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Selection of Best Consultant by using Analytical Hierarchy Process (AHP)

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Abstract Consultant selection is a complex problem involving qualitative and quantitative multi criteria decision. In this study, an AHP-based consultant selection model is applied to develop and assist in decision making process to resolve the consultant selection problem in choosing the most favourable consultant's criteria combination. The Analytic Hierarchy Process (AHP) is an established decision method used to synthesize judgements and select the best alternative. When the objectives and scopes of study are set, then the data collection are made through two methods which are through literature review and pair-wise questionnaire survey. Information obtained from the questionnaire is interpreted into a simpler form and analysed by using the Expert Choice software. Results shows that financial capability of the consultant prioritize the decision of the selection while dominating the sub-criteria for selection is the profit made by the consultant within the last 3 years.

1. Introduction

Malaysia has a large construction industry of over RM 146 billion. Construction sector contributed to Malaysia's GDP at RM13695 Million [1]. The highest percentage share was contributed by civil engineering projects which recorded 42.6%. This was followed by the construction of non-residential building at 28.4%, followed by 24.2% in construction of residential buildings, and finally special trades at 4.8%. From the figure, private sectors dominates at 56.2% equivalent to RM20.5 billion while public sector 43.8% proportionate to RM16 billion [1]. Being a primary national economic contributor, the construction industry is facing prolonged problems such as time overrun, cost overrun, poor safety and poor quality [2]. Construction projects are known with the involvement of various parties from the industry itself as well as the support from the government for approving the development, financial budget and so forth. Prior to accomplish successful project, all parties involved directly or indirectly should work closely with aligning their respective areas of work and having collective coordination coupled with bilateral communication within private and public sector that involves for the project. It is concede that there are many factors that drive success for a construction project, primarily the mega projects which including financial, construction quality, and the progress level of the project itself [3]. Preceding to transform Malaysia into developed world by 2020, good teamwork among clients, consultants and contractors to implement and complete construction projects in a timely manner will be relish by in Malaysia's construction practitioners[4]. The design consultants typically consist of engineers, civil engineers and structures, mechanical and electrical engineers and other specialist designers, including interior designers, landscape architects, lighting experts, city planners, and so on. In the context of the construction project, the consultants specialize in their respective fields of expertise. Consultants act as facilitators who fulfil the client's request and also act as the facilitator of the construction project. In addition, they also act as advisers to clients on matters



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pertaining to design and legal requirements and by-laws that are closely related to the construction project. In the context of cost and contract negotiations, commonly a quantity surveyor acts as a cost consultant and contract for a project that covers the requirements of the deed and contract of the project. The need to choose the right and accurate consultants for the project is a very important yet risky challenge for any construction client's. Hence the right choice should be based on a decision-making that is analytic[3]. It is vital for the client/owner to select the best consultant in their project. Hence, client satisfaction towards consultant's work is very important in order to be able to survive in the marketplace. Based on the research findings, the construction cost would be five times higher to form a new construction client's rather than maintaining existing clients. It is therefore ultimate concerns for multiple construction players to be prepared as in order for them to be remain and survive in nowadays global marketplace, they should continuously attempt to elevate their achievement prior to be endure and sustain in nowadays comprehensive marketplace [5]. Successful project is led by the best selection of suitable, qualified project team, and experience project manager with good leadership skills. The criteria are most often related to the candidate's personal skills and experience in handling similar or multi projects. This study aims in providing an effective selection and recruitment of consultants on different projects for the contribution success of a project in terms of time, cost and quality. By employing a multi-criteria decision making, it is important for the selection of this consultant to be based on elements categorized into a price-related element and not closely related to the price. [6,7]. Consultant selection can be viewed as an intricate indefinite grouping problem, in which decisions are purely judge based to the consultant's qualification criteria, consultant's performance criteria and the field expertise judgment. Furthermore, multi-criteria decision making that are inter-related on the choice of consultant's is largely reliant on the ambiguity and uncertainty symbolic nature of construction projects couple with individual judgments of the construction expert's [7]. In earlier study by [8], also justified that when involving a development, the consultant selection process needs to consider the several elements that will influence the selection results as well as the decision-making process requiring the participation of various parties looking on numerous point of view. The most important issue in the process of consultant selection is to develop an effective method to select the best one [9]. As mentioned above, this problem is a group decision making. Hence, in this research all issues and problems associated to the consultant will be discussed and the best criteria for selecting consultants will be weighted by using Analytical Hierarchy Process (AHP) method.

