A STUDY OF STEEL STRUCTURE DESIGN & BUILD SYSTEM IN CONSTRUCTION INDUSTRY

LEE KOK SHENG

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

Faculty of Engineering and Science
Universiti Tunku Abdul Rahman

JAN 2015

DECLARATION

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

Signature : _____

Name : LEE KOK SHENG

ID No. : 13UEM06793

Date : 5 May 2015

APPROVAL FOR SUBMISSION

I certify that this project report entitled **"A STUDY OF STEEL STRUCTURE DESIGN & BUILD SYSTEM IN CONSTRUCTION INDUSTRY"** was prepared by **LEE KOK SHENG** has met the required standard for submission in partial fulfilment of the requirements for the award of Master of Project management at Universiti Tunku Abdul Rahman.

Approved by,

Signature : _____

Supervisor : Dr Lee Wah Peng

Date : 5 May 2015

Specially dedicated to

my beloved family, supervisor, friends, contractors, architects, clients, consultants and friends to make this research a success.

ACKNOWLEDGEMENTS

At the outset, I would like to thank everyone who had contributed to the successful completion of this project. I would like to express my gratitude to my research supervisor, Dr Lee Wah Peng for his invaluable advice, guidance and his enormous patience throughout the development of the research. Without his help and guidance, this research will probably end up with a wrong direction.

In addition, I would also like to express my gratitude to my company management and clients who had helped and given me support to complete this final year project within the time line.

Lastly, I would like to thanks all the respondents who participated in this research by spending their valuable time and effort to complete the questionnaire. This research will never complete without their involvement and valuable opinion.

ABSTRACT

A STUDY OF STEEL STRUCTURE DESIGN & BUILD SYSTEM IN CONSTRUCTION INDUSTRY

Lee Kok Sheng

Steel structure is the most popular building framing system applied to the industrial building such as manufacturing plant, warehouse, factory, power plant and aircraft hangar due to its speed of construction and ease of design. Therefore, several steel structure fabricators are appear in the construction industry as a design builders that provide one stop solution services from design, fabricate and installation service to expedite the project delivery lead time. Design & build system is one of the efficient procurement systems introduced to address the problems associated with the conventional design-bid build system and its innovative practices have been developed to cope with the rapid growth in the construction industry.

The aim of this paper is to investigate the important level of the key selection criteria in steel structure design and build contract on different type of the profession in the construction industry and compare to the conventional design bid build system. The expectation of the research result will be the key selection criteria on steel structure design and build contract selected by different type of profession on the needs that are relevant and value to them. Beside, this paper also presented the challenges in implementing steel structure design and build contract in construction industry and strategies to overcome the challenges in order to increase the usage of design and build system in result to be more adaptable into the current steel structure construction market. At the end of this study, the design builders knows the needs from different profession on the steel design and build system and align their strategy to meet client expectation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS / ABBREVIATIONS

JKR	Jabatan Kerja Raya
PAM	Pertubuhan Arkitek Malaysia
IEM	Institute Engineer Malaysia
σ	Standard deviation

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

In the current trend of construction procurement methodologies, design and build procurement systems have gained the attention of the industry as a whole. Design and build contract can be apply to the entire project or separate into few packages in order to achieve the optimum result during project execution. Steel structure package are the most famous package that project owner will decide to go for design and build system as it can bring several benefit to it. Generally steel structure package under design and build contract will be in a lump sum basis which include other item such as metal roofing, roof insulation, rain water goods and any other accessories that attached to the steel structure. Besides, steel structure is the most popular building framing system applied to the industrial building such as manufacturing plant, warehouse, factory, power plant and aircraft hangar due to its speed of construction and ease of design. Therefore, several steel structure fabricators are appear in the construction industry as a design builders that provide one stop solution services from design, fabricate and installation service to expedite the project delivery lead time. The most favorable reason that project owner chosen steel structure package to be under design and build contract is design builders can provide schedule adherence as well as take full responsibility for all the coordination work from head to toe of the project stage. Thus, design & build system is proof to

be an efficient procurement systems introduced to address the problems associated with the conventional design-bid build system and its innovative practices have been developed to cope with the rapid growth in the construction industry.

Under the steel structure design and build packages, project owner in selecting a capable and reliable design builders is critical to the success of the projects. Thus, a set of selection criteria to pre-qualify the design builders and reflect clients' needs is important in the early stage of the project. In the design & build field, although various researchers and organization have identified many selection criteria for design-builders, few have make an analysis to weighting selection criteria for steel structure design and build contract in questionnaire survey and make a comparison to the conventional design bid build system on different types of profession in the construction industry (Palaneeswaran & Kumaraswamy, 2005). Besides, design and build system also encounter several challenges during implementing this innovative procurement method in the steel structure construction packages. At the end of this paper, a set of strategies are develop to overcome the challenges to increase the usage of design and build system so that it will be more adaptable in to the current steel structure construction market. This study will also be a reference to the steel structure design builders to align client expectation during tender stage and project execution.

1.2 Problem Statement

The construction industry faces critical challenges due to the economy crisis that happen recently. As a whole, the industries are not performing well and suffer from the low profit margin, persistent project overruns in schedule and budget. A survey from UK construction industry showed that profit margin on construction work is 1-2 % (Yeo & Ning, 2000). Construction industry performance can be improved by use of an appropriate project delivery method. Design & build method is consider one of the appropriate method to improve the overall cost and time compare to the conventional method (Konchar & Sanvido 1998). There are various criteria which must be taken into consideration in the steel structure design & build delivery system. Such as price, experience, design software, delivery time, past performance, financial capability, responsiveness to the RFP, and quality control system.

In the current steel structure design & build market, there are several selection criteria for the design-builder to meet and in order to fulfilled client from different type of profession in the construction industry. Criteria selected by the client needs to be identified for the potential success of future projects. It’s important for both client and design-builder to keep accurate historical records of past projects, and use that information and attempt to repeat success on future projects. This research explores the criteria that pre-selected in the questionnaire survey to 5 type of profession to investigate the important level of these criteria to the client.

The five type of the profession that selected in this research is architect, consultant engineer, contractor, quantity surveyor and owner or developer. The steel structure design & build contract will be award by these group of profession if the design-builders meet the requirement that they need.

1.3 Aim

The aim of this paper is to identify the challenges in implementing steel structure design and build system in construction industry and overcome the challenges' by developing the strategy to increase usage of design and build system.

In order to know better on key criteria to select the steel structure design builders, this study is aim to investigate how different type of profession in construction industry looking at the selection criteria for the steel structure design and build system and compare it with the current design bid build system. Throughout the analysis on the selection criteria behavior on each profession, design-builder will be more confident to align project owner needs and deliver the design and build project in an effective way.

1.4 Objectives

The objectives of the research are:

i) To investigate the important level of the selection criteria for steel structure design & build system through a quantitative questionnaire survey research method to different type of profession in the construction industry and compare with the conventional design bid build system.

ii) To identify the challenges in implementing steel structure design and build system in the current construction industry.

iii) To develop a strategy to increase the usage of the steel structure design and build system package in the current construction industry

1.5 Scope and Limitation

This research focuses on analysis of the key selection criteria for the steel structure design & builds system in the construction industry through questionnaire survey that cover different type of profession in the field. There are architects, consultant engineer, contractor, quantity surveyor and owners or developers. This research are focusing on the steel structure design & build package instead of the whole project including others packages such as earthwork, reinforcement concrete work and the

mechanical and electrical work for the building. In this study, 10 selection criteria have been pre-selected in the questionnaire survey to different type of profession. There are company financial backgrounds, price offer, in-house design team (Technical knowledge), quality control system, experience in the industries, contract terms & conditions, delivery schedule, erection safety standard, project management system and value engineering (Propose better solution).

1.6 Chapter Outline

This report contains a total of five chapters. Each chapter carries a different main function and is summarized as below:

Chapter 1 - INTRODUCTION gives the overall view of the research studies that covers the background of design & builds system, problems and questions, aims and objectives, scope and significance of the research in the constructions industry. The summary of the research methodology and approach together with the outline structure of the project will also be discussed.

Chapter 2 - LITERATURE REVIEW provide a review on previous article, reports, books and research to have greater understanding of the rationale of research and knowing the research gap to improve the research quality. The advantages and disadvantages of design & build system with the conventional procurement system in the construction industry will be one of the topic that discuss in this chapter.

Chapter 3 – RESEARCH METHODOLOGY discuss in detail on the possible method that may be used to establish the relationship between type of profession and the key selection criteria to adopt design & build system on the steel structure design in the current construction industry. The method of the data analysis, sequence to carry out the research and description of the selected data analysis method will be also being clearly stated in this chapter.

Chapter 4 - RESULTS AND DISCUSSION to show the result of the data analysis based on the data collected from the questionnaire survey and illustrate in the appropriate format. The questionnaire survey result will be revealed on the key selection criteria from different type of profession in the construction industry and discussion on the result with the suggestions on improvement of selection criteria in general. Furthermore, discussion on the strategy to overcome the challenges in implementing design and build system will also be cover in this chapter.

Chapter 5 - CONCLUSION AND RECOMMENDATIONS revisit previous chapters and give objective comment on the selection criteria for the steel structure design & build system in the construction industry. This chapter also summarized the key selection criteria on steel structure design & build system from different type of profession as well as in overall construction industry. Based on the result results, recommendations for future research have to be including in this chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 Definition of design and build system and conventional design bid build system

2.1.1 Design and Build System

Songer and Molenaar (1997) define design and build system as the innovative project procurement system in which the design-builders is contractually responsible for both design and construction. Design-builders provide a one stop solution service for design, fabrication, erection, quality, cost control, schedule adherence as well as take full responsibility for all the coordination work from the proposal to the construction stage.

Khaled and Nabil (2004) mentioned the primary benefit of design and build system is to have one party responsible for the development of the project and save time by overlapping design and construction phases. Shorten the project lead time result in cost saving for the management and preliminaries cost at site for design-builders. Same goes to project owner to occupy the building earlier and start generate profit.

Next, design and build system introduce to address the problem associated with the conventional design bid build system and to cope with the growth in both

the private and public sector (Edwin & Ann, 2005). With the current fast track construction behavior, design and build procurement system will stand a better advantage compare to the conventional design bid build system.

2.1.2 Conventional Design Bid Build System

Design bid Build known as a most common project procurement system in the construction industry (Miller, 2000). Under this project delivery method, project owner procure design and construction service separately through the well-established selection process while designer selected based on qualification and construction firm selected based on price (Susan,Giovanni & Jin, 2013). In design bid build system; there are few parties involve before the project is advertised for tender. First, the architect develop the design concepts based on owners needs and structural consultant design and prepare for the construction drawings to quantity surveyor to call for tender.

Secondly, contractors pick up the tender document and review a full set of plans and specifications to prepare a bid proposal. If the contractor's price is acceptable, the owner will sign a contract with the contractor and construction can then begin.

Under design bid build project, owner retains significant interface risk between the designer and builders. As clients sign contracts individually with designers and builders, there is no contractual bond between them, except the

channels for coordination and communication (Tsung & Min-Lan, 2009).Therefore, project owners need to pay extra attention on the coordination work during execution.

2.2 Types of Design and Build Contract

2.2.1 Turnkey design and build

Masterman (2003) discussed the turnkey design and build contract as a project delivery system that including installing and commissioning of the plant equipment together with operator recruitment and training by one organization to ensure the plant can operate and maintain well under turnkey contractors. Where by the plant owner just need to insert the key into the lock and turned it to operate the plant immediately with all facilities ready.

Turkey design and build concept is first introduce in United States in early 1900s and widely used in private sector on complex production plant such as oil refinery, power plant, manufacturing plant and other process plant with machinery involve. This type of design and build system generally apply in the process engineering industry rather than construction industry.

