A STUDY ON THE DESIGN CHANGES AFFECTING THE CONSTRUCTION PROJECT: POINT OF VIEW FROM CONTRACTOR PERSPECTIVE

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ABSTRAK

Walaupun tempoh penangguhan projek yang dijalankan mengambil masa yang panjang, isu-isu kritikal seperti perbelanjaan kos yang berlebihan dan ketidaksempurnaan kualiti bahan merupakan antara faktor yang membawa kepada perubahan reka bentuk. Walaubagaimanapun, hal-hal sedemikian masih belum dikaji secara menyeluruh. Kajian ini adalah untuk mengkaji perubahan reka bentuk yang mempengaruhi projek pembinaan dari sudut pandangan perspektif kontraktor. Di samping itu, ia juga bertujuan untuk mendapatkan maklumat tentang perubahan reka bentuk dan seterusnya menganalisa berkaitan perubahan reka bentuk yang mempengaruhi projek pembinaan. Skop kajian ini akan meliputi kawasan-kawasan di negeri Pantai Timur Malaysia. Kajian ini memberi tumpuan kepada perubahan reka bentuk dalam skop pengamal kejuruteraan sekitar Pantai Timur Malaysia. Lampiran soal selidik disediakan dan diserahkan kepada individu yang terlibat dalam projek pembinaan. Pengumpulan data dilakukan dengan melakukan pengumpulan maklumat melalui kajian literatur dan kajian soal selidik berkaitan dengan kontraktor yang telah dipilih dan didaftarkan di bawah CIDB. Berpandukan data dari borang kaji selidik yang diedarkan kepada industri, kesemua maklumat yang diperolehi dari kajian ini dikaji menggunakan kaedah indeks kepentingan relatif (RII) dan juga dibantu dengan menggunakan perisian SPSS. Hasil dari kajian ini, 37 penyebab utama dalam perubahan reka bentuk telah dikenalpasti. Sebagai kesimpulannya, kesemua objektif kajian telah dicapai dan antara faktor paling utama yang mempengaruhi perubahan projek adalah pertama perubahan reka bentuk, kedua adalah keadaan ekonomi semasa, manakala ketiga kesilapan yang berlaku semasa dalam fasa pembinaan, keempat penggantian bahan dan prosedur dan kelima pula adalah kekurangan data serta maklumat yang diperlukan untuk menghasilkan sesebuah reka bentuk. Pembelanjaan kewangan yang melebihi had semasa proses pembinaan projek merupakan kesan utama perubahan reka bentuk yang dipilih oleh responden dalam kajian ini dan mereka bersetuju bagi memilih atau mencari jalan penyelesaian yang lebih produktif selain dari mengubah reka bentuk asal projek bagi menangani masalah perubahan reka bentuk ini.

ABSTRACT

Although many project time delays, cost overruns and quality defects particularly in the construction sector are attributed to design changes, the associated issues have not yet been thoroughly investigated. At this time, problems with design changes are still one of the major problems in construction. In today's practice, every design made at the early stage has been agreed upon by the parties involved in the construction work but on request of the client and been approved by the consultant, the design of the construction can be changed. The objective of this is to study the change in design affecting the construction project from the contractors' point of view. Questionnaires survey were distributed to the group of contractors accordingly in order to obtain information and analysis on the subject matter which is by identifying the causes affecting the change in design of construction project. The scopes of this research will cover the area in East Coast of Malaysia. It is focusing on the causes of design change in the engineering practitioners. Data gathering carried out by doing literature review and applying a questionnaire survey through contractors that has been selected and registered under CIDB. An analysis being carried out using SPSS software & Relative Importance Index (RII) has shown a tremendous result in finding the most influential factors affecting the design changes. According to all the data being collected, the entire objectives for this study are archived and there are 37 main causes to the design changes in construction projects which have been identified. They are change in design, current economic situation, error or omission occurred during construction phase, replacement of material and work procedure as well as lack of data and information required for the design. While for the effect of design changes, the respondent choose cost overrun while conducting the project as it cannot be completed in time and they agreed to look for another solution other than changing the design to overcome this design changes problems.

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LIST OF SYMBOLS

AI	Average Index
CIDB	Construction Industry Development Board
DCI	Design changes caused by improvement
DCO	Design changes originated by Owner
DCP	Design changes process
ECER	East Coast Economic Region
PWD	Public Works Department
RII	Relative Importance Index

LIST OF ABBREVIATIONS

AI	Average Index
CIDB	Construction Industry Development Board
DCI	Design changes caused by improvement
DCO	Design changes originated by Owner
DCP	Design changes process
ECER	East Coast Economic Region
PWD	Public Works Department

CHAPTER 1

INTRODUCTION

1.1 Introduction

Construction industry is one of the sectors that are experiencing rapid growth in Malaysia today. Lots of construction project are currently undergoing in various fields of civil engineering and some of them are still in the planning stages. During this time, one of the ongoing development on the East Coast of Malaysia in under the East Coast Economic Region (ECER) project where has not only attracted local contractors to compete for this opportunity but even overseas companies also shown their interest to be together to compete for the successful development of Malaysia.

Through various studies conducted by other researchers, design in construction is an important factor to determine a project to run smoothly without any serious problems that resulting delay of work. However, an original design which has been agreed upon by all parties involved may sometimes be changed on the inevitable reasons and as far as they concern, if the original design has to be changed, the construction process of the construction work will be interrupted regardless in terms of performance or in terms of finance. This design change is likely to occur when there are parties who ask to change or want to correct the mistakes made during the initial stages of design. For those involved with this change, they will need to submit a new repayment form to the responsible party and there is sometimes a misunderstanding occur resulting difficulty of claiming refunds process.

Every parties involved in a project are very concerned about the costs and risks of their contracts. The risks that linked with design changes are very important and they need to be taken good care to ensure that these changes can be avoided. They need to talk to find a plausible and specific solution because if they fail to do so most likely this will cause project performance will be interrupted. In addition, the other issues that they will face are the rising costs because every problem happen will make cost increases.

The changing environment and the ever-changing construction condition are commonplace today. Companies should always develop and improve their management system to be more successful. Therefore, each design change must be based on their knowledge and emphasize the surrounding factor and must first be approved by all parties. In this situation, finding solutions that allow design changes to be avoided is a very important solution. Effective actions can be taken to improve the process with this knowledge (P.-E.Josephson & Y.Hammarlund, 1998).

1.2 Problem Statement

At this time, problems with design changes are still one of the major problems in construction. As always, every design made at the early stage has been agreed upon by the parties involved in the construction work but on request of the client and been approved by the consultant, the design of the construction can be changed. This change has indirectly resulted in the delay in completing the project and it causes an impact on the increased cost of the contractor. Additionally, the impact of these design changes is that the quality of a construction is likely to experience some disabilities arising from failure to detect the surrounding factors and risks that will be occurred.

According to Bernama, "The National Accounts Committee (PAC) said the delay in the construction of the East Coast Expressway Phase 2 (LPT2) project which was supposed to be completed in 2009 was due to the changes of construction from the federal highway to the highway toll". An additional allocation of RM800 million was channelled to the Public Works Department (PWD) supervised scope of the project which made the original cost of RM2.09 billion increasing to RM2.9 billion (Nur Jazlan Mohamed, 2014). This clearly shows that the design change has many side effects that can increase the cost for construction work.

1.3 Objective

These are three main objective obtained from the problem statement above:

i. To study the cause of design changes affecting construction project.

ii. To obtain the information about the causes of the design changes through questionnaires survey.

iii. To analyse what are the causes of design changes that affect the construction project and how to solve it.

1.4 Scope of Study

Related to the objective obtained, the scope for this research will cover the area of East Coast, Malaysia. It will be focusing on engineering contractor perspective. The suggestions are focusing on the method and procedure on how to improve the managing system of design change order in contractor perspective. The person who works in this field that have at least three years working experiences in construction will be selected and they have to answer the questionnaires that has been prepared.

1.5 Significance of Study

It becomes a necessity and importance to know the causes and risks associated with design changes in a project. The importance of this study is aimed at identifying the causes and who should be responsible to cover all costs involved once the design of a project is changed.

This study involves various parties involved in design change cases as they have a lot of experience and are able to track what are the causes and effects of these design changes. This study is also helpful and useful as an alternative reference source or to improve future research by other researcher.

Initial steps to address financial problems and project delay can be contained by identifying what causes the design change. This can be used as an assistant or as a benchmark for the parties involved to get the best results. All the findings from this study are expected to help to reduce the design change in a construction and this can indirectly help reduce costs.

1.6 Thesis Structure

This thesis comprises of five chapters. The first chapter consists of introduction section. It states the background, problems statements, objectives of study, scope of study, and lastly the significant of study. For chapter two, the key terms in purpose for this study are described and also the literature review that related and suitable for this study. Chapter three explains the research methodology for research data collected and the method of data analysis to be employed. For chapter four, the result obtained from study area and year of study were presented and the analysis from the result was discussed. Finally, chapter five comprises the conclusion from the overall chapter and relates some recommendations for future work on study field.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Changes are the common thing in all construction project (Ibbs, et al., 2001). The scale for project design to change is very high depending on various factors. There are so many factors that can cause changes even in owner perspective, consultant and also the contractor's point of view. Usually, changes involved alteration on addition, omission, and substitution in term of quality and quantity of work and also the schedule of the project (Wang, 2000). Changes maybe only involved small part or the work but not have lot of effect to the project because it was wisely managed depending on the project and the workers. On the other hand this can be vice versa resulting had more effect in the construction project in terms of cost and time.

In the previous study, there a lot of case study on the design changes such as a case study to determine the impact of change order in electrical and mechanical fields (Hana, et al, 2000), and issue related to the factor affecting construction cost performance in project management projects (Memon, et al., 2014).

This study was looked into the Malaysia construction industry and structural implementation scenario that related to the issue on the causes of design changes affecting the construction project cost.

2.2 Definition of Design Change

There is no constant definition that state what is ‘change’. Every field had their own definition on it. Change is any work that involved in modification of the original plan, execution time, cost of project, is inevitable in most construction project and planed resources of time completion and cost available for the project (Hanna, et al., 2002). It is means that changes are not only occurs to the work or things related to the work that are consisting in the contract, but it is also on the terms and condition of the contract (P.P. Hibberd, 1986). Change may occurs on the project for some reasons such as measurement errors, design error, addition to the scope of work and so on. A design change is defined as any change in the design or construction of a project after the contract is awarded and signed. Such changes are related not only to matters in accordance with the provision of the contract but also changes to the work conditions (Burati et al., 1992). Similarly, Akinsola et al. (1997) noted that these changes are any additions, omissions or adjustments made to the original scope of work after a contract is awarded. It may cause an adjustment to the contract price or contract time, and it occurs regularly on construction projects (Ibbs, 2012). Likewise, Park (2003) defined that construction changes refer to work state, processes or methods that differ from the original construction plan or specification and usually resulted from different in work quality and conditions, scope changes or uncertainties that make construction dynamic and unstable.

2.3 Definition of Change Order

Changes order are mean that the modification of the section that are already under construction and disrupt the performance of the project. (Hanna and Murat, 2002). In other word, change order also mean the nature of the construction activities which encounters an obvious and significant diversion from that described in the contract document, and the owner and his respective clearly alters the terms and conditions of the contract directly, that is giving by a formal instruction to add work, delete work, change the standards of work and others (Hsieh et al. 2003).

2.4 Basic of Changes

A change is defined in literature as any deviation from an agreed upon well-defined scope and schedule. Stated differently a change is any modification to the contractual guidance provided to the contractor by the owner or owner's representative (Fisk,1988 and Yu, 1996). All of them are includes changes of specification, plans, or any other contract document. A change order is the formal document that is used to modify the original contractual agreement and become part of project's documents (Al-Dubaisi, 2000).

Initially, the contractor receives the contract package in the form of plans, drawings, equipment lists and other documents. This constitutes the basis of his proposal. Contractor will calculate material cost, labor cost, and schedule based on the original package. Obviously any changes to this set of documents will alter his plans and calculations.

Changes can be initiated by all parties in the construction process. All changes, however, must be approved by Owner before implementation. CII Publication 6-10 (1990) summarizes initiation of change orders as follows:

1. Owner may request/order a change, usually a scope change.
2. Engineer may originate a change because of differing site conditions or new governmental regulations etc.
3. Project management firm/person may originate a change, usually in schedule.
4. Contractor may initiate a change due to design errors, value engineering, or field requirement.

Changes can be classified in many different ways depending on the basis and the purpose of classifications. In this review, the most common classifications will be presented. Changes in a construction project can be classified based on the cause that forced them (Burati, Farrington & Ledbetter 1992, Thomas and Napolitan 1994). The cause or originator based classification is best suited for the assessment of cost impacts of changes. These causes can be numerous. In a study by J. Burati, et al (1992), deviations or changes in constructions are caused by design, construction, fabrication,

transportation or operability. Design changes, which were found to constitute 52.5% of total changes, fall mainly into three categories:

1. Design changes caused by improvement through design process (DCI). Examples are changes resulting from design reviews, technological advances or constructability reviews.
2. Design changes originated by Owner (DCO). Examples are scope changes.
3. Design changes initiated by Engineer or Consultant familiar with the process (DCP). Examples are additions of pumps, valve or instrumentation that affect the operation of the facility.

Design errors and omissions mentioned in the study are also other possible causes of changes in construction. Hester et al (1991), summarizes the sources of changes from different studies. The lists show a consensus as to the sources of changes. Yu Kelving (1996) cites owner's change of mind as the prime source of changes in residential housing projects.

Second, changes can be classified in terms of net effect on scope (CII publication 6-10(1990), Fisk 1988) as follows:

1. Additive change. This involves addition of work to the original scope (adding a new module for example).
2. Deductive change: Unlike the previous type this change involves deletion of work or shrinking the scope of work – Contractors call this a negative change since it usually involves deduction in contract value.
3. Rework – due to quality deficiency. Although this type involves no scope change it could have a huge cost impact.
4. Force majeure change: Although this has the effect of a change, a force majeure caused change may entitle the contractor to schedule adjustment and (1) or cost adjustment depending on the conditions of contract.

Third, changes can be classified by the procedure used to introduce them (CII publication 6-10 (1990), Fisk 1988, Cox 1997). This classification is important in discussing the legal aspects of changes.

1. Formal or directed change: is a change introduced by the owner or his agent under the mechanism of the change clause.
2. Constructive Change: Is a change that resulted from a failure to do or not do on part of the owner or owner's agent. This type is not initially documented as a change and hence becomes a potential source of dispute. The failure of the owner or owner's agent may take the form of error in design or drawings, wrong Engineer's interpretation of contract documents, change in construction sequence imposed by a construction requirement etc. (Fisk 1988, Cox 1997).
3. Cardinal change is a change outside the scope of the contract and executed only after complete redefinition of the scope and re-negotiation of the contract. This can also be called a "scope change". This is not necessarily a single change but can be the result of a number of changes that have the net effect of modifying the original scope.

A study by CII on effects of changes on labor productivity (Thomas and Napolitan 1994) presents several other listings and classifications of changes that show a great similarity. First changes are classified on the basis of the subject of change such as "changes to process design". In a second listing changes are classified in a form of a matrix showing type and originator. A third listing shows changes classified according to the account group responsible for the change (client, home office, and field). Many of the listings, as noted by the CII report, are usually developed for the purpose of cost accounting and back charging and add little in clarifying the impacts of changes.

2.5 Definition of Rework

Rework was defined as the unnecessary effort of re-doing a process or activity that was incorrectly implemented at the first time (Love, Smith, & Li, 1999; Love, 2002). Another study by Hwang et al. (2009) revealed that terms such as non-conformances, quality deviation, quality failures and defects have been seen as synonymous with rework. Rework has become one of the most collective concerns in construction projects.

Rework can be described as unneeded effort of redoing an activity or operation that was enforced in a wrong way from the beginning (Love & Li, 2000). According to Palaneeswaran (2006), most of rework cases arises from changes, damages, defects, errors, omissions and other non-conformances. Table 2 exhibits the keywords used in the definition of rework by past studies.

2.6 Standard of Design

Design is wide enough to include not merely structural calculations and the dimensions, shape and location of the work, but the choice of particular materials for particular functions and, similarly, the choice of particular work processes. In other words, in sophisticated contracts the designs includes the specifications as well as the drawings (I.N. Duncan Wallace, 1970).

If the contractor is required to use a design and construct method, the contractor shall be responsible for the proposed design directly to the owner flowing from the breach. This is likely to arise where an architect or engineer is not engaged by the employer. Generally, design and build method imposes on the contractor a duty to ensure the building would be reasonably fit for its purpose (IBA v EMI Electronics Ltd & BICC Construction Ltd, 1980).

2.7 Causes of Design Changes

Many practitioners and also researcher have identified that poor management practices as major cause of project changes such as design error and omission, lack of proper planning and scheduling, scope change, lack of materials and labour among many other factors involved, (Jergeas, 2008). In a perfect world, there would be no changes order but there are high expectations of perfect construction project. Every parties need to take their roles in order to success the project. Changes in design information are inevitable due to the iterative nature of the design process (Mokhtar, etc al, 2000). An effective or management design changes required a comprehensives understanding of the root causes of changes. The cause of changes can be classified by four groups which are in a point of view of the owner, consultant, contractor and others.

2.7.1 Change Related to Owner

The owner directly initiates the changes of the design in some cases and the design changes are required because the owner himself failed to mention the specification needed or fulfill certain requirement to carry out the project, and those are the other examples:

1. Changes of schedule
2. Scope changes
3. Inadequate project objective
4. Replacement of material and procedure
5. Impediment on prompt decision making process
6. Owner financial problem
7. Changes of specification

2.7.2 Changes Related to Consultant

The consultant may directly initiates that the changes are required because of consultant fail to fulfill the requirements of the project. (Arain and Low,2006). Those are related changes based on consultant:

1. Changes in design by consultant
2. Error or omission occurred
3. Lack of coordination
4. Design complexity
5. Conflict between contract document
6. Inadequate scope of work of contractor
7. Technology changes
8. Honest wrong belief
9. Value engineering
10. Changes in specifications
11. Lack of required data
12. Noncompliance design with owner
13. Consultant lack of experiences and professional
14. Design discrepancies
15. Lack of knowledge about the material and equipment

2.7.3 Change Related to Contractor

Contractor also has issue to finish up the project and may suggest changes to the design of the project or the design changes may be required because of:

1. Lack of equipment
2. Lack of skill of manpower
3. Financial problem
4. Lack of contractor involvement in design
5. Profitability
6. Lack of experiences of contractor
7. Unfamiliar with site condition

8. Poor procurement process
9. Lack of data requirement
10. Honest wrong belief
11. Complexity of design
12. Improper design planning
13. Long lead procurement

2.7.4 Other Changes

This section includes the causes of project change that are not directly related to the participant (Arain and Low, 2006).

1. Safety consideration
2. Weather condition
3. Economic condition
4. Changes in government regulation
5. Unforeseen problems
6. Social-cultural factor

2.8 Causes Elaboration

The potential causes of design changes in construction project in general and large building and infrastructure project in specific are examine in this survey.

2.8.1 Change in Design

Design changes often occur when a project is initiated before the design has been finalized by the relevant party. The project owner often objects to any design changes at this stage and he is entitled to do so in order to avoid any loss. However, new design elements that may not have been considered before the project starts or the obvious design advantages assumed by the change may be in favor of the implementation of this change. Design changes can also occur if the design is reviewed by consultants who have different opinions with the design team, and he or she may wish to make changes. The owner or project manager should carefully approve any form of change.

2.8.2 Change of Planning by Owner

Change of plans or scope of a project is by far the most significant cause of changes in construction as stated in the literature. Normally, this source of changes happened because of insufficient planning at the early stage of project definition or simply because of the lack of involvement of the owner at the design stage. This type of changes is normally costly, especially if they are made later in the construction process. An example of change of scope or change of plans is the increase in building area, an increase or decrease in the number of floors. Early involvement of the owner in the project objective definition and then their enrollments in the design of the facility normally reduced such changes to the minimum.

2.8.3 Change of Schedule

Time has an equivalent money value. This makes changes in the schedule as costly as change in scope or materials. As the contract was signed the contractor has leveled his resources over the time frame agreed upon with the owner. A change in the schedule means the contractor will either provide additional resources in a shorter time or idle some sources that he committed for certain activities. In both cases additional cost is incurred. Although there are numerous causes of schedule change such as market conditions, user requirements, or lack of funding, the owner must be certain that the cost of change of schedule is well covered by the anticipated benefits.

2.8.4 Conflict between Contract Documents

It has become a habit where documents for a development will be different as it is designed by different engineers or design staff during the design phase of the project. Despite close collaboration between design staff and other employees, sometimes differences of opinion and design still take place. Usually contracts include guidelines on documents that are regulated in case of conflict. However the owner may know that the relevant party or the contents of the document that is included during the submission of the contract is not the best and may decide to make the change. In order to avoid such a thing, the owner or involved person must spend enough time and effort to review the contract documents for any possible conflict before contract award to avoid any change. During the study, if there are phrases that can be interpreted differently should

be rewritten to avoid confusion. The contractor will usually find any expressions or notes in a contract document to justify a cheaper option.

2.8.5 Substitution of Materials or Procedures

If the contract calls for certain materials or work procedures, then a change order is required to substitute these materials or procedures. In the Saudi environment for example, where material standardization is not common and the market is full of all kinds of materials, making a pre-selection of material is quite difficult. This feature of the Saudi's market forces people to move away from lump sum contracts that cover supply of material leaving the door open for the owner to select materials during installation.

The substitution of procedures includes changes in application methods of paints or insulation material for example. It is very obvious that different procedures may cause different cost to the contractor and hence adjustment to the original contract value is required in such instances.

2.8.6 Error and Omissions in Design

From the beginning of the design history, it is impossible to create a 100% error free design. Quite often, among the many documents of the project, one will find a note was deleted, a detail mis-referenced or an incomplete specification sheet. The contractor's main objective is to escape the extra cost and will look for ways to minimize cost. This is quite legitimate and justified. In this case the owner will pay the extra cost (change order) or accept an inferior product or design. A quality assurance program in the designer office should minimize this source of changes.

2.8.7 Lack of Coordination

It is quite important in a multi-environment like a construction project to keep strong and continuous coordination. The owner should convey his new ideas and concerns which form the basis for changes to the consultants in a timely manner. The owner should avoid giving direct orders to the contractor without the involvement of the party who is acting on his behalf that is consultant. The consultant has to ask the contractor to update of any concern they might have with the scheduled work. If they

keep in mind that changes have an exponential relationship with time, they do not need to drags this issue any further. To solve this issue, the ways to improve coordination has to be done including coordination meetings, progress reports, and conference calls among others.

2.8.8 Value Engineering

The ideas of cost saving were shared by other are always be the priority of the organization. This is a source of changes that cannot be ignored. Value engineering may be practiced formally as an official value engineering study that has all the required elements of this practice or it may be practiced in a simple and unorganized way. In either case, the cost saving must be high enough to justify a change because it is not worth going through the problems of changes if the benefit cost ratio is not suitable to the project.

2.8.9 Owner Financial Difficulties

The owner of the project may run into financial difficulties that force him to make changes in an attempt to reduce cost. The fact that many of the owners in this country especially in large building construction projects are wealthy individuals who might not have sound and reliable financial sources makes this risk a real one. Again proper planning and review of the project cash flow is enough to eliminate this problem.

2.8.10 Contractor Financial Difficulties

Due to the fact that in Saudi Arabia, they have many new contractors in large scale building construction projects, but many of them face financial difficulties in executing large projects. These difficulties affect their ability to execute and deliver the project. Therefore, delays in the completion schedule (schedule change) may occur due to the financial problems.

2.8.11 Contractor Desire to Improve his Financial Conditions

Although no contractor wants to admit it, changes are looked at as a source of additional work. The contractor may talk directly to the owner and convince him to do certain changes only to give him the additional benefit of change work. The contractor may take any excuse to claim that certain parts of the work are not in his scope and therefore request compensation for doing it.

2.8.12 Technology Changes

Major construction projects and especially those which have technology items might face this reason for change especially if the time between design and construction is long. The presence of new technology in the market such as a new HVAC system, a new desalination unit or a new erection method might encourage the owner or the consultant to initiate this type of change.

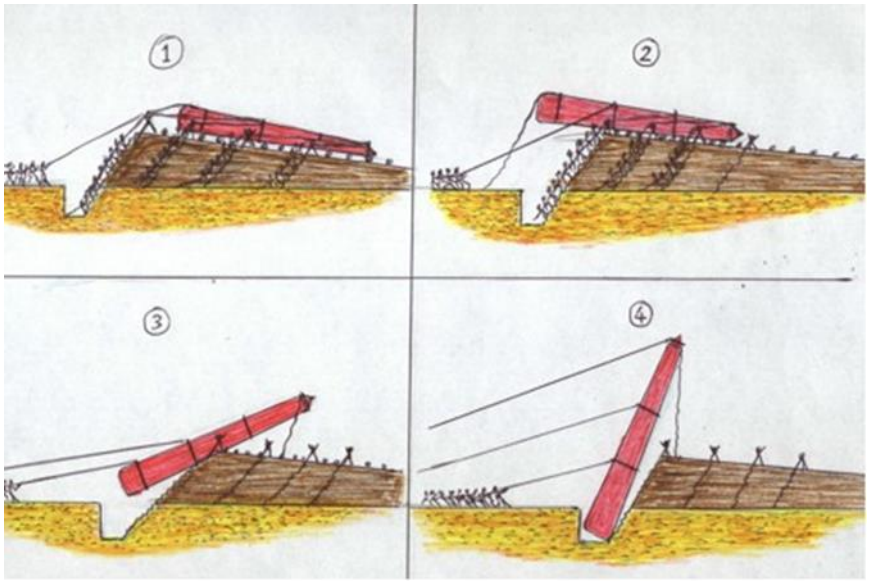

Figure 2-1: Ancient Technology in Construction

Figure 2-2: Modern Technology Nowadays

2.8.13 Differing Site Conditions

This cause of changes happens most of the time on soil conditions in building construction. The contractor may face rock instead of soft soil as the tender document may have indicated. This will require extra effort for excavation and extra compensation to the contractor. This type of changes occurs mostly on renovation or revamp projects where new constructions interface with existing structures and require things to be re-evaluated.

2.8.14 Shortage of Skilled Labour

Certain jobs may require certain expertise that is not available in the local market and that reason make the owner or consultant have to think other ways for example by modify the method or procedure of construction. This type of change is more likely to happen in construction involving some degree of technological complexity or expertise and not in normal building construction.

2.8.15 Lack of Equipment

Like the other factor of change that has been mentioned, the lack of equipment or machineries may force a change to the plan. For example, lifting of some heavy structure may require the special crane that is not available in the country and that may force the contractor to think of other lifting methods. The issue in this problem comes from the fact that some designs are done outside the country by the companies that not familiar with the resources available in the local area. This required full participation of the owner and consultant during design will minimize this source of changes.

2.8.16 Defective Workmanship

Defects can arise because the work was not carried out in a 'good and workmanlike manner' in accordance with good practice or a particular design, or because the wrong materials have been used – matters which would usually be the responsibility of the building contractor and its supply chain. Alternatively the designer could be at fault, because a particular design is not working in the manner that it should. In the frequently used design and build scenario, the contractor would normally have primary liability for both types of failure – although it may have consequential claims against its designers and supply chain. Defective workmanship of completed work may bring about demolition and re-work or may bring about changes in some instances.

Figure 2-3: The Example of Defective Workmanship

2.8.17 Weather Conditions

Weather conditions can affect many aspects of the construction project from site work to worker comfort. For the purpose of this discussion, weather conditions are divided into hot and dry, cold, wet, thunderstorms, and windy. The most common effects are briefly mentioned for each condition (Crissinger, 2005). Those cause is an example of the force majeure condition and sometime, the contractor are force to change the design or work schedule due to this conditions.

Figure 2-4: Raining Season May Affect the Work Progress

2.8.18 Safety Consideration

If some safety aspects were overlooked during the design phase, the owner or consultant may initiate a change to install additional safety features in the facility. This cannot be different from any other design oversight, except for the fact that safety is usually un-compromised. The addition of specific safety controls such as a relief valve in an industrial facility or an escape door in a building is typical of such changes.

2.8.19 Politics

Political environment is concerned with government policy and the effect of political decisions upon construction projects. The significant roles played by the government in the construction industry are mostly clients, regulators of the national economy, and regulators of the construction environment such as laws that guide ethics and construction practices and many others. This inferred that governments can significantly increase or decrease the demand for construction services through budgetary measures and monetary policies (Akanni et al., 2015). In its capacity as regulators of the construction environment, governments influence the development and building approval processes and enforce compliance with Acts and Regulations. As observed by Mansfield et al. (1994), governments may also invoke their powers to initiate or stop projects on political, social and environmental grounds. Political stability, national unity and good political leadership are thus crucial to national development.