2. Literature Review

Prior studies have reported lacking in performance of a construction project is mainly derived by the factors of faulty in design or issues related to technical that was primarily caused by the consultant. This is much largely dependent on the limited ability of public authority to evaluate consultant competence, especially aspects related to design and execution of projects [10]. One of the problems that arose from the issues is that the client have to face for a time overrun eventually causing delay. It is a big issues related to project management consultants (PMC) as surveys was being conducted among them [11]. Time overrun can be due to the changes of design schedule and government restraints. By the perspective of the clients, even though the construction projects were planned and organized perfectly, it will still face the risk of delays. Although many tools such as computer modelling technologies, Building Information Modelling (BIM) which created to assist the process of site management, delays keep occurring in construction projects [12]. In addition, insufficient cost also may contribute to the construction delay due to the inflation and capital equipment. The latest technological developments are indispensable in a construction project. The latest technology that has begun to be accepted slowly in the construction industry is the Building Information Modelling (BIM) system. BIM, which is basically a 3D processed model, combines architectural, engineering and construction (AEC) information and is capable of replacing and simplifying design procedure. However, the use of BIM has a risk where it requires the justification of acoustic consultants to ensure that the change in information complies with the prototype or the standards permitted to meet current requirements [13]. Building failure is not a rare issues as it can occur due to the type of materials used, the design method adopted, the environmental impact of the problem, the construction method used and the type of building to be built. Building failures usually occur when the tested material is more

geared towards its strength limit, so the material fails to cover the pressure applied to it. As an example, a new multi-purpose stadium in Eastern state of Malaysia which was constructed by an international construction firm was collapsed a major part of the roof construction. The major cause such stadium collapsed has been identified due to failure of design and materials used, coupled with urgency during construction and lack of supervisory just to reach on completion within the prescribed period. This is definitely the fault of design consultants as they do not consider the wind load while designing it and lack of supervision throughout the designing and construction process.

3. Research Methods

This study entails the use of multi-criteria decision making (MCDM) tools namely the Analytical Hierarchy Process (AHP) which was first introduced by Professor Saaty [14]. AHP is employed to elucidate multifaceted choice argument, engage a multi-level hierarchy structure of goals, criteria, sub-criteria, and options [15]. A methodology in obtaining the optimal consultant criteria is firstly, by identifying the criteria for consultant selection. The process involved in AHP basically involves the assessment of criteria and sub-criteria by relevant experts in their respective field. Among the key contributions given by AHP is that it can determine the most dominant criteria and sub-criteria for each given goal. The first stage in AHP is to build a hierarchical framework that consists of goals, criteria and sub-criteria. Next, the AHP model will be developed through a pair-wise questionnaire that will be assessed by the experts. Subsequently, the results of the questionnaire will be computed and calculated the geometric mean before it is formed to the matrix structure and the weight of each criteria is obtained. Specifically, the AHP method, can determine to the extent on which responses are consistent or inconsistent through the consistency index. The framework of consultant's selection are shown in the model presented in **Figure 1** below.

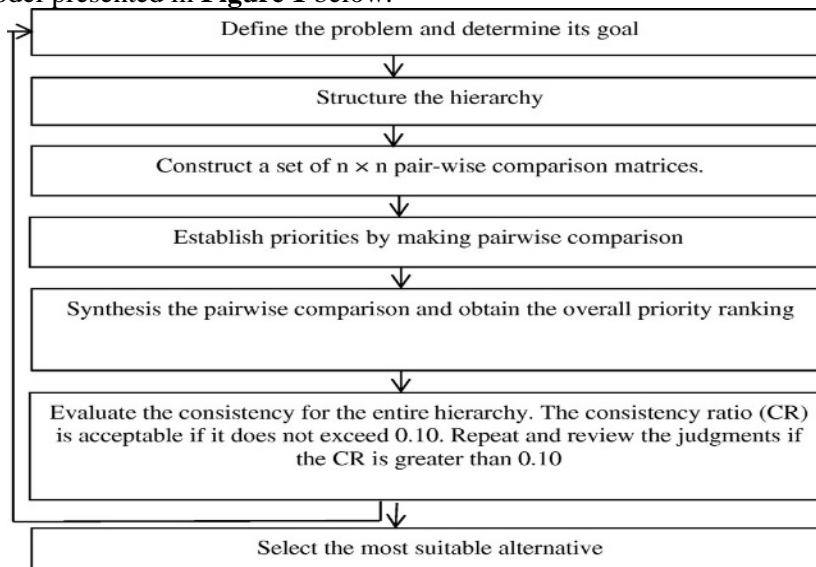


Figure 1. Proposed AHP for consultant's selection (modified after [7])

To create a judgement in a structured manner and to produce preferences, the judgement requisite to be fragmented by succeeding steps below and also simplified in **Figure 2**.