2.2.3 Pure design and build

The general contractor under the pure design and build contract are aim for a complete total solution to client with sufficient in house design and construction expertise to resolve any task that arises from the project owner. (Rowlinson, 1987) The major different between normal design and build and the pure design and build

system is that the former method provides a bespoke design solution to meet client's specific requirement while the latter giving a value engineering solution by providing in house proprietary building system that may not fully satisfy to the client need but giving more benefit on the design concept, sequence of work that may lead to saving in time and cost of the project. (Masterman, 2003)

With the pure design and build contract, project owner have to pay more attention to check and confirm the proprietary building system propose by the builder are safe to build. Therefore, common construction practice under this type of design and build contract will require a third party professional person to counter check the design and give a certain confident level to the project owner. Beside the design issue, owners have more risk to deal with the contractor draft contract rather than any other nationally recognized standard form therefore, project owner have to be more careful on the evaluation on the contract terms.

2.2.4 Competitive design and build

Under the competitive design and build system, project owners will engage with the consultant to develop a brief design outline as a basis to the tenderers. Hence, pre-qualified contractor will come out with the conceptual design and specific material according to the design outline set by the owner's consultant and submits the proposal with their bid just like the design and build contract.(Chimay & Nosa, 1996) This method gives the project owners more confident while carry out tender process with their own in house experience consultant on the similar type of projects as well

to minimize the difference on the design concept that submit by the normal individual design builders.

However, although the design outline is prepared by owner's in house consultant, the design builders also responsible on the structure design and ensure its fit for intended purpose. By then, the project owners will evaluate the tender base on the relevancy to the consultant prepare design outline and the value that the design builders provide to the client to achieve the optimum result.

2.3 Advantage and Disadvantages of design and build system compared to the conventional method

2.3.1 Advantage

Design and build system is considered to be the fastest project delivery system. Konchar and Sanvido (1998) did an empirical research study and indicated that the delivery speed of design and build system is faster compare to the conventional design-bid-build system in U.S. This is mainly because of the nature of design and build system encourages overlapping of design and construction process, which can shorten the delivery schedule and improve project management efficiency (Gordon, 1994). Besides that, the buildability of the design work will be greatly increased due to the early input of construction knowledge to the design process and close communication among project participants provided that the client's requirements are specified clearly in the beginning stage (Songer & Molenaar, 1997). Furthermore, early completion of the project will also provide cost saving and earlier use of facility to the end user. On the other hand, conventional method has often been

criticized for its disadvantage on integrate the separate design and construction functions and impossibility of the contractor becoming involved sufficiently early in the procurement process to have significant contribution.

The design & build system also provide close relationship between the designer and contractor, and better buildability will lead to cost reduction at the same time increase the value of the project (Songer & Molenaar, 1997). The single point of responsibility will motivate design-builders to foster creative design and construction solutions, which will, in turn, improve the overall project performance. As compare to the conventional design bid build project, it's consumed more time on the contracting part with the designer and contractor in the tender stage. The one stop solution concept give a full responsibility to the design-builder will also reduce claims and litigations. Some others research show that the owners might have lesser controlling power over the project quality and design toward design & build system, however there is no valid reason for the construction quality in design & build system to be lower than the conventional design-bid-build approach. (Ndekugri & Turner, 1994)

In addition to the advantage above, DB system can secure the certainty of project cost and schedule at early stage. The DB system contract normally award in a lump-sum basis which able to provide owners with early estimation of project cost (Rowlinson, 1997). With only entity to have the total control over design, scope and budget, DB system offers higher possibility of completing the project on time with the available budget that set by the owners. Furthermore, improvement of the communication with the in-house designer and the design-builder can reduce the

possible design changes which expose can lead to project cost increase (Bramble & West, 1999). For the conventional design bid build project, the contractor tender their price in the bill of quantity that provided by quantity surveyor in a provisional sum basis and it might expose owner risk while having error in quantity calculated, contractor over price and underprice due to human error and error in material specification which will substantially increase the project price. At the end of the project, they will be the re-measurement process which will increase on the man power from both parties to verify all the quantity supplied and quality of the work (Griffith & Sidwell, 1995)

2.3.2 Disadvantages

The major disadvantages on the design and build system as an alternative project procurement method compare to the conventional design bid build system will be the tender price. Project owner foreseen that the design and build contract with the single point of responsibility on the contractor can shorten the construction period and have a certainty of the project price. However, most of the contractors included those cost in the project costing and it may turn out to be higher compare to the conventional system (Hamimah & Fauziah, 2001). This will be easily solved with the conventional design bid build system where the risks are well distributed to each party. While owners are making the decision to have a design and build contract, they might be involve in a high cost tendering cost to be pay out to the unsuccessful design builderss (Franks, 1992). It is simply because of an expensive commitment borne by the contractor on the engagement of consultants to prepare and produce the proposal design and estimated costs. The contractors appointed consultants have to be

remunerated for their expertise and the work done. This may prove to be worthless if the contractor is not successful in the bidding process and the cost of the work will transfer to the contractor. However, in the conventional process would not have this issue as the contractor only involved in very minimum tender cost.

Secondly, design and build system have less flexibility in accommodating client changes in design. Although the provision in the contract allow for variation orders, it is considered disruptive and will affect the cost and time of the project. The more important is that the cost involve to change the design is higher compare to the conventional method as the contractor has to incorporate the new design fee and the preliminary works done and in some cases, may claim direct loss and expenses from the client. Furthermore, the design builders is entitled to claim for time extension for changes made by the client. As compared this to the conventional method, client only need to pay for the additional item based on the unit rate stated in the bill of quantity and escape from all the re-design cost (Hamimah & Fauziah, 2001). Therefore, design and build system are not really suitable for the complex building as the chance expose to changes is high compare to straight forward building structure.

2.4 Design & Build Project Selection Criteria

2.4.1 Introduction

In order to have a great success in a design and build project, selecting a capable design builders has long been regarded as a top priority to the project owners in the tender stage (Molenaar & Songer, 1998). Therefore, a set of selection criteria to reflect clients or decision makers needs to achieve project objectives are greatly important (Masterman & duff, 1994). In real construction practice, there will be a chance for different profession in the construction industry to award and decide which steel structure design builders to perform the work. So, there will be a different point of view on the selection criteria to be a focus on for each profession. Bo Xia and K. Molenaar (2013) summarized twenty-six selection criteria and classified them into ten categories, i.e., price, experience, technical approach, management approach, qualification, schedule, past performance, financial capability, responsiveness to the request of proposal, and legal status in descending order of their relative importance to the owners itself. The result of this analysis showed that although price still remain the most important selection category but its relative importance compare to others categories has declined significantly in the recent years. The qualification, experience and past performance, by contrast have become more important to design and build project owners for selecting design builders. With the result showed above, the continuous study on the selection criteria on the steel structure design and build project has been extend to the contractor, architect, quantity surveyor and consultant engineer to analyze the focus on the selection criteria on each profession.

However, to appoint design builders through the listed selection criteria discussed above are not an easy task for the profession in the construction industry. Different sets of selection criteria and their weightings in request for proposal reflect different requirement of the profession toward the design builders. So, decision maker from different profession shall carefully define and summarize the evaluation criteria for specific focus and expectation on the project in order for the design builders to match the client needs (Bo Xia & K. Molenaar, 2013).

2.4.2 Selection Criteria for design and build

2.4.2.1 Price

With refer to the selection categorized by Bo Xia and K.Molenaar (2013), the frequency of price appear in the request of proposal content are the highest compare to others criteria. The price mention here will be the proposal price or price breakdown for the entire project and also consider of the life cycle cost of the project to achieve sustainability.

2.4.2.2 Experience

Design builders experience are the second highest frequency which evaluate the contractor experience toward the value engineering proposal, LEED and the local environmental with the comparable projects and facilities. General experience with design and build process will be on of the evaluation criteria under experience category.

2.4.2.3 Technical approach

Technical capability of the design builders can significantly lead the project to have a optimize design on the project. Thus, in house design capability and creativity will be one of the decision maker considerations in the tender evaluation stage. On the other hand, contractor ability to achieve LEED certificate and environmental mitigation design approach will be added advantage under this category.

2.4.2.4 Management approach

Project management system is one of the main focus during tender evaluation, decision maker will look at the company organization structure, stability and project staffing to make sure there can deliver a management plan for cost, quality, safety and risks as all these will greatly reduce the chances to cause the project to delay or additional cost.

2.4.2.5 Qualification

Qualification will be one of the minimum requirement to enter into a project as the proper license or resume of all key personal and subcontractors will be take into consideration of the project owners. Besides, sufficient available staff resource within the team can ensure the project can be deliver on time without hiring new staff or labor which are not familiar with the existing project.

2.4.2.6 Schedule

Project scheduling to meet the client required time line is always to be in the consideration to ensure the proposed schedule by the design builders are logic and take consideration of the uncertainty might be happening during project execution.

2.4.2.7 Past Performance

Design builders past performance will be a guideline to the project owner to evaluate the contractor performance on similar projects with relative to budget, schedule, quality, safety, and compliance to laws, regulations and requirement. Previous owners satisfactory will increase the confident level to the project owners on the contractor can be perform the same on to his/her project.

2.4.2.8 Financial Capability

Design builder sufficiency and stability of financial resources can well satisfy the project owner by ensuring the warranty of the project can be claim after the project completion. This will also be ensuring by the insurance and bonding capacity by the design builder.

2.4.2.9 Responsiveness to the RFP

Under the responsiveness to the request of proposal, project owners expected the proposal by design builder can be submit on time and comply the entire requirement stated in the request of proposal document. The understanding and insight related to project and owner needs can well align the objective between project owner and design builder. Presentation and interview performance can also bring significant impact to the project owner to have confident on the design builder to deliver the project.

2.4.2.10 Legal Status

Lastly, the current legal status including suits, claim, conflicts of interest, bankruptcy will be a consideration to the project owner contract department to ensure the contractor have not involve in any litigation history. If happen to be in one of the above mention, the design builder are required to explain the situation during tender interview to the project owner to have a mutual understanding on the legal status that hold by the design builder.

2.4.3 The decision maker for design and build project

2.4.3.1 Developer or owners

Developer or owners is one of the key stakeholders in the development and projects that make the decision to choose which design and build selection criteria are important to them. According to the Gransberg and Barton (2007)

research study to analyze the evaluation criteria in federal design-build request for proposal the result of the analysis show that price, experience, technical and management approaches and the qualification are the major group for selection. In addition, the categories of price have higher weighting and its means the owners are more focus into the price offer by the design builders.

2.4.3.2 Architect

Architects play a very important role in design and build project by helping client to draft out the minimum requirement and building outline for the design builders to proposal their own value engineering proposal. Architect engages by owners as a lead to run the project and award the contract to the contractor. Therefore, understand the architect needs will be one of the advantage to the design builders. Their major concern will be the adequacy of current contract provisions in defining their design responsibility in the design and build contract (Chan & Yu, 2005). In Chan and Yu (2005) research, the architect would like to have a proper form of design consultant agreement between contractor and architect.

2.4.3.3 Consultant engineer

In the conventional design bid build project, consultant engineer take a role of design the project to the owners and have a full responsibilities toward the design. However, consultant engineer in design and build project will act as a role to help owners to manage the appointed design builders. So, the engineer will be more to project management in the design and build contract. They can be either engaged

by the client to manage the project or as a partner to the design builders to bid for design and build project. For the engineer engage by the owner, they will be more particular into the technical capacity of the design builder while doing the tender evaluation. As per research, most of the consultant required design builders to have an independent checker to counter check on the design and the checker have to liable for his/her comment and instruction given to the design builders (Chan & Yu, 2005).

2.4.3.4 Contractor

Contractors are the executer for the project and most of the time the schedule and price will be most important to the contractor as they wish to complete the project with lower cost and faster schedule. Therefore, contractor may look for design builders to perform part of the job to minimize the cost of the project such as steel structure design and build and others packages involved specialized knowledge and experience (Gransberg & Barton, 2007).

2.4.3.5 Quantity surveyor

When owners chose to have a conventional method to deliver the project, quantity survey is a must for owners to calculate and preparing the entire tender document for the contractor to bid. However, client still can appoint nominated design and build sub-contractor to participant in the project. Therefore, quantity survey usually need to pre-qualified the design builders on certain package in the very beginning stage. It’s important to identify the support needed by the quantity

surveyor during the pre-qualification process. According to K.Al-reshaid and Kartam (2005), criteria used in the pre-qualification process will be the credentials and experience of the various design builders.

2.5 Challenges face by project owners on design and build projects

As per discuss in the previous section on the advantages and disadvantages of design and build project with the conventional design bid build procurement system. Design and build project delivery system brings various design disciplines and construction together to minimize incident of re-works that result in cost and time savings for the project owners. However, it's still face some challenges during implementation of this innovation system in the construction industry in different stages (C21 Steering Committee, 1999). The main reason may be due to project owners felt that they need to bear more risk on to the design and build project. According to the research by Ling and Poh (2008) on the problem face by project in design and build project, they conclude that the project owners will face more problem and challenges in the early stage such as during tender preparation and evaluation on preparing all the tender document and brief that suit to owners need and selecting the most appropriate contractor to perform the work. Besides, they also conclude that engage a project management company in the early stage of the project can minimized the problem encounter during preparation and execution.

2.5.1 Tender Preparation

Tender preparation will be the first step after the project owners decide to go for design and build contract. In this stage, project owners will engage project managers or in house project team to prepare the request for proposal (RFP) document that clearly defined the scope of work. Design and build project delivery is more on labor-intensive and technically demanding for the owners than the conventional design bid build contract (Fahmy S & Jergeas, 2004). Therefore, for owners that are not familiar with the knowledge of construction industry, design and build might not be suitable for them. It is mainly because of the owners can't develop a clear and comprehensive project brief during tender preparation (Ndekugri I & Church R, 1996). In the pass research study have shown that tender preparation stage is the most critical element of design and build system to be successful (Songer & Molenaar, 1997). So, it is recommended that owners with no in-house project management team have to engage project manager or quantity surveyors to help them prepare design and build tender documents and request for proposal, decide on conditions of contract to be used and level of information to be provided to the tenderers. Next, previous studies had emphasized that the more detail scope of work in the tender document can lead to lower cost and schedule growth (O' Connor, J. Vickroy G, 1985). However, owners should resist the temptation to offer solutions and focus instead on expressing their needs and requirement. It is recommended that project managers help owners to identify the complete scope of works to avoid uncertainty and providing contractors with opportunity to claim after the contract awarded.

2.5.2 Tender Evaluation

Tender evaluation is the next stage after preparing the tender document and it's important to evaluate the appropriate design builders through the comprehensive selection criteria that set by the owners. The design builder with high technical expertise and health and safety management capability will be stand better chance to satisfy the owner's expectation (Ling & Chan, 2004). With the comparison in between design and build and design bid build project, it will be difficult to evaluate design and build tenderer because need to look at the both aspect of price and design concept. The evaluation process will be more difficult if the owners brief is ambiguous and does not communicate his expectation to the project manager or the quantity surveyor in the early stage during tender preparation (Masterman JWE, 1996). In detail, the owners have also evaluated whether consultants engaged by design builder are up to the standard or not. The criteria for evaluation have to include consultants' financial capacity, level of expertise, and experience in design skills and track record in design and build tender (Kubr M., 1993). Due to the challenges face while doing the tender evaluation, the time taken to award the tender is inherently longer compare to conventional straight forward tender that allow owner to compare "apple to apple" based on the item listed in the bill of quantity. Therefore, project managers must have a knowledge and experience to evaluate different aspects of design builder project performance and make a judgment on the best value given instead of award to the lowest price bidder (Ling, 2004). Besides, the project owners also advised to have a pre-qualification before accepting the tender from design-builder. Pre-qualification is important to reduce the number of proponents to three or four to allow better competition in the second phase (Jergeas

G & Fahmy S, 2006). The pre-qualification system should reflect client needs on the selection criteria and weighting of criteria so the bidder can align their proposal accordingly.

2.5.3 Design Stage

Once contract awarded, the design and build project manager have a bigger responsibility to integrate both design and erection. The project manager will then involve many important roles to play which normally does not have in conventional design bid build projects (Stillman GR, 2002). One of the advantage of the design and build project is having a good coordination between design and construction which the design team and construction team are under same roof to speed up the decision making process if any design issue arise (Akintoye A, 1994). However, the challenges face by the project owners is that there is being excluded from the design builder team discussions and this may cause communication breakdown between project owners and design builder. Therefore, owners and design builders need to have a good, proper and comprehensive checking and communication system to ensure design is coordinated and construction complies to brief by owners (Cecil R, 1983). In design and build contract, design builder would submit their drawings to owners for approval. However, owners felt that they have to absorb more risk because they need to approve design builder design and drawings. It is recommended that owners do not hold designers for reviews, revisions, and resubmissions as it would be counterproductive and may cause project to delay.

2.5.4 Construction stage

In design and build project, owners feel they lose control of the design and construction processes during construction stage and it's simply because of owners absence of overall design and construction in the design and build contract (Preece CM & Tarawnah S, 1997). In result with this issue, the service quality experienced by owners during the construction stage of design and build projects has been found to be less satisfied compare to design bid build project. Therefore, most of the contractor failed to deliver what has been agreed in the contract and the service quality performance did not meet to owner's expectation (Ling YY & Chong CLK, 2005). In Ling and Poh (2008) research studies on the difficulties face by owners during construction stage, the result shown that owners sometimes under-estimated the time needed to obtain statutory approvals may take weeks to obtain and this may cause the project to be delay. The another problem encountered was when contractors submit shop drawings or method statement to owners for approval and the owners are unsure whether the submission meet to owners needs or not and sometimes the risk are passed back to owners once the submission drawing approved by the owners. Furthermore, owners are unsure the extent to which they are allowed to check on contractors in a design and build project environment. This will be one of the disadvantages of design and build project as the owners do not have the benefit of designer's independent construction oversight and monitoring on behalf of owners. Project owners are recommended not to interface the construction method and sequence provided the propose method are safe to be construct. This is to ensure that project owners can enjoy the benefit on the design and build contract whereby the single point of responsibility is still with the design builder.

2.6 The success factors of design and build project

Several empirical studies relevant to the identification of factors influencing Design and Build project performance were reviewed. The idea of project success is developed to set criteria and standards by which project managers can complete projects with the most favorable outcomes (Chan & Chan, 2001). The success of design and build project is consider as an intangible perceptive feeling which varies with different management expectations, among persons, and with the phase of the project (Pariff & Sanvido, 1993). In addition, project owners, designers, consultants, contractors, quantity surveyor, as well as sub-contractors have their own set of project objectives and criteria to define a success of the project. Therefore, Muller and Turner (2007) concluded that people judge the success of projects differently depending on their personal objectives, and it can be the case that one person judges a given project as successful, while another judges it as a failure.

Pinto and Slevin (1998) proposed 10 factors that may bring an impact to project mission, top management support, project schedule/plans, client consultation, personnel, technical tasks, client acceptance, monitoring and feedback, communication and troubleshooting. All of them were considered as critical for success at various stages of project life cycle. In addition, accordingly to Chan et al. (2001) he has developed a series factors contributing to the success of design and build projects which different from Pinto and slevin (1998). These factors are the duties, responsibilities and capabilities of different project participants including end-users, contractor, architect and design consultants in design and build projects. Besides all that, Turner and Muller (2006) also showed that a project managers'

success at managing the project is dependent on their competence, particularly their leadership styles comprising emotional intelligence, management focus and intellect. In this research, we will further discuss on the client, end user, contractor and design consultant attributes in the success of design and build projects. Hamimah (2012) have done a comprehensive research study through questionnaire on the priority and critically of each variable.

Mutual trust and respect between client and contractor has been emphasized by the profession in the construction industry as important criteria for design and build project to success. In addition, to ensure project success, all project stakeholders should share a clear understanding of financial and technical performance required, install adequate communication channel, achieve a high degree of cooperation, sharing of common project goal and develop an ability to resolve conflicts quickly. It is important for all project stakeholders to understand and accept their new roles and duties and the risk and the legal liability they have to face in design and build project. With the great teamwork in between client and contractor it can maximize the advantages of design and build contract and deliver the project with the optimum value and satisfactory level for both parties (Ng & Aminah, 2006).

2.6.1 Client & End User attributes in the success of design and build projects

In Hamimah Adnan (2012) research, there are total six variables identified through the literature review that the client should consider: prequalify potential tenderers/contractors, develop a clear understanding of project scope, assess

contractor's proposal thoroughly, develop a clear client's brief, comprehensive pretender site investigation and limit the change of client requirement during construction. The result of analysis shows that the critical factor is the client developing a clear understanding of project scope in achieving project success. The second critical success factor will be the client shall develop a clear client's brief and followed by the third factor is the assessment of contractor's proposal thoroughly. The next factor is the design builders should limit the changes in client requirements during construction and it will affected the project duration and cost of the projects. At the end of the project, the overall performance of the project will be disrupted. Furthermore, the end user input to project is very important in contributing to design and build project to success beside the above listed factor. If the end users' needs are uncertain or ambiguous, it is difficult to develop a comprehensive and clear client's brief for the contractor to propose a suitable design and construct the building. Therefore, end-users should have a thorough understanding of their own needs and the same applies to other project participants (Ng & Aminah, 2006).

2.6.2 Contractor & design consultant attributes in the success of design and build projects

From the same research by Hamimah Adnan (2012) on the contractor attributes in the success of design and build project. There are nine variable listed in the questionnaire which consist of capable and have experience in managing design and build project, understand and commit to the achievement of the project objective, strong financial ability, establish a clear project goals and direction to avoid misunderstanding, develop design management expertise, establish building knowledge during design development, using appropriate building technology to

speed up project delivery, utilization of appropriate construction methods and lastly is the good relationship with the local authority. The result shows the highest rank factor as the contractor is capable and has experience in managing design and builds projects. Beside the factor listed above, the respondent on this research also given their opinion on the contractor shall have strong support from building material suppliers to avoid uncertainty of material supply. In addition, the decision maker on design and build project believe that the contractor should have strong design management expertise and project management capability to understanding the buildability of the project and develop a good design through the utilization of appropriate construction method.

CHAPTER 3

METHODOLOGY

3.1 Introduction

Research methodology is the bridge which connects the idea and outcome of a research. It allows the researchers to figure out an answer or outcome on their hypothesis or problem found through various research methods. Hence, a correct and well-organized research methodology is always the key of success of a research. Sridhar (2008) defines research methodology as a scientific way which solves the research problem systematically through adopting a few steps logically.

The overall research approach consists of literature review and questionnaire survey which are designed specifically for achieving the stated research objective. Quantitative research method will be used in this research project to measure the data to achieve the research objective.

The research adopted the quantitative method because numbers represent values and levels of theoretical constructs and concept, and the interpretation of numbers is viewed as strong scientific evidence of how a phenomenon works (Detmar & Boudreau, 2004). Quantitative research can produce knowledge by

capturing and translating objective reality into testable hypotheses, in the form of statistical analyses.

Data collection techniques by questionnaire survey for quantitative research can be categorized into self-completed and interviewer-completed, both of which will be use for data collection. In this study, the respondents will ask to rate the important level of each criteria that set out in the questionnaire survey. Where by 5 = strongly agree and 1 = strongly disagree. The population frame for this study comprised 5 profession types in the construction industry who have experience in managing and procuring design and build project. There are client or developer, architect, consultant engineer, contractor and quantity surveyor. Questionnaires will be sending to 30 people from each type of profession by online survey software and email based on the 10 pre-selected criteria. There are design builder company financial backgrounds, price offer, in house design team, quality control system, experience in the industries, contract terms and conditions, delivery schedule, erection safety standard, project management system and value engineering service which is more relevant to the steel structure design and build project.

The questionnaire contained three sections. The section A asked respondents to provide demographic information about themselves and brief information relating to the current construction industries market segment. Section B will be the respondent involvement and challenges face in steel structure design and build project. Where by section C asked the respondent to rate and ranks the important level of each pre-selected criteria on design and build project and design bid build project. In section C, respondent also asked to give their opinion on the strategy to

improve the implementation of steel structure design and build system. Besides, the survey package also comprised a cover letter stating the objective of the study as well as the researcher brief introduction that send together with the email and online survey. A pilot survey was conducted prior to the major fieldwork and minor changes were made to the questionnaire. From the returned questionnaires, statistical analysis was carried out.

