Available online at: https://ijact.in

Date of Submission	22/10/2018
Date of Acceptance	18/11/2018
Date of Publication	30/11/2018
Page numbers	2874-2878 (5 Pages)

ISSN:2320-0790

COMPUSOFT
An International Journal of Advanced Computer Technology

MANAGING MULTI-CRITERIA CONTRACTOR SELECTION FOR PUBLIC CONSTRUCTION PROJECTS IN MALAYSIA

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Abstract: Managing the selection of a right contractor for construction projects is vital for the industry because of its complexity. Furthermore, contractors have a direct impact on project's outcome and their selection needs to be done carefully and systematically. As a matter of fact, public construction projects in Malaysia are repeatedly agonised from time over run, overspending and quality concerns. These issues are greatly affected by the contractors who are likely manipulating the tender price with the sole purpose of securing the contract, hence leading to various problems throughout the project life cycle. Thus, this paper intends to manage the contractor selection process via the aim of developing a set of contractor selection criteria for public construction projects in Malaysia. A total of 43 selection criteria are collected via literature review, questioned to 276 Malaysian construction practitioners and analysed using Statistical Package of Social Sciences (SPSS) and SmartPLS. Analysis showed that all 43 selection criteria were significant in selecting contractors in Malaysia. The findings of this paper would encourage the governing bodies and authorities to consider the use of multi-criteria assessment in selecting contractors for public construction projects, rather than being solely reliant on the tendered price.

Keywords: Tender selection; construction; SmartPLS software.

I. INTRODUCTION

In construction, contractors have a significant impact on project performance; a well-qualified and preselected contractor has the tendency of delivering high-quality projects within the allocated project period [1]. By minimising quality issues throughout the project lifecycle, unnecessary expenