.4.5 Dynamic Sensitivity Graph

As the Figure 4.9 shows the impact of the alternatives is traditional method. This is because it have the highest ranking compared to D&B and IBS. IBS is the lowest attraction among the contractors in Malaysia, so according to (Hamid, 2012) cost was one probable cause of concern. It states that when there is sufficient labour supply, in-situ construction methods can be more economical. Further, in IBS projects, contractors have to pay the supplier upfront to purchase components. It is a high capital investment where 30% of the value of the project is to be paid upfront. In addition, contractors also faced problem in securing progress payment from clients, thus forcing them to delay payment to components suppliers. Delayed payment means a delay in the components' delivery, which eventually affects the productivity of the projects.

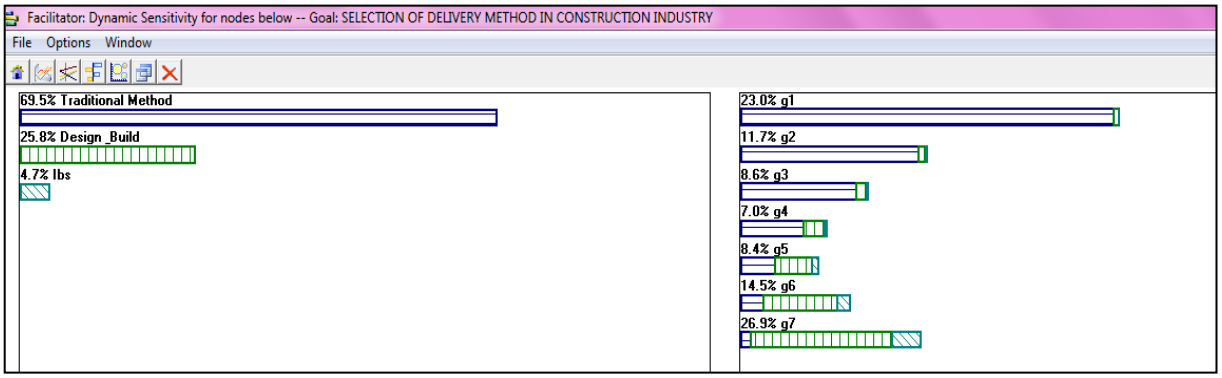


Figure 4.9: Dynamic sensitivity graph

4.4.6 Performance Sensitivity Graph For Traditional Method

As the Figure 4.10 shows the gradient on the traditional method that contractor for G1 is more suitable to use this method compared to the contractors G7. According to (Hamid, 2012) because of the contractors need to cover the amortised cost of setting up a prefabrication yard, as well as the variable costs of manufacturing components and of their on-site assembly. Some contractors in Malaysia suffered from poor productivity and financial performance to be involved in IBS.