The hypothesis are made on the different type of the profession in the industry have their own focus on the selection criteria of the steel structure design & build. The analysis of this research is able to give a good reference to a design-builder during project tendering to align project owners needs as well as to each profession in the construction industries to aware which criteria in steel structure design & build system are important to them.

3.2 Research Methodology Sequence

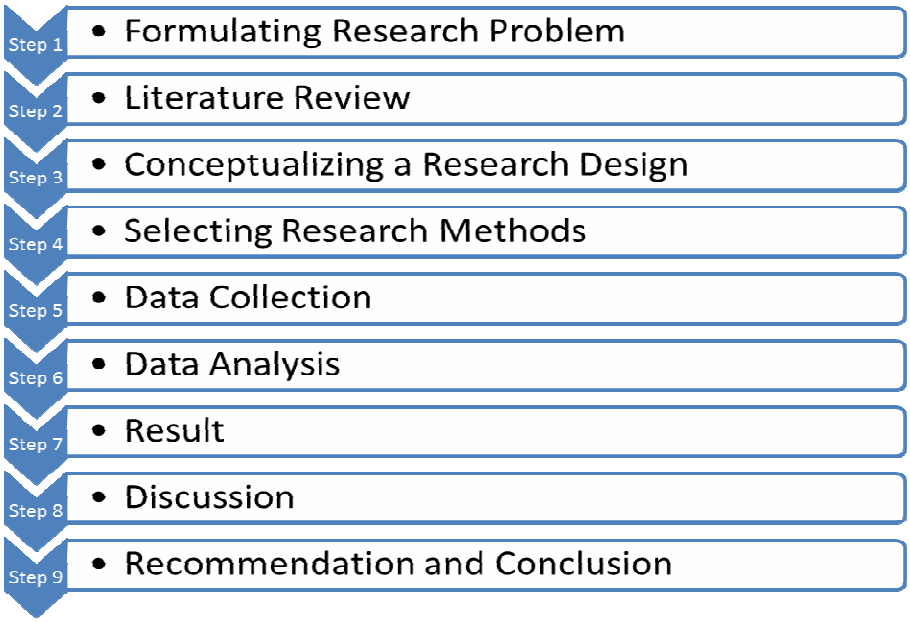

Figure 3.1: Research Methodology Sequence

3.3 Formulating Research Problem

The first step to do in the research methodology is formulating a research problem. Aim and objectives are determined giving the direction of research and allowing the researcher plans and works towards the direction. The ability, workability, possibility, scope and limitation of the research should all be considered to minimize the obstacles during the research is carrying out.

3.4 Literature Review

Literature review does not produce any new work but gives the fundamental on issue related with research topic to the researcher through the work done by other researcher including research, case studies, books, thesis, journals and etc. Through literature review on the critical point of current knowledge, researcher can have deeper understanding and conduct his research in a better way.

3.5 Conceptualizing a research design

In the conceptualizing research design stage, research design is a plan, structure and strategy of investigation so perceived as to obtain answers to research question problems. The plan is complete scheme or program of the research. It is considered as an overall layout for a research, dealing with four basic questions which are which question to study, which data are relevant, which data to collect and the way to analyze the result (Philliber, Schwab, & Samsloss, 1980). In research design stage,

researcher will determine the methods as well as the procedure used in his research methodology based on the four questions mentioned.

3.6 Selecting Research Methods

The author collected the needed data by selecting the suitable research methods to achieve the aim and objectives of this study. Basically, the data collected will be divided into two categories, which are primary data and secondary data.

Primary data is the outcome from a conducted primary research. Primary data shall be the data which unique to the research did and it should be no one else accesses it until the data collector publishes it. Thus, the primary research conducted should be requires the use of immediate data in determining the survival of the market. Primary research is usually undertaken after the researcher has gained some insight on that particular issue through secondary data reviewing or analyzing on previous published primary data. The popular ways to generate primary data include questionnaire, interview, case-studies, observation, focus group and etc.

Secondary data is the data that has been collected by other researchers for a different research purpose. It usually been obtained from two kinds of research strands, which are quantitative and qualitative. Secondary data is helpful to the researcher in designing his or her primary research as it forms the bottom line of the primary data.

3.6.1 Primary Data

In this research, questionnaire survey method is used to obtain primary data from the respondent from different profession in the construction industries. A questionnaire form was designed and got approved to conduct the survey on design and build related issue. Online questionnaire form with web link was then set up by to shorten the collecting period of the questionnaire and covered bigger range of respondents. The questions designed in the questionnaire form allowed the author to get the data needed for his research and related with the aim and objectives of the research. In order to obtain a more accurate and precise data, the respondent must be a professional in construction industry that have experience in the design and build project. The questions set in the form of close ended questions. The close ended questions will ask different professionals on the opinion on the key selection criteria in design and build project, the important level of the design and build system toward the construction industry and the strategy to improve the implementation of design and build system.

3.6.2 Secondary Data

Design and build system has been long time introduce to the construction industry as an alternative procurement method to improve the conventional design bid build system. Therefore, there are many secondary data available for the author to take as reference and guideline to have deeper understanding toward the design and build system. Some secondary sources such as related book written by professional on this

innovative design and build system and journal that published by the profession in the construction industry.

In this study, journal becomes the main source to reflect how those professionals in the construction sector comment on the selection criteria to deliver a success design and build project. It shall be no surprise that both advantage and disadvantage of design and build system can be found from the journals that reviewed by the researcher. However, it shall be noted that those data collected and point of view only represented to the whole design and build contract rather than focus on the steel structure design and build portion. Besides, part of the information and data collected by the previous researcher will be used as a reference and guideline to this study in order to have a comprehensive study focus on the steel structure design and build system.

On the other hand, the articles that published on the newspaper, magazine and internet will also be used as secondary data. Professionals might give their opinions in an article or interview and publish on the construction related magazine. Meanwhile, the mega project on the steel structure design and build project detail can be gained from the internet and newspaper as well.

3.7 Data Collection, Analysis and Result

3.7.1 Average Index

The primary data collected back from the professional through questionnaire will then be analyzed by using Average Index. The formula for the Average Index is shown as below (Al-Hammad, Al-Mohsen, & Assaf, 1996).

$$\text{Average Index} = \frac{\sum \alpha_i x_i}{\sum x_i}$$

Where,

α_1= constant representing the weight given to i

x_i= variable representation the frequency of response for i = 1, 2, 3, 4, 5…n

Based on the formula stated,

x_1 = frequency of the Strongly Disagree and corresponding to $\alpha_1 = 1$

x_2 = frequency of the Disagree and corresponding to $\alpha_2 = 2$

x_3 = frequency of the Neither Agree or Disagree and corresponding to $\alpha_3 = 3$

x_4 = frequency of the Agree and corresponding to $\alpha_4 = 4$

x_5 = frequency of the Strongly Agree and corresponding to $\alpha_5 = 5$

Rating scale for the formula is classified and result is identified based on the index calculated in order to determine the level of agreement.

Table 3.1: Classification of the Rating Scale

Rating Scale	Classification
Strongly Disagree	1.00 ≤ Average Index ≤ 1.50
Disagree	1.50 ≤ Average Index ≤ 2.50
Neither Agree or Disagree	2.50 ≤ Average Index ≤ 3.50
Agree	3.50 ≤ Average Index ≤ 4.50
Strongly Agree	4.50 ≤ Average Index ≤ 5.00

3.7.2 Standard Deviation

In statistics analysis, standard deviation (σ) is used to show the variation exists from the average or mean. The lower the standard deviation, the closer the data to the mean value and the higher the consistency the group of data is.

$$\sigma = \sqrt{\frac{\sum(x - \overline{x})^2}{N}}$$

Where,

x = Each value in the data

$\overline{x}$ = Mean of the values

N = Number of value

3.8 Evaluation, Discussion, Recommendation and Conclusion

The result from the respondents is evaluated and discussed to understand the reason behind. This will help the researcher make a conclusion on his study with the support of valid data collected and statement analyzed. Recommendation has been given by the researcher on his overall research process and research found as the contribution to the construction industry.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents and discusses on the finding on steel structure design and builds system in construction industry. The data collected from the online questionnaire survey was arranged and showed in graphs and charts for better understanding after statistical calculation was carried out. Besides, explanation was made based on the group of data collected on different kind of questions.

4.2 Survey Respond

A total of 150 sets of questionnaires were distributed to the online inbox or mailbox of selected respondents by using online webpage link (Google form). The selected respondents are the construction profession that have experience in the design and build project which is Architect, Contractor, Owners or Developer, Consultant Engineer and Quantity Surveyor.

Out of the 150 sets of questionnaires that had been distributed, only 64 sets of responses were collected back. Thus, the successful return rate for this survey is only 42.67%, which is considered as moderate return rate.

Table 4.1: Data Distribution and Collection

Distributed Collected	150 sets 64 sets
Rate of return of successful survey	**42.67%**

4.3 Respondent Background

4.3.1 Professional

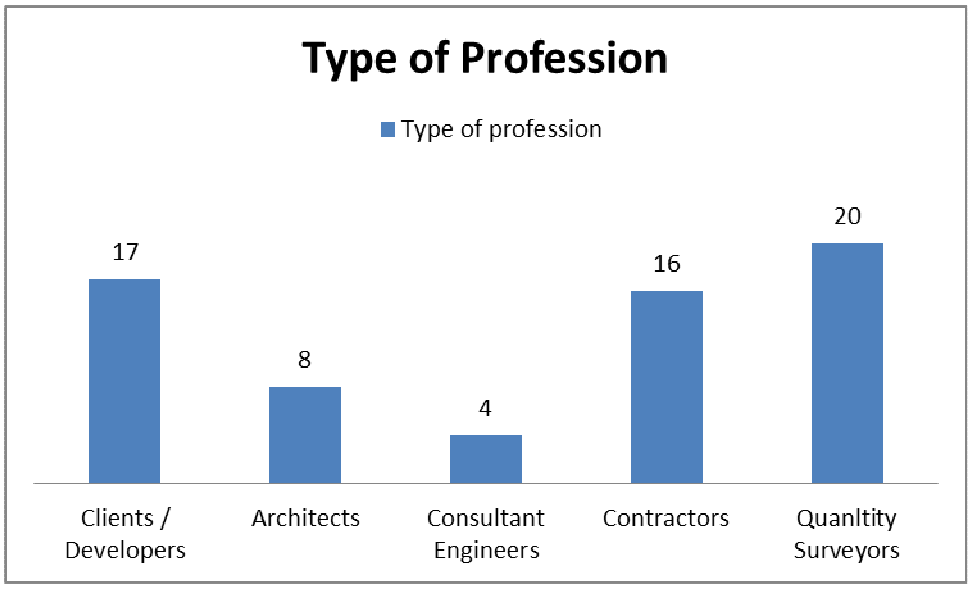

Figure 4.1: Number of Respondents on Different Professional

Figure 4.1 show the number of different profession took part in this questionnaire survey. Among the 65 respondents, Quantity surveyor contributes the highest percentage of the survey response rate (31%), which has 20 persons in total. Client or

Developer is the second largest group with 17 respondent (26%) followed by contractors with 16 respondent (25%) to this survey. The rest of the construction professional such as consultant engineer and architect constitute the (18%) left.