Figure 2-5: East Coast Rail Link (ECRL) Ground Breaking Ceremony

2.8.20 Social-cultural factor

The socio-cultural dimensions of the environment consist of customs, lifestyles, and values that characterize a society (William, 2002) while population demographics, rising educational levels, norms and values, language and attitudes toward social responsibilities are examples of socio-cultural variables (Engobo, 2009). These variables have the potential to influence or affect organizations that operates within the society.

The study of Engobo revealed that Delta State communities shared most of the aforementioned variables as it comprises mainly Igbo (Anioma people), Urhobo, Isoko, Ijaw and Itsekiri and in the management of construction projects within the communities, ‘‘Pidgin English’’ which is an adulterated form of the English language is commonly used for oral communication among the illiterate workforce. Also the incessant kidnapping of expatriate construction workers, militancy and the demand by the groups of unemployed youths for illegal fees popularly called ‘‘settlement’’ which usually causes delays ranging from days to weeks on construction activities are examples of the lifestyles. Thus, William and Engobo signaled that managers and supervisors of construction work within this region need to adopt appropriate leadership styles in the management of projects to avoid unnecessary time and cost overruns (Akanni et al., 2015)

2.8.21 The Scope of Work for the Contractor is Ill-defined

This might happen for example when work is contracted to different contractors but the boundaries are not made clear. It takes quite extensive efforts to draw the boundary lines between different packages or phases of the same projects especially in large complex projects where all systems are virtually interconnected. Clear demarcations on drawings besides clarifying notes are a must to avoid such situations. In many instances, the owner contracts a third party to do work that he thought was included but cannot prove it was.

2.8.22 Ill-defined Project Objective

As been stated by Al-Dubaishi (2000), this might be a sub-category of change of design or plans but specifically indicates that the objectives of the project were not well defined.

2.8.23 Unforeseen problems

Unforeseen problems can be defined as a problem that are not been expected to happen for example jurisdictional fees and prerequisites, decay and dry rot, existing conditions for the situation example where the older owner failed to mention in the contract, hazardous materials, and also damaged items.

2.8.24 Long lead procument

Initial acquisition of materials or parts to accommodate initial use or long turnover. The contractor may choose to seek pre-granting commitments approved by the buyer to meet the long term requirements.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter is about method and types of project that will be used and conducted in this study. The study included a literature review on the relevent respondants from contractor point of view based on given question, to identify the problem may arise by design changes and identify suitable method to solve the problem occurs by the changes in Malaysia. The selected contractors were seen as representation of the Malaysian construction industry for managing design changes in construction. Selected contractors need to have different backgrounds and experiences, and are considered reliable samples by researchers as they will represent different groups in the construction industry. Flowchart is provided below to illustriate flow of research:

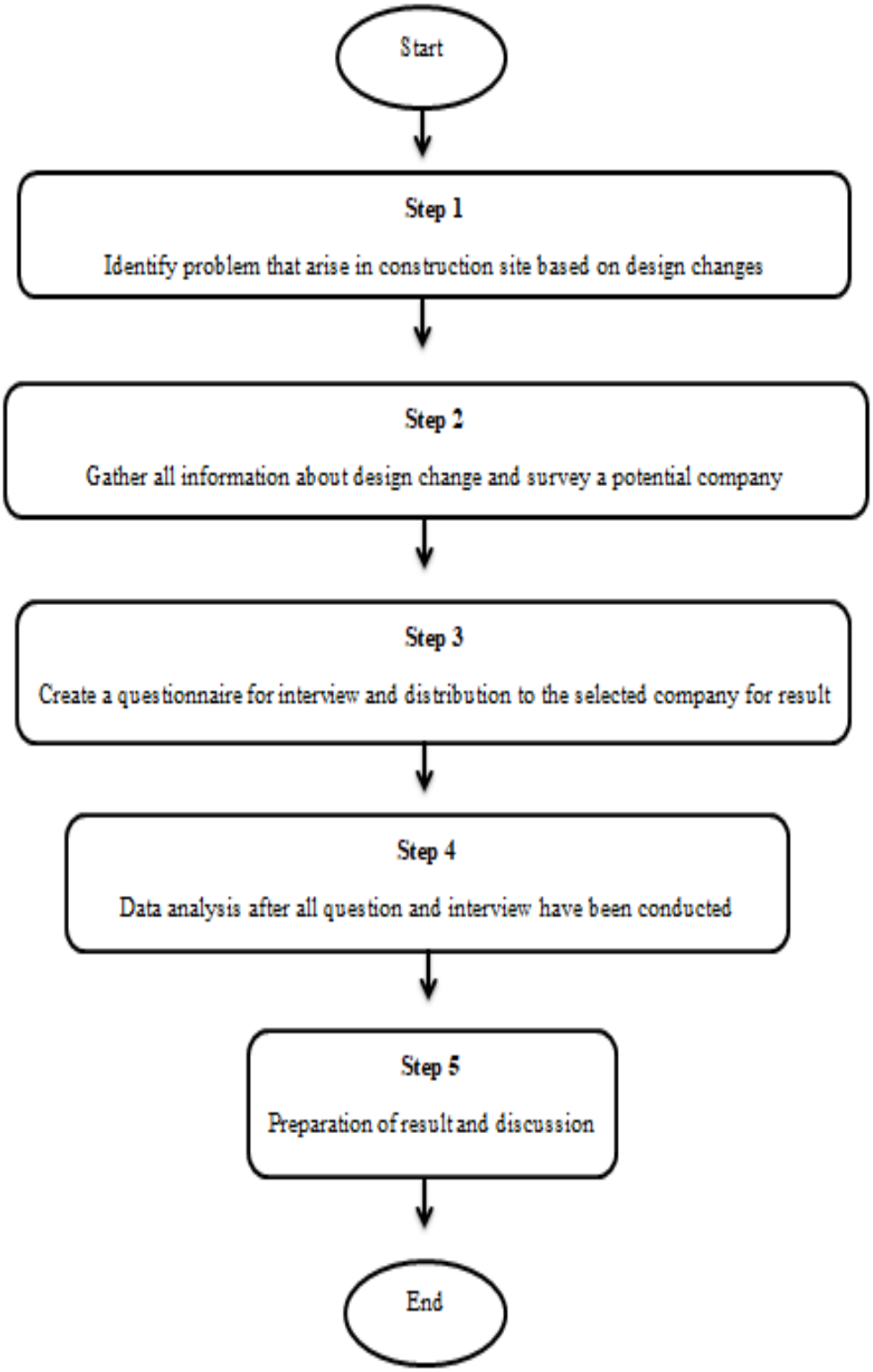

Figure 3-1: Flowchart for Methodology Process

3.2 Identify Problem & Issue

Usually, to identify the problem statement, the issue about design changes order can be found in articles, newspapers, journals, thesis and book. The problems statements was analyzed as the issues happened and stated by the author of all these sources.

3.3 Population and Sampling

Population is the whole gathering of individuals, articles or occasions that viewed properties. The target of population for this study is that contractors engaged with construction project in East Coast of Malaysia. Testing is a procedure, measures or strategies used to choose the suitable examples or part of the populace to decide the characteristics or parameters of the overall population. The methodology utilized used by researchers to assemble individuals, questions or places in the study. It is the way toward choosing a person or object from the chose populace and certains delegate components of the attributes of the whole populace.

Testing can be partitioned into two classes, probability and non-probability sampling (Latham, 2007). Probability sampling is the random sampling and non-probability sampling known as non-random sampling. In this study, non-probability sampling which convenient sampling is utilizes on account of nature in study and the surveys will accommodate review from grade A contractor that has enrolled with the CIDB as a respondents. 54 contractors from different organization that vary around East Coast of Malaysia has been registered as respondent for this study.

3.4 Questionnaire Development

The consultants and contractors interviewed, were randomly chosen and considered as convenience sample. The selected companies had different backgrounds and experiences, and assumed to be reliable samples by the researchers as they will represent different groups in the construction industry. All chosen consultant and contractors were companies with extensive experience in civil, infrastructure works and structures for the commercial, industrial and residential uses, among others. Meanwhile, the respondents interviewed were experienced project managers and engineers with extensive involvement in construction projects. The interviews were conducted to obtain objective for the research produce by the researchers based on literature review.

There were limitations to this research which could have inadvertently affected the results. Some of the selected firms were unresponsive and unsupportive, therefore making the data for the research incomplete and possibly biased. There were also time limitations to complete the research, thus fewer interviews were conducted than initially planned for.

3.5 Types Of Question

Below is type of questions that can be included in questionnaires:

3.5.1 Open question questionnaires

Open questions differ from other types of questions used in questionnaires in a way that open questions may produce unexpected results, which can make the research more original and valuable. However, it is difficult to analyze the results of the findings when the data is obtained through the questionnaire with open questions.

3.5.2 Multiple choice question

Respondents are offered a set of answers they have to choose from. The downsize of questionnaire with multiple choice questions is that, if there are too many answers to choose from, it makes the questionnaire, confusing and boring, and discourages the respondent to answer the questionnaire.

3.5.3 Scaling Questions

Also referred to as ranking questions, they present an option for respondents to rank the available answers to the questions on the scale of given range of values (for example from 1 to 10).

3.6 Sources Of Data

The study depended on both primary and secondary data. Primary data was made up of first-hand data collected by the candidate through the use of questionnaires, interviews and site visits (observation). The secondary sources of data were obtained using relevant books, journals, magazines and research papers.

3.7 Research Instrument

The research data was collected mainly through interviews and questionnaires. Field observations through site visits were also employed to gather data on design changes .

3.7.1 Questionnaire Design

The questionnaire, which consisted of 4 section that is closed-ended questions was designed to obtain data on the sources and causes of design changes, the questionnaire further sought to obtain information on the level of knowledge of construction professionals on the concept and benefits of lean construction. Interviews were also used to obtain more specific information about material waste and lean construction. The answer in in the form of scale from 1 to 5 which is 1for strongly disagree, 2 for disagree, 3 for average, 4 for slightly agree and 5 for strongly agree. In addition the background of the respondents also will be including in it to know their contribution in the project and experiences in construction industry. The reasons in adopting this simple answer are to provide the simplicity for the respondent to answer and easier to make evaluation of collected data. The questionnaire will be designed in order to get the respondent's opinion and views related to the objectives of this study. This questionnaire will be distribute using Google forms to make sure there is no waste of time for respondent and can be fill at any time and any where's.

3.8 Processing and Analyzing Data for Result

All the result that have been collected from the questionnaire are tabulated to the graph and the data will be gathered and tabulated accordingly based on the returned questionnaires and the interview responds and feedback. The graph will be the medium for the percentage distribution which will present the respondent's profiles data such as work sector, job position, working experience period and others.

3.8.1 Microsoft Excel

Microsoft excel will be used to calculate average index for data that we get. The average index will be calculate by using formula below:

$$Average\ index(AI) = \frac{\Sigma aixi}{\Sigma xi}$$

Where :

a = constant which represent the weightt of the i

x = the variable that represent the frequency of respondant i

I = 0,1,2,3,4, ……

The result of frequency analysis and the average index for each of the causes are tabulated in the same table. The highest values of average index shows the most important factor. This average index can be convert to percentage of index. Classification of the average index was referred to Abd. Majid and McCaffer (1997):

1. 1.00 ≤ average point ≥ 1.50
2. 1.50 ≤ average point ≥ 2.50
3. 2.50 ≤ average point ≥ 3.50
4. 3.50 ≤ average point ≥ 4.50
5. 4.50 ≤ average point ≥ 5.00

3.8.2 Relative Importance Index

The data collected from the questionnaire will be analyzed by using relative importance index method (RII). Kometa et al. used the relative importance index method to determine the relative importance of the various causes and effect of delays. This method also will be adopted to this study. The point scale ranged from 1 (disagree) to 5 (strongly agree) was adopted and trasformed to relative importance index (RII) for each factor as follow:

$$Relative\ importance\ index = \frac{\Sigma W}{\mathrm{A\ x\ N}}$$

Where:

W = point given for each factor by respondents

A = highest point (i.e. 5 in this case)

N = total number of respondent

This RII value will indicate the range number from 0 to 1 that represent less effect to most effect.

*1 = Less Effect	$0.1 \leq RII \geq 0.2$	*4 = More Effect	$0.6 \leq RII \geq 0.8$
*2 = Rarely Effect	$0.2 \leq RII \geq 0.4$	*5 = Most Effect	$0.8 \leq RII \geq 1.0$
*3 = Average Effect	$0.4 \leq RII \geq 0.6$		

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

The problem occurred from design changes in construction project is the important things that need to be giving more attention. It is very important to get the result of the design changes affecting construction project so that those result can be used to overcome the problem of design changes. This study is about the design changes affecting the construction project that analysing the collected data throughout the questionnaire survey.

The technique that be used to analyses the data collected from questionnaires survey is frequency analysis and relative important index (RII). The set of questionnaires was distributed in East Coast Malaysia focused on contractor perspective.

For the collection data and the analysis, to achieve the objective of this study the questionnaires were divided to 4 parts which are:

Part 1: Background information

Part 2: The causes of design changes

Part 3: The effect of design changes

Part 4: How to improve the design changes

4.2 Initial Analysis of Background Information

The first analysis that been done is about the background information of the respondent. As mentioned before, this study only involves East Coast of Malaysia that is Kelantan, Pahang and Terengganu. From the analysis, the frequency value of Kelantan is 24%, Pahang is 48%, while Terengganu shows 28% of respondent. The pie chart below shows that Pahang states is the higher percentage while Terengganu is in the second place and for the third position goes to Kelantan.