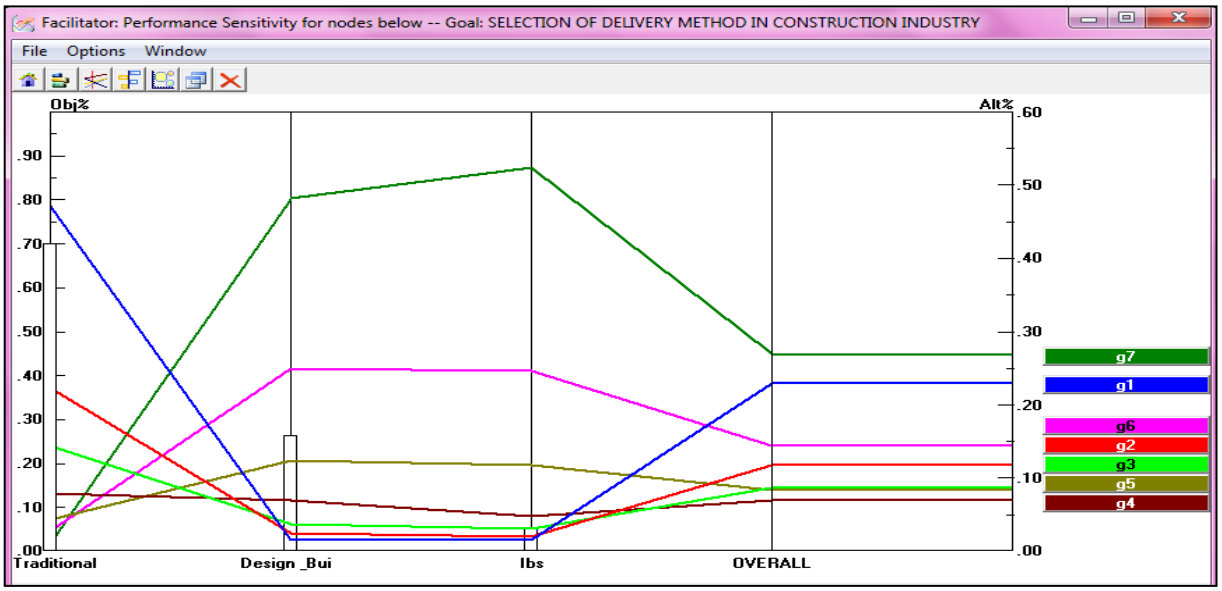


Figure 4.10: Performance sensitivity graph on traditional method

4.4.7 Gradient Sensitivity Graph For Traditional Method

As the Figure 4.11 shows the gradient on the traditional method. As we can see the result shows that contractors G7 is the highest ranking weight to use the traditional method because of the lowest bid for the contractors contract. Then, it followed by the contractors G1 that is the smallest contractor are already familiar with the traditional method in construction industry (S. M. Sapuan, 2008).

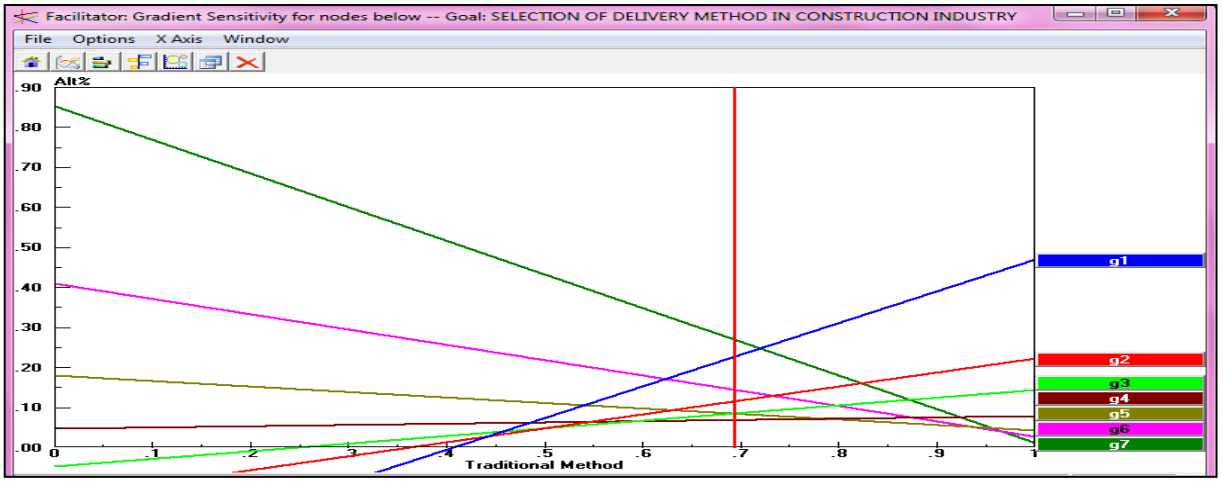


Figure 4.11: Gradient sensitivity graph on traditional method

4.4.8 Gradient Sensitivity Graph For Design And Build Method

As the Figure 4.12 shows the gradient on the design and build method. The Figure 4.12 shows that contractors G7 is the higher ranking weight that be able to use D&B method in construction industry. That is because of fast-tracking of the design and construct portions of the project, with overlapping concurrency of design and construction phases for different segments of the project and elimination of a separate construction contractor bid phase following completion of the design phase. Next, this method can reduced construction engineering and inspection (CEI) costs to the contracting agency when these quality control activities and risks are transferred to the design-builder. Moreover, fewer change and extra work orders resulting from more complete field data and earlier identification and elimination of design errors or omissions that might otherwise show up during the construction phase (F.Report, 2008).