4.3.2 Experience

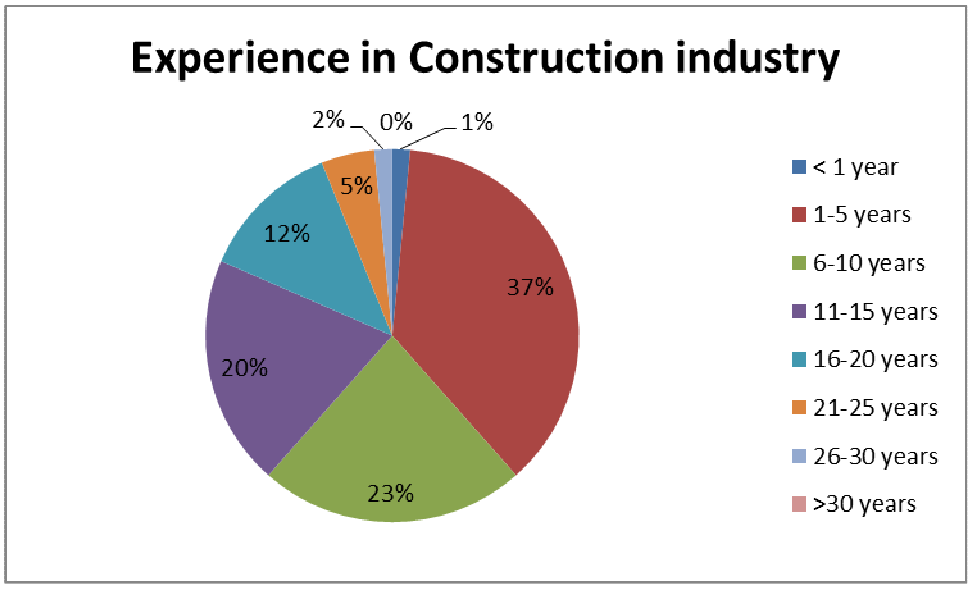

Figure 4.2: Experience of Respondents

Respondents who have 1 to 5 years' experience in the construction industry are the biggest group involved in this survey. 24 out of the 65 respondents fall in this group which is 37% out of 100%. The second largest group will be 6 to 10 years' having 15 respondents in the group which contribute 23%. The next group is the respondents who have 11-15 years' experience in the industry with 13 respondents and contribute 20% to the analysis. The rest will be the smaller group with 8 respondents from the group of 16-20 years' experience, 21-25 years 3 person, and each person from group less than a year and more than 30 years of experience.

4.3.3 Market Segment involved in construction industry

Majority of the respondents are involved in the commercial buildings. From the Figure 4.3 shows below, 42 respondents (65.0%) are involved in commercial buildings such as office, residential and condominium. Only 35.0% or 23 persons are in industrial building such as warehouse, factory and aircraft hangar project. Which is more relevant to this study as the industrial building involved more on steel structure work compare to the commercial buildings.

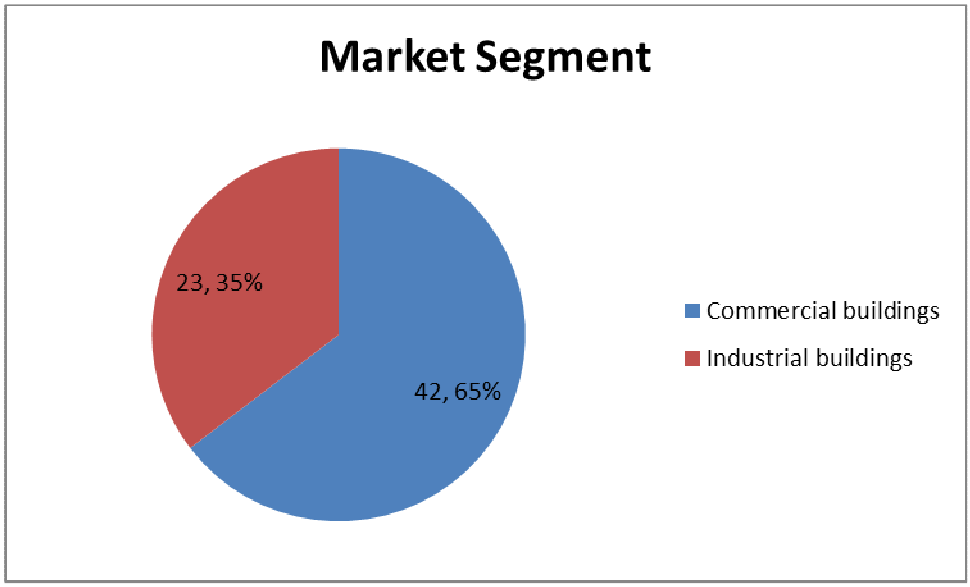

Figure 4.3: Market Segment involved in construction industry

4.4 Respondent Involvement and Challenges face in Design and Build

4.4.1 Involvement in design and build project

Among the 65 respondents, only 42 (65%) respondents have experience in design and build project. In other words, there will be 23 (35%) respondents does not involve in the design and build project. It show that the implementation of design and build project are getting common in the construction industry.

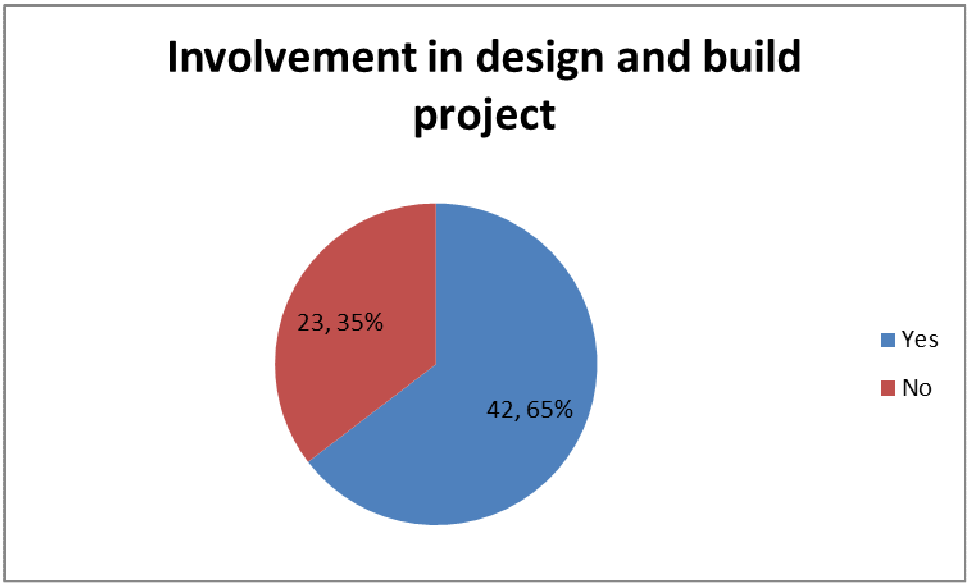

Figure 4.4: Involvement in design and build project

For those respondents who involved in the design and build project, they are required to proceed to the next questions and section C. On the other hand, respondents who do not participate in the design and build project will automatically direct to section C question 3 to answer the key selection criteria for conventional design bid build system through the system that set up by the author on the webpage.

In other words, the remaining question listed in section B and section C expect question 3 will not form part of the result analysis (starting from Subtitle 4.4.2) are all based on the 42 respondents who answered 'Yes' in the question '*Do you have experience in Steel Structure design and build procurement system?*

4.4.2 Project Scope Involved and Willingness to Counter Propose

Table 4.2: Involvement in design and build project by different profession

Position	Number of Respondents		% of Involved Respondent
	Overall	Involved in Design and Build	
Client or Developer	17	14	87.5%
Architect	8	7	87.5%
Consultant engineer	4	4	100.0%
Contractor	16	10	62.5%
Quantity surveyor	20	7	35.0%
Total	65	42	74.5%

Table 4.3: Major project scope involved in design and build project

Profession	Major Project scope involved in design and build project					
	All Scope	RC Work	Steel Work	M&E Work	Infra Work	Others
Client or Developer	10	0	4	0	0	0
Architect	3	0	2	1	0	1
Consultant engineer	2	0	1	1	0	0
Contractor	1	1	6	1	1	0
Quantity surveyor	2	2	3	0	0	0
Total	18	3	16	3	1	1

Table 4.2 shows the number and percentage of the involvement of different profession in steel structure design and build project. With the collected data, it's shown that all the profession in the construction industry have deal with design and build project and have average involvement percentage at 74.5%. All the Consultant

engineer are involved in the design and build project with 100% score in this survey and they are the smallest group compare to others profession with only 4 respondent. On the other hand, quantity surveyors are the biggest group of respondent but with lowest involvement rate in the design and build project with 35% score. This is because of quantity surveyor normally engage by client to perform the ordinary material take off and prepare tender document for design bid build project.

Therefore, they might lack of experience in the design and build project. Next, contractor and developer have a same number of respondent but with different involvement rate in the questionnaire survey. Contractor scored 62.5% which is the second lowest after quantity surveyor. This might be the contractor do not have enough experience and man power to handle the design and build project therefore their involvement will be lesser compare to others profession. For developer, they are having 87.5% scored in this survey and same score with the architect and 7 out of 8 respondents are have involved in design and build project. Developer and architect have a very close relationship in the construction industry especially in the design and build project. Developer might want to explore the design and build system by engaging architect to work out the proposal. Therefore, bolt profession should have experience in the design and build project in order to give an optimum solution to client or developer.

Table 4.3 further discussed on the involvement of profession dealing with the scope of work in the design and build project. The author have separate the project scope into five categories which is all scope, RC work, Steel structure work, M&E work and infrastructure work. This collected data is to further analyze the implementation rate on the steel structure work design and build compare to others

scope. The result shows that most of the professions are involved in the all scope of work as a single contract offer to the client. However, part of the profession will implement the design and build system on to other scope such as RC work, M&E work, infra work, Steel structure work or others scope of work that not listed in the questionnaire survey. Steel structure design and build recorded as a second largest group that the profession chooses to propose alternative project delivery method compare to other scope like RC work, M&E work and Infra work. This is further supported by Figure 4.5: on the willingness to counter proposes steel structure package by using design and build system as a project delivery method. The respondent tends to counter propose the conventional design by consultant and the quantity provide by the quantity surveyor in the bill of quantity when tendering the steel structure package. This is to have cost saving and better project coordination during the execution stage and make the tenderer different from others so that they can win the job.

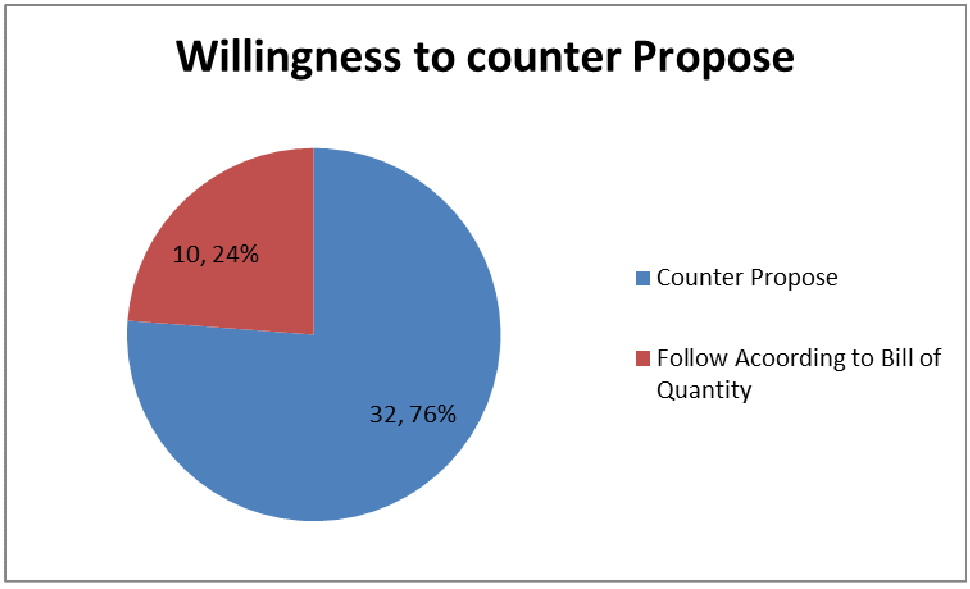

Figure 4.5: Willingness to counter proposed

The above figure shown that 76% of the respondent are willing to counter propose steel structure package from the conventional design bid build system. Only 24% which is 10 out of 42 respondents are reluctant to have alternative project delivery method and filling up the bill of quantity as per tender bill of quantity. Steel structure package are normally easy to be counter propose as the information and cost required are relatively low compare to other project scope. Therefore, numbers of steel structure fabricator turn up to be design builders to provide their services to the client to achieve optimize result.

4.4.3 Challenges face in implementing design and build system

In the questionnaire survey, respondent are required to give their opinion on the challenges face while implementing the steel structure design and build system either on preparing specification, tender evaluation, sub-contracting or responsive on the proposal from the design builder. Figure 4.6 below conclude that 52% of the respondents are facing challenges while implementing the system and 48% of respondent do not face any challenges during the implementation process.