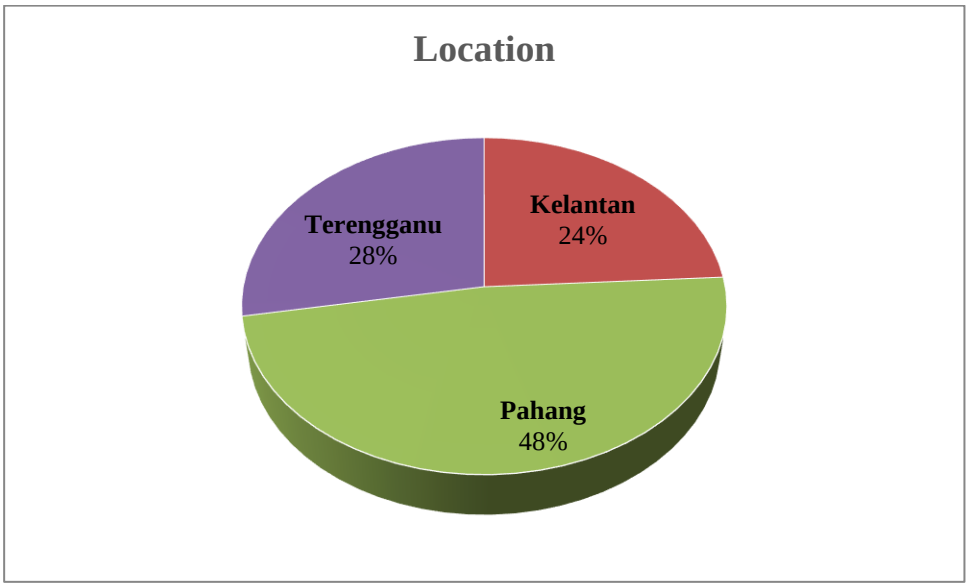

Figure 4-1: The Location of the Study

For the position of the respondent in the industries, the first rank was engineer with the percentages of 33%. This is because in a construction organization, there are more than one engineer involved in construction where work is divided into three groups that are civil, electrical and mechanical work. The second place was held by a quality surveyor which recorded 24% followed by site supervisor and others which shared the third place with a percentage of 15%. Subsequently, for the fourth which recorded a 7% goes to project manager and the final place for this part is quality assurance with 6% respondents. Other position involves in this study are, accountant with 1%, accounts executive, project manager, safety, and also site engineer with 2% each, and assistant project manager with 4% of respondent.

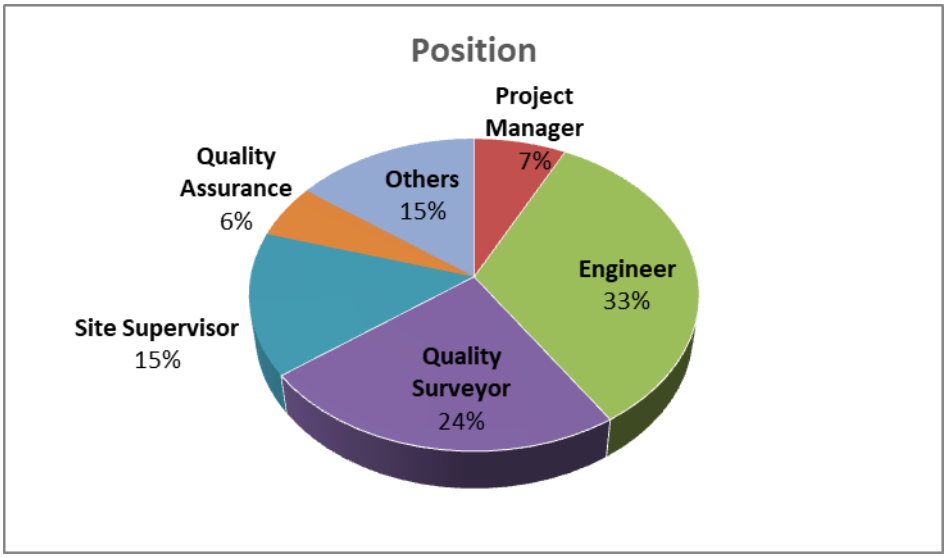

Figure 4-2: The Position of Respondents

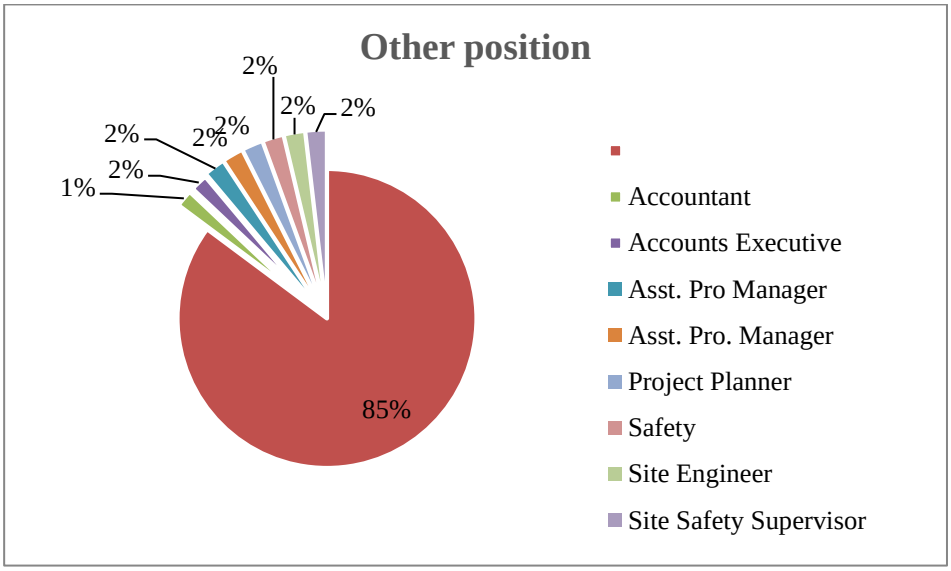

Figure 4-3: Other Position of Respondents

For academic qualification, mostly in degree holder. There are about 65% of percentage. This is because most of them are engineer. 20% of diploma mostly are site supervisor and 15% of master which is involving project manager, quality surveyor, and quality assurance.

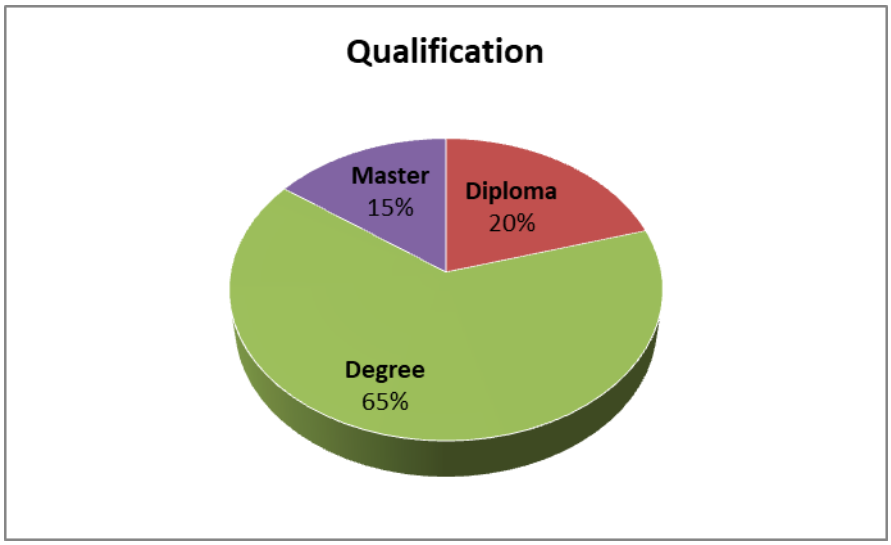

Figure 4-4: Academic Qualification of Respondents

For the years of experience obtained by respondents, it is divided into five, which is 1-5 years which records the highest percentage of 46% followed by 11-15 years by 22%. Third place is 16-20 which recorded 17% and fourth with 13% with 6-10 years. 20 years & above recorded the last position with a percentage of 2%.

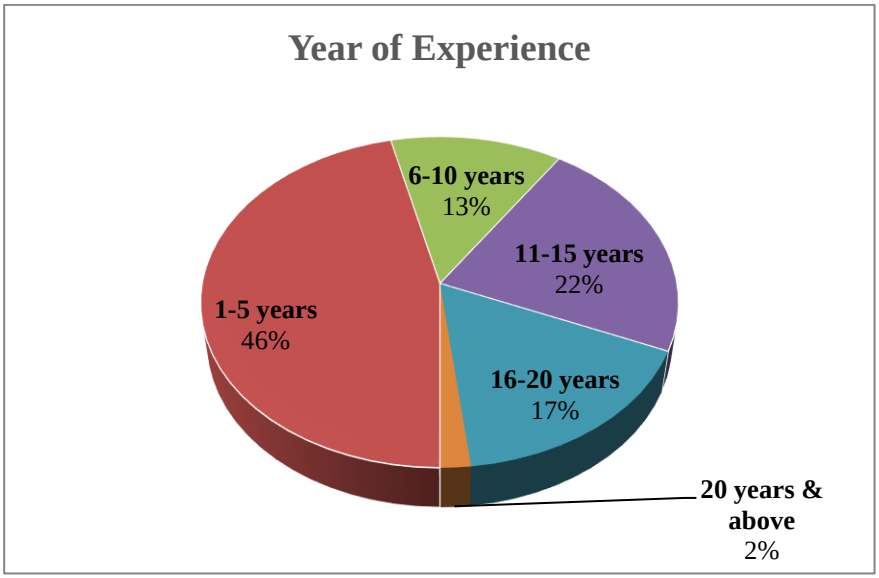

Figure 4-5: Years of Respondent's Experience

For the total number of projects participated by the respondents, the 1-5 project was the highest number that recorded 43% of the total respondents followed by 6-10 projects where 35% are the number of percentages recorded. For the third place, 11-15 projects were selected because they recorded 17% of the total and it was ahead of the 16-20 project which recorded only 5%.

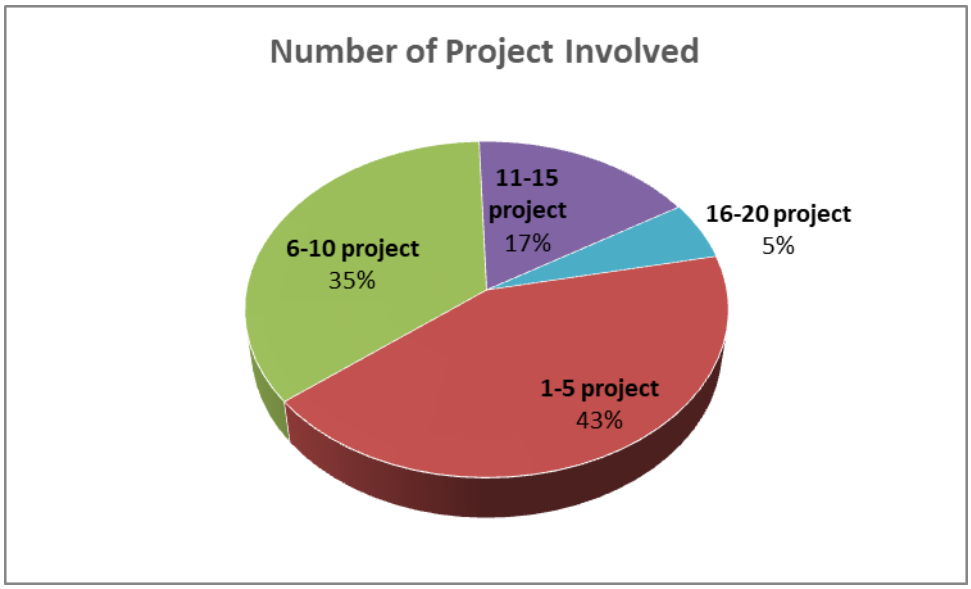

Figure 4-6: Project has Been Involved

The last question for the background information is “How many project has you execute occurs design changes?”. For this question, most of respondents answer 1-5 project has changes their design that is 78% followed by 6-10 project that is 15%. The third place is 11-15 project has changes their design involving 7% of respondents. Based on the answer for this question, the years of working experience plays a role in determining the number of design changes.

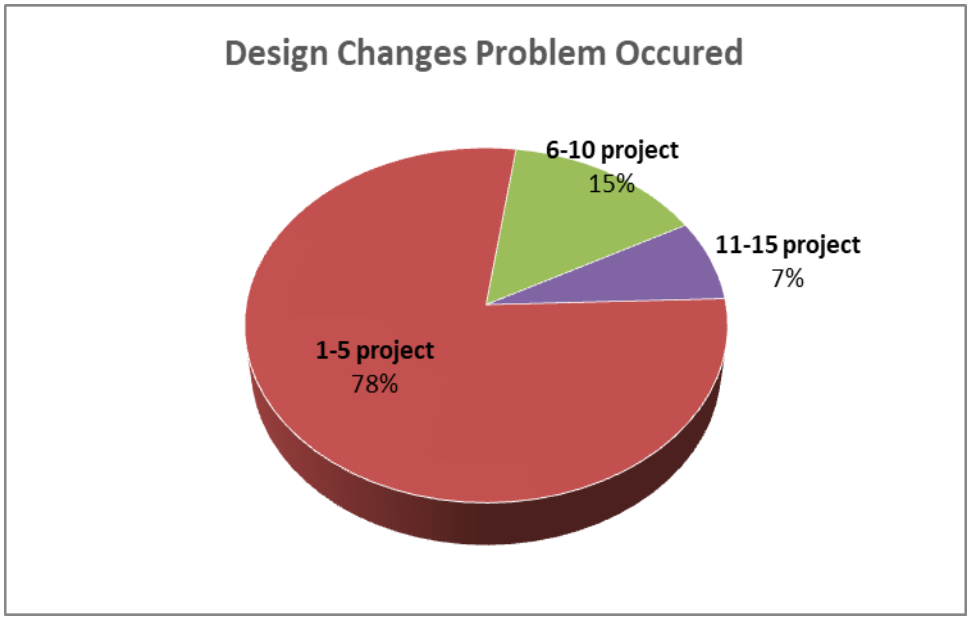

Figure 4-7: Design Changes Faced by Respondents

4.3 Analysis of the Causes of Design Changes

The results obtained from the questionnaires of the causes of design changes are very important information in achieving the objectives of this study. There are 37 sources related to design changes that need to be selected by the respondent when reviewing the given survey and all of them are listed in the table. The results of this study can help the researcher list down the popular causes to less popular by relative importsnce index (RII) value. From the table below, a bar graph has been made to summarize the result.