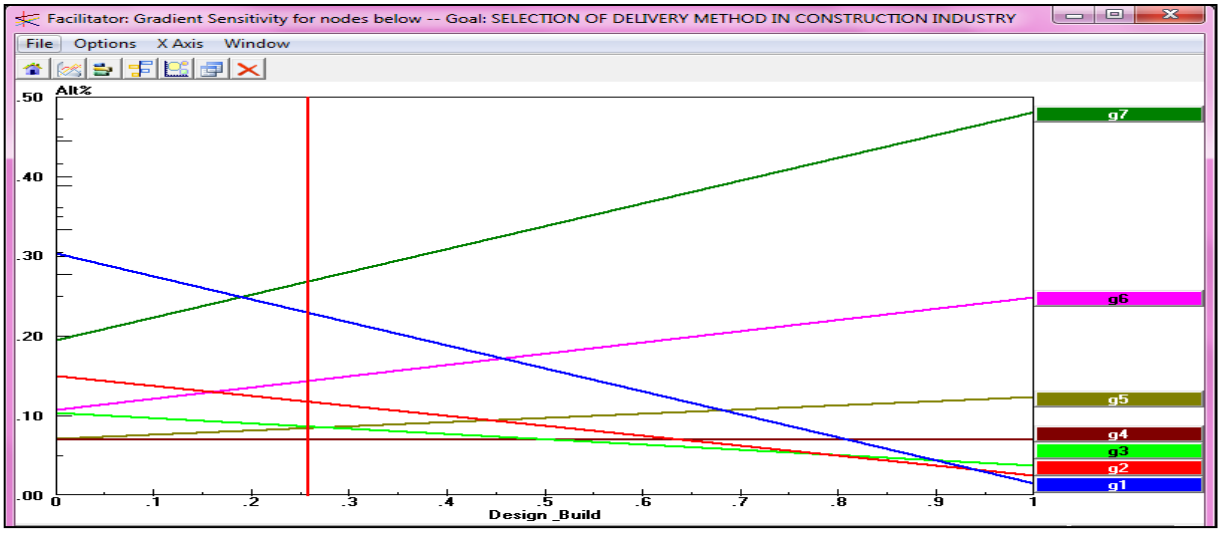


Figure 4.12: Gradient sensitivity graph on design and build method

4.4.9 Gradient Sensitivity Graph For Industrial Building System Method

As the Figure 4.13 shows the gradient on the industrial building system that the result is contractors G7 is the highest ranking of weight for IBS method compared to the contractors G1. According (Hamid, 2012) the context and scope of this research is on Malaysian contractors classified under the class G7 classification, registered under the Construction Industry Development Board Malaysia (CIDB)'s registration scheme. Being the largest in term of capital, the G7 contractors will most probably take the lead in the domestic construction industry and eventually will influence the overall constituents of the industry to change from conventional to IBS. The G7 contractors sub-contract a large amount of the contract to smaller contractors, thus creating work demand in IBS and influencing further adoptions. The G7 contractors also employ the largest group of professionals, where their perspective towards IBS is worth being measured.

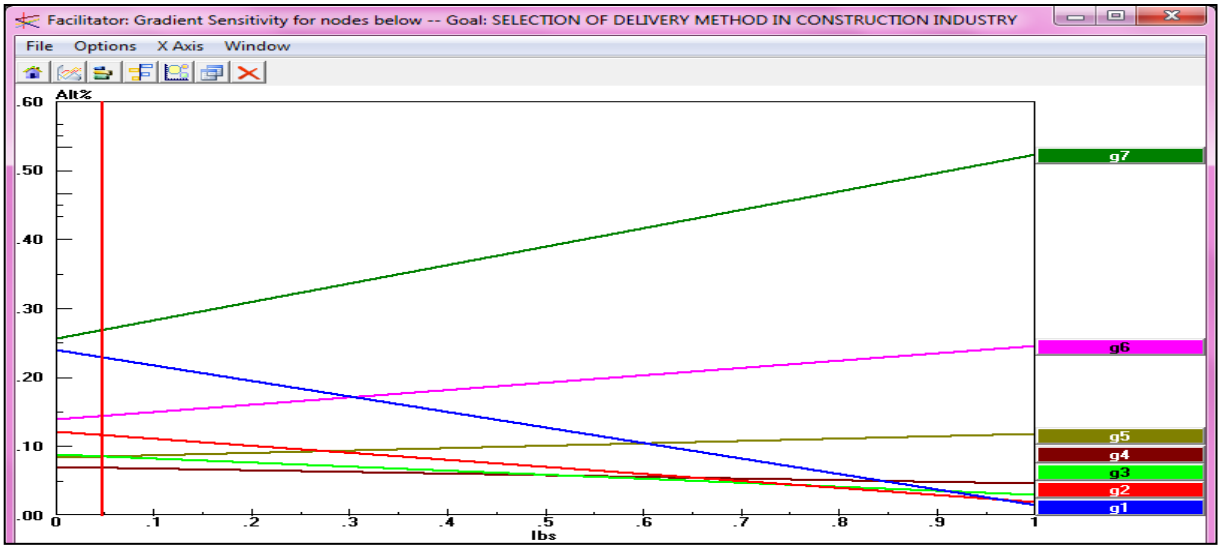


Figure 4.13: Gradient sensitivity graph on industrial building system method

4.4.10 Two-Dimensional Sensitivity Graph

As the Figure 4.14 shows the best method in construction industry that be refer by the professional player in industry is traditional method. As the Figure 4.14 shown that the traditional method is the best that because of the dot at the right top of the graph. Then, it is means that contractors G1 is the most suitable. Hence, according to (Ling, 2014) the traditional is best method because of provides more price certainty to the client at the every phase of the project. It can reduce any design and construction uncertainty which often causes the contractor to unnecessary increase the project cost. Cost of project will be more lower when use the bill of quantities to bid the tender. Besides, the contractor will be paid based on fixed price or by lump sum price of the project and work for within the time period for lump sum payment. In terms of quality, traditional procurement method also provides high level of quality and functional certainty. This is because the method gives the client opportunity to integrate the parties that have expertise for working together such as best architect and best contractor.

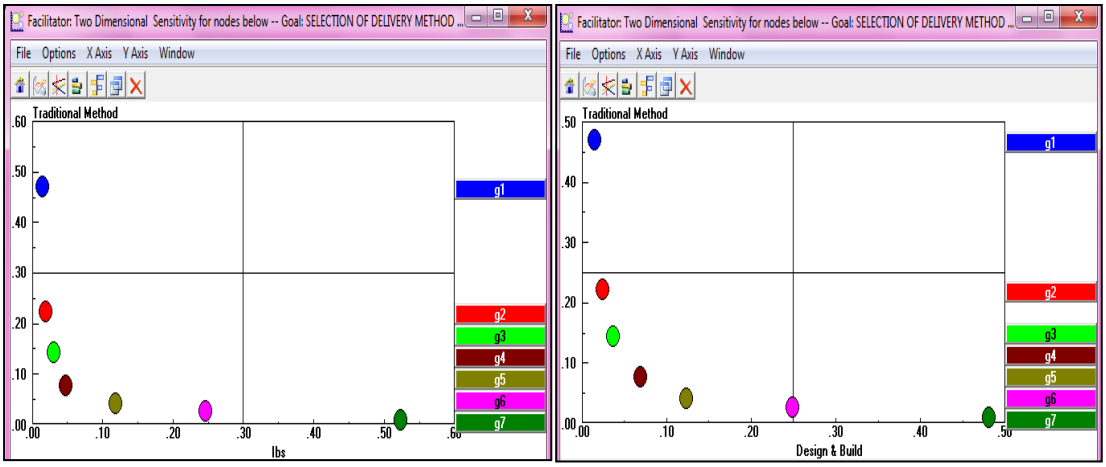


Figure 4.14: Two-D sensitivity graph

CHAPTER 5

CONCLUSION

5.1 Introduction

In this chapter is the conclusion of the result obtained and the objectives of the research have been archieved. There also will contain the recommendation for the players among the construction industry in Malaysia.

5.2 Conclusion Of The Research

Based on the overall result, the study has come out with the conclusion based on objectives that have been set up. First of all, the traditional method is most ranking for the method used in construction industry is because of the traditional procurement method is the project's client is able to have full influences toward the overall process of the project. This action can increase the quality and functionality of the project. Other than that, best quality of project is guarantee when the building contract attached with the bill of qualities and project specification. Traditional procurement method is easy to develop the project and arrange, manage and evaluate the effect of change and reduce the number of contract conflict. In addition, it having balanced allocation of risk between project's client and contractor compare to design and build method. It also known as tried procurement method because it have been tested in the long term period and is a very familiar procurement method (Ling, 2014).

On the other hand, for the design and build method cost remains the primary factor for awarding design-build contracts, even when other factors such as duration, team reputation, and quality are included in the deliberations. While low bid continues to be used as the basis for contract award decisions for many design-build projects, best-value approaches using multiple criteria including cost are gaining momentum. Best value selection provides for the consideration of both cost and other more subjective factors such project management, quality control, and team reputation and is gaining popularity among contracting agencies of design-build projects due to its ability to consider all relevant factors that affect the desirability of a design-build proposal (F.Report, 2008).

Lastly, for the industrial building system is the government should launch a forum on a regular basis of academics and associated practitioners active in IBS for exchange of information and experience, development of new techniques and advice on promotion and implementation of IBS. An online portal was also suggested to disseminate international trends, products and processes associated with the IBS. It is also important to study in detail the business process involved in the application of IBS in construction and the financial aspect, as in the loan and payback system that can be implemented in the current banking system and to study the most appropriate safety net that can be instituted to motivate the contractors to be more innovative in IBS and involved in high technology such as robotics and modular building. This knowledge on this will accelerate IBS uptake in Malaysia among contractors (Hamid, 2012).

5.3 Recommendation For The Research

The recommendation of this research are the contractors might consider creating cluster or a consortium of integrated team by creating a partnership when and where it is needed. The positive integration of supply chain has become a major factor in delivering successful construction projects. The integrated team brings together a series of different organisations consisting of IBS key players (client, designer contractor, and specialist/manufacturer), which is linked by a flow of practices, information, financial, and contractual relationships. Then, IBS association need to create "one voice" for the industry should be established among the contractors hence better defines and communicates their needs.

Public demands for accountability regarding project schedule and quality can be more readily met through the terms and conditions inherent in a design-build contract, where qualified design-builders take on more project risk associated with meeting the contract schedule and performance criteria because of their ability to apply innovative techniques that lower the costs of project delivery while achieving desired performance results. This is to allow them to work together toward design and construction practices within the context of the project procurement delivery arrangement approach with the same common goals and objectives. This approach will help to create a new environment within which IBS can flourish in a much shorter time and create more integrated and capable supply chain (S. M. Sapuan, 2008).

5.4 Recommendation For Further Research

- Increase the number of respondent and questionnaire for the site study in order to obtain more accurate and precise data.
- Identify the method in construction industry that usually used in construction industry among the contractors in Malaysia.

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APPENDIX A
SAMPLE APPENDIX 1

Questionnaire Survey Form

TITLE: SELECTION OF METHOD IN CONSTRUCTION INDUSTRY BY USING AHP METHOD

I am Nur Syafikah Nasrudin, final year student from Faculty of Civil Engineering and Earth Resources. I am conducting this survey for "Selection of Method In Construction Industry" by using AHP method for my research thesis for Final Year Project at Universiti Malaysia Pahang. AHP method is a decision making that derive a ratio scale from paired comparison.

Choose only one(1) answer for every questions. I will appreciate if u could complete the following table. Any information given is confidential and will used as an academic purpose only.

SECTION A: DEMOGRAPHIC RESPONDENT

NAME OF COMPANY

_____

POSITION

_____

GENDER

- MALE
- FEMALE

EXPERIENCE IN CONSTRUCTION INDUSTRY

- < 5 years
- 5-10 years
- 11-15 years
- >15 years

COMPANY ORGANIZATION

- GOVERNMENT
- CONSULTANT
- CONTRACTOR
- DEVELOPER
- CLIENT

SECTION B: TO IDENTIFY THE CRITERIA AND THE SUITABILITY METHOD BY ANALYTICAL HIERARCHY PROCESS (AHP) METHOD

CONTRACTOR G1 (< RM 200,000)

1. How much important do you think Traditional method is than Design and Build (D&B) method in selection of delivery method in construction and suitable for G1?

    - o 9 Extremely preferred
    - o 7 Very strongly preferred
    - o 5 Strongly preferred
    - o 3 Moderately preferred
    - o 1 Equally preferred
    - o 3 Moderately preferred
    - o 5 Strongly preferred
    - o 7 Very strongly preferred
    - o 9 Extremely preferred

2. How much more important do you think Traditional method is than Industrial Building System (IBS) method in selection of delivery method in construction and suitable for G1?