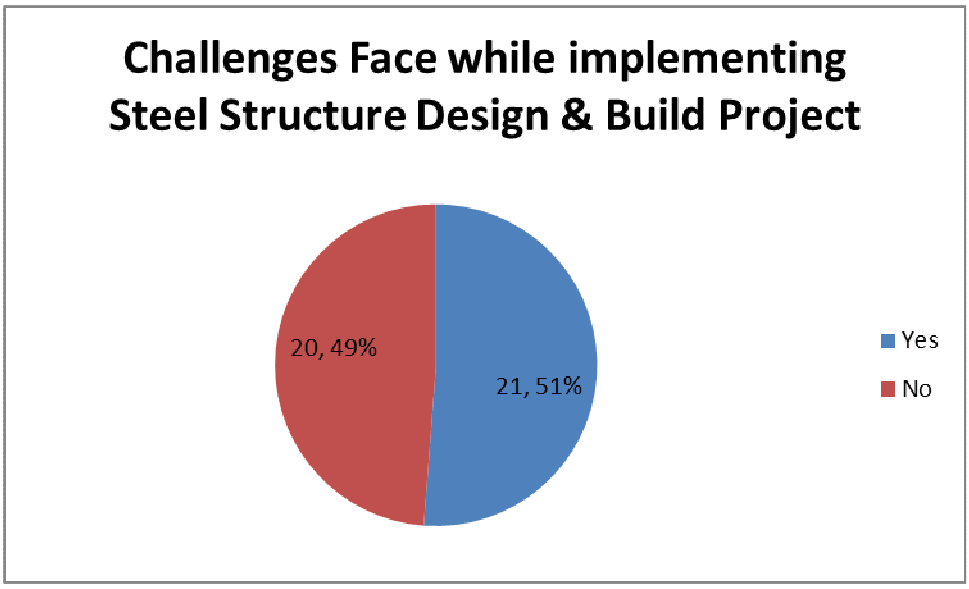

Figure 4.6: Challenges face while implementing steel structure design and build project

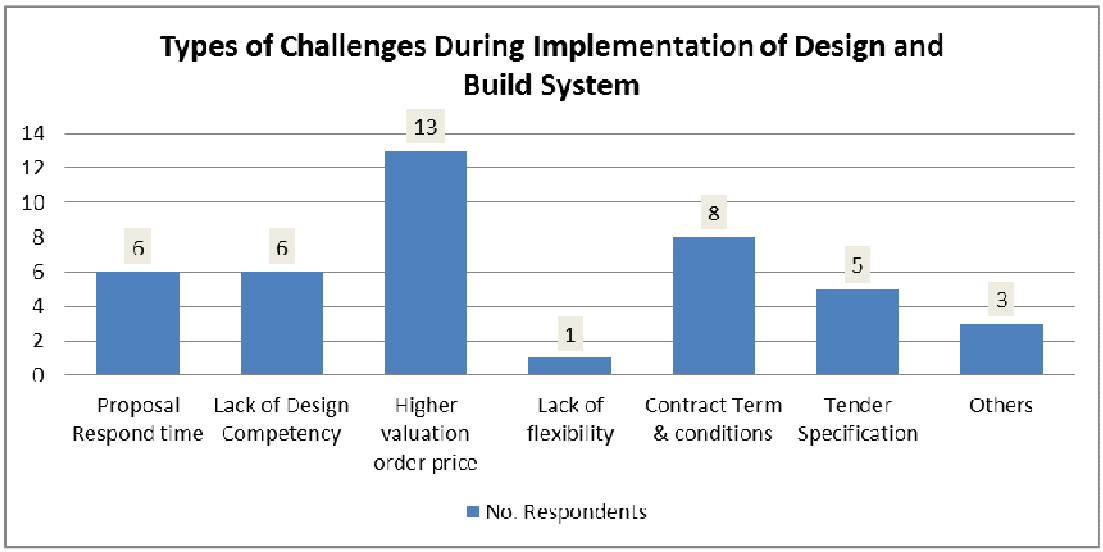

Figure 4.7: Types of Challenges during implementing steel structure design and build system

With regards to figure 4.7, data collected in the questionnaire shows that higher valuation order price are the most frequent challenge that face by profession

while implementing steel structure design and build project. This is mainly due to design and build contract is always quoted in lump sum price and seldom provide unit rate to client during tender stage. It will be a disadvantage compare to the design bid build project that have a unit rate shows in the bill of quantity and the variation order price are fixed throughout the construction period. Next will be the contract terms and condition that offer by the design builder. Most of the time the steel structure design builder will be using their own term and condition to protect the design builder interest. This will lead to higher risk on owner's sites that are using the standard contract like PAM, IEM or JKR Form of contract. Therefore, client or project owners have to spend more time to review the design builder terms and to include additional term and condition to protect both parties' benefits. The third most challenges face by the profession is the proposal respond time and lack of design competency with 6 votes out of 42 votes.

According to the comment from the respondents, design builders always tend to take more time to counter proposed the conventional design in order to have a competitive design and pricing to the project owners. In result with this challenges, the tendering stage might be longer compare to the conventional deign bid build system. Besides, some of the design builder are lack of design competency in the steel structure design and this may take a longer time for project owners to get a third party checker to evaluate the design concept and make sure the steel structure are safe to erect. This will prolong client approval stage and may cause delay to the project. Follow by the tender specification at fifth position. The tender specifications here refer to the detail and scope of work that reflects to client needs have to be clearly specified in the tender document to act as a guideline to all bidders. However,

the person in charge for the tender specification document does not have enough experience to clearly specify the material and the method statement in the tender document as a reference point to the bidder. Therefore, with the unclear tender specification design builder are proposing their own solution and may not meet to the clients need and hard to compare to others design builders during tender evaluation stage.

The last challenges will be lack of flexibility in term of the design and erection of the project. the profession always having a problem while changing the design of the project as this will bring a cost impact to the design builder and they might charge at high variation order price to the project owners and this can be verify by the respondent opinion at figure 4.7 that higher valuation order price are the most challenges face by the profession in the construction industry. On the other hand, respondent also giving their opinion on others challenges face during implementation of the system such as the coordination arrangement between main contractor and steel structure design builder. This issue happens frequently while clients or developer award the steel structure packages to the design builders as a nominated sub-contractor which is under the main contractor contract while both parties have no working relation with each other's. Besides, the work program might be disturbed by the steel structure design builder that nominated by client. Furthermore, respondent also commented they are facing problem when counter propose conventional method to design and build method to client and need to convince the project stakeholder by fact and figures on the advantage that the design and build system can bring to customer.

4.5 Strategy to increase the usage of steel structure design and build system

After several discussion on the challenges face by the profession in the construction industry on implementing the steel structure design and build system, the author have develop a set of strategy to overcome those challenges. Therefore, the data collected from the respondent on section C question 1, 2 & 4 shows their opinion on the best strategy to improve the implementation process based on the important level of the design and build system. Design and build system can appear in different form of combination and have been discussed in the literature review on previous chapter.

4.5.1 Type of design and build system

The type of design and build system listed in the questionnaire are separate to three different form which is pure design and build, integrated design and build and fragmented design and build system. The respondent is asked to choose the best design and build form that suit to steel structure design and build project. The figure 4.8 below shows that the respondent chosen pure design and build system as the most preferable project delivery method while dealing with steel structure project. In pure design and build project, design builder have sufficient resources and construction expertise that within the organization to complete any issue arise by the project owners. Therefore, this type of design and build system are best suit to the steel structure project that require faster construction time and immediate response on the issue arise.

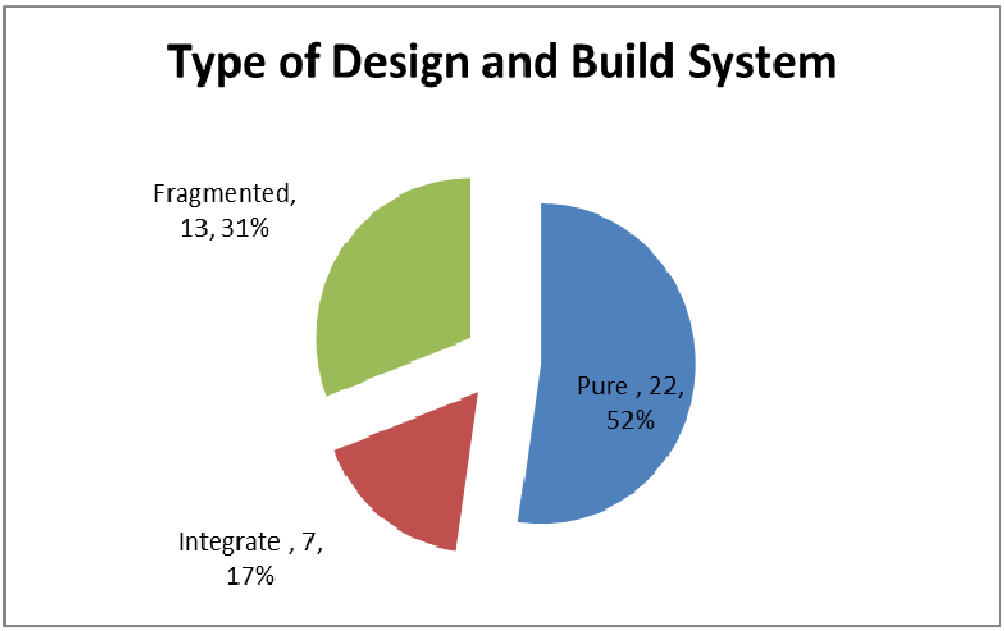

Figure 4.8: Type of Design and build system.

Choosing a proper type of design and build system can make a different to the project quality result. The project owners need to evaluated the design builder are fall under which type of the design and build type and choose the one that can maximize the advantage of using design and build. For example, fragmented design and build system is more suitable to large scale of project with complex building layout and required more specialist to comment and advise on the project. If the project owners prefer to execute the project under design and build system, the tenderers are require to outsource the design work or get consultation from third party if the internal resources are not sufficient. However, this type of design and build system still can achieve the benefit of design and build system through in-house project management system by the design builder. Lastly, the integrate type of design and build system where by the design builder only have limited core designer and project manager to manage the project. Whenever the project require the special

consultation service or advise from third party, the design builder are ready to buy in the expertise when necessary.

4.5.2 The important level of steel structure design and build system

Conventional design bid build system still the most common project delivery method use in the construction industry. However, the profession should aware that the important of the design and build project delivery system is to bring the industry toward a better side by resolving the disadvantage of the conventional project delivery method.

Table 4.4: Importance of steel structure design and build system

Importance level design and build system toward steel structure construction industry	**Overall**			
	Average Index	**SD (σ)**	**Rating Scale**	**Rank**
To simplified contractual arrangements	3.667	1.374	Agree	3
To improve project time, cost and quality	**4.571**	**0.904**	Strongly Agree	1
To reduce project owner liability	3.405	1.415	Neither Agree or Disagree	4
To provide integration of design and construction expertise	3.238	1.359	Neither Agree or Disagree	5
To overcome co-ordination and communication error on the design	3.857	1.320	Agree	2

As shown in Table 4.4, all the importance of steel structure design and build system toward the industry are agreed by the profession. Among the importance of the design and build system, the profession felt that project time, cost and quality can be improve through design and build system on steel structure project and it has the highest average index and lowest standard deviation score (4.571, σ 0.904). This is

the most important function that the construction profession are expecting on the design builder when deliver the project. Design builder normally counter propose the original design by the consultant and optimize the steel structure by using their in house software and expertise. Therefore, the overall cost and time of the project can be reduce through optimizing the design and value engineering by design builder. On the other hand, this scoring is actually reflected the respondents are serious on the improvement of project time; cost and quality management through design and build system.

The respondent also agreed on the design and build system can simplified the contractual arrangement between owner and design builder. In comparison to the conventional design bid build system, the owners need to deal with more than 5 parties which including architect, consultant engineer, quantity survey, main contractor and sub-contractor. However, the design and build system only deal with the design builder and have a single point of responsibility on the project. Therefore, it can be minimize the design co-ordination and communication in between contractor and designer. This can further support by the data collected in the questionnaire survey with average index of 3.857 and standard deviation of 1.320 and it falls in the agreed categories.

