Selection of Contractor by Using Analytical Hierarchy Process (AHP)

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Abstract. Construction projects is progressing rapidly in Malaysia and have been as one of an important factor in contributing the boost of country's economic. Well known as a sectors with involvement of multiple players, thus, contractor selection is an important aspect in construction sector especially for client or parties involve that need to hire the best contractor to manage and complete their project within time-line and bearable cost couple with comprised quality. Furthermore, without a suitable method use in selection of contractor, it will affect the completion of whole project. This paper aiming in make use of the analytical hierarchy process (AHP) as a decision support model to select contractor. The AHP allows constructing decision as hierarchies and each criterion can be evaluated through weighted determined by the expert in construction field. The objectives of this study is to develop the main criteria used by client in selection of contractors also identify the weighted criteria by using AHP method from current practice in Malaysia. Besides, this method is one of the decision-making that is necessary to eliminate the risks of project failure due to poor contractor's performance.

1. Introduction

The decline in the construction industry occurred around 2005 to 2006 with a rate of negative 5.1%. There was a reduction in the number of projects and many bankrupts' contractors [1]. In Malaysia, issues faced for selection of contractor where they do not emphasizing an important aspect in the delivery of construction projects where it linked to project success, in term of time schedule, cost, and quality. Besides, the overall project quality and owner satisfaction is relevant to the contractor performing the work. Contractor need to understand the procedures for obtaining government, private projects or tenders. Many of them are blacklisted because they cannot afford financial risk and responsibility given to complete the projects, also demand in 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 sufficient 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 Analytical Hierarchy Process (AHP) where a theory of measurement through pair wise comparisons and relies on the judgments of experts to derive priority scales was applied.

2. Literature Review

In this challenging era, to get successful project construction we need to manage the flow or process in an effective manner. The demands from clients, competition, and regulatory agencies have been growing rapidly [2], a failure to properly manage them can lead to problems for the entire project and construction team. Various studies have shown that overall project quality and owner satisfaction is directly related to the contractor performing the work [3,4]. Selection of a contractor deemed as major challenge for many construction firms and there is a need for employing systematic tools prior to select the best alternative among different contractors [5]. The selection of a proper construction contractor increase chances of successful completion of a construction project [6]. 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 [7]. To choose capable construction contractor is one of the important aspect faced by the client or parties involve who wishes to achieve successful complete projects outcomes. This type of tasks is challenging, because construction industry is rapid growth and competitive around the world. [8] Agree that the probability of construction failure is quite high for individual contractors, and it is important for project owners to confront and manage these risks if they wish to achieve good project results. In the other words, we need to find the decision making tools where we can seek the best of the satisfactory options to be the best solution to the problem [9]. However, failure to make effective decision leads to poor, ineffectual and wrong decisions [10].

3. Research Methods

This study employing quantitative analysis a multi-criteria decision making (MCDM) namely the Analytical Hierarchy Process (AHP). Figure 1 below depicts the research flow process. Based on the figure, this study first scrutinizing the literature review on the "factors for the selection of contractors". Drawing largely upon factors of pre-selection of contractors developed by [11], a hierarchy of the selection was further developed. Analytical hierarchy process (AHP) is a decision aiding method developed by Professor Saaty back in 1980's [12] and this method is still being in practised up during this era. Regardless of aiding in decision making, AHP also assists stakeholders especially in solving complex and conflict multicriteria and subjective issue by facilitating to prioritize and rank the associated problem [13].

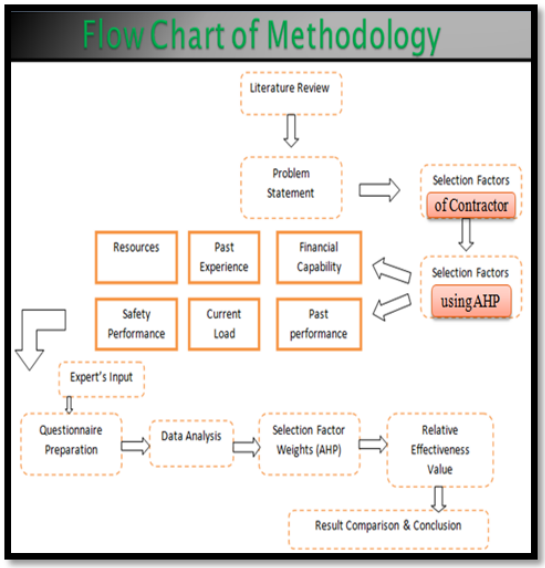

Figure 1. Research Methods Flowchart

AHP is designed based on the pair-wise comparison scale and as shown in **Table 1.** It relies on the judgement of expert from scale one (1) to nine (9).