    - o 9 Extremely preferred
    - o 7 Very strongly preferred
    - o 5 Strongly preferred
    - o 3 Moderately preferred
    - o 1 Equally preferred
    - o 3 Moderately preferred
    - o 5 Strongly preferred
    - o 7 Very strongly preferred
    - o 9 Extremely preferred

3. How much more important do you think Design and Build (D&B) method is than Industrial Building System (IBS) method in selection of delivery method in construction and suitable for G1?

- o 9 Extremely preferred
- o 7 Very strongly preferred
- o 5 Strongly preferred
- o 3 Moderately preferred
- o 1 Equally preferred
- o 3 Moderately preferred
- o 5 Strongly preferred
- o 7 Very strongly preferred
- o 9 Extremely preferred

CONTRACTOR G2 (< RM 500,000)

1. How much important do you think Traditional method is than Design and Build (D&B) method in selection of delivery method in construction and suitable for G2?

- o 9 Extremely preferred
- o 7 Very strongly preferred
- o 5 Strongly preferred
- o 3 Moderately preferred
- o 1 Equally preferred
- o 3 Moderately preferred
- o 5 Strongly preferred
- o 7 Very strongly preferred
- o 9 Extremely preferred

2. How much more important do you think Traditional method is than Industrial Building System (IBS) method in selection of delivery method in construction and suitable for G2?

- o 9 Extremely preferred
- o 7 Very strongly preferred
- o 5 Strongly preferred
- o 3 Moderately preferred
- o 1 Equally preferred
- o 3 Moderately preferred
- o 5 Strongly preferred
- o 7 Very strongly preferred
- o 9 Extremely preferred

3. How much more important do you think Design and Build (D&B) method is than Industrial Building System (IBS) method in selection of delivery method in construction and suitable for G2?

- o 9 Extremely preferred
- o 7 Very strongly preferred
- o 5 Strongly preferred
- o 3 Moderately preferred
- o 1 Equally preferred
- o 3 Moderately preferred
- o 5 Strongly preferred
- o 7 Very strongly preferred
- o 9 Extremely preferred

CONTRACTOR G3 (< RM 1,000,000)

1. How much important do you think Traditional method is than Design and Build (D&B) method in selection of delivery method in construction and suitable for G3?

    - o 9 Extremely preferred
    - o 7 Very strongly preferred
    - o 5 Strongly preferred
    - o 3 Moderately preferred
    - o 1 Equally preferred
    - o 3 Moderately preferred
    - o 5 Strongly preferred
    - o 7 Very strongly preferred
    - o 9 Extremely preferred

2. How much more important do you think Traditional method is than Industrial Building System (IBS) method in selection of delivery method in construction and suitable for G3?

    - o 9 Extremely preferred
    - o 7 Very strongly preferred
    - o 5 Strongly preferred
    - o 3 Moderately preferred
    - o 1 Equally preferred
    - o 3 Moderately preferred
    - o 5 Strongly preferred
    - o 7 Very strongly preferred
    - o 9 Extremely preferred

3. How much more important do you think Design and Build (D&B) method is than Industrial Building System (IBS) method in selection of delivery method in construction and suitable for G3?

- 9 Extremely preferred
- 7 Very strongly preferred
- 5 Strongly preferred
- 3 Moderately preferred
- 1 Equally preferred
- 3 Moderately preferred
- 5 Strongly preferred
- 7 Very strongly preferred
- 9 Extremely preferred

CONTRACTOR G4 (< RM 3,000,000)

1. How much important do you think Traditional method is than Design and Build (D&B) method in selection of delivery method in construction and suitable for G4?

- 9 Extremely preferred
- 7 Very strongly preferred
- 5 Strongly preferred
- 3 Moderately preferred
- 1 Equally preferred
- 3 Moderately preferred
- 5 Strongly preferred
- 7 Very strongly preferred
- 9 Extremely preferred

2. How much more important do you think Traditional method is than Industrial Building System (IBS) method in selection of delivery method in construction and suitable for G4?

- 9 Extremely preferred
- 7 Very strongly preferred
- 5 Strongly preferred
- 3 Moderately preferred
- 1 Equally preferred
- 3 Moderately preferred
- 5 Strongly preferred
- 7 Very strongly preferred
- 9 Extremely preferred

3. How much more important do you think Design and Build (D&B) method is than Industrial Building System (IBS) method in selection of delivery method in construction and suitable for G4?

- 9 Extremely preferred
- 7 Very strongly preferred
- 5 Strongly preferred
- 3 Moderately preferred
- 1 Equally preferred
- 3 Moderately preferred
- 5 Strongly preferred
- 7 Very strongly preferred
- 9 Extremely preferred

CONTRACTOR G5 (< RM5,000,000)

1. How much important do you think Traditional method is than Design and Build (D&B) method in selection of delivery method in construction and suitable for G5?

    - o 9 Extremely preferred
    - o 7 Very strongly preferred
    - o 5 Strongly preferred
    - o 3 Moderately preferred
    - o 1 Equally preferred
    - o 3 Moderately preferred
    - o 5 Strongly preferred
    - o 7 Very strongly preferred
    - o 9 Extremely preferred

2. How much more important do you think Traditional method is than Industrial Building System (IBS) method in selection of delivery method in construction and suitable for G5?

    - o 9 Extremely preferred
    - o 7 Very strongly preferred
    - o 5 Strongly preferred
    - o 3 Moderately preferred
    - o 1 Equally preferred
    - o 3 Moderately preferred
    - o 5 Strongly preferred
    - o 7 Very strongly preferred
    - o 9 Extremely preferred

3. How much more important do you think Design and Build (D&B) method is than Industrial Building System (IBS) method in selection of delivery method in construction and suitable for G5?

- 9 Extremely preferred
- 7 Very strongly preferred
- 5 Strongly preferred
- 3 Moderately preferred
- 1 Equally preferred
- 3 Moderately preferred
- 5 Strongly preferred
- 7 Very strongly preferred
- 9 Extremely preferred

CONTRACTOR G6 (< RM 10,000,000)

1. How much important do you think Traditional method is than Design and Build (D&B) method in selection of delivery method in construction and suitable for G6?

- 9 Extremely preferred
- 7 Very strongly preferred
- 5 Strongly preferred
- 3 Moderately preferred
- 1 Equally preferred
- 3 Moderately preferred
- 5 Strongly preferred
- 7 Very strongly preferred
- 9 Extremely preferred

2. How much more important do you think Traditional method is than Industrial Building System (IBS) method in selection of delivery method in construction and suitable for G6?

- 9 Extremely preferred
- 7 Very strongly preferred
- 5 Strongly preferred
- 3 Moderately preferred
- 1 Equally preferred
- 3 Moderately preferred
- 5 Strongly preferred
- 7 Very strongly preferred
- 9 Extremely preferred

3. How much more important do you think Design and Build (D&B) method is than Industrial Building System (IBS) method in selection of delivery method in construction and suitable for G6?

- 9 Extremely preferred
- 7 Very strongly preferred
- 5 Strongly preferred
- 3 Moderately preferred
- 1 Equally preferred
- 3 Moderately preferred
- 5 Strongly preferred
- 7 Very strongly preferred
- 9 Extremely preferred

CONTRACTOR G7 (> RM 10,000,000)

1. How much important do you think Traditional method is than Design and Build (D&B) method in selection of delivery method in construction and suitable for G7?

    - o 9 Extremely preferred
    - o 7 Very strongly preferred
    - o 5 Strongly preferred
    - o 3 Moderately preferred
    - o 1 Equally preferred
    - o 3 Moderately preferred
    - o 5 Strongly preferred
    - o 7 Very strongly preferred
    - o 9 Extremely preferred

2. How much more important do you think Traditional method is than Industrial Building System (IBS) method in selection of delivery method in construction and suitable for G7?

    - o 9 Extremely preferred
    - o 7 Very strongly preferred
    - o 5 Strongly preferred
    - o 3 Moderately preferred
    - o 1 Equally preferred
    - o 3 Moderately preferred
    - o 5 Strongly preferred
    - o 7 Very strongly preferred
    - o 9 Extremely preferred

3. How much more important do you think Design and Build (D&B) method is than Industrial Building System (IBS) method in selection of delivery method in construction and suitable for G7?

- 9 Extremely preferred
- 7 Very strongly preferred
- 5 Strongly preferred
- 3 Moderately preferred
- 1 Equally preferred
- 3 Moderately preferred
- 5 Strongly preferred
- 7 Very strongly preferred
- 9 Extremely preferred