The lowest average index score of importance of design and build system on the steel structure project is reduce project owner liability and provide integration of design and construction expertise. The respondents have doubt on the agreement level on this statement with average index scoring of 3.405 & 3.238 and it falls under categories of neither agree or disagree. In fact, if the design and build system can be

implement throughout the whole project will be more advantage to the project owners. Therefore, the profession rated lower important level for steel structure project as its only form part of the scope in the entire project. The steel structure designs builders are hardly achieve the integration between the main contractor and design builder. By adopting design and build on the steel structure package, the owners can only reduce their liability on that particular package and others scope are still within the project owners' risk. 2012 is more likely used to resolve the payment disputes between payer and payee. Unless, the project owners choose the whole project to be a design and build project under one main contractor then it can achieve better benefit and it will be more important toward the entire project.

4.5.3 Strategy develop to improve design and build system

After several discussion on the challenges face while implementation and the study on the disadvantages of using design and build system as a project delivery method in the literature review, the author have develop a set of strategy to improve the implementation of the design and build system on the steel structure project. The strategy is further support by the result obtained from the questionnaire survey to all the profession that have design and build experience in steel structure project. As per result shows in the table 4.5 below, the most workable strategy selected by the respondent is to prequalified potential steel structure design builders or tenderers before the project kick off. This strategy obtained a highest average index with 4.333 and standard deviation of 1.016. Therefore, the project owners need to have a comprehensive pre-qualification in term of quality control system, reputation of the

design builder as well as the technical capabilities to solve the problem arise within the shortest time.

Table 4.5: Strategy to improve design and build system

Strategy	Average Index	Standard Deviation, σ	Rating Scale	Rank
To prequalified potential steel structure design builders or tenderers	**4.333**	1.016	Agree	1
To develop a clear project scope	4.190	**0.932**	Agree	2
To develop a clear client brief to reduce the variation work	3.857	1.373	Agree	4
To provide schedule of rate on the supply scope	3.571	1.094	Agree	5
To assists project owner on preparation of tender specification or bill of quantity	3.524	1.500	Agree	6
Assess contractor or tenderers proposal thoroughly	4.000	1.195	Agree	3

The respondent agreed to have clear project scope of work on what the design builder offer in the proposal. This strategy is slightly lower that the highest strategy by have average index of 4.190 and lowest standard deviation of 0.932. This means that the respondent have highest consistency on selecting this strategy to resolve their problem on the high variation order issue after contract award. The lowest average index (3.524) and highest standard deviation (1.500) is fall on “To assists project owners on preparation of tender specification or bill of quantity”. The respondent are generally agree to this strategy on helping the project owners to develop the tender specification but the respondent are not consistent on this strategy and this can be reflect by the highest standard deviation result. This may due to the project owners felt that they have an obligation to award the project to the design builders if getting them to help on the tender specification and stated in the bill of quantity. However, this strategy can be more realistic when the design builder have a close relationship

with the project owners and can give the high confident level to deliver their project on time within their budget. This can be save a lot of time on negotiation the scope cover in the contract, design and execution in pre and post contract.

Table 4.6: Strategy developed to improve the implementation process.

No	Challenges Face during implementation	Strategy to improve the process
1	Higher Valuation Order Price	To Provide schedule of rate on the supply scope
2	Contract Term & Conditions	Assess tenderers proposal thoroughly
3	Lack of Design Competency	To prequalified potential design builders
4	Proposal Respond Time	To develop a clear project scope
5	Tender Specification	To assists project owner on preparation of tender specification
6	Lack of Flexibility	To develop clear client brief to reduce variation work

The table 4.6 shows above are the strategy developed to resolve the challenges face during implementation of steel structure design and build project. The challenges faces are arranged from the highest vote to the lower vote from the data collected in the questionnaire survey. Project owners facing issue on the higher variation order price from the design builders during project execution stage. This is mainly due to the design and build contract are in lump sum price without quantity and price stated in the bill of quantity. Therefore, the project owners have a difficulties to identify the real cost of the item on the variation order. Further on that, the design and the erection method is by the steel structure design builders and project owners are hardly detect the design tonnage offer by the design builders. To resolve this issue,

the project owners should always obtain the schedule of rate from the design builder on the supply scope and take that as a reference point to justify the variation order price that quoted from the design builders.

Secondly, the project owners have difficulties on dealing with the contract terms and conditions offer by the design builder. As discussed in the literature review in chapter 2, the design builders always have their own bespoke contract instead of the conventional standard contract form such as PAM, IEM and JKR form. This is difficult to the project owners on dealing with unfamiliar contract term and this might increase the project risk face by the project owners. Therefore, the client should assess the tenderers proposal thoroughly and understand the overall term and condition listed in the proposal and discussed the terms with the design builders to achieve win-win situation. The lack of design competency shows in the third place on the challenges face by the project owner can be resolve by prequalified capable design builders on their design capacity and the type of design and build that the design builders (Pure, Fragmented or Integrated) to evaluate the resource and expertise in their team.

Proposal response time and tender specification is crucial to the project owners while adopting design and build as a project delivery method. This challenges can be improve by having a clear project scope in tender specification document that prepared by the project owners. This can be shortening the time frame for bidders' clarification on the tender document during tender stage. Lastly, design and build project normally not as flexible as the convention design bid build system where by the consultant are engage by the project owners. The change of design might incur

extra cost and require re-planning the schedule on the entire project to the design builders. However, it can be improve by develop a clear client brief on the project scope and design concept before contract award to reduce the variation order during execution and complete the project within client budget and schedule.

4.6 Key Selection criteria by different profession in design & build and conventional design bid build system

4.6.1 Key Selection Criteria by Design & Build Professions

According to the data collected from the questionnaire survey on the selection criteria of steel structure design and build system by different profession, the result is being analyzed by using average index to define the important level of the criteria and check the consistency of the data by using the standard deviation method. The result is being ranked from 1 to 10 where by 1 are the key selection criteria for the particular profession type and 10 will be least important in the selection criteria. Therefore, the result shows in the table indicated the lowest the number is the most important to the profession and vice versa. The 10 pre-selected criteria will be design builder company financial backgrounds, price offer, in house design team, quality control system, experience in the industries, contract terms and conditions, delivery schedule, erection safety standard, project management system and value engineering service which is more relevant to the steel structure design and build project.

Table 4.7: Selection Criteria for design and build professions

Profession	Selection Criteria by design and build professions									
	Financial Background	Price Offer	Technical Knowledge	Quality Control	Experience	Contract Terms	Delivery Schedule	Safety Standard	Project Management	Value Engineering
Developers or Clients (N=14)										
Average Index	**1.929**	4.071	3.857	7.000	6.929	6.214	6.428	6.429	6.643	5.500
SD (σ)	**0.267**	3.792	1.231	2.801	1.639	0.802	2.344	3.031	2.500	3.674
Rank	**1**	3	2	10	9	5	7	8	6	4
Architects (N=7)										
Average Index	7.286	4.286	**1.857**	4.286	2.143	9.143	6.429	7.714	7.571	4.285
SD (σ)	2.138	**0.488**	1.069	2.138	0.690	1.464	1.718	2.059	0.787	3.251
Rank	7	5	**1**	4	2	10	6	9	8	3
Consultant Engineers (N=4)										
Average Index	3.000	4.000	**1.500**	4.500	6.000	7.750	6.500	7.500	6.750	7.500
SD (σ)	1.633	3.367	1.000	2.517	2.708	2.630	**0.577**	2.081	0.957	3.697
Rank	2	3	**1**	4	5	10	6	8	7	9
Contractors										
Average Index	7.300	**3.200**	5.600	7.700	4.300	6.000	4.300	5.400	5.300	5.900
SD (σ)	2.983	2.300	3.373	**1.251**	2.452	3.560	2.214	2.633	2.750	2.807
Rank	9	**1**	6	10	3	8	2	5	4	7
Quantity Surveyors										
Average Index	5.143	**3.286**	3.857	6.000	5.571	6.286	4.857	7.285	5.429	7.286
SD (σ)	3.976	3.450	2.410	2.517	**1.618**	2.360	2.340	3.039	2.637	2.928
Rank	4	**1**	2	7	6	8	3	9	5	10

The result above shows that the selection criteria that is important to each profession type. The developers have lowest value on the design builders' company financial background with average index of 1.929 and most consistence data on these criteria with standard deviation of 0.267. The result reflect that the respondent from developer or clients group have a same opinion on this criteria as they felt that the design builders should have a strong financial background to finance and execute the project without cash flow problem. As the project cash flow is crucial to the

developer as they can't claim money from the buyer bank loan if there is no progress for the project. Therefore, most of the times the developers have to spent large amount of money to keep the project running without delay. The developers have more confident to the strong financial background design builder on their finance management to keep the progress smooth.

Architect and the consultant have same key selection criteria on the technical knowledge and capability on the design builder with the lowest value at 1.857 and 1.500. They believe that the design builders with strong technical knowledge and capability to resolve the design issue during construction period. Especially for the steel structure project that involve in the connection detail, finishing work and this might be one of the reason that architect and consultant are favorable to the design builders that with good reputation in terms of technical. Besides, strong technical capability builders can take up the liability on design and quality control of the project and at the same time reduce the work load and responsibility of the architect and consultant engineer in design related work. As steel structure works always form part of the project and the lead architect and consultant still have to take up the whole project design liability in "back to back" basis. Therefore, technical knowledge in steel structure design and build project is most important criteria for architect and consultant to make their decision to award.

Lastly, the contractors and quantity surveyor always focus on the price offer by the design builder. In the table shows above, contractors and quantity survey have lowest value on the price offer criteria with average index of 3.200 and 3.286. The result reflects that the contractors and quantity surveyor share a same focus on the price that the design builders offer to execute the project. Most of the time the

contractors and quantity surveyor will have enough of experience to evaluate the price offer by the design builders and they thought that all the design builders offers is the same and award to the lowest price bidders. So, the design builders have to come out with more value engineering solution that can reduce down the price and optimize the design to lower down the design tonnage to win the project.

4.6.2 Key Selection Criteria by Design Bid Build Professions

The same analysis method is applied to different profession on the selection criteria for the conventional design bid build project. The respondent in this group included the respondent that no design and build experience and only focus on the conventional design bid build system. The total 65 respondent are participating in this questionnaire survey.

Table 4.8: Selection Criteria for design bid build professions

Profession	**Selection Criteria By Conventional design bid and build professions**									
	Financial Background	Price Offer	Technical Knowledge	Quality Control	Experience	Contract Terms	Delivery Schedule	Safety Standard	Project Management	Value Engineering
Developers or Clients (N=17)										
Average Index	**2.250**	4.500	3.750	6.000	6.250	6.250	6.750	6.500	6.750	6.000
SD (σ)	**0.447**	3.899	1.528	2.530	1.342	0.856	2.352	3.307	2.956	3.795
Rank	**1**	3	2	4	6	7	9	8	10	5
Architects (N=8)										
Average Index	3.750	**2.000**	3.000	5.750	3.500	8.000	5.750	8.000	8.000	7.250
SD (σ)	3.240	1.069	2.000	1.909	1.773	2.138	1.389	**0.756**	1.309	2.964
Rank	4	**1**	2	5	3	8	6	9	10	7
Consultant Engineers (N=4)										
Average Index	**3.250**	4.250	3.500	4.500	4.750	7.250	5.500	7.750	5.750	8.500
SD (σ)	1.708	3.863	3.786	2.517	**0.500**	4.193	1.732	1.708	2.630	1.290
Rank	**1**	3	2	4	5	8	6	9	7	10

Contractors (16)										
Average Index	4.250	**1.938**	7.813	6.125	4.750	5.188	4.063	6.500	5.125	9.250
SD (σ)	3.044	1.289	2.536	1.455	**0.683**	2.316	1.914	3.204	2.630	1.183
Rank	3	**1**	9	7	4	6	2	8	5	10
Quantity Surveyors (20)										
Average Index	**3.750**	6.650	4.600	6.700	5.550	5.800	5.300	6.550	6.900	6.800
SD (σ)	2.918	3.031	3.050	2.273	**1.395**	2.262	2.155	2.911	2.751	3.318
Rank	**1**	7	2	8	4	5	3	6	10	9

The result shows that the developer, consultant engineer and quantity surveyors have lowest value with average index of 2.250, 3.250 and 3.750 individually. The major differences on design bid build project with design and build project are the contractors or the bidders are not required to take responsibility on the project. Therefore, they will have different opinion on the selection criteria compare to the design and bid project. As per result showing above, they put more focus on the bidders' company financial background instead of others selection criteria. This is mainly because of in design bid build project; the reputation in term of payment to sub-contractors is one of the key to success on the project. The bidders with the strong company financial background stand a better advantage on the price by lower down the payment term. Besides, bidders with strong financial background will reflect on better performance during construction stage by ensuring the payment to each sub-contractors are on time and the project can be complete on time without any delay cause by the payment issue.

