COMPARING ANALYTICAL HIERARCHY PROCESS (AHP) AND LIKERT SCALE FOR CRITERIA OF CONTRACTOR SELECTION

NUR NAJIHAH BINTI BAKRI

B. ENG (HONS.) CIVIL ENGINEERING

UNIVERSITI MALAYSIA PAHANG

UNIVERSITI MALAYSIA PAHANG

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ID Number   : AA14059
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NUR NAJIHAH BINTI BAKRI

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ABSTRAK

Industri pembinaan di Malaysia adalah salah satu sektor ekonomi negara yang utama. Semasa era pertumbuhan ekonomi dalam pembangunan Malaysia, manfaat industri pembinaan terhadap Keluaran Dalam Negara Kasar (KDNK) adalah dalam lingkungan 3%-6% setahun. Selama lapan tahun dari tahun 1989 hingga tahun 1996, industri pembinaan mencatatkan kadar pertumbuhan pesat. Perkembangan industri pembinaan bersamaan dengan ekonomi negara. Dalam projek pembinaan, peranan kontraktor adalah penting untuk memastikan projek itu dapat disiapkan tepat pada masanya dan dalam lingkungan bajet yang dietetapakn dengan kualiti yang baik. Oleh itu, pemilihan kontraktor memainkan peranan penting dalam kejayaan industri pembinaan. Dalam kajian ini, saya melakukan penyelidikan mengenai kriteria utama yang penting dalam pemilihan kontraktor yang baik dengan menggunakan Proses Hierarki Analitikal (AHP) dan Skala Likert. Dua kaedah ini telah digunakan dalam kajian ini adalah untuk membandingkan sama ada kedua-dua kaedah ini akan mendapatkan keputusan yang berbeza atau sama. Kedua-dua kaedah ini merupakan proses membuat keputusan bagi menghapuskan risiko kegagalan projek disebabkan prestasi kontraktor yang lemah.

ABSTRACT

The construction industry in Malaysia is one of the first sectors of national economy. During era of economic growth in Malaysia's development, the benefaction of construction industry to gross domestic product (GDP) is in the range of 3%-6% per year. For eight years from year 1989 to year 1996, the construction industry has recorded double-digit growth rates. The development of the construction industry is directly proportional to the national economy. In construction project, contractor role is important to ensure that the project will be able to deliver on time and within the budget cost with a good quality. Thus, the contractor selection plays important role in construction industry successfulness. In this study, a questionnaire survey is carried out to determine the main criteria for contractor selection in Malaysia. In this research, two methods were used which are Analytical Hierarchy Process (AHP) and Likert Scale to compare whether the results would be different in both methods. Both of this method are decision-making process that is obligatory to eliminate the risks of project failure due to poor contractor's performance.

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LIST OF SYMBOLS

x	Principal eigen value
m	Range of scale
CI	Consistency Index
RI	Random Consistency Index
CR	Consistency Ratio
a	a number in the group
n	quantity of numbers in the group

LIST OF ABBREVIATIONS

GDP   Gross Domestic Product

CIDB   Construction Industry Development Board

AHP   Analytical Hierarchy Process

CHAPTER 1

INTRODUCTION

1.1   Introduction

Construction industry is one of important sector that contributing in developing and enhancing economic sector in Malaysia. Construction Industry Development Board (CIDB) is reported that this industry achieved RM110 billion worth of projects in 2013.

Generally, Malaysia construction industry can be divided into two areas which are general construction and special trade work. General construction consists of building construction such as residential construction and commercial construction, and civil engineering such as sewers, roads, highways, bridges, and tunnels. The second area is special trade works consists of metal works, electrical works, tiling, flooring, painting. Glass works and others.

Each type of construction project requires a team to plan the project, to design structure, to construct and to maintain the construction project. General construction for building construction is usually done by 'general contractor' or also known as main contractor. The main contractor will take full responsibility for the complete job except for specified part that may be passing to the special trade contractors known as subcontractor.

Usually, subcontractor do only specific part such as painting, carpentry or electrical work. Basically, subcontractors have no responsibility for the whole structure. They always obtain orders for their work from main contractor, architects or property owners. For Malaysia construction industry, all the contractors are required to register with the Construction Industry Development Board (CIDB) for construction works.

The process of selection contractor by the client is one of the most challenging decision-making stages in the construction project. Because the contraction selection will affect the success of a construction project which means to achieve the optimum result in cost, time and quality of the building. General contractor will conduct all the important task during the construction process such as planning and defining the budget of the project, discussing the required contracts with subcontractors and other parties, make scheduling for the work, ordering and making the requisition of the materials required in the construction process, inspecting the quality of the material and take responsible for any issue arise during the construction process of the building.

Failure to select the competent contractor might lead in delaying project which can increase the cost more than predicted cost. Cost, time, quality and safety are the most important element need to be considered to select the best contractor. There are many methods that can be used in contractor selection. This report is focusing on criteria in selecting contractor, and comparison between Analytical Hierarchy Process (AHP) and Likert Scale method. Comparison between two methods are made to know whether there is different result when these two methods is used.

1.2   Problem Statement

According to CIDB news 2005, construction industry declined between year 2005 to 2006 with a rate negative 5.1%. Since 2009, the government has registered 253 abandoned private housing projects in Peninsular Malaysia which involving 64,290 residential units *(Kumar & Kanyakumari, 2017)*. In Malaysia, issues faced for selection of contractor where they are not focus on important aspect in delivery of construction projects. The most important aspect that need to be highlighted are time schedule, cost, and quality. Besides that, the overall project quality affected by contractor performing the work. So, it is important to know about the past experiences in project construction of that contractor. Moreover, contractor need to understand the procedures for obtaining government, private projects or tenders. There are many of the contractors are blacklisted because they cannot afford financial risk and responsibility giver to complete the projects, also demand in the price from chosen contractors when come from closed tender.

From observation, it is found that the contractors with insufficient financing where most of them do not have enough capital to finance their undertakings. Then, lack of experience and skills in technical or through management in construction phase which contractor unable to complete the project given according to agreed costs and time scheduled. Also, their quality performance for previous project that give them positive or negative impact. However, this study will identify the best criteria or factors that are important during selection of contractors using both Analytical Hierarchy Process (AHP) and Likert Scale. Both methods are used as a comparison if there is different in result when different methods are applied.

1.3 Objective

Aim of this research are:

1) To identify the main criteria for contractor selection.
2) To identify mean of weighted criteria by using Analytical Hierarchy Process (AHP) and Likert Scale.
3) Comparison the result obtained between method Analytical Hierarchy Process (AHP) and Likert Scale.

1.4   Scope of study

This study will focus to the contractor selection issue for construction industry in Malaysia. The most important aspect in every construction project is to deliver project on time within the cost budget and good quality. So, in order to meet this aspect, the selection of contractor must be conducted carefully.

Through method uses which are analytical hierarchy process (AHP) and Likert Scale, we can find out the ranking review from the expert in construction industry to identify important criteria affecting the choice of contractors and best possible alternatives for the project that can be develop. Two methods will be conducted to determine whether there is different within the methods used.

1.5   Significant of study

This study has been conducted in order to identify the best criteria that emphasized from parties involve in construction industry for selection of contractor. Through this research, various information and view from expert that involve had been found and obtained based on the feedback from the survey questionnaires form (through Google form).

Besides, from this study we conclude that the best criteria needed to select proper contractor. Without a proper method for select the competent contractor, it will affect the performance overall project. So, the issues which is always arise in construction industry can be solve and increase chances of project delivery within cost, time also quality.

CHAPTER 2

LITERATURE REVIEW

2.1   Introduction

The selection of the contractor by the client is one of the most challenging decision-making stages of a construction project. Contractor selection decision is one of the most important factors that affect the success of a construction project. In other words, it means to achieve the optimum result in cost, time and quality triangle for the construction project management *(Kog & Yaman, 2014)*. The main objectives of the contractor selection process are to reduce project risk, maximize the quality, and maintain the strong relationships between projects parties *(Marzouk, Kherbawy, & Mostafa, 2013)*. The selection of contractors is an important aspect in the delivery of construction projects and is linked to project success, in the terms of schedule, cost, and quality *(Hatush & Skitmore, 1998)*.