- i) Specify a research problem and decide the choice of understanding desired.
- ii) Arrange the judgement hierarchy from the uppermost is the aim or the goal, followed by the criteria from an extensive perceptions subject to the goal and finally the sub-criteria belongs to the criteria.
- iii) Create a set of pair-wise comparison matrices. Every criteria in the higher hierarchy being measured to the lower sub-criteria respectively.

iv) Every weighted is measure to determine the most dominant criteria and sub-criteria. Weighted obtained for every criteria is known as local weight, while the multiplication of weighted obtained for criteria and sub-criteria produces the global weight.

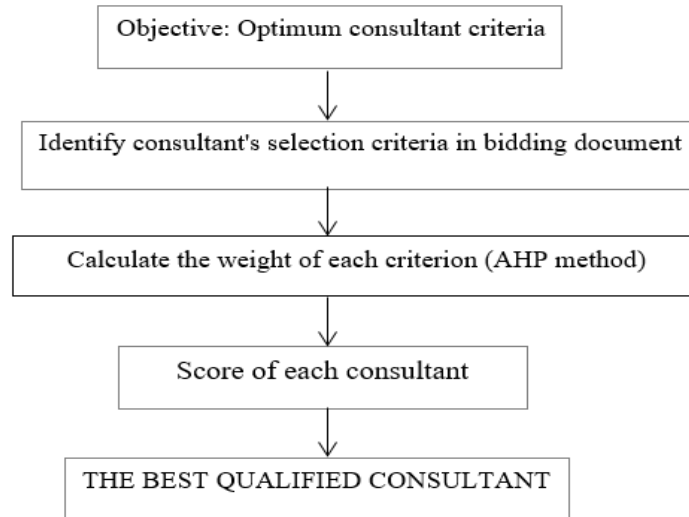


Figure 2. AHP in decision making

Within the context of this study, hierarchical structures that contains goal, criteria and sub-criteria is shown in **Figure 3** below.

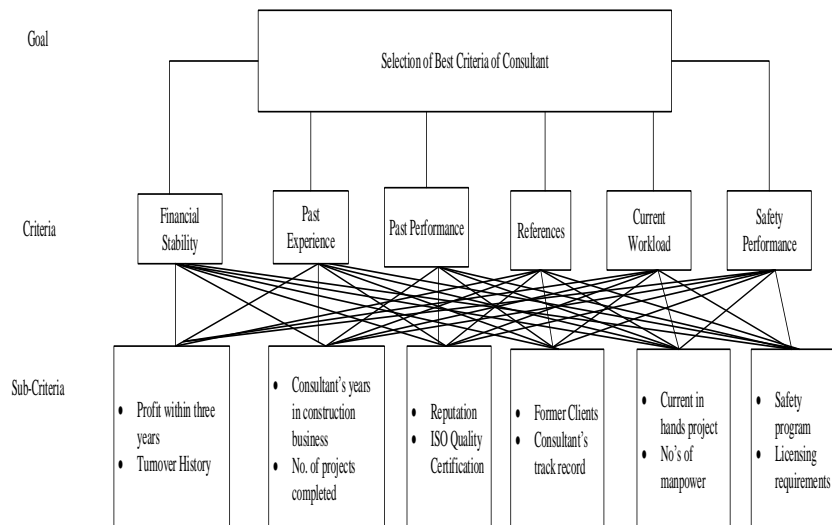


Figure 3. Decision Hierarchy Structure

AHP is used to develop relation measures from isolated and repeated paired comparisons [16]. Pairwise comparisons are the central theory within the utilization of AHP method. Pairwise assessments include choosing which criteria is much more imperative to the others criteria and if one is determined important, on what scale of qualitative judgement is the importance. The pairwise comparisons are then incorporate over the use of definite algebra, and preferences for every criteria. Every criteria are then normalized to aggregating of one, and the dominant criteria is ranked as the top best preferences [17]. **Table 1** below depicts number of criteria being compared, in $n(n - 1)/2$. This is due to the reciprocity values and the transverse criteria are proportionate for a homogeneity.