Table 1. Scale of Relative Importance for Pair-Wise Comparison [12]

Numerical Rating	Verbal Judgement of Importance
9	Extremely importance
7	Very strongly importance
5	Essential or Strong importance
3	Moderate Importance
1	Equal Importance
2,4,6,8	Intermediate value

The pairwise comparison of various factors generated are organized into a square matrix as depicted in **Eq. 1** below.

$$A = aij = \begin{Bmatrix} a11 & \dots & a1n \\ \vdots & \ddots & \vdots \\ an1 & \cdots & ann \end{Bmatrix} \qquad \textbf{Eq. 1}$$

The principal eigenvalue and the corresponding normalized right eigenvector of the comparing matrix give the relative importance of the various factors being compared. The elements of the normalized eigenvector are termed weights with respect to the factors or sub-factors and ratings with respect to the alternatives. Equation (3) showed formula of each matrix that needs to be normalized.

$$Aw = \lambda \text{ max}.W \qquad \textbf{Eq. 2}$$

[12] demonstrated that $\lambda_{max} = n$ is a necessary and sufficient condition for consistency. Inconsistency may arise when λ_{max} deviates from *n* due to varying responses in the pairwise comparisons. Therefore, [12] proposed a method to measure the inconsistency by first estimating the consistency index (CI). The CI is defined in Eq. (3). Then, to obtain the consistency ratio (CR), the CI is divided by the random consistency index (RI) in Eq. (4), value of RI as tabulated in **Table 2.** The CR value should not greater than 0.1 otherwise the pairwise comparison result should be rejected.

$$CI = \frac{(\lambda \text{ max} - n)}{(n-1)} \qquad \textbf{Eq. 3}$$

$$CR = \frac{CI}{RI} \qquad \textbf{Eq.4}$$

Table 2. Random Consistency Index (RI)

Number of Factors	3	4	5	6	7	8
Random Index (RI)	0.58	0.90	1.12	1.24	1.32	1.41

As this kind of multi-criteria decision making method requires only expert judgement, thus, sampling size is not a big issue, according to [14], if an expert is well versed in his field, his decision is sufficient unless political expediency requires that several judges from different constituencies are necessary. This study employing the purposive sampling methods with the pair-wise questionnaire only considered construction expert with ten (10) years of construction experience. Distribution of the questionnaire conducted by using face to face method, taking into account that this method may unfamiliar to the respondent.

4. Results and Discussion

4.1. Demographic Data

The respondents profile is tabulated in **Table 3** below. From the table, only respondents with more than 10 years of construction experience are taken into account for further analysis. This leads to only the opinion of twelve (12) construction experts who will be analyzed to the next level. Data in the table depicts that respondent with 10 to 14 years of experience is 58% while respondent with over 15 years is 42%. While the percentage breakdown for profession shows Civil and Structural Consulting Engineer recorded the highest percentage with 33.33%, Archictect and Public Authority at 25% respectively, while the rest belongs to senior site project manager at 16.67%.

Table 3. Respondent Profile

Profession	Experiences (Years)			
	1 to 5 years	6 to 9 years	10 to 14 years	Over 15 years
C&S Consultant Engineer	*2	*1	2	2
Architect	-	-	2	1
SiteProject Manager	-	-	1	1
Public Authority	-	-	2	1

* data is not accounted for because it does not comply with inclusion criteria expert with > 10 years experiences.

4.2. AHP Results and Discussion

Table 4 below depicts results of the AHP analysis results into six (6) factors that have been listed as factors that contribute in the selection of contractors. The analysis illustrates that the priority vector (PV) as the relative importance weighted for each factor, while prioritized ranking (PR) has arranged in descending in order to facilitate the discussion of each factors. Obviously in the table, financial capability (0.478) monopolizes the factor compared to the other five factors. Next is followed by past performance (0.252), past experience (0.148), resources (0.073), current workload (0.038) and finally the safety performance (0.006) factors.

Table 4. Factors PV and PR

Factors (F)	Priority Vector (PV)	Prioritized Ranking (PR)
F1 (Financial Capability)	0.4776	1
F2 (Past Performance)	0.2518	2

F3 (Past Experience)	0.1483	3
F4 (Resources)	0.0735	4
F5 (Current Workload)	0.0376	5
F6 (Safety Performance)	0.0066	6

The financial capability of a contractor company is indeed an important element in the selection criteria of the contractor prior to being procured. The finding of financial capabilities correspond to previous study [15] whom conduct a risk assessment related to the choice of contractors and found that among the important criteria to be assessed is the contractor financial capabilities. Similarly, study by [16] ranked financial capability as the top final contractor selection factor by using the analytical hierarchy process. In like manner, [17] found the top knotted of critical success factors for Malaysian contractors in international construction projects are the contractor's experience, effectiveness in decision making and contractor's cash flow. Past performance report of a contractor strongly encourages the client to decline or select the contractor. The contractor's past performance will also stimulate the success of a construction project. Nevertheless, the report should undergo a transparent and fair system without any personal interest. Among the significant factors in the evaluation of past performance reports listed by [18] are through a transparent and fair procurement system. Interestingly, this study found that the respondents evaluated safety performance as an unimportant factor in the selection of contractors. This is in line with the results obtained by [16] whom reported safety performance as the last factor to be assessed for the selection of contractor. On the other hand, the respondent also ignored the factors of current workload or burden borne by the contractor. A possible explanation for this finding is that, if the contractor is competent enough, the current workload is not a major problem for the prospective contractors. This is largely dependent on the maturity level of contractor companies in managing and allocating their in hands projects without affecting their construction performance level.

5. Conclusion

This study aims to identify which factors is prioritized during selection of a contractor. The results provides some empirical findings that illuminates client perspectives in making fast decision during selection of a contractor. It appears that financial capability (0.478) dominates the ranking, followed by past performance (0.252), past experience (0.148), resources (0.073), current workload (0.038) and finally the safety performance (0.006) factors. This study is conducted on the basis of extracting expert judgement quantitatively. Future studies can consider to employ a qualitative method in the form of depth interview pertaining the obtained factors in this study, or adopting a mixed method approach.

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