Table 4-1: Causes of Design Changes Affecting the Construction Project

Causes of design changes effecting the construction project	**Respondent Frequency**					**RII**
	*1	*2	*3	*4	*5	
Changes in design	0	0	9	18	27	**0.866**
Current economic situation	0	2	13	23	16	**0.796**
Error or omission occurred during construction phase	0	1	13	28	12	**0.788**
Replacement of material and procedure	0	2	10	33	9	**0.781**
Lack of data and information required for design	0	3	14	24	13	**0.774**
Weather condition	1	2	13	23	15	**0.77**
Changes of design specification	0	3	13	25	13	**0.77**
Owners financial problems	1	7	5	27	14	**0.77**
Safety consideration between surrounding, civilian, worker, and equipment	1	3	13	25	12	**0.762**
Government regulation changes	2	1	15	24	12	**0.759**
Improper design planning	0	3	19	18	14	**0.759**

Different site's geological conditions	0	4	12	30	8	**0.759**
Financial problems faced by contractor	0	4	12	24	14	**0.759**
Scope changes by owner due to lack of the information	0	3	15	26	10	**0.755**
Complexity of design complicate the work of contractors	1	4	12	27	10	**0.751**
Design discrepancies realized after project began	1	14	10	31	8	**0.751**
Impediment in prompt decision making process	0	1	18	26	9	**0.748**
Unfamiliar with site condition	1	6	12	27	8	**0.729**
Local social-culture factor	2	5	17	22	8	**0.726**
Lack of coordination	1	3	19	23	8	**0.726**
Poor of procurement process	1	5	17	22	9	**0.722**
Non-compliance of designer	1	4	14	31	4	**0.722**
Lack of communication between contractor and consultant	1	5	19	20	9	**0.718**
Inadequate project objective	1	3	20	24	6	**0.715**
Profitability from project	0	5	17	28	4	**0.714**
Lack of experiences of contractor	1	5	16	27	5	**0.703**
Inadequate scope of work of contractor	1	3	19	27	4	**0.7**
Consultant lack of experiences and professional	2	3	24	17	8	**0.696**
Lack of knowledge about the material and equipment	2	6	19	18	9	**0.696**
Technology changes over time	1	4	17	24	8	**0.692**
Unforeseen problems	1	10	16	19	8	**0.689**

Long lead procurement	1	5	19	26	3	**0.688**
Conflict between contract document	1	3	25	21	4	**0.688**
Lack of contractor involvement in design	1	5	26	19	3	**0.674**
Change of project schedule	1	5	30	10	8	**0.67**
Lack of skilled worker	1	7	25	16	5	**0.648**
Honest wrong belief	2	9	27	14	2	**0.622**

*1 = Less Effect $0.1 \leq RII \geq 0.2$ *4 = More Effect $0.6 \leq RII \geq 0.8$

*2 = Rarely Effect $0.2 \leq RII \geq 0.4$ *5 = Most Effect $0.8 \leq RII \geq 1.0$

*3 = Average Effect $0.4 \leq RII \geq 0.6$

From the causes of design changes affecting the construction project cost graph, it shows that changes in design are the popular choice shows 0.866 for the RII value. Then followed by current economic situation equal to 0.796, error or omission occurred during construction phase decrease to 0.788 while replacement of material and procedure indicate RII value of 0.781 and lack of data and information required for design shows 0.774.

Then weather condition, changes of design specification, and owners financial problems are shared same value of RII that is 0.77. Safety consideration between surrounding, civilian, worker, and equipment shows 0.762, while four causes that are government regulation changes, improper design planning, different site's geological conditions, financial problems faced by contractor sharing the same value of RII that is 0.759.

Meanwhile, scope changes by owner due to lack of the information stated RII value of 0.755. Next, complexity of design complicates the work of contractors and design discrepancies realized after project began shows RII are equal to 0.751 each. Then for impediment in prompt decision making process the RII value drop to 0.748.

For unfamiliar with site condition, it show the RII value is 0.729 on the top of local social-culture factor and lack of coordination with the RII are 0.726. Then, it decrease to 0.722 for poor of procurement process and non-compliance of designer. Lack of communication between contractor and consultant stated 0.718 and for inadequate project objective it shows the reading decrease to 0.715. Below it with the value of RII shows 0.714 goes to profitability from project.

Next, lack of experiences of contractor shows 0.703, inadequate scope of work of contractor is 0.7, while consultant lack of experiences and professional and lack of knowledge about the material and equipment shared the same value of RII that is 0.696 then it drops to 0.692 for technology changes over time.

Other than that, unforeseen problems indicated 0.689 for the value of RII then it drop 0.001 for long lead procurement and conflict between contract documents became 0.688. Meanwhile, lack of contractor involvement in design show that 0.674 for this causes, change of project schedule is 0.67 and lack of skilled worker drop to 0.648. Finally, most of the respondents agree that honest wrong belief is the lowest choice for the causes of design changes that affecting project cost with the value of RII is 0.622.

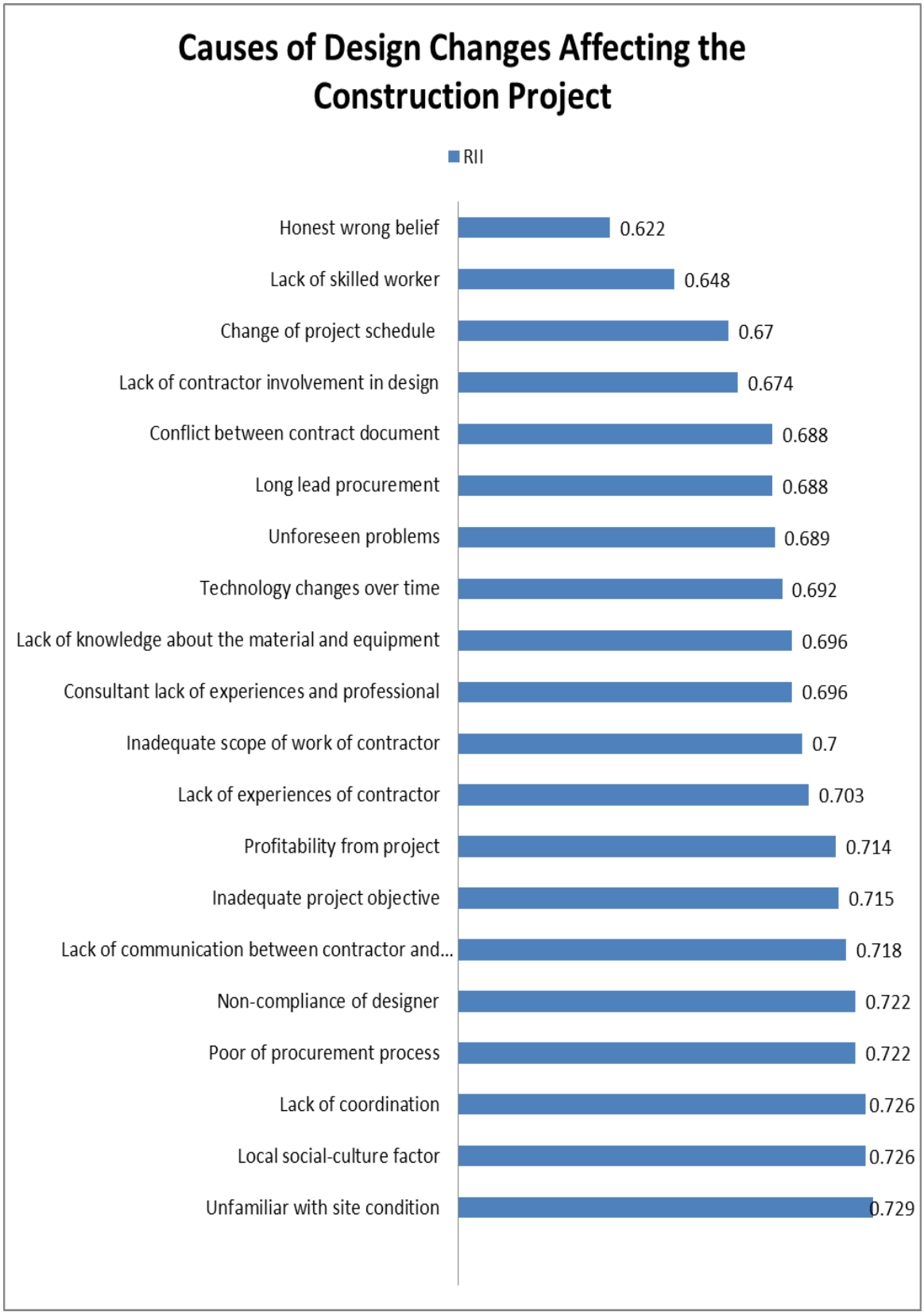

Figure 4-8: RII Value for Causes of Design Changes Affecting the Construction Project

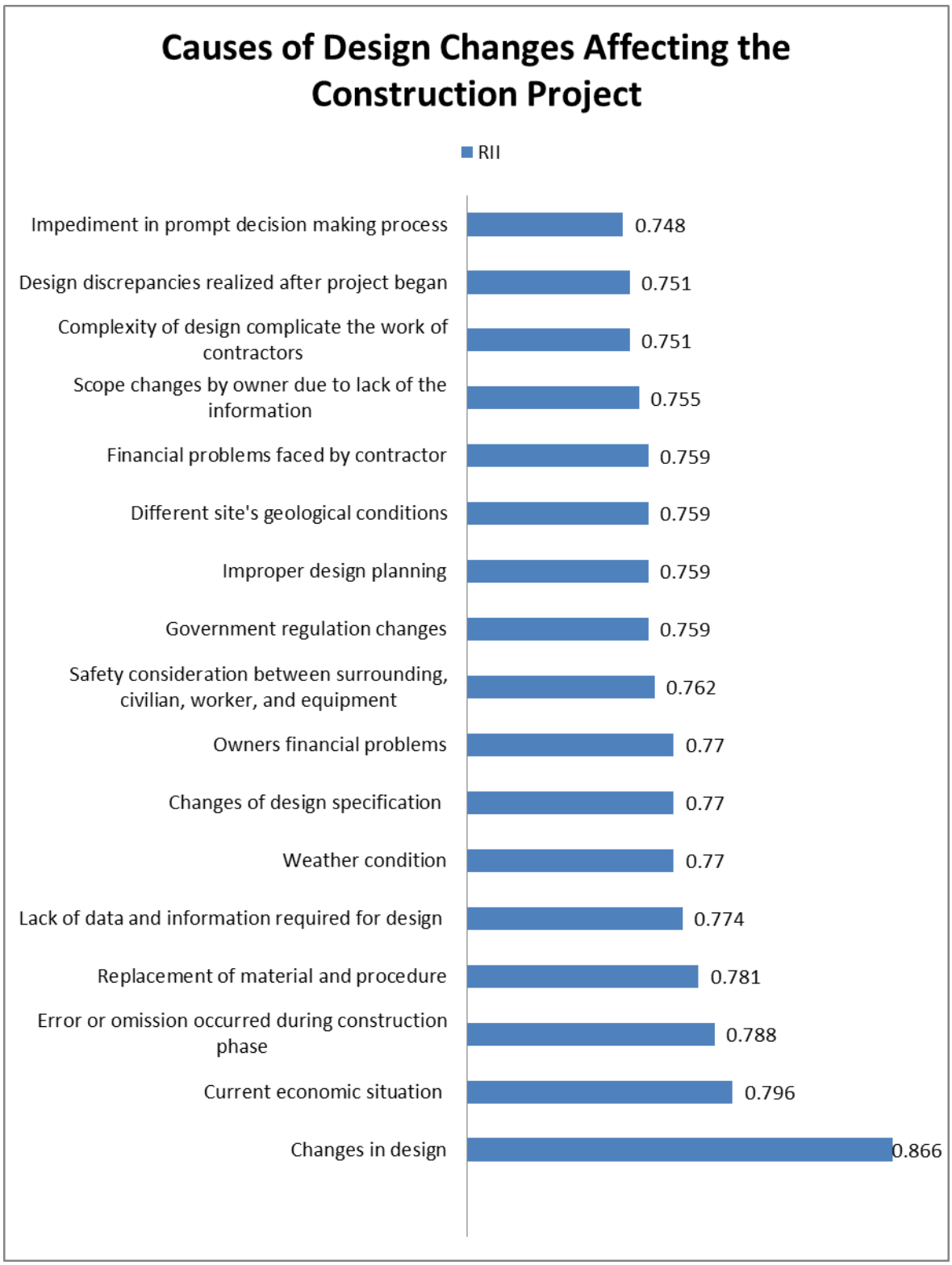

Figure 4-9: RII Value for Causes of Design Changes Affecting the Construction Project

4.4 Analysis of the Effect of Design Changes

The result regarding the effect of design changes is also important for this study where if every party aware about the effect of design changes, the design changes can be handling properly. There are 14 effects that was list out from the literature review. This 14 effect can make respondent easier to choose which effect that they thought is the most occur during construction.

Table 4-2: The Effect of Design Changes to the Construction Project

The effect of design changes to the construction project	**Respondent Frequency**					**RII**
	*1	*2	*3	*4	*5	
Cost overrun while conducting the project because cannot be done in time	0	0	11	26	17	**0.826**
Schedule delay due to the design problems	0	0	12	26	15	**0.811**
Additional payment to the designers because they have to designing other design	0	2	13	21	18	**0.807**
Reduce profits against contractors, consultants, and owners.	0	2	10	26	16	**0.807**
Budget cuts due to high spending on the design	1	1	12	18	21	**0.796**
Construction cost increase (construction materials)	1	0	12	30	11	**0.792**
Uncertain spending as it relies on the design	0	1	16	22	15	**0.785**
Tying down of client capital due to non-completion of the project	0	0	14	32	8	**0.751**
Higher peak quantities of labor or equipment required if the design specification are change	1	1	20	23	9	**0.744**

The performance of the project is low	0	2	19	25	8	**0.74**
Cost of machinery increased that depend on the design specification	0	4	20	18	12	**0.737**
Employee payment increase due to additional works	0	0	25	20	9	**0.733**
Time overrun when contractor cannot do any work due to the design problems.	0	2	23	23	6	**0.726**
Workers work slower or less efficiency	0	4	28	17	5	**0.692**

*1 = Less Effect $0.1 \leq RII \geq 0.2$ *4 = More Effect $0.6 \leq RII \geq 0.8$

*2 = Rarely Effect $0.2 \leq RII \geq 0.4$ *5 = Most Effect $0.8 \leq RII \geq 1.0$

*3 = Average Effect $0.4 \leq RII \geq 0.6$

From the table 4.4, it clearly shows that cost overrun while conducting the project because cannot be done in time states the high value of RII that is 0.826 while schedule delay due to the design problems indicated the RII value equal to 0.811. Additional payment to the designers because they have to designing other design and reduce profits against contractors, consultants, and owners decreace to 0.807.

Then the value of RII decrease to 0.796 for budget cuts due to high spending on the design and 0.792 for construction cost increase (construction materials). Uncertain spending as it relies on the design is 0.785 while tying down of client capital due to non-completion of the project show 0.751 value of RII. Next, higher peak quantities of labor or equipment required if the design specification are change indicated 0.744.

The performance of the project is low shows 0.74 for the value and cost of machinery increased that depend on the design specification is 0.737. Below that, employee payment increase due to additional works indicate the value of 0.733 while time overrun when contractor cannot do any work due to the design problems stated 0.726. Lastly, workers work slower or less efficiency is the effect that contractor need to worry less because it just shows 0.692.