Table 1. Pairwise compare the criteria and sub-criteria

i \ j	Objective 1	Objective 2	Objective 3	Objective 4	...	Objective n
Objective 1	1	i_{12}	i_{13}	i_{14}	...	i_{1n}
Objective 2	i_{21}	1	i_{23}	i_{24}	...	i_{2n}
Objective 3	i_{31}	i_{32}	1	i_{34}	...	i_{3n}
Objective 4	i_{41}	i_{42}	i_{43}	1	...	i_{4n}
...
Objective n	i_{n1}					$i_{nn}=1$

i_{ab} : (a=1,..,n; b=1,..,n) = values (see table 1.)

AHP is very well known for its simple concepts. In similar vein, despite being able to provide the dominant criterion among others, it is an option because its ability to give precision in the results through the consistency index analysis offered. This consistency index is calculated on each criterion, and in the event of inconsistency, the consistent ratio can be calculated and if necessary, the pair-wise comparison can also reconsidered [18]. Generally, as suggested by Prof. Saaty, the consistency index (CI) should be less than 0.1 (10%) so that analysis can be adopted and analysed further [14,19-21]. If the CI is too high, it clearly shows that the respondent's decision is inconsistent and dubious in its accuracy. This further explains that the analysis of the consistency index is very useful in determining the probability of an error during the expert judgment [22]. In contrast, the decision making can be further examined, conceding that the values of consistency index and consistency ratio are sufficient. The AHP incorporates an effective technique for checking the consistency of the evaluations made by the decision maker when building each of the pairwise comparison matrices involved in the process. By reducing complex decisions to a series of pairwise comparisons, and then synthesizing the results, the AHP helps to capture both subjective and objective aspects of a decision. In addition, the AHP incorporates a useful technique for checking the consistency of the decision maker's evaluations, thus reducing the bias in the decision making process.

4. Results and Discussion

4.1. Demographic Respondent Analysis

This section is explanatory from **Figure 4** to **Figure 7**. Figure 4 illustrates the respondents by gender. From the total 30 responses received, 18 responses (60%) received from male and 12 responses (40%) received from female. Figure 5 below shows the respondent's experience in construction. It appears that only one respondent is having construction experience more than 10 years, while nine respondents having 5-6 years of experience, the others ten respondents are having experience 3-4 years and 1-2 years respectively. On the other hand, figure 6 depicts the respondent's position. It shows that, 11 respondent's monopolized in the survey is a Design Engineer, 10 respondents is a site engineer, 2 holds a position as Executive and Project Coordinator respectively, and 1 respondent hold position as Site Supervisor, Manager, Architect, Quantity Surveyor, and Structural Engineer accordingly while Figure 7 illustrates the company/organization of the respondents's. Apparently, 47% (14) of the respondents from the contractor organization, 20% (6) is the consultant, 13% (4) is the client, 13%(4) from the government or public authority while the remaining 7% (2) is from the architect firm.