Furthermore, architect and contractor think that the price is the key selection criteria for design bid build project. They have an average index score at 2.000 and 1.980 which is lowest among the others selection criteria. This also reflected that in design and build project, price will be the first priority for them to take into

consideration as the architect which to get the lowest price bidder that comply all the specification that stated in the bill of quantity and contractors will try to get the lowest price bidders in order to meet the budget. In design bid build project, the bidders are hard to provide value added to the project owners as all the material and designs are well prepare in the tender document. Therefore, most of the bidders will only lower down their margin in order to secure the project.

4.6.3 Comparison of Key Selection Criteria by different profession on design and build and design bid build system

Table 4.9: Comparison in between design and build and design bid build

Procurement types	**Comparison in between design and build and design bid build**									
	Financial Background	Price Offer	Technical Knowledge	Quality Control	Experience	Contract Terms	Delivery Schedule	Safety Standard	Project Management	Value Engineering
Developers or Clients										
Design & Build	**1**	3	2	10	9	5	7	8	6	4
Design Bid Build	**1**	3	2	4	6	7	9	8	10	5
Architects										
Design & Build	7	5	**1**	4	2	10	6	9	8	3
Design Bid Build	4	**1**	2	5	3	8	6	9	10	7
Consultant Engineers										
Design & Build	2	3	**1**	4	5	10	6	8	7	9
Design Bid Build	**1**	3	2	4	5	8	6	9	7	10
Contractors										
Design & Build	9	**1**	6	10	3	8	2	5	4	7
Design Bid Build	3	**1**	9	7	4	6	2	8	5	10
Quantity Surveyors										
Design & Build	4	**1**	2	7	6	8	3	9	5	10
Design Bid Build	**1**	7	2	8	4	5	3	6	10	9

Table 4.9 shows that the summary on the ranking on design and build and design bid build system by different group of profession. For developer or clients group they share same criteria on the company financial background as their key selection criteria during tenders' evaluation stage. As developer or clients, their decision is not affect by the types of procurement method as long as the company is in good financial background and not involved in any dispute on payment.

On the other hand, the architect has different key selection criteria on the types of procurement method use. The architect concern more on the technical knowledge of the bidders more than a price in design and build project. The reason being is that in steel structure design and build project, the material and design concept that proposed by the design builders is way important compare to price that are normally compete in conventional design bid build project. Architect believe that design builder are specialist on the steel structure project and the construction material proposed by the design builder are fit for purpose with greater benefit as design builder are well known on the element that consist in the steel structure package. Therefore, this makes a different on the selection criteria on architect toward design and build and design bid build project.

Consultant engineers chosen technical knowledge as a key selection criteria in the design and build project and company financial background for the design bid build project. When comparing the both type of procurement method, consultant has more focus on the technical knowledge and confident level that give to the consultant engineers. This is important as the consultant engineers are act as a lead consultant overseeing the whole project when choosing the sub-contractor on steel structure

packages. Besides that, design builder are providing warranty and quality control on the material proposed and design work. This is indirectly reducing consultant engineer's burden by selecting a technical sound design builders. As in design bid build project, the design and the quality liability is still with the consultant engineer, therefore they have to choose a strong financial background company to ensure the project can finish on time.

As for contractors, the price offer by the steel structure design builder is the key selection criteria for both type of the procurement system. Contractors will only take consideration on the design and build system on the steel structure package while the design builder can provide a cost saving to the main contractors. From that, the contractors will only counter propose the conventional design by replacing the alternative proposal that provide by the design builder to the clients and sometimes share the saving with the clients. Therefore, the price offer is always the key selection criteria to the main contractor when dealing with steel structure package on design and build system. In design bid build, the contractors normally choosing the best price offer from the bidders on the steel structure package that follow consultant design and material specified in the bill of quantity. The bidders normally hard to differentiate themselves in the conventional design bid build system on steel structure project unless the bidders can lower down the profit margin to attract the main contractors.

Lastly, the quantity surveyors choose the price offer as key selection criteria for the design and build system and company financial background for the conventional design bid build system. As quantity surveyors, they have the

responsibility to keep the cost as low as possible by not contracting the quality of the project. Therefore, they always welcome the alternative design proposal from the design builders on the steel structure project with cost saving. However, the only focus is on the company financial background in the conventional design bid build system to make sure the bidders can finance the project if any payment or claim delays by the project owners. Therefore the strong company financial background is the key selection criteria for quantity surveyors during tender evaluation stage.

CHAPTER 5

CONCLUSIONS & RECOMMENDATIONS

5.1 Introduction

This chapter concludes the research finding by reviewing aim and objectives. Besides, this chapter also includes the implication of the research toward the construction industry. Lastly, the limitations of this research and recommendations for further study are also highlighted in this chapter.

5.2 Conclusions

From the analysis, the author have identified the challenges faced in implementing steel structure design and build system in the current construction industry. The results showed the major challenges faced are the high valuation order price when the project is in the construction stage. Besides, the challenges face during implementation on the steel structure design and build system will be the contract terms and condition, proposal respond time, lack of design competency, tender specification, lack of flexibility and any others opinion that contribute by the respondent are recorded in this study.

Further from that, the author have developed a set of strategy to increase the usage of the steel structure design and build system package by overcome the challenges face that discussed in the previous chapter. The strategy is supported by the data collected from the questionnaire survey by the respondent from different profession in the construction industry. The results indicated that project owners have to prequalify the potential steel structure design builders before the official tender of the project. This strategy is chosen to be the most effective solution to increase the usage of steel structure design and build system. Besides, there will be others strategies have developed in this study to incorporate in the design and build system so that the project owners can minimize the challenges face while implementing the steel structure design and build system. Thus, the usage of the system will be increase significantly by the benefits that come along with the system.

This study also investigated the important level of the selection criteria for steel structure design and build system through quantitative questionnaire survey research method. Besides that, the author also compared the key selection criteria result of design and build system with the conventional design bid build system by different profession in the construction industry. The result shows that developers are focus on both systems where by the company financial background is the key selection criteria to them. Next will be the architect with the key selection criteria on the technical knowledge in design and build system and focus on price in design bid build project. Follow by consultant engineer key selection criteria on the technical knowledge in the design and build system and company financial background for the conventional system. Where by the contractor is having a same important level on the selection criteria on the price offer by design builders. Lastly the quantity

surveyors put their focus on the price offer in the design and build project and company financial background in the conventional system. The hypothesis is achieved as different types of profession have their own key selection criteria during tender evaluation stages.

5.3 Limitations

5.3.1 Number of Respondents

Although there are 20 sets each of online questionnaire survey being set out to 5 different professions in the construction industry, only 65 complete responds received and only 42 respondent have experience in the design and build system. Therefore, the imbalance respondent in between the profession group might affect the accuracy of the result obtained.

5.3.2 Recommendations for Further Research

In order to get a more accurate result and the collected data can equally represent the group of professions, the author suggest that the respondent from each profession should have an equal numbers that valid for analysis. An in depth study could be compare the key selection criteria on different profession by using different research method and analyzing tools that can interpreted the data in comprehensive way. With the result shows above, it can help the design builders to understand the key selection criteria on different profession and align the design and build proposal according to the needs of different profession.

REFERENCES

Akintoye A. (1994). Design and build: a survey of construction contractors' views. *Journal of Construction Management*, 12, 155–63.

Bramble B.B & West J.D. (1999). Design-build, contracting claims, Aspen Law & Business, N.Y, 15, 256 -315

C21 Steering Committee. (1999). Construction 21: re-inventing construction. Singapore: Ministry of Manpower and Ministry of national development.

Cecil R. (1983) Design and build. *Journal of Architect* 13, 177

Detmar S, Gefen D, Boudreau MC (2004). *The IS world Quantitative,* Retrieved from http://www.dstraub.cis.gsc.edu:88/

Edwin, H.W Chan, Ann T.W & Yu (2005) Contract strategy for design management in the design and build systems. *International Journal of Project Management 23* 630-639

Franks, J. (1992*)* Design and build tendering – do we need a code of practice? Chartered Builder, June, page. 8-10.

Fahmy S & Jergeas (2004), Design –build delivery system on trial. *AACE International Trans* pg 11.1-7.

Gorden C.M. (1994) Choosing appropriate construction contracting method. *Journal of Construction Engineering,* 120 (1), 196

Griffith, A. & Sidwell, A.C. (1995). Constructability in building and engineering projects. Macmillan, London.

Hamimah & Fauziah (2001), Success Factors of Design and Build Projects in Public Universities. *Social and Behavioral Sciences,* 170 – 179

Jergeas G & Fahmy S. Ten (2006) critical principles for successful design–build projects. Cost Eng 2006;48 (11):29–34.

Konchar, M., & Sanvido, V. (1998). Comparison of U.S. project delivery system. Constr. Eng. Manage. 124(6), pg 435-444

Kubr M.(1993) How to select and use consultants? Geneva: InternationalLabour Office.

Khaled Al-Reshaid, & Nabil Kartam,(2005) Design-build pre-qualification and tendering approach for public projects. *International Journal of Project Management 23* ,309-320

Ling FYY (2004). How project managers can better control the performance of design–build projects. *International Journal of Project Manage,* 22:477–88.

Ling FYY, Chan SL, Chong E & Ee LP (2004). Predicting performance of design–build and design-bid-build project. *Journal of Construction Engineering Management,* 130, (1):75–83.

Masterman JWE. An introduction to building procurement systems. London: E & FN Spon; 1996.

Masterman, J. W. E., & Duff, A. R. (1994). The selection of building procurement system by client organizations" Proc., 10th Annual ARCOM conf., R, M. Skitmore, and M. Betts, eds., Vol. 2, pg 650-659.

Masterman, J.W.E. (2002). An Introduction to Building Procurement Systems, 2nd edition. Spon Press, London.

Molenaar K R, Songer AD, (1997) Project Characteristic for Successful Public-Sector Design-Build. *Journal of Construction Engineering and Management, ASCE*, 123 (1), 34-40

Ndekugri, I & Turner, A (1994) Building procurement by design and build approach. *Journal of Construction Engineering and Management*, 120 (2).

O' Connor J, Vickroy G. (1985) Control of construction project scope. Austin: Construction Industry Institute.

Philiber, S.G., Schwab, M.R. & Sloss, G.S. (1980). Social Research. United States: F. E. Peacock.

Rowlinson, S.(1987). "Design Build - Its Development and Present Status."Occasional paper, No. 36, The Chartered Institute of Building, Ascot.

Stillman GR. Project management on design–build projects. AACE International Trans 2002:PM1.1–4.

Sridhar, M.S. (2008). Introduction to research methodology. Retrieved from http://www.slideshare.net/mssridhar/introduction-to-research-methodology-presentation.

Susan M, Giovanni C & Ruoyu Jin (2013) Study of the Relationship between Procurement Duration and Project Performance in Design-Build Projects, *J Manage Eng, ASCE,* 29: 382-391.

Tsung –Chieh Tsai & Min-Lan Yang (2009) Risk Assessment of Design-Bid-Build And Design-Build Building Projects, *Journal of the Operations Research Society of Japan*, 20-39.

APPENDICES

APPENDIX A: Questionnaire Form