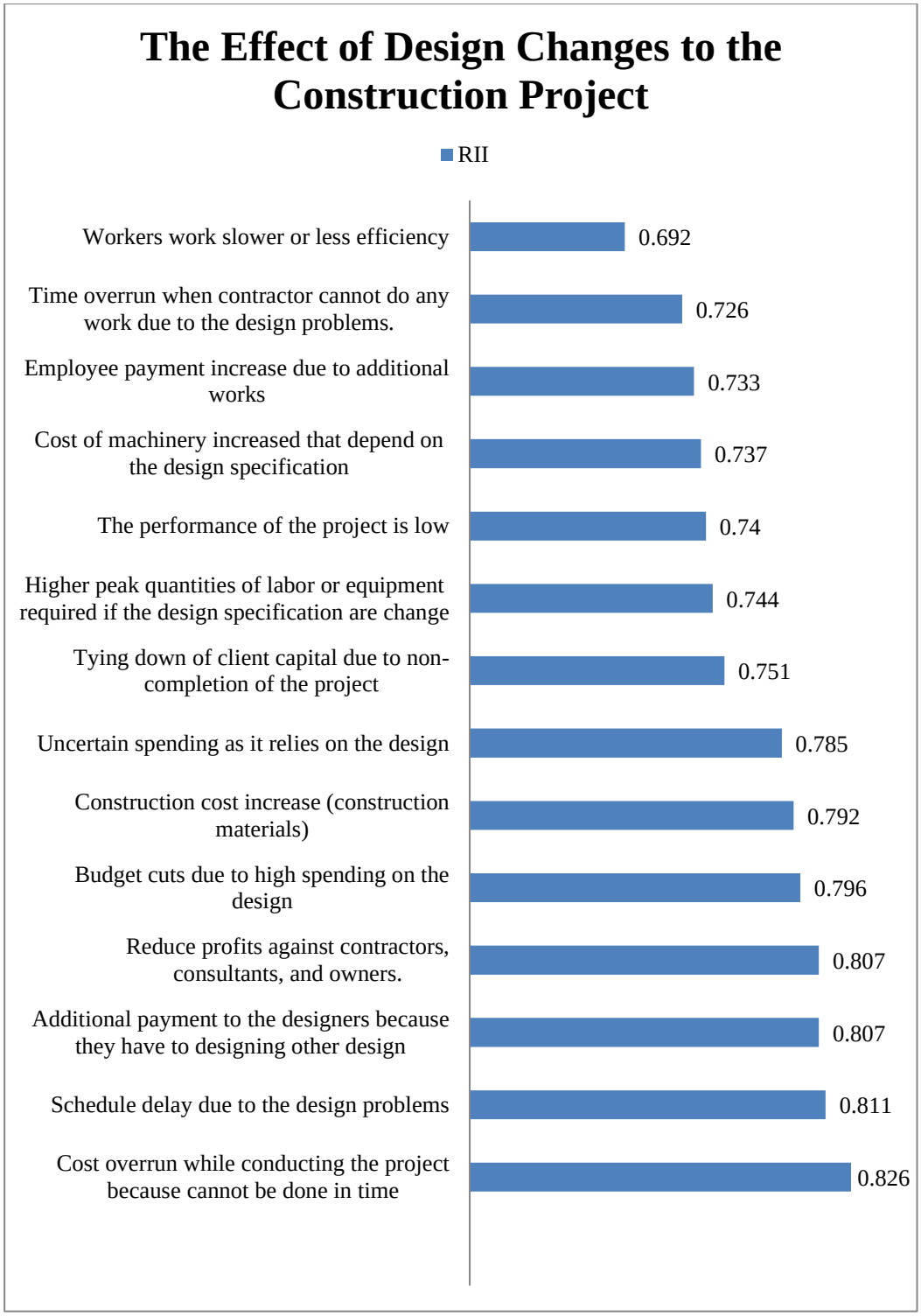

Figure 4-10: RII Value for the Effect of Design Changes to the Construction Project

4.5 Analysis of how to improve design changes problems

The result of how to improve design changes problem is the last question in the questionnaires. These are the several ideas get from the literature review used to get the opinion from the respondent what are the improvement will be the best solution for the design change problem that affect the project cost.

Table 4-3: How to Improve Design Changes Problem?

How to improve these design changes problem?	Respondent Frequency					RII
	*1	*2	*3	*4	*5	
Look for another solution other than changing the design.	0	1	9	21	23	**0.844**
Communicate with others that involved. Effective communicate is vital to the successful completion of any construction project.	0	0	11	22	21	**0.837**
Awarding bids to the right/experience consultant and contractor	0	0	15	15	24	**0.833**
Ensure that the site conditions are suitable with the design by collecting as much information and data as may be relevant to the site condition.	0	2	8	19	24	**0.829**
Ensure adequate financial resources to cover any expenditure during construction work.	0	1	13	18	22	**0.826**
Planning the construction of the project carefully and in detail.	0	0	14	23	17	**0.811**
Get confirmation of the design from all parties involved with construction before project started.	0	1	12	26	15	**0.811**
Identifying potential problems in design before the project starts	0	1	12	26	15	**0.803**
The consultant should play a role to avoid any design changes.	0	3	11	23	17	**0.8**

Ensure that the owner is satisfied with the design	0	1	12	28	13	**0.796**
Choose a professional and experienced designer for design work	0	2	11	28	13	**0.793**

*1 = Less Effect $0.1 \leq RII \geq 0.2$
*2 = Rarely Effect $0.2 \leq RII \geq 0.4$
*3 = Average Effect $0.4 \leq RII \geq 0.6$
*4 = More Effect $0.6 \leq RII \geq 0.8$
*5 = Most Effect $0.8 \leq RII \geq 1.0$

Look for another solution other than changing the design is the most selected improvement by the respondent that indicated 0.844 for the RII value while communicates with others that involved where effective communicate is vital to the successful completion of any construction project shows RII value drop to 0.837.

Awarding bids to the right/experience consultant and contractor is 0.833. Next, ensure that the site conditions are suitable with the design by collecting as much information and data as may be relevant to the site condition shows 0.829. Other than that, for the method of ensure adequate financial resources to cover any expenditure during construction work shows 0.826.

Meanwhile, planning the construction of the project carefully and in detail shared the same RII value with get confirmation of the design from all parties involved with construction before project started as much as 0.811. Identifying potential problems in design before the project starts shows 0.803. For the method of the consultant should play a role to avoid any design changes drop 0.003 become 0.8. Ensure that the owner is satisfied with the design become second last choice for the improvement that indicated 0.796. Lastly, choose a professional and experienced designer for design work become the last choice that show 0.793 for the RII value.

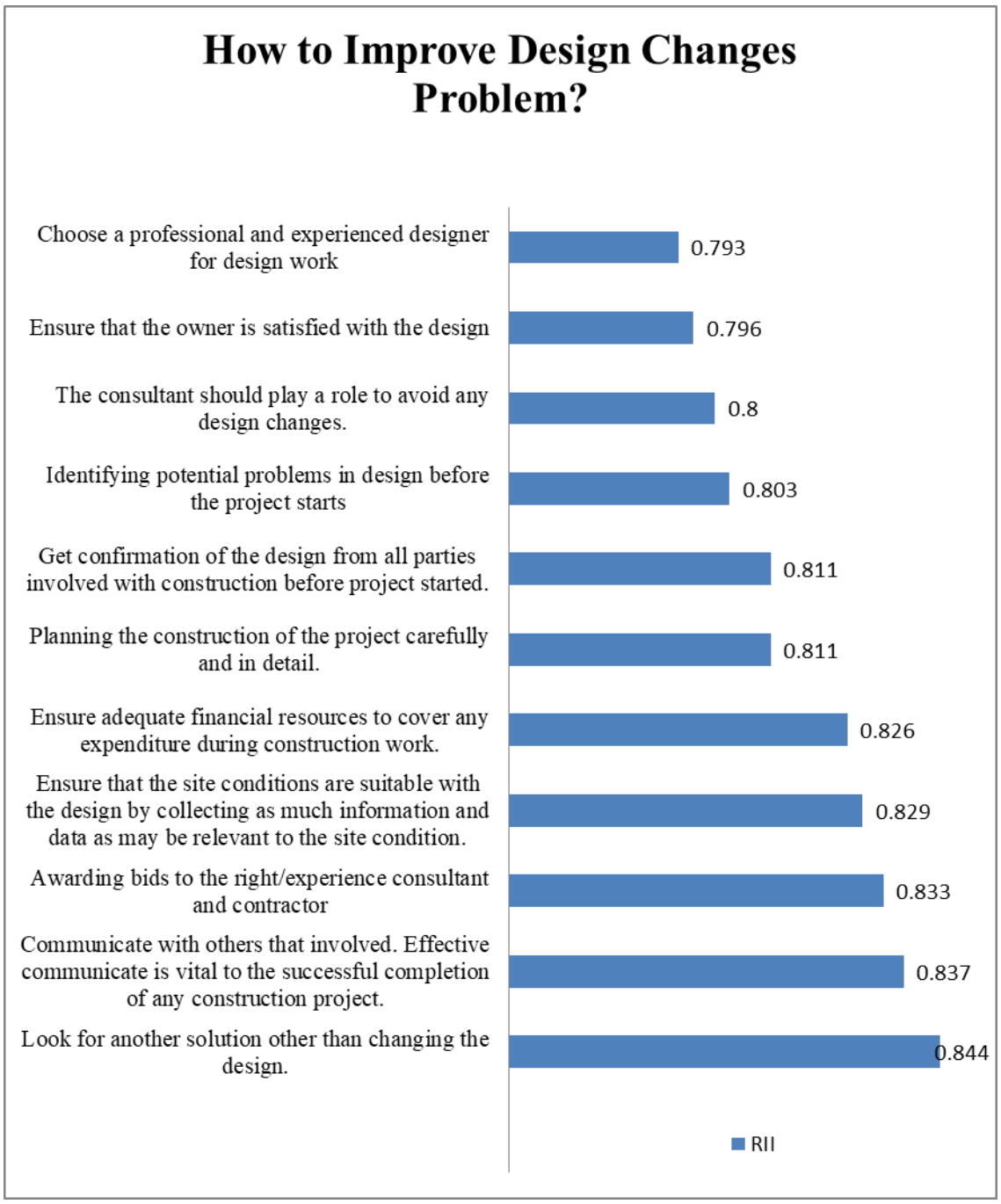

Figure 4-11: RII Value on How to Improve Design Changes Problem

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

In this chapter, the study is concluded and few recommendations on study matters are discussed. All of the discussion based on the analysis and result from previous chapter and this is the end of part of this study. The conclusions are made to answer the two objectives of the study by listing five factors or the main way for each objective and recommendations are personal observation and review while conducting this study.

5.2 Conclusion for Objective of Study

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

5.2.1 Objective 1: Study the cause of design changes affecting construction project

In this study the cause of design changes affecting construction project has been obtained from the literature review and discussed in chapter 2 where all information related design changes are listed and described. In this discussion, it is more of a description of the purpose of design change, change order, describes the basic of change, the definition of rework, standard of changes, causes of design changes and it elaboration. For easier explanations, this objective aims to provide more insight into the topic of this study.

5.2.2 Objective 2: Identify the causes of design changes that affecting the construction project

This objective has been achieved with a literature review conducted and discussed in chapter 2. To get a view from the contractor, the source of the change is then listed in the survey form and distributed to be filled by the selected respondents. Among the findings of this study are as follows:

i. Changes in design (0.866)

ii. Current economic situation (0.796)

iii. Error or omission occurred during construction procedure (0.788)

iv. Replacement of material and procedure (0.781)

v. Lack of data and information required for design (0.781)

From the East Coast of Malaysia contractor point of view, the main causes of changes affecting the construction project cost are due to the factor of changes in design, where design changes involve multiple parties and they all have to be paid to solve the problem. We all knows that a new design take a great deal to be completed. Current economic situation nowadays also one of the causes that affecting the project cost where all materials used in construction are dependent on the current price and if for example the design change had to be made today and after a few months then the prevailing market price of building materials increased this would cause the cost the contractor.

Besides that, error or omission occurred during construction phase is also the most chosen causes that effecting the project cost where mistakes occur during construction works require high spending to be completed. For example, errors in the design of an underground pipe installation that did not follow the invert level caused them to re-excavate the ground and do two works that is unplugging and re-installing the pipe according to the invert level and if the pipe is not safe to use, they have to change that pipe with the new one and that also the cost that they have to bear. Replacement of material and procedure of work and also lack of data and information required for design are also the causes that have been choose by the respondents. The

occurrence of this matter is closely related to the problems faced by the owner himself apart from the political and bureaucratic nature of the Malaysian construction industry.

If the owner has a problem with their acceptance with the original design, they will ask for the design to be changed according to their wishes. This results in an increase in spending to produce a new design. Moreover, the great influence of a politician also plays a big role in this problem when they have a very strong influence and may request to change the design at any time if they want to make other development close to the workplace area.

5.2.3 Objective 3: Identify the effect of design changes to the construction project and how to solve it

This objective has been achieved by conducting an empirical study through a survey form conducted solely to the respondents from the contractor perspective. All the data have been analysed and some are illustrated as below:

1. The effect of design changes:

   i. Cost overrun while conducting the project because cannot be done in time (0.826)

   ii. Schedule delay due to the design problems (0.811)

   iii. Additional payment to the designers because they have to designing other design (0.807)

   iv. Reduce profits against contractors, consultants, and owners (0.807)

   v. Budget cuts due to high spending on the design (0.796)

Every problem that happens will have its own effect. In the design changes there are also effects, especially cost. Based on the study that has been conducted, the major effects of design changes to the construction project cost are cost overrun while conducting the project because cannot be done in time. This is because the payment claim process can only be made if the working phase is completed.

If there is a change in the design, the contractor has a problem with making a claim because it has delayed their work process. As has been said, design changes can also make the working schedule delayed. This matter not only stops there, if the design changes occur, this will causes the additional payment to the designers because they have to designing other design that follow the owner need and specification. This also will reduce the profits against the parties involves especially contractors, consultants, and also the owners causes budget cuts due to high spending on the new design.

2. The ways on how to solve it:

i. Look for another solution other than changing the design (0.844)

ii. Communicate with others that involved. Effective communicate is vital to the successful completion of any construction project (0.837)

iii. Awarding bids to the right/experience consultant and contractor (0.833)

iv. Ensure that the site conditions are suitable with the design by collecting as much information and data as may be relevant to the site condition (0.829)

v. Ensure adequate financial resources to cover any expenditure during construction work (0.826)

Through the research, many respondents agree and choose to look for another solution than changing the design because design changes not only burdens one side but also burdens all parties involved in terms of energy, time, and especially finance. Finding a new alternative to solve this problem is an indispensable way in this industry to enable maximum energy, time, and financial savings to be possible. Other ways that they choose is to communicate with others that involved in the project. This is because effective communication is vital to the successful completion of any construction project. There will make all parties to be more understood with their scope of work and this will make the work done smoothly without any changes. Besides that, the owner or the parties involves in awarding the bid should be considered to award the project to the right or most experience consultant and contractor.

Extensive experience in construction can prevent undesirable problems occurred and if those things happen, they should have a way to solve the problem by using their expertise and experience before. To carry out the construction work, they have to ensure that the site conditions are suitable with the design by collecting as much information and data as may be relevant to the site condition. Sometimes the data obtained is insufficient and it causes difficulties for designers to design buildings according to the characteristics required by the owners and if the designs do not follow the specifications specified and the soil structure condition is also incapable of accommodating the load, this is likely to cause major disaster in construction. Lastly, the owner, consultant, and also contractor have to ensure adequate financial resources to cover any expenditure during construction work. If they have enough finance it is certain there is no undesirable thing happen in the event that requires a sum of money to settle the problems.

5.3 Recommendation

From this study, some recommendations can be given as follow;

i. This study was based on the contractor's point of view and for the recommendation, they should not take projects beyond their ability level. This is because many say that the lack of expertise by the contractor is one of the reasons for the design change that has increased the cost of the project. The contractor also needs to increase their management level to increase the level of capability of their company. They also need to have sufficient experience, technical capability, and sufficient manpower to execute the project.

ii. The client also should not interfere frequently during the work progress and keep making changes to the design or requirements. This can cause in ordinate delays in the project. They also need to pay the contractor in time after completion of work. The client also must make quick decisions to solve any problems that arise during the execution.

iii. The issue of causes and effects of design changes affecting the project cost is not an easy topic to be studied. There are many subjective parameters involve caused by the unique nature of the construction process itself. Furthermore the views on the issues can be varied from different parties in the industry. To further understand on the issue, it is also good to study on other parties' point of view so that comparison can be made on a wider scope and better measures can be proposed for the benefit of all the stakeholders in the industry.

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APPENDIX A
QUESTIONNAIRE SURVEY FORM

Faculty of Civil Engineering & Earth Resources

Questionnaire Survey Form

(Construction Management)

Title

A Study on the Causes of Design Changes Effecting The Construction Project Cost: Point of View from Contractor Perspective

I am a final year student (AA14021) in Bachelor in Civil Engineering from Universiti Malaysia Pahang (UMP). This research is mainly conducted for academic purposes only. All data obtained will be kept strictly confidential. This questionnaire is divided into five sections and each section may represent an objective. Please respond and complete all sections.

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QUESTIONAIRE FOR THE RESPONDANT

"A Study on the Causes of Design Changes Effecting the Construction Project Cost: Point of View from Contractor Perspective"

SECTION A

Location: ……

Position: ……

Academic Qualification:

Diploma	☐	Master	☐	Other:_____	
Degree	☐	PHD	☐		

Year of experience:

1-5	☐	6-10	☐	11-15	☐	16-20	☐	20 & above	☐

How many projects has your organization been involved with?

1-5	☐	6-10	☐	11-15	☐	16-20	☐	20 & above	☐

How many project has you execute occurs design changes?

1-5	☐	6-10	☐	11-15	☐	16-20	☐	20 & above	☐

SECTION B

The table below gives a list of the identified **the causes of design changes effecting the construction project cost.** Please kindly rank these causes by ticking the appropriate option from the options ranked 1–5.

5 – Strongly Agree 4 – Highly Agree 3 - Average

2 – Slightly Agree 1 – Disagree

No	The causes of design changes effecting the construction project cost	Option				
		1	2	3	4	5
1	Scope changes by owner due to lack of the information					
2	Change of project schedule					
3	Owners financial problems					
4	Replacement of material and procedure					
5	Inadequate project objective					
6	Changes of design specification					
7	Impediment in prompt decision making process					
8	Error or omission occurred during construction phase					
9	Changes in design					
10	Technology changes over time					
11	Conflict between contract document					
12	Lack of coordination					
13	Inadequate scope of work of contractor					
14	Consultant lack of experiences and professional					
15	Design discrepancies realized after project began					
16	Honest wrong belief					

17	Complexity of design complicate the work of contractors					
18	Non-compliance of designer					
19	Lack of knowledge about the material and equipment					
20	Lack of data and information required for design					
21	Profitability from project					
22	Lack of contractor involvement in design					
23	Lack of skilled worker					
24	Financial problems faced by contractor					
25	Different site's geological conditions					
26	Poor of procurement process					
27	Lack of experiences of contractor					
28	Lack of communication between contractor and consultant					
29	Improper design planning					
30	Long lead procurement					
31	Unfamiliar with site condition					
32	Weather condition					
33	Safety consideration between surrounding, civilian, worker, and equipment					
34	Government regulation changes					
35	Current economic situation					
36	Local social-culture factor					
37	Unforeseen problems					

SECTION C

The table below gives a list of the identified **the effect of design changes to the construction project cost**. Please kindly rank these causes by ticking the appropriate option ranked 1 – 5.

No	The effect of design changes to the construction project cost	Option				
		1	**2**	**3**	**4**	**5**
1	Time overrun when contractor cannot do any work due to the design problems.					
2	Cost overrun while conducting the project because cannot be done in time					
3	Workers work slower or less efficiency					
4	The performance of the project is low					
5	Schedule delay due to the design problems					
6	Additional payment to the designers because they have to designing other design					
7	Higher peak quantities of labor or equipment required if the design specification are change					
8	Uncertain spending as it relies on the design					
9	Budget cuts due to high spending on the design					
10	Cost of machinery increased that depend on the design specification					
11	Construction cost increase (construction materials)					
12	Employee payment increase due to additional works					
13	Tying down of client capital due to non-completion of the project					

14	Reduce profits against contractors, consultants, and owners.					

SECTION D

From your experience, **how to improve these design changes problem?** Please kindly rank these causes by ticking the appropriate from the options ranked 1 – 5.

No	How to improve these design changes problem?	Option				
		1	**2**	**3**	**4**	**5**
1	Get confirmation of the design from all parties involved with construction before project started.					
2	Identifying potential problems in design before the project starts					
3	Choose a professional and experienced designer for design work					
4	Ensure adequate financial resources to cover any expenditure during construction work.					
5	The consultant should play a role to avoid any design changes.					
6	Ensure that the owner is satisfied with the design					
7	Ensure that the site conditions are suitable with the design by collecting as much information and data as may be relevant to the site condition.					
8	Planning the construction of the project carefully and in detail.					
9	Look for another solution other than changing the design.					
10	Communicate with others that involved. Effective communicate is vital to the successful completion of any construction project.					
11	Awarding bids to the right/experience consultant and contractor					

APPENDIX B
RESULT FROM SPSS

Location

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Kelantan	13	24.1	24.1	24.1
	Pahang	26	48.1	48.1	72.2
	Terengganu	15	27.8	27.8	100.0
	Total	54	100.0	100.0	

Position

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Project Manager	4	7.4	7.4	7.4
	Engineer	18	33.3	33.3	40.7
	Quality Surveyor	13	24.1	24.1	64.8
	Site Supervisor	8	14.8	14.8	79.6
	Quality Assurance	3	5.6	5.6	85.2
	Others	8	14.8	14.8	100.0
	Total	54	100.0	100.0	

Other_position

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		46	85.2	85.2	85.2
	Accountant	1	1.9	1.9	87.0
	Accounts Executive	1	1.9	1.9	88.9
	Asst. Pro Manager	1	1.9	1.9	90.7
	Asst. Pro. Manager	1	1.9	1.9	92.6
	Project Planner	1	1.9	1.9	94.4
	Safety	1	1.9	1.9	96.3
	Site Engineer	1	1.9	1.9	98.1
	Site Safety Supervisor	1	1.9	1.9	100.0
	Total	54	100.0	100.0	

Qualification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Diploma	11	20.4	20.4	20.4
	Degree	35	64.8	64.8	85.2
	Master	8	14.8	14.8	100.0
	Total	54	100.0	100.0	

Year_of_Exp

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-5	25	46.3	46.3	46.3
	6-10	7	13.0	13.0	59.3
	11-15	12	22.2	22.2	81.5
	16-20	9	16.7	16.7	98.1
	20 & above	1	1.9	1.9	100.0
	Total	54	100.0	100.0	

Project_involved

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-5	23	42.6	42.6	42.6
	6-10	19	35.2	35.2	77.8
	11-15	9	16.7	16.7	94.4
	16-20	3	5.6	5.6	100.0
	Total	54	100.0	100.0	

The causes of design changes effecting the construction project cost

Design_Changes_problem

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-5	42	77.8	77.8	77.8
	6-10	8	14.8	14.8	92.6
	11-15	4	7.4	7.4	100.0
	Total	54	100.0	100.0	

Scope changes by owner due to lack of the information

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	4	7.4	7.4	9.3
	Average	10	18.5	18.5	27.8
	Highly Agree	31	57.4	57.4	85.2
	Strongly Agree	8	14.8	14.8	100.0
	Total	54	100.0	100.0	

Change of project schedule

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	5	9.3	9.3	11.1
	Average	30	55.6	55.6	66.7
	Highly Agree	10	18.5	18.5	85.2
	Strongly Agree	8	14.8	14.8	100.0
	Total	54	100.0	100.0	

Owners financial problems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	7	13.0	13.0	14.8
	Average	5	9.3	9.3	24.1
	Highly Agree	27	50.0	50.0	74.1
	Strongly Agree	14	25.9	25.9	100.0
	Total	54	100.0	100.0	

Replacement of material and procedure

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	2	3.7	3.7	3.7
	Average	10	18.5	18.5	22.2
	Highly Agree	33	61.1	61.1	83.3
	Strongly Agree	9	16.7	16.7	100.0
	Total	54	100.0	100.0	

Inadequate project objective

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	3	5.6	5.6	7.4
	Average	20	37.0	37.0	44.4
	Highly Agree	24	44.4	44.4	88.9
	Strongly Agree	6	11.1	11.1	100.0
	Total	54	100.0	100.0	

Changes of design specification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	3	5.6	5.6	5.6
	Average	13	24.1	24.1	29.6
	Highly Agree	25	46.3	46.3	75.9
	Strongly Agree	13	24.1	24.1	100.0
	Total	54	100.0	100.0	

Impediment in prompt decision making process

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	1	1.9	1.9	1.9
	Average	18	33.3	33.3	35.2
	Highly Agree	26	48.1	48.1	83.3
	Strongly Agree	9	16.7	16.7	100.0
	Total	54	100.0	100.0	

Error or omission occurred during construction phase

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	1	1.9	1.9	1.9
	Average	13	24.1	24.1	25.9
	Highly Agree	28	51.9	51.9	77.8
	Strongly Agree	12	22.2	22.2	100.0
	Total	54	100.0	100.0	

Changes in design

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Average	9	16.7	16.7	16.7
	Highly Agree	18	33.3	33.3	50.0
	Strongly Agree	27	50.0	50.0	100.0
	Total	54	100.0	100.0	

Technology changes over time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	4	7.4	7.4	9.3
	Average	17	31.5	31.5	40.7
	Highly Agree	24	44.4	44.4	85.2
	Strongly Agree	8	14.8	14.8	100.0
	Total	54	100.0	100.0	

Conflict between contract document

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	3	5.6	5.6	7.4
	Average	25	46.3	46.3	53.7
	Highly Agree	21	38.9	38.9	92.6
	Strongly Agree	4	7.4	7.4	100.0
	Total	54	100.0	100.0	

Lack of coordination

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	3	5.6	5.6	7.4
	Average	19	35.2	35.2	42.6
	Highly Agree	23	42.6	42.6	85.2
	Strongly Agree	8	14.8	14.8	100.0
	Total	54	100.0	100.0	

Inadequate scope of work of contractor

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	3	5.6	5.6	7.4
	Average	19	35.2	35.2	42.6
	Highly Agree	27	50.0	50.0	92.6
	Strongly Agree	4	7.4	7.4	100.0
	Total	54	100.0	100.0	

Consultant lack of experiences and professional

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	2	3.7	3.7	3.7
	Slightly Agree	3	5.6	5.6	9.3
	Average	24	44.4	44.4	53.7
	Highly Agree	17	31.5	31.5	85.2
	Strongly Agree	8	14.8	14.8	100.0
	Total	54	100.0	100.0	

Design discrepancies realized after project began

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	4	7.4	7.4	9.3
	Average	12	22.2	22.2	31.5
	Highly Agree	27	50.0	50.0	81.5
	Strongly Agree	10	18.5	18.5	100.0
	Total	54	100.0	100.0	

Honest wrong belief

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	2	3.7	3.7	3.7
	Slightly Agree	9	16.7	16.7	20.4
	Average	27	50.0	50.0	70.4
	Highly Agree	14	25.9	25.9	96.3
	Strongly Agree	2	3.7	3.7	100.0
	Total	54	100.0	100.0	

Complexity of design complicate the work of contractors

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	3	5.6	5.6	5.6
	Average	15	27.8	27.8	33.3
	Highly Agree	26	48.1	48.1	81.5
	Strongly Agree	10	18.5	18.5	100.0
	Total	54	100.0	100.0	

Non-compliance of designer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	4	7.4	7.4	9.3
	Average	14	25.9	25.9	35.2
	Highly Agree	31	57.4	57.4	92.6
	Strongly Agree	4	7.4	7.4	100.0
	Total	54	100.0	100.0	

Lack of knowledge about the material and equipment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	2	3.7	3.7	3.7
	Slightly Agree	6	11.1	11.1	14.8
	Average	19	35.2	35.2	50.0
	Highly Agree	18	33.3	33.3	83.3
	Strongly Agree	9	16.7	16.7	100.0
	Total	54	100.0	100.0	

Lack of data and information required for design

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	3	5.6	5.6	5.6
	Average	14	25.9	25.9	31.5
	Highly Agree	24	44.4	44.4	75.9
	Strongly Agree	13	24.1	24.1	100.0
	Total	54	100.0	100.0	

Profitability from project

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	5	9.3	9.3	9.3
	Average	17	31.5	31.5	40.7
	Highly Agree	28	51.9	51.9	92.6
	Strongly Agree	4	7.4	7.4	100.0
	Total	54	100.0	100.0	

Lack of contractor involvement in design

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	5	9.3	9.3	11.1
	Average	26	48.1	48.1	59.3
	Highly Agree	19	35.2	35.2	94.4
	Strongly Agree	3	5.6	5.6	100.0
	Total	54	100.0	100.0	