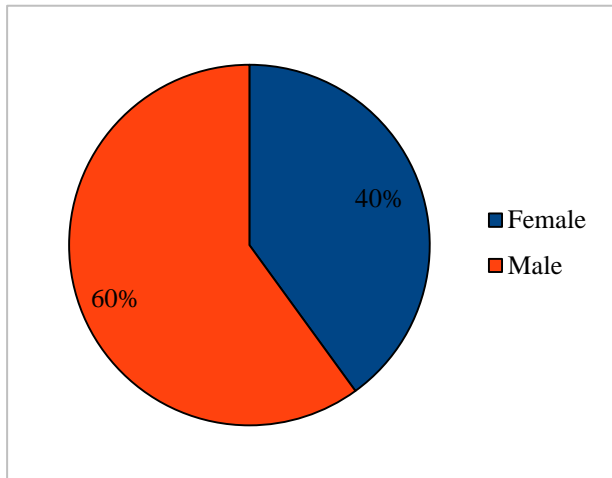


Figure 4. Respondent's by Gender

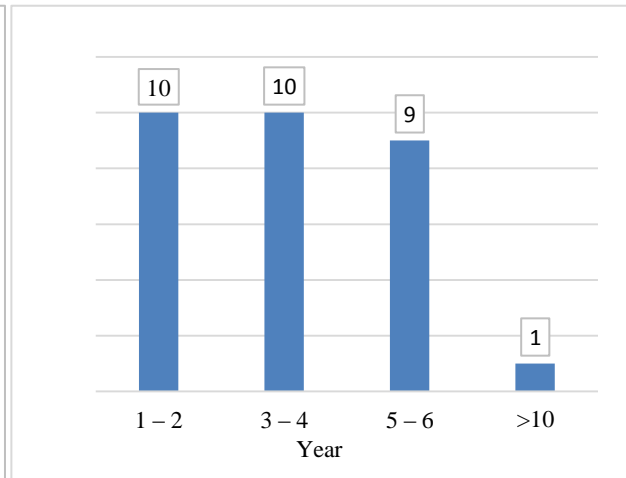


Figure 5. Respondent's Experiences

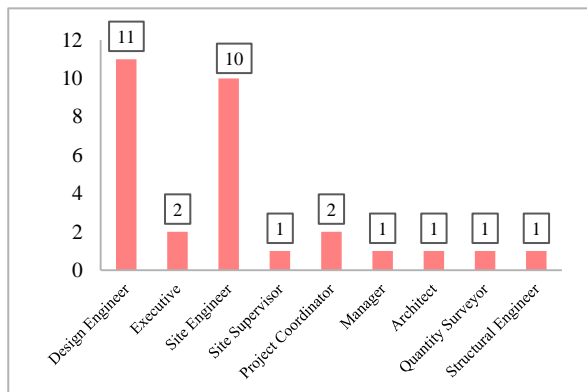


Figure 6. Position of the Respondent's

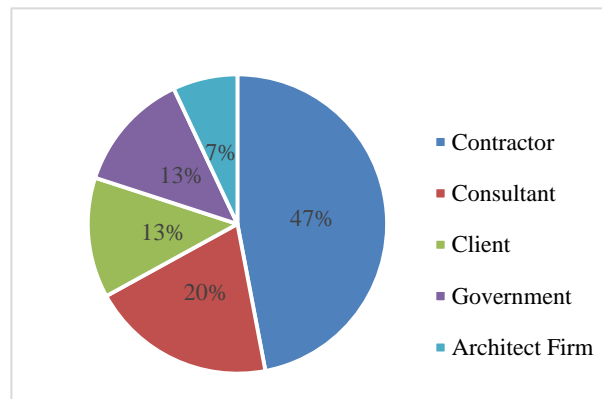


Figure 7. Company/Organization of the Respondent's

4.2. AHP Results and Discussion

Figure 8. below depicts the results on the prioritization of criteria for the selection of consultant by analysing by using the 'Expert Choice' program.

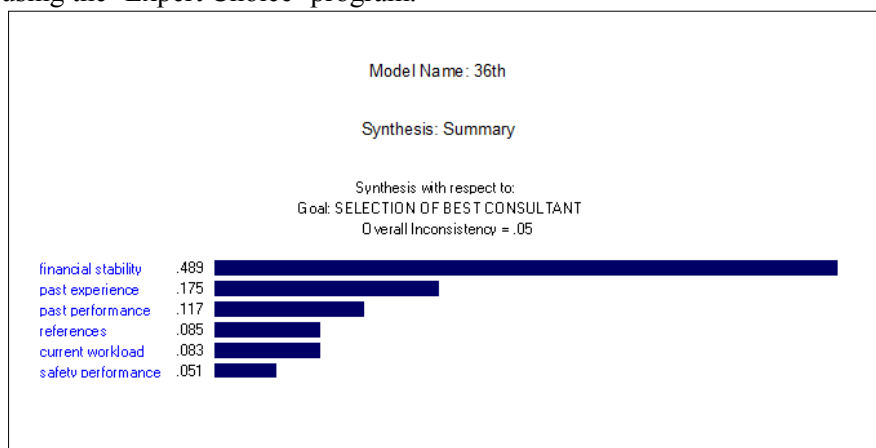


Figure 8. Priorities of criteria selection of consultant

Apparently, from the figure 8, the results achieved consistencies at 0.05 (5%) and is less than 0.10(10%) as per recommendation by [14,19]. Financial stability is dominating the prioritization weighted at 0.489, followed by past experience of the consultant weighted at 0.175, past performance of the consultant (0.117), references by others weighted at 0.085, consultant workload weighted at 0.083 finally safety performance of the consultant at 0.051. The findings of financial stability is cohere with a report by [23]. The importance of the consultant's selection is closely related to the consultant financial position and stability[23]. Figure 9 on the other hand, depicts the results for the prioritization of the sub-criteria selection of the consultant. It shows from the figure that, top prioritization of sub-criteria in selecting the consultant is the profit made by the consultant within the last 3 years weighted at 0.291, No's of projects completed weighted at 0.199, reputation of the consultant weighted at 0.156, consultant track record 0.075, consultant's current project 0.061, turnover history 0.058, safety program 0.046, consultant's year in construction business 0.033, ISO quality certification 0.026, manpower 0.020, former clients 0.019 finally licensing requirements 0.015.

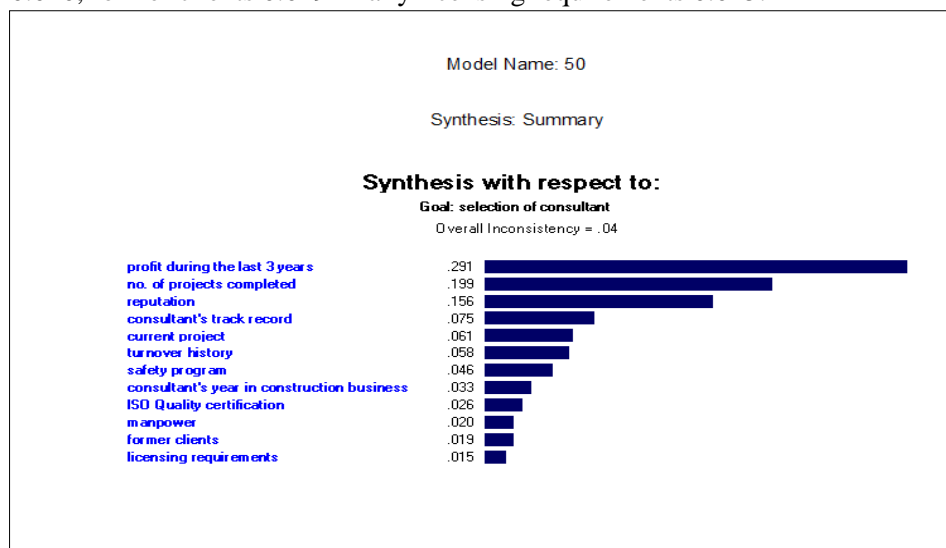


Figure 9. Priorities of sub-criteria selection of consultant

The finding confirms that in the construction sector where the function of a consultant is indispensable, among the criteria identified in the project consultant selection is the experience of the consultant. This shows that job perceptions and past experience are very valuable in the success of a project. This is acknowledged as the consultant is the party to be referred by each project team in the event of any technical or non-technical problems. In addition, it can be concluded that data analysis and results may differ if analysed to other construction clients. This is influenced by the different cultural organizational factors of the client. In order to solve the problem of these differences, proper selection of consultants with great criteria needs to be built. According to this paper's findings, the results obtained can be support by a few evidences from the previous research. It is widely accepted view that, at a minimum, performance measures of a project are based on time, cost and quality[24]. Furthermore, in an observation-based study by [25], in order to achieve a completed project that meets the owner's quality expectations, all parties to a project must acquire an understanding of those expectations, incorporate them into the contract pride and other contract documents to the extent possible, and commit in good faith to carry them out. This is supported by [26], stated the effectiveness and quality of the consultant's work is taken into account. In placing more emphasis, [10] states that the competence, commitment and attitudes of design consultants strongly influence the quality and cost of built facilities. Thus, selecting the right design consultants is of utmost importance for any construction client.

According to a study by [27] the cost variance was the most common technique used to measure design performance. It is not only confined to the tender sum, but the overall cost that a project incurs from inception to completion, which includes any costs arise from variations, modification during construction period and the cost arising from the legal claims, such as litigation and arbitration. In advance, other study claimed that time path and budget were considered more important for consultants that were also involved as project manager [28]. These studies have found the similar results where price is the professional fee charged by the consultant. Which states that in many cases, price is the main determinant in consulting selection [29].

5. Conclusion

The success of any construction project is much dependent on the selection of the team-work or parties involved during the construction stage, including the consultant. This study esteem the practise of multi-criteria decision making (mcdm), the Analytical Hierarchy Process (AHP) for the selection of consultant. Results shows that financial capability of the consultant prioritize the decision of the selection while dominating the sub-criteria for selection is the profit made by the consultant within the last 3 years. Results presented will be an aided tools specifically the client for choosing the right consultant while not risking the construction performance.

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