The failure and success of the project is affected by numerous decisions made by client. These decisions are taken at different stages of project development from feasibility, studies, planning, design, contractor selection and risk assessment to proper supervision. Several researchers such are Moselhi and Martinelli (1992); Ng (1992); Ellis and Herbsman (1991); Mema and Smith (1990) and Russell (1988) concluded that contractor prequalification is a decision-making process involving a wide range of decision criteria as well as many decision-making parties *(Hatush & Skitmore, 2016)*

This paper investigates the criteria currently used by clients for screening contractor. The weight of selected criteria will be measured using two methods which are Analytical Hierarchy Process (AHP) and Likert Scale.

2.2   Contractor

Anyone who is directly employs or involves construction workers or conducts construction work is called contractor. Contractors include sub-contractors, any individual self-employed worker or business that carries out, manages construction work. Furthermore, they must have the skills, knowledge, experience and, where relevant, the organisational capability to carry out the work safely and without risk to health *(Contractors: roles and responsibilities, 2015)*.

Construction project is a massive and it involves a worldwide effort to build various types of structures and facilities. It is being commenced by a client and achieved by assembling materials, parts, and systems into the major sub-sections of the structure and the finished structure itself then becomes part of the building which is necessary for the conduct of business life *(Zaini, Adnan, & Haron, 2010)*.

2.2.1 Category of contractor

According to Government of Malaysia (2012) started from 15 October 2012, the limitation of acquisition value for the government work for the building work / civil / mechanical and electrical are shown in the Table 2.1 and Table 2.2 below:

Table 2.1   Limit of building/civil/mechanical work cost (CIDB,2015a)

Registration Grade	Limitation of acquisition work value (RM)
G1	Less than 200,000.00
G2	200,001.00 to 500,000.00
G3	500,001.00 to 1,000,000.00
G4	1,000,001.00 to 3,000,000.00
G5	3,000,001.00 to 5,000,000.00
G6	5,000,001.00 to 10,000,000.00
G7	More than 10,000,000.00

Table 2.2   Limit of electrical work cost (CIDB,2015a)

Registration Grade	Limitation of acquisition work value (RM)
G1	Until 200,000.00
G2	Until 500,000.00
G3	Until 1,000,000.00
G4	200,001.00 to 3,000,000.00
G5	200,001.00 to 5,000,000.00
G6	200,001.00 to 10,000,000.00
G7	More than 200,001.00

2.3   Issues in selection of contractor

Issues that arise during the selection of contractors in Malaysia are because they do not understand the procedures for obtaining projects or tenders for both government and private sectors. Many contractors have been blacklisted for not being able to take on financial risks and are responsible for the work to be given. In addition, for a closed bid price demand from chosen contractor, clients need to be more careful in selecting contractors who can full fill their needs. Therefore, the current contractor needs to have a strong finance to carry out a project and be able to complete the project according to the time and price set. Having a good reputation will give a positive impact to the client choosing a suitable contractor for building construction.

‘Lowest bid’ selection practice has been criticized because it involves high-risk exposure of the client. The selection based on lower price basis can be one of the reasons for the project completion delays, poor quality/ or financial losses *(Zavadskas., Turskis, & Tamosaitiene, 2008)*. Besides that, they also stated that insufficient time for execution, complicated procedures or poor information channels may be the reasons of problems in the selection of contractors. Contractor evaluation has been recognized as a complex task due to its uncertainty and difficult formalization.

Other than that, *(Utusan Online, 2017)*state issue raised include impractical construction design and the quality of breeding work is unsatisfactory. Where consultants failed to ensure contractors complied with the design provided as in the case of elevator mains not in size. Besides, consulting company also had no experienced staff at the project site for monitoring purposes resulting in a lot of work being carried out not according to specifications.

2.4   Qualified contractor

Contractor in Malaysia are required to register and obtain the following certificates;

1) Construction Industry Development Board (CIDB)- The certificates are issued by CIDB to allow the contractor to undertake construction jobs based on registered Class/Grade. SPKK (Sijil Perolehan Kerja Kerajaan) or Governement Procurement Working Certificate- allow contractors to participate in government projects that they are qualified for.

2) STB (Sijil Taraf Bumiputera) or Bumiputea Status Certificate- The certificate is issued by Bahagian Pembangnan Kontraktor & Usahawan (BPKU) which allow contractors to participate in government projects which are allocated for Bumiputera contractors only.

3) Registration with other agencies/corporation e.g. TNB, Telekom, JKR, UTM, Petronas, SPAN- allows local contractors/suppliers to participate in procurement activities of the respective agencies. The certificate is issued by the relevant agencies.

Effective 20 July 1995, it is mandatory for all contractors, both local and foreign to register with the Construction Industry Development Board of Malaysia CIDB or Lembaga Pembangunan Industri Pembinaan Malaysia (LPIPM) before undertaking or completing any construction work in Malaysia except those who have been given exemption under Section 40(1) of the Construction Industry Development Board Act 1994. Anyone who undertakes to carry out and complete any construction work without registering as a registered contractor with the CIDB commits an offence under the Act and if convicted may be fined up to fifty thousand ringgits.

2.4.1 Contractor registration and procedures with CIDB

Construction Industry Development Board of Malaysia (CIDB) established in 1994 which the CIDB 520 Act is an act to form the CIDB. It is implemented to offer CIDB expertise relevant to the local construction industry and other related matters. In the amendment of Act 520, involve three main points which first is improved construction quality through the registration of building personnel, skills certification and competence. Secondly is quality assurance of building materials through standardization and compliance and third placement of responsibility to manage and ensure building safety and construction work during or after construction work on contractors and site managers.

In Malaysia to start a construction related business as contractor they need to apply CIDB license. For registration of contractors as per the Act, they cannot undertake any construction works unless they are registered also hold a valid certificate of registration issue by CIDB. Besides, non-registration will get fine not exceeding RM 50,000.00. There has restriction that need to follow which the contractor is not allowed to execute any construction works outside his registered category as stated in table 2.1 and table 2.2.

2.4.2 Tender evaluation guidelines MOF

Procurement by tenders, tender value limit for all procurement whether work, supply or services of more than RM 200,000 a year shall be tendered. For work before any work tender is invited, the Agency shall:

a. Development of all the RM 200,000 under work turnover to class F contractors.

h. Work tenderizes must be made among companies registered with the Contractor Service Centre (PKK) and the Malaysian Industrial and Building Development Board (CIDB) according to the following classes and grades.

Table 2.3: Contractor classes

	PUSAT KHIDMAT KONTRAKTOR (PKK)
CLASS	PROJECT VALUE
A	More RM10,000,000
B	RM5,000,001 until RM10,000,000
C	RM2,000,001 until RM5,000,000
D	RM500,001 until RM2,000,000
E	RM200,001 until RM500,000
F	More RM2000,000

Table 2.4: Contractor classes (continue)

	LEMBAGA PEMBANGUNAN INDUSTRI DAN PEMBINAAN MALAYSIA (CIDB)
GRED	PROJECT VALUE
7	RM10,000,000 above
6	To RM10,000,000
5	To RM5,000,000
4	To RM3,000,000
3	To RM1,000,000
2	To RM500,000
1	To RM100,000

For the electrical work of the invitation should be made among companies registered with PKK according to the following class shown in table 2.5:

Table 2.5: Contractor classes for electrical work

CLASS	FINANCIAL LIMIT
I	More to RM200,000
II	To RM1,000,000
III	To RM500,000
IV	To RM200,000

2.4.3   Stages for tender evaluation

a) First stage – prefix evaluation

Is a basic assessment in which all tenderers will be analyzed in terms of minimum perfection (3% of project costs) and current work performance.

b) Second stage – assessment of technical and financial capabilities

Tenders tend to be evaluated in detail which is in technical and financial capabilities. All tenderers will be evaluated in terms of financial position, work experience, technical staff also equipment capabilities.

c) Third stage – rating assessment of tenderes who pass technical and financial capabilities.

The tender evaluation committee will certify the tender that has satisfied the requirements and passed the preliminary also second level assessment. A scoring system was introduced to determine the capabilities of the tenderer and at the same time minimized the subjective elements.

2.5   Criteria of contractor

i.   Financial Stability

Involves contractor's sound financial position and profitability, here is considered minimum average annual construction turnover within the last five years.

ii.   Technical Ability

Qualification and knowledges of technical personal, technical skills that construction workers have been essential to completing any job

iii.   Past Performance

Past client's levels of satisfaction with the quality of previous works and maintenance services during defects liability period by the contractors in the past five years.

iv.   Resources

Availability of competent personnel, owned major plants and equipment for construction.

v.   Quality Management

Policies, processes and procedures put in place to improve an organization's ability to deliver quality to client, minimise the defects assets delivery and identify and solve defects issues. Quality assurance and quality control engineer in management

vi.   Health and Safety Concerns

Safety performance/ accidents rate in the past five years.

vii.   Current Workload

Construction activities which are underway, on-going and nearing completion.

2.6   Analytical Hierarchy Process

Analytical Hierarchy Process (AHP) technique depends on evaluating pairs' options, within relevant criteria. Besides that, it compares the criteria consistent with their intensity and preferences. Then, decision making is used to evaluate the options that meets a selected group of criteria and goals *(Remon, Fayek, Aziz, & Eskander, 2018)*.

The Analytic Hierarchy Process (AHP) is an effective tool for dealing with complex decision making and can assist the decision maker to set priorities and make the best decision. Reducing complex decisions to a series of pairwise comparisons after that synthesizing the results. AHP helps in both subjective and objective aspects of a decision. Moreover, AHP combine a useful method for checking the consistency of the decision maker's evaluations, and finally can reduce the bias in the decision-making process.

2.6.1 Apply AHP Method

a) Define the problem and determine its goal.

b) The hierarchy from the top (the objectives from a decision-maker's viewpoint) through the intermediate levels (criteria on which sub sequent levels depend) to the lowest level which usually contains the list of alternatives.

c) Construct a set of pair wise comparison matrices (size n x n) for each of the lower levels with one matrix for each element in the level immediately above by using the relative scale measurement shown in Table 2.6. The pair-wise comparisons are done in terms of which element dominates the other.

d) There is $n(n-1)$ / judgments required to develop the set of matrices in step 3. Reciprocals are automatically assigned in each pair-wise comparison.

e) Hierarchical synthesis is now used to weight the eigen vectors by the weights of the criteria and the sum is taken over all weighted eigen vector entries corresponding to those in the next lower level of the hierarchy.

f) Having made all the pair-wise comparisons, the consistency is determined by using the eigen value, Imax , to calculate the consistency index, CI as follows: C.I.= $(Imax-n)$ / $(n-1)$ where n is the matrix size. Judgment consistency can be checked by taking the consistency ratio (CR) of CI with the appropriate value. The CR is acceptable, if it does not exceed 0.10. If it is more, the judgment matrix is inconsistent. To obtain a consistent matrix, judgments should be reviewed and improved.

g) Steps (d-f) are performed for all levels in the hierarchy.

h) The pair-wise comparison matrices were formulated base from Saaty's 9-point priority scale measurement as shown in Table 2.6 below:

Table 2.6: Scale measurement

Importance	Explanation
1	Equally preferred
2	Equally to moderately preferred
3	Moderately preferred
4	Moderately to strongly preferred
5	Strongly preferred
6	Strongly to very strongly preferred
7	Very strongly preferred
8	Very to extremely strongly preferred
9	Extremely preferred

2.6.2 Consistency Index and Consistency Ratio

We need to check the consistency of the result. When many pair wise comparisons are performed, some inconsistencies may typically arise. The AHP incorporates an effective technique for checking the consistency of the evaluations made by the decision maker when building each of the pair wise comparison matrices involved in the process *(Saaty, 1980).* Consistency Index (CI) is obtained by used formula:

$$CI = \frac{x - m}{m - 1} \qquad 2.1$$

A perfectly consistent decision maker should always obtain CI=0, but small values of inconsistency may be tolerated. In particular, if

$$\frac{CI}{RI} < 0.1 \qquad 2.2$$

The inconsistencies are tolerable, and a reliable result may be expected from the AHP. In RI is the Random Index shown in table 2.7:

Table 2.7: Random Consistency Index

m	2	3	4	5	6	7	8	9	10
RI	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

If the value of Consistency Ratio is smaller or equal to 10%, the inconsistency is acceptable. If the Consistency Ratio is greater than 10%, we need to revise the subjective judgment *(Saaty, The Analytic Hierarchy Process, 1980).*

2.6.3 Geometric Mean

$$Mean = (a_1 \times a_2 \times \dots a_n)^{1/n} \qquad\qquad 2.3$$

a = a number in the group
n = quantity of numbers in the group

Equation 2.3 above shown the formula of geometric mean where are well-known approaches to deriving information from pair-wise comparison matrices in decision making process *(Tomashevskii, 2015)*. This tool can be generalized to group decision making.

The Geometric Mean Method (GMM) decision support tool, which has all components of a standard measuring tool, is composed of pair-wise comparisons as an initial measuring procedure *(Tomashevskii, 2015)*.

2.7   Likert Scale

The scale development process is accomplished in five steps which are; 1) Define the measured characteristics and assuming it is unidimensional. 2) Generate a pool of potential Likert items rated on a 5 or 7 disagree-agree response scale. 3) Have the items rated by a panel of experts on a 1 – 5 scale on how favourable the items measure the construct (from 1 = strongly disagree, to 5 = strongly agree). 4) Select the items to keep for the final scale. 5) Administer the scale and to some of the responses of all items *(Theodoros A. Kyriazos & Stalikas, 2018)*.

Likert scale is one of the most rating scale that have been used to measure attitudes directly in example the person knows their attitude is being studied. Likert scale was developed the principle of measuring attitudes by asking people to respond a few questionnaires about the topic, in terms of the extent to which they agree with them and so tapping into the cognitive and effective components of attitudes *(McLeod, 2008)*

Likert scale was developed by Rensis Likert in 1932 to measure attitudes. The typical Likert scale used is a 5 or 7 point ordinal scale to rate the degree to which they agree or disagree with a statement *(Sullivan & Artino, 2013)*. The most familiar Likert scale that were developed in 1932 is five-point bipolar response. These scales range from a group of categories which are least to most by asking people to indicate how much they agree or disagree, approve or disapprove, or believe to be true or false *(Allen & Seaman, 2007)*.

The original Likert scale is a set of items offered for a real or hypothetical situation under study. Respondents are asked to show their level of agreement from strongly disagree to strongly agree with the given items on a metric scale. Then, all items in combination disclose the specific dimension of the attitude towards the issue, hence, necessarily inter-linked with each other *(Ankur Joshi, Saket Kale, Satish Chandel, & Pal, 2015)*.

2.7.1 Applying Likert Scale method

a) Define the focus to measure

b) Construct five-point scale agree to disagree as shown in Table 2.8.

c) Rate the Likert Scale item using scale 1-5

d) Define the score for each scale are 1=1, 2=2, 3=3, 4=4, 5=5

e) Calculate the Relative Importance Indices(RII) of the scored.

f) Rank from 0 to 1, the criteria which scored highest value are the most important criteria.

Table 2.8: Scale measurement for Likert Scale

Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
1	2	3	4	5

CHAPTER 3

METHODOLOGY

3.1   Introduction

Methodology known as a system of methods used in an area of study. Methodology shows the complete sequences of the study have been conducted to achieve all the research objective. Thus, in this chapter we will review the method used in this research.

Collecting data is very important to this research for statistical analysis. In this research, we highlighted seven criteria of selection contractor. A questionnaire survey was conducted to expert parties that involve in construction field in Malaysia. The data was collected for two different type of methods in contractor selection which are using Analytical Hierarchy Process (AHP) and Likert Scale. The purpose of two methods being used is to determine whether there is different result due to different method is used to determine the best criteria in contractor selection.

For the Analytical Hierarchy Process (AHP), firstly, we must develop the pairwise comparison matrix. In this process, two criteria are evaluated at a time in terms of their relative importance from scales 1 to 9. The gradations for the pairwise comparison as Table 3.1. below. Next, the weight of individual criteria is calculated. After normalized comparison matrix is developed, each value in the matrix is divided by the sum of its column. The mean of each row of this matrix is determined to get the weights of the individual criteria. The sum of these normalized weights is 1. Lastly, the assessment of the consistency matrix. We will determine consistency ratio as discussed in Chapter 2.

Table 3.1: Pairwise comparison (Saaty's AHP)

Definition	Index	Definition	Index
Equally important	1	Equally important	1/1
Equally or slightly more important	2	Equally or slightly less important	1/2
Slightly more important	3	Slightly less important	1/3
Slightly to much more important	4	Slightly to way less important	1/4
Much more important	5	Way less important	1/5
Much to far more important	6	Way to far less important	1/6
Far more important	7	Far less important	1/7
Far more important to extremely more important	8	Far less important to extremely less important	1/8
Extremely more important	9	Extremely less important	1/9

Second methods that we used to compare the AHP method is Likert Scale. Likert scale is a psychometric scale that commonly used in research. This method is the most widely used to scaling responses in survey research. This method is much simple than AHP method. Thus, five-point Likert scale is being used in this research. The questionnaire for criteria of contractor selection is developed. Five-point Likert scale is used to allow the individual to express how much they agree or disagree with a statement. After that, the consistency is calculated.

3.2   Criteria for contractor

Purpose of the contractor selection is to select the most qualified and capable contractor that can complete the project within the budget, time and good quality of work. From the research journals studied, we list out seven main criteria of contractor selection for this research.

- Financial Stability
- Technical Ability
- Past Performance
- Resources
- Quality Management
- Health and Safety Concerns
- Current Workload

For the two methods which are Analytical Hierarchy Process (AHP) and Likert Scale, we use the same criteria as list above to analyse whether the different type of methods can affect the sequence of important criteria.

3.2.1 Pair-wise comparison for AHP

The analytic hierarchy process (AHP) proposed by Saaty is a well-liked method of multi-criteria decision-making (MCDM) that requires qualitative data. This method has been used on a wide range of applications in many decision-making situations. The information is given in a linguistic form as this method uses a reciprocal decision matrix obtained by pairwise comparisons. The pairwise comparison was initiated by Fechner in 1860 and developed by Thurstone in 1927. Based on this pairwise comparison, Saaty then proposes the analytic hierarchy process (AHP) in 1980 as a method for multi-criteria decision-making. This method is easier to evaluate as it provided a way of breaking down the general method into a hierarchy of sub-problems *(Alonso & Lamata, 2006)*.

Figure 3.1: Structure of AHP
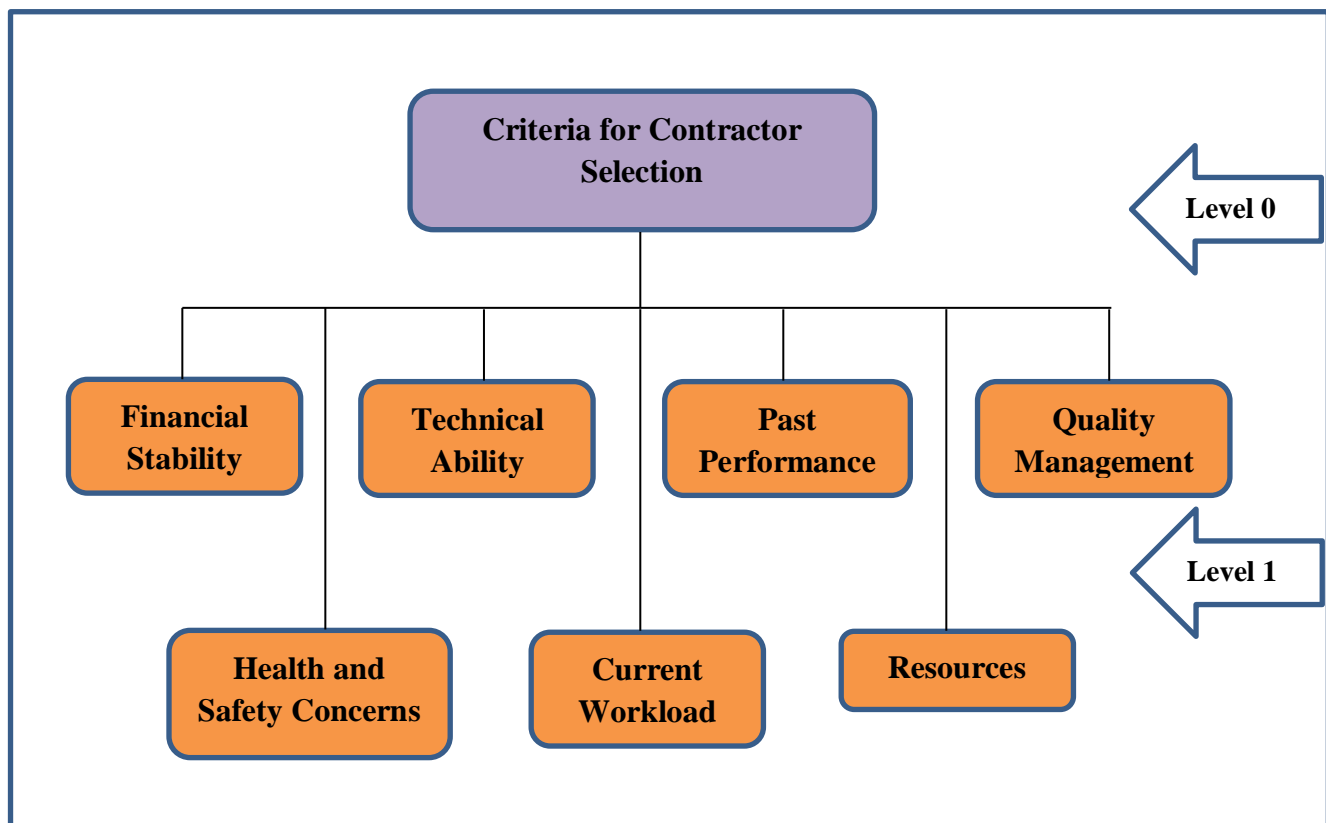
Figure 3.1 shows the structure of AHP pairwise that we carried out in this research. The pairwise is then scoring the scale between 1 to 9 as Table 3.1. According to the AHP structure, the result the pairwise are as below;

1. Financial Stability – Technical Ability
2. Financial Stability – Past Performance
3. Financial Stability – Resources
4. Financial Stability – Current Workload
5. Financial Stability – Health and Safety Concerns
6. Financial Stability – Quality Management
7. Technical Ability – Past Performance
8. Technical Ability – Resources
9. Technical Ability – Current Workload
10. Technical Ability – Health and Safety Concerns
11. Technical Ability – Quality Management
12. Past Performance – Resources
13. Past Performance – Current Workload
14. Past Performance – Health and Safety Concerns
15. Past Performance – Quality Management
16. Resources – Current Workload
17. Resources – Health and Safety Concerns
18. Resources – Quality Management
19. Current Workload – Health and Safety Concerns
20. Current Workload – Quality Management
21. Health and Safety Concerns – Quality Management

3.2.2 Consistency Index

Consistency Index is proposed by Saaty to check if our opinions are consistent in our scoring. Some inconsistency is expected and acknowledged in AHP analysis since the numeric values are obtained from the subjective preferences of individuals. However, the question is how much inconsistency is allowed for final matrix judgments. Thus, consistency ratio (CR) is calculated comparing the consistency index (CI) of the matrix in questions versus the consistency index of a random-like matrix (RI). A random matrix is expected to be inconsistency as it is where the judgements is made randomly. Saaty defined the consistency ratio as CR = CI/RI which is a consistency ratio (CR) of 0.10 or less is acceptable to continue the AHP analysis. However, if the consistency ratio (CI) is greater than 1.10, it is necessary to revise the judgements to detect the cause of the inconsistency and correct it *(J.Alonso & Lamata, 2006)*.

Table 3.2: Random Consistency Index

Number of things	1	2	3	4	5	6	7	
Number of comparisons	0	1	3	6	10	15	21	

3.2.3   Likert Scale

Likert scale type data are widely used to measure attitude providing a range of responses to a given question. It is an important tool in psychology and in social surveys, and is an ever-present method of gather attitudinal or opinion data *(Regina Dittrich, Brian J Francis, Reinhold Hatzinger, & Katzenbeisser, 2007).*

When Likert Scale is designed with a series of questions that when combined measure a particular trait, means is used to describe the scale *(Harry N. Boone & Boone, 2012).* An alternative technique for calculating a composite score for each respondent is to calculate mean-item summated score which is respondent's summated score divided by the number of items forming the scale or subscale thereby creating a mean-item score for each respondent that falls within the range of the values for the response continuum options *(Warmbrod, 2014).*

$$RII = \frac{\sum Pi\ Ui}{N(n)} \qquad\qquad 3.1$$

RII = Relative Importance Indices
Pi = Respondents' rating
Ui = Number of respondents placing an identical weighting/rating
N = Sample Size
n = The highest attainable score (in this study *n* is 5)

The value for RII ranges from 0 to 1, the criteria that scored the highest value of RII are the most important criteria. Then, the criteria will be arranged according their importance *(Z., Nasly, Ahmad, Marshall-Ponting, & Zuhairi, 2014).*

Although Likert Scale is widely used in social science research, it can be discovered its limitation as well. This is because the Likert Scale data measures subjective feelings, so results may change rely on person takes the test *(Subedi, 2016).*

3.3   Questionnaire

Questionnaire is defined as a set of items designed to measure one or more basic constructs which is also known as latent variables *(Fabrigar, L. R., & Ebel-Lam, 2007)*. Besides that, questionnaire is a set of objectives and systematize self-report questions whore responses are then total up to yield a score. Item score is defined as the number allocate to performance on the item, task, or stimulus *(Dorans & J., 2018)*.

This research data is collected through questionnaire to the related firm in construction industry. In questionnaire, there are two parts of questions consist of different method in contractor selection which are for Analytical Hierarchy Analysis (AHP) method and Likert Scale method. The survey is conducted through Google Form with three different section as below;

i.   **Section 1:** Personal Information

This section is to gained individual information from expert parties involve in respective field. This section focuses on personal information background which are included respondent name (not compulsory), gender, years of experience in related field, position in company and company or organization profile.

ii.   **Section 2:** Criteria for contractor selection using Likert Scale method

This section focused on criteria for contractor selection using 5-point Likert Scale method.

iii.   **Section 3:** Criteria for contractor selection using Analytical Hierarchy process (AHP) method

This section focuses on the pairwise comparison matrices between seven main criteria. It is formulated based from Saaty's 9-point priority scale measurement. From the data analysis, the more weighted score of its criteria will selected as the best criteria needed in contractor selection.

Figure 3.2: Flow Chart of Methodology
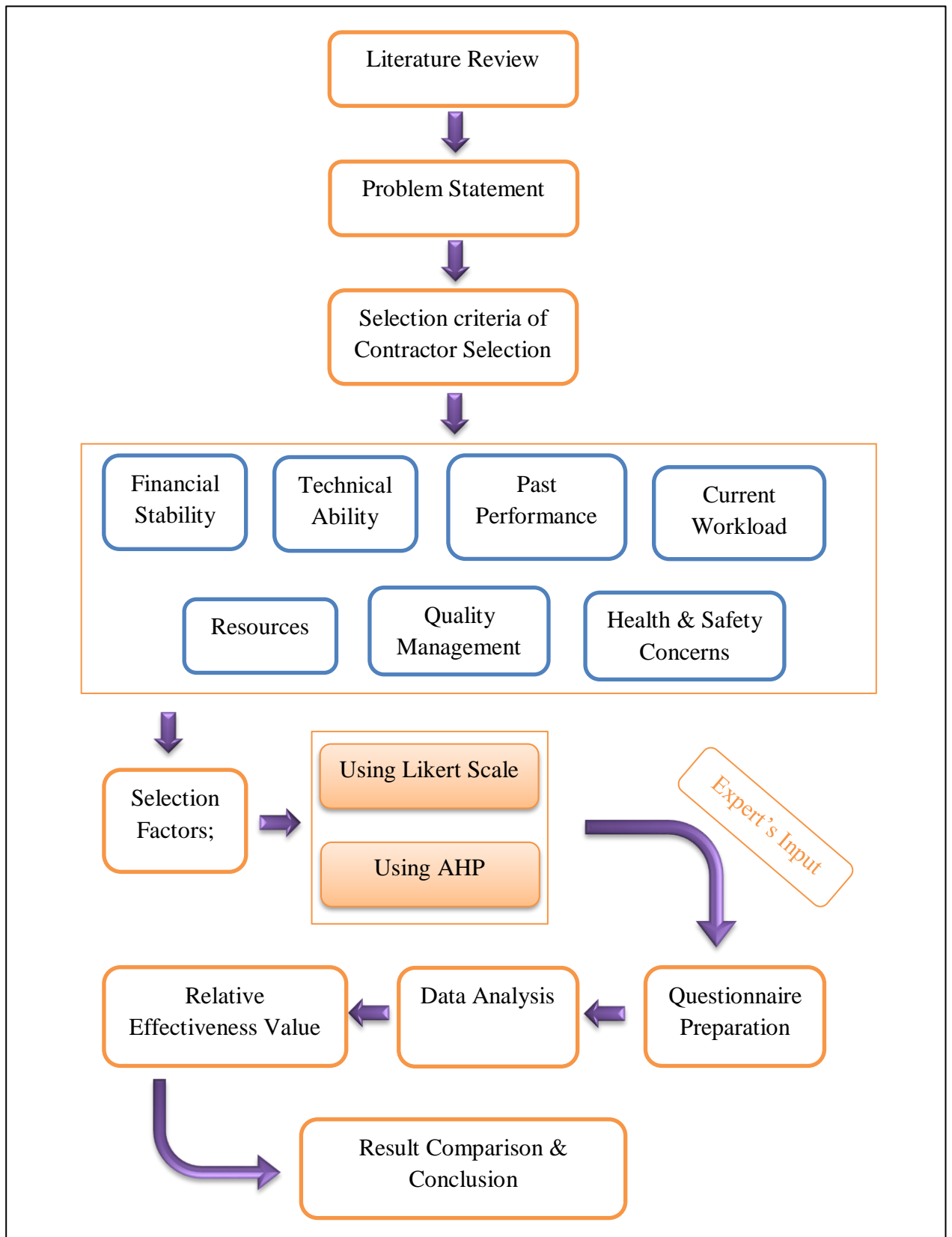
CHAPTER 4

RESULTS AND DISCUSSION

4.1   Introduction

Data in this research were collected through questionnaire in google form. This questionnaire purpose is focussed on the main criteria needed to select the best contractor in Malaysia. Furthermore, the data analysis was collected by using two methods of contractor selection which are Likert Scale and Analytical Hierarchy Process (AHP) as comparison of the consistency result selected by respondents. All the data were analysed, and the result will be presented by using pie chart, graph and bar chart.

4.2   Questionnaire Collection

The data were collected in term of questionnaire through Google Form. Respondents are required to fill up three part in the questionnaire which are part one consists of personal information for respondents, second part is criteria for contractor selection by using five-point Likert Scale, and last part is criteria for contractor selection using Analytical Hierarchy Process (AHP). The questionnaire has been distributed to various types of company and organization in construction field. However, only 19 sets of questionnaires were managed to get response and filled accordingly as shown in Table 4.1. Whereas, Figure 4.1 shows pie chart for percentage of gender respondents which are 52.6% respondents are male and 47.4% respondents are female.

Table 4.1: Number of respondents

	A	B	C	D	E	F	G
1							Likert Sc
2	No	Name	Gender	Experienc	Position	Organizati	financia
3	1		Female	1	Site engin	C&S	
4	2	L	Female	4	Civil engir	C&S	
5	3	MUHAMM	Male	1	Clerk of W	C&S	
6	4	Nurul	Female	2	Draughtpe	Authority	
7	5	Hafiz	Male	4	Architect	Architectu	
8	6	Amran	Male	3	Site super	Authority	
9	7	aizam	Male	3	project ex	formwork	
10	8	zoul.ali	Male	2	Superviso	C&S	
11	9	Aiman	Male	2	Senior De	C&S	
12	10	Fatin	Female	5	Civil engir	C&S	
13	11	Yana	Female	6	Site engin	Authority	
14	12	Muhd ama	Male	3	Site engin	Authority	
15	13	Amira	Female	5	Site engin	C&S	
16	14	Muhd faiz	Male	4	Site super	Authority	
17	15	Farah anis	Female	6	Architect	Architectu	
18	16	Siti sarah	Female	2	Site engin	C&S	
19	17	Haris haki	Male	3	Site super	C&S	
20	18	Siti Farah	Female	4	Architect	Architectu	
21	19	Muhd Azn	Male	5	Site engin	C&S	

Figure 4.1: Percentage of respondent gender
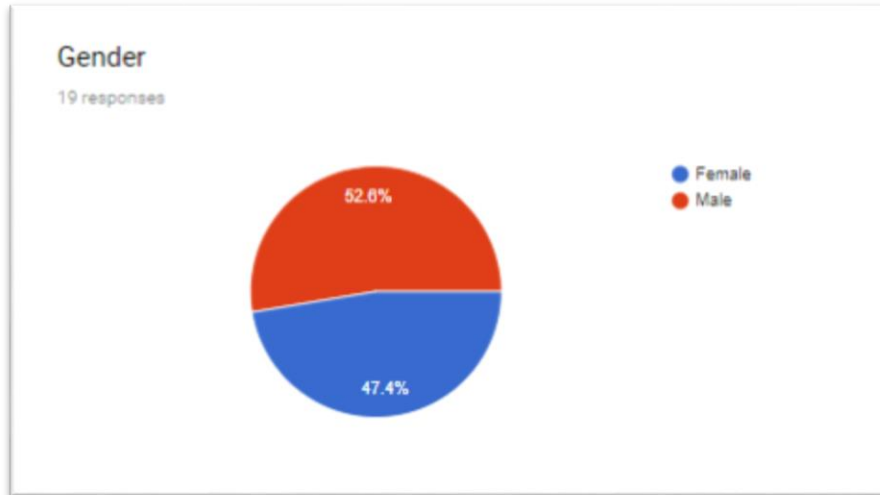
4.3 Personal Information

In questionnaire section 1, the respondent must fill in their personal information. All questions are compulsory to fill in except name of the respondent. The questionnaire regarding personal information of respondents will be discuss below.

4.3.1 Designation

For this research purpose, the respondent that eligible to answer this questionnaire must involved in construction industry. Figure 4.2 shows the bar chart for respondents involved in this questionnaire. Most of the respondents were engineers. They all must have a certain level of professional knowledge to give an opinion in the questionnaire.

Figure 4.2: Respondents position in construction industry
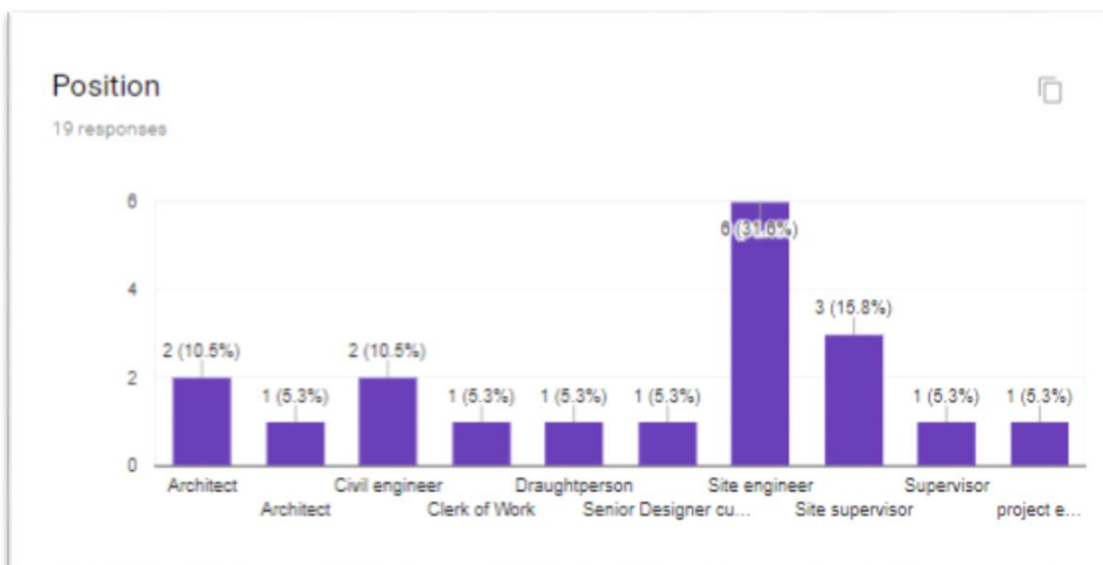
4.3.2 Type of company

In this research studies, the questionnaire has been distributed to the different field in construction industry. Figure 4.3 shows the pie chart of the company or organization that involved in this questionnaire. From the chart below, most of the respondents from C&C which are 52.6%, followed by Authority (26.3%), Architectural Firm (15.8%) and 5.3% from Formwork specialised company.

Figure 4.3: Pie chart types of company or organization
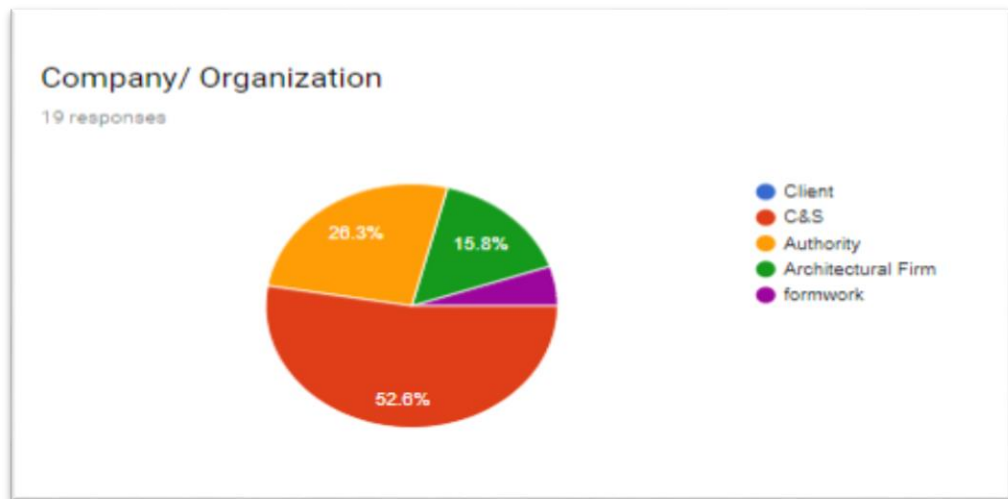
4.3.3 Individual duration experience in Construction Field

Figure 4.4 shows the respondents duration of experience in their field of work. The respondents that has been fill this form are from one to six years of experience in their related field of construction.

Figure 4.4: Duration of experience in construction industry

4.4 Analysis of criteria for contractor selection using Likert Scale method

Likert Scale is a unidimensional scale used to collect the respondent attitudes and opinions. When respondent to an item on the Likert Scale, the user responds specifically based on their level of agreement or disagreement. For this research, 5 level of measurement were used. With five answer options, this 5-point Likert Scale question is used to gather information about a topic by including a neutral answer option for respondents to select in case they don't wish to answer from the extreme choices.

Table 4.2 shows the summary of respondents to the Likert Scale question in questionnaire. The table shows the count of respondent level agreement for each criteria of contractor selection. Table 4.3 shows the mean and percentage of criteria selected by respondents for Likert Scale question.

Table 4.2: Summary of Likert Scale result

	score	financial stability	technical ability	past performance	resources	quality management	current workload	health & safety performance
Strongly Disagree	1	0	5	3	3	5	3	8
Disagree	2	0	8	7	6	3	10	6
Neutral	3	0	4	4	6	8	5	4
Agree	4	1	1	4	4	3	0	0
Strongly Agree	5	18	1	1	0	0	1	1

Table 4.3: RII of criteria select by respondents for Likert Scale method

Criteria	Mean
Financial Stability	0.99
Past Performance	0.53
Resources	0.52
Quality Management	0.49
Current Workload	0.45
Technical Ability	0.44
Health & Safety Concerns	0.39

From Table 4.3, we can conclude that respondents select financial stability as the most important criteria in contractor selection with RII 0.99. Next criteria are past performance with RII 0.53, followed by resources (RII = 0.52), quality management (RII = 0.49), current workload (RII = 0.45), technical ability (RII = 0.44 and least chosen criteria is health and safety concerns (RII = 0.39). Furthermore, as we can see Relative Importance Indices (RII) of the criteria such as past performance, resources, quality management, current workload, technical ability, and health and safety concerns were only slightly different from each other.

4.5 Analysis of criteria for contractor selection using AHP

Selection on contractor is one of the most important decisions in construction project because it influences the success of the project. So, in order to determine the capable contractor, we have conducted the research on criteria that must consider in contractor selection. Table 4.4 shows the result of weighted criteria chosen by 19 respondents from the calculation using online AHP calculator and excel. Then, the data result is summarised into percentage as shown in Table 4.5. Respondent choose criteria financial stability as the most important criteria in contractor selection by 45%, followed by current workload (16%), technical ability (13%), past performance (8%), health and safety concerns (7%), quality management (6%) and least chosen is resources by 4%.

Table 4.4: Weighted criteria

Respondent	Financial Stability	Technical Ability	Past Performance	Resources	Current Workload	Health & safety Concerns	Quality Management
1	0.335	0.118	0.173	0.025	0.298	0.026	0.025
2	0.499	0.124	0.174	0.03	0.074	0.075	0.024
3	0.452	0.121	0.032	0.023	0.05	0.149	0.173
4	0.458	0.049	0.138	0.022	0.217	0.08	0.036
5	0.443	0.143	0.076	0.029	0.154	0.115	0.04
6	0.424	0.141	0.035	0.024	0.237	0.052	0.087
7	0.243	0.099	0.448	0.109	0.042	0.033	0.026
8	0.467	0.042	0.024	0.172	0.205	0.057	0.033
9	0.505	0.19	0.027	0.073	0.097	0.064	0.044
10	0.469	0.129	0.088	0.028	0.215	0.031	0.04
11	0.48	0.167	0.031	0.026	0.131	0.055	0.11
12	0.443	0.2	0.035	0.022	0.14	0.061	0.099
13	0.462	0.122	0.036	0.021	0.218	0.048	0.093
14	0.477	0.112	0.028	0.024	0.236	0.039	0.084
15	0.49	0.193	0.029	0.024	0.114	0.052	0.098
16	0.506	0.188	0.023	0.03	0.128	0.088	0.037
17	0.468	0.157	0.032	0.03	0.191	0.07	0.052
18	0.51	0.114	0.027	0.019	0.177	0.08	0.073
19	0.442	0.095	0.04	0.021	0.179	0.177	0.046

4.5.1 Consistency Index and Consistency Ratio

If the value of Consistency Ratio is smaller or equal to 10%, the inconsistency is acceptable. If the Consistency Ratio is greater than 10%, we need to revise the subjective judgment. Table 4.5 shows the result for consistency for AHP comparison.

Table 4.5: Result for consistency for AHP comparison

Respondent	CI	CR (%)
1	0.09	7.0
2	0.12	8.9
3	0.13	9.5
4	0.13	9.7
5	0.12	9.1
6	0.12	8.7
7	0.13	9.6
8	0.13	10
9	0.12	9.2
10	0.13	9.7
11	0.13	10
12	0.13	9.9
13	0.13	9.8
14	0.13	9.9
15	0.13	10
16	0.13	9.9
17	0.12	9.2
18	0.13	9.6
19	0.13	9.7

4.5.2 Geometric Mean

Differ from Likert Scale, in AHP we used geometric mean rather than arithmetic mean AHP involves reciprocal value during matrices. Uses of geometric mean instead of arithmetic mean you are preserving ratios instead of intervals. Then, to obtain the group judgment for each entry of the comparison matrices we can use the weighted geometric mean method (WGMM).

Table 4.6: Geometric mean of criteria select by respondents for AHP method

Criteria	Geometric Mean
Financial Stability	0.45
Health & Safety Concerns	0.16
Current Workload	0.13
Technical Ability	0.08
Quality Management	0.07
Resources	0.06
Past Performance	0.04

Table 4.6 shown the geometric mean and percentage of criteria selected by respondents using AHP method. Most of the respondents selected financial stability as the most important criteria for contractor selection with 0.45. Followed by health and safety concerns (0.16), current workload (0.13), technical ability (0.08), quality management (0.07), resources (0.06) and past performance (0.04).

4.6   Comparison between AHP and Likert Scale

Table 4.7 shows the comparison ranking between AHP and Likert Scale. As we can see, the table shows that both methods scored criteria of Financial Stability as the highest rank. This shows that the most critical criteria that we should focus in contractor company is their financial position and profitability which we should considered minimum average annual construction turnover within the last five years. *(Borvorn Israngkura Na Ayudhyaa & Kunishimab, 2017)* stated in their research that when there was not enough cash to pay their subcontractor on time or they need to reduce subcontractor payment. In this case, it will affect the subcontractor performance.

As for other criteria there were different in their rank. Analytical Hierarchy Process (AHP) rank Current Workload, Technical Ability, Past Performance, Health & Safety Concerns, Quality Management, and Resources according their most importance. Whereas, Likert Scale rank criteria Past Performance, Resources, Quality Management, Current Workload, Technical Ability, and Health & Safety Concerns according their most importance. But, as we can see in Likert Scale method, the mean of these criteria is only slightly different from each other.

These different occurred likely because there is different point measurement used. For AHP we used 9-point to measure from disagree to agree but for Likert Scale we only used 5-point. Respondents has more option when answered AHP's questions compared to Likert Scale's questions. Respondents tends to avoid extreme measurement such as strongly disagree or strongly agree when answering questions as we can see in Table 4.2.

Table 4.7: Comparing ranking between AHP and Likert Scale

Criteria	AHP	Criteria	Likert Scale
Financial Stability	0.45	Financial Stability	0.99
Current Workload	0.13	Past Performance	0.53
Technical Ability	0.08	Resources	0.52
Past Performance	0.04	Quality Management	0.49
Health & Safety Concerns	0.16	Current Workload	0.45
Quality Management	0.07	Technical Ability	0.44
Resources	0.06	Health & Safety Concerns	0.39

CHAPTER 5

CONCLUSION

5.1   Introduction

Conclusion and recommendation will be discussed in this chapter. Conclusion about all objective that has been stated in chapter 1 will be discussed briefly. Moreover, outcome through analysis and observation made from chapter 4 meet the objective requirement.

5.2   Conclusion

The objective that are stated in chapter 1 as below;

1) To identify the main criteria for contractor selection.
2) To identify mean of weighted criteria by using Analytical Hierarchy Process (AHP) and Likert Scale.
3) Comparison the result obtained between method Analytical Hierarchy Process (AHP) and Likert Scale.

5.2.1   Objective 1: To identify the main criteria for contractor selection.

The first objective of this research was achieved through the literature review in chapter 2. The information shows that selection of contractor is very important in construction project. Contractor plays important to ensure that the project is able to complete on time within the budget and with standard quality.

In my opinion, for this research we will consider the results from AHP method to determine criteria of contractor selection. We prefer AHP compared to Likert Scale because in AHP we conduct pair wise comparison to determine its weighted of each criterion. Besides that, The AHP incorporates an effective technique for checking the consistency of the evaluations made by the decision maker when building each of the pair wise comparison matrices involved in the process.

As a conclusion, the main criteria for contractor selection are Financial Stability, Health & Safety Concerns, Current Workload, Technical Ability, Quality Management, Resources, and Past Performance by using AHP method.

5.2.2   Objective 2: To identify mean of weighted criteria by using Analytical Hierarchy Process (AHP) and Likert Scale.

To identify the best criteria for contractor selection, we used two methods which are Analytical Hierarchy Process (AHP) and Likert Scale. Through AHP, we developed a model for the decision where break down the decision into hierarchy of goals and criteria. Then, we created pairwise that undergo 9-point level measurement for respondents to select. Then, we determine the geometric mean for each criterion selected. As for Likert Scale, it is simpler than AHP. In this research we used 5-point level measurement. Purpose of Likert Scale were carried out to determine the difference in each criteria ranking to their importance when two different methods were used.

5.2.3 Objective 3: Comparison the result obtained between method Analytical Hierarchy Process (AHP) and Likert Scale.

When two different methods were used in this research, the result is slightly different in their weight of attribute as shown in Table 4.7. The differ in results maybe because of different scale measurement were used in Likert Scale methods. From the results we can conclude that most of the respondents tends to avoid extreme measurement such as strongly disagree or strongly agree when answering questions in Likert Scale part as they only have five choices to answer from disagree-agree measurement compared to AHP method. From the result analysis in chapter 4, the most importance criteria needed to select the contractor is Financial Stability as both methods give highest score to this criterion compared to others.

5.3 Recommendation

From the analysis and personal opinion throughout this research, there are several recommendations to manage criteria needed in selection of the best contractor in construction industry in Malaysia;

a) Construction industry in Malaysia needed to be exposed about the criteria in contractor selection, so that the project can be delivered on time, within the cost budget and with a good quality.

b) All future engineers must be informed well about the JKR standards of the criteria needed in contractor selection in Malaysia.

c) After conducted this research, we should use same level of measurement in order to get more efficient result. Respondents tends to avoid extreme measurement such as strongly disagree or strongly agree when answering questions when there is only five option.

d) Besides that we should comparing between two criteria for Likert Scale method.

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APPENDIX A
EXAMPLE QUESTIONNAIRE FORM

Main Criteria of Contractor Selection survey

As part of my research thesis for Final Year Project at the University Malaysia Pahang, I am conducting survey for topic 'Selection of Contractor using both Likert Scale and Analytical Hierarchy process (AHP) methods.

Name (not compulsory)

Short answer text

Gender *

○ Female

○ Male

Experience (years) *

Short answer text

Position *

Short answer text

Company/ Organization *

○ Client

○ C&S

○ Authority

○ Architectural Firm

○ Other...

Questionnaire Part A (Survey Data)

This questionnaire is to determine the criteria of the selection contractor using Likert Scale method. Choose only one (1) answer for every questions.

1) How much you agree financial stability is important criteria in contractor selection? *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

2) How much you agree technical ability in construction worker is important criteria in contractor selection? *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

3) How much you agree past performance client's satisfaction with previous work quality and maintenance services during defect liability by the contractor is important criteria in contractor selection? *

	1	2	3	4	5	
Strongly Dissagree	○	○	○	○	○	Strongly Agree

4) How much you agree resources (availibility of competent personnel, owned major plants and equiptments for construction is important criteria in selection contractor? *

	1	2	3	4	5	
Strongly dissagree	○	○	○	○	○	Strongly agree

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5) How much you agree quality management of the company is important *
criteria in selection contractor?

	1	2	3	4	5	
Strongly dissagree	○	○	○	○	○	Strongly agree

6) How much you agree current workload of the company is important *
criteria in selection contractor?

	1	2	3	4	5	
Strongly dissagree	○	○	○	○	○	Strongly agree

7) How much you agree health and safety performance is important in *
selection contractor?

	1	2	3	4	5	
Strongly dissagree	○	○	○	○	○	Strongly agree

Questionnaire Part B (Survey Data)

This questionnaire is to determine the criteria of the selection contractor using Analytical Hierarchy Process (AHP). AHP method using a set of criteria for a decision making that derive ratio scales from paired comparisons. Choose only one (1) answer for every questions.

1) Which criteria is more important in contractor selection? *

○ Financial Stability

○ Technical Ability

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance

2) Which criteria is more important in contractor selection? *

○ Financial Stability

○ Past Performance

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance

3) Which criteria is more important in contractor selection? *

○ Financial Stability

○ Resources

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme Importance

4) Which criteria is more important in contractor selection? *

○ Financial Stability

○ Current Workload

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance

5) Which criteria is more important in contractor selection? *

○ Financial Stability

○ Health and safety concerns

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance

6) Which criteria is more important in contractor selection? *

○ Financial Stability

○ Quality Management

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance

7) Which criteria is more important in contractor selection? *

○ Technical Ability

○ Past Performance

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance

8) Which criteria is more important in contractor selection? *

○ Technical Ability

○ Resouces

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance

9) Which criteria is more important in contractor selection? *

○ Technical Ability

○ Current Workload

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance

10) Which criteria is more important in contractor selection? *

○ Technical Ability

○ Heath and Safety Concerns

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance

11) Which criteria is more important in contractor selection? *

○ Technical Ability

○ Quality Management

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance

12) Which criteria is more important in contractor selection? *

○ Past Performance

○ Resources

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance

13) Which criteria is more important in contractor selection? *

○ Past Performance

○ Current Workload

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance

14) Which criteria is more important in contractor selection? *

○ Past Performance

○ Health and Safety Concerns

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance

15) Which criteria is more important in contractor selection? *

○ Past Performance

○ Quality Management

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance

16) Which criteria is more important in contractor selection? *

○ Resources

○ Current Workload

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance

17) Which criteria is more important in contractor selection? *

○ Resources

○ Health and Safety Concerns

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance

18) Which criteria is more important in contractor selection? *

○ Resources

○ Quality Management

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance

19) Which criteria is more important in contractor selection? *

○ Current Workload

○ Health and Safety Concerns

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance

20) Which criteria is more important in contractor selection? *

○ Current Workload

○ Quality Management

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance

21) Which criteria is more important in contractor selection? *

○ Health and Safety Concerns

○ Quality Managment

How much criteria above more important than other one on scale 1 to 9? *

	1	2	3	4	5	6	7	8	9	
Equal	○	○	○	○	○	○	○	○	○	Extreme importance