Lack of skilled worker

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	7	13.0	13.0	14.8
	Average	25	46.3	46.3	61.1
	Highly Agree	16	29.6	29.6	90.7
	Strongly Agree	5	9.3	9.3	100.0
	Total	54	100.0	100.0	

Financial problems faced by contractor

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	4	7.4	7.4	7.4
	Average	12	22.2	22.2	29.6
	Highly Agree	24	44.4	44.4	74.1
	Strongly Agree	14	25.9	25.9	100.0
	Total	54	100.0	100.0	

Different site's geological conditions

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	4	7.4	7.4	7.4
	Average	12	22.2	22.2	29.6
	Highly Agree	30	55.6	55.6	85.2
	Strongly Agree	8	14.8	14.8	100.0
	Total	54	100.0	100.0	

Poor of procurement process

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	5	9.3	9.3	11.1
	Average	17	31.5	31.5	42.6
	Highly Agree	22	40.7	40.7	83.3
	Strongly Agree	9	16.7	16.7	100.0
	Total	54	100.0	100.0	

Lack of experiences of contractor

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	5	9.3	9.3	11.1
	Average	16	29.6	29.6	40.7
	Highly Agree	27	50.0	50.0	90.7
	Strongly Agree	5	9.3	9.3	100.0
	Total	54	100.0	100.0	

Lack of communication between contractor and consultant

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	5	9.3	9.3	11.1
	Average	19	35.2	35.2	46.3
	Highly Agree	20	37.0	37.0	83.3
	Strongly Agree	9	16.7	16.7	100.0
	Total	54	100.0	100.0	

Improper design planning

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	3	5.6	5.6	5.6
	Average	19	35.2	35.2	40.7
	Highly Agree	18	33.3	33.3	74.1
	Strongly Agree	14	25.9	25.9	100.0
	Total	54	100.0	100.0	

Long lead procurement

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	5	9.3	9.3	11.1
	Average	19	35.2	35.2	46.3
	Highly Agree	26	48.1	48.1	94.4
	Strongly Agree	3	5.6	5.6	100.0
	Total	54	100.0	100.0	

Unfamiliar with site condition

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	6	11.1	11.1	13.0
	Average	12	22.2	22.2	35.2
	Highly Agree	27	50.0	50.0	85.2
	Strongly Agree	8	14.8	14.8	100.0
	Total	54	100.0	100.0	

Weather condition

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	2	3.7	3.7	5.6
	Average	13	24.1	24.1	29.6
	Highly Agree	23	42.6	42.6	72.2
	Strongly Agree	15	27.8	27.8	100.0
	Total	54	100.0	100.0	

Safety consideration between surrounding, civilian, worker, and equipment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	3	5.6	5.6	7.4
	Average	13	24.1	24.1	31.5
	Highly Agree	25	46.3	46.3	77.8
	Strongly Agree	12	22.2	22.2	100.0
	Total	54	100.0	100.0	

Government regulation changes

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	2	3.7	3.7	3.7
	Slightly Agree	1	1.9	1.9	5.6
	Average	15	27.8	27.8	33.3
	Highly Agree	24	44.4	44.4	77.8
	Strongly Agree	12	22.2	22.2	100.0
	Total	54	100.0	100.0	

Current economic situation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	2	3.7	3.7	3.7
	Average	13	24.1	24.1	27.8
	Highly Agree	23	42.6	42.6	70.4
	Strongly Agree	16	29.6	29.6	100.0
	Total	54	100.0	100.0	

The effect of design changes to the construction project cost

Time overrun when contractor cannot do any work due to the design problems.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	2	3.7	3.7	3.7
	Average	23	42.6	42.6	46.3
	Highly Agree	23	42.6	42.6	88.9
	Strongly Agree	6	11.1	11.1	100.0
	Total	54	100.0	100.0	

Cost overrun while conducting the project because cannot be done in time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Average	11	20.4	20.4	20.4
	Highly Agree	26	48.1	48.1	68.5
	Strongly Agree	17	31.5	31.5	100.0
	Total	54	100.0	100.0	

Workers work slower or less efficiency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	4	7.4	7.4	7.4
	Average	28	51.9	51.9	59.3
	Highly Agree	17	31.5	31.5	90.7
	Strongly Agree	5	9.3	9.3	100.0
	Total	54	100.0	100.0	

The performance of the project is low

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	2	3.7	3.7	3.7
	Average	19	35.2	35.2	38.9
	Highly Agree	25	46.3	46.3	85.2
	Strongly Agree	8	14.8	14.8	100.0
	Total	54	100.0	100.0	

Schedule delay due to the design problems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Average	13	24.1	24.1	24.1
	Highly Agree	26	48.1	48.1	72.2
	Strongly Agree	15	27.8	27.8	100.0
	Total	54	100.0	100.0	

Additional payment to the designers because they have to designing other design

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	2	3.7	3.7	3.7
	Average	13	24.1	24.1	27.8
	Highly Agree	21	38.9	38.9	66.7
	Strongly Agree	18	33.3	33.3	100.0
	Total	54	100.0	100.0	

Higher peak quantities of labor or equipment required if the design specification are change

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Average	14	25.9	25.9	25.9
	Highly Agree	32	59.3	59.3	85.2
	Strongly Agree	8	14.8	14.8	100.0
	Total	54	100.0	100.0	

Uncertain spending as it relies on the design

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	1	1.9	1.9	1.9
	Average	16	29.6	29.6	31.5
	Highly Agree	22	40.7	40.7	72.2
	Strongly Agree	15	27.8	27.8	100.0
	Total	54	100.0	100.0	

Budget cuts due to high spending on the design

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	1	1.9	1.9	3.7
	Average	13	24.1	24.1	27.8
	Highly Agree	18	33.3	33.3	61.1
	Strongly Agree	21	38.9	38.9	100.0
	Total	54	100.0	100.0	

Cost of machinery increased that depend on the design specification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	4	7.4	7.4	7.4
	Average	20	37.0	37.0	44.4
	Highly Agree	18	33.3	33.3	77.8
	Strongly Agree	12	22.2	22.2	100.0
	Total	54	100.0	100.0	

Construction cost increase (construction materials)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Average	12	22.2	22.2	24.1
	Highly Agree	30	55.6	55.6	79.6
	Strongly Agree	11	20.4	20.4	100.0
	Total	54	100.0	100.0	

Employee payment increase due to additional works

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Average	25	46.3	46.3	46.3
	Highly Agree	20	37.0	37.0	83.3
	Strongly Agree	9	16.7	16.7	100.0
	Total	54	100.0	100.0	

Tying down of client capital due to non-completion of the project

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Slightly Agree	1	1.9	1.9	3.7
	Average	20	37.0	37.0	40.7
	Highly Agree	23	42.6	42.6	83.3
	Strongly Agree	9	16.7	16.7	100.0
	Total	54	100.0	100.0	

Reduce profits against contractors, consultants, and owners.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	2	3.7	3.7	3.7
	Average	10	18.5	18.5	22.2
	Highly Agree	26	48.1	48.1	70.4
	Strongly Agree	16	29.6	29.6	100.0
	Total	54	100.0	100.0	

How to improve these design changes problem?

Get confirmation of the design from all parties involved with construction before project started.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	1	1.9	1.9	1.9
	Average	12	22.2	22.2	24.1
	Highly Agree	25	46.3	46.3	70.4
	Strongly Agree	16	29.6	29.6	100.0
	Total	54	100.0	100.0	

Identifying potential problems in design before the project starts

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	1	1.9	1.9	1.9
	Average	12	22.2	22.2	24.1
	Highly Agree	27	50.0	50.0	74.1
	Strongly Agree	14	25.9	25.9	100.0
	Total	54	100.0	100.0	

Choose a professional and experienced designer for design work

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	2	3.7	3.7	3.7
	Average	11	20.4	20.4	24.1
	Highly Agree	27	50.0	50.0	74.1
	Strongly Agree	14	25.9	25.9	100.0
	Total	54	100.0	100.0	

Ensure adequate financial resources to cover any expenditure during construction work.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	1	1.9	1.9	1.9
	Average	14	25.9	25.9	27.8
	Highly Agree	17	31.5	31.5	59.3
	Strongly Agree	22	40.7	40.7	100.0
	Total	54	100.0	100.0	

The consultant should play a role to avoid any design changes.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	3	5.6	5.6	5.6
	Average	10	18.5	18.5	24.1
	Highly Agree	24	44.4	44.4	68.5
	Strongly Agree	17	31.5	31.5	100.0
	Total	54	100.0	100.0	

Ensure that the owner is satisfied with the design

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	1	1.9	1.9	1.9
	Average	13	24.1	24.1	25.9
	Highly Agree	27	50.0	50.0	75.9
	Strongly Agree	13	24.1	24.1	100.0
	Total	54	100.0	100.0	

Ensure that the site conditions are suitable with the design by collecting as much information and data as may be relevant to the site condition.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	2	3.7	3.7	3.7
	Average	10	18.5	18.5	22.2
	Highly Agree	18	33.3	33.3	55.6
	Strongly Agree	24	44.4	44.4	100.0
	Total	54	100.0	100.0	

Planning the construction of the project carefully and in detail.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Average	13	24.1	24.1	24.1
	Highly Agree	24	44.4	44.4	68.5
	Strongly Agree	17	31.5	31.5	100.0
	Total	54	100.0	100.0	

Look for another solution other than changing the design.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	1	1.9	1.9	1.9
	Average	11	20.4	20.4	22.2
	Highly Agree	19	35.2	35.2	57.4
	Strongly Agree	23	42.6	42.6	100.0
	Total	54	100.0	100.0	

Communicate with others that involved. Effective communicate is vital to the successful completion of any construction project.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Average	11	20.4	20.4	20.4
	Highly Agree	21	38.9	38.9	59.3
	Strongly Agree	22	40.7	40.7	100.0
	Total	54	100.0	100.0	

Awarding bids to the right/experience consultant and contractor

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Average	15	27.8	27.8	27.8
	Highly Agree	15	27.8	27.8	55.6
	Strongly Agree	24	44.4	44.4	100.0
	Total	54	100.0	100.0	

APPENDIX C
RESULT FROM MICROSOFT EXCEL

The causes of design changes effecting the construction project

changes affecting the construc	Respondent Frequency					RII	Rank
	*1	*2	*3	*4	*5		
Changes in design	0	0	9	18	27	0.866	1
Current economic situation	0	2	13	23	16	0.796	2
Error or omission occurred durin	0	1	13	28	12	0.788	3
Replacement of material and pro	0	2	10	33	9	0.781	4
Lack of data and information rec	0	3	14	24	13	0.774	5
Weather condition	1	2	13	23	15	0.77	6
Changes of design specification	0	3	13	25	13	0.77	7
Owners financial problems	1	7	5	27	14	0.77	8
Safety consideration between su	1	3	13	25	12	0.762	9
Government regulation changes	2	1	15	24	12	0.759	10
Improper design planning	0	3	19	18	14	0.759	11
Different site's geological condit	0	4	12	30	8	0.759	12
Financial problems faced by con	0	4	12	24	14	0.759	13
Scope changes by owner due to	0	3	15	26	10	0.755	14
Complexity of design complicate	1	4	12	27	10	0.751	15
Design discrepancies realized af	1	14	10	31	8	0.751	16
Impediment in prompt decision m	0	1	18	26	9	0.748	17
Unfamiliar with site condition	1	6	12	27	8	0.729	18
Local social-culture factor	2	5	17	22	8	0.726	19
Lack of coordination	1	3	19	23	8	0.726	20
Poor of procurement process	1	5	17	22	9	0.722	21
Non-compliance of designer	1	4	14	31	4	0.722	22
Lack of communication betweer	1	5	19	20	9	0.718	23
Inadequate project objective	1	3	20	24	6	0.715	24
Profitability from project	0	5	17	28	4	0.714	25
Lack of experiences of contract	1	5	16	27	5	0.703	26
Inadequate scope of work of cor	1	3	19	27	4	0.7	27
Consultant lack of experiences a	2	3	24	17	8	0.696	28
Lack of knowledge about the ma	2	6	19	18	9	0.696	29
Technology changes over time	1	4	17	24	8	0.692	30
Unforeseen problems	1	10	16	19	8	0.689	31
Long lead procurement	1	5	19	26	3	0.688	32
Conflict between contract docur	1	3	25	21	4	0.688	33
Lack of contractor involvement	1	5	26	19	3	0.674	34
Change of project schedule	1	5	30	10	8	0.67	35
Lack of skilled worker	1	7	25	16	5	0.648	36
Honest wrong belief	2	9	27	14	2	0.622	37

The effect of design changes to the construction project

esign changes to the constructi	Respondent Frequency					RII	Rank
	*1	*2	*3	*4	*5		
Cost overrun while conducting th	0	0	11	26	17	0.826	1
Schedule delay due to the design	0	0	12	26	15	0.811	2
Additional payment to the design	0	2	13	21	18	0.807	3
Reduce profits against contracto	0	2	10	26	16	0.807	4
Budget cuts due to high spending	1	1	12	18	21	0.796	5
Construction cost increase (cons	1	0	12	30	11	0.792	6
Uncertain spending as it relies on	0	1	16	22	15	0.785	7
Tying down of client capital due	0	0	14	32	8	0.751	8
Higher peak quantities of labor c	1	1	20	23	9	0.744	9
The performance of the project	0	2	19	25	8	0.74	10
Cost of machinery increased tha	0	4	20	18	12	0.737	11
Employee payment increase due	0	0	25	20	9	0.733	12
Time overrun when contractor c	0	2	23	23	6	0.726	13
Workers work slower or less eff	0	4	28	17	5	0.692	14

How to improve these design changes problem?

mprove these design changes p	Respondent Frequency					RII	Rank
	*1	*2	*3	*4	*5		
Look for another solution other t	0	1	9	21	23	0.844	1
Communicate with others that in	0	0	11	22	21	0.837	2
Awarding bids to the right/exper	0	0	15	15	24	0.833	3
Ensure that the site conditions ar	0	2	8	19	24	0.829	4
Ensure adequate financial resour	0	1	13	18	22	0.826	5
Planning the construction of the	0	0	14	23	17	0.811	6
Get confirmation of the design fr	0	1	12	26	15	0.811	7
Identifying potential problems in	0	1	12	26	15	0.803	8
The consultant should play a role	0	3	11	23	17	0.8	9
Ensure that the owner is satisfie	0	1	12	28	13	0.796	10
Choose a professional and exper	0	2	11	28	13	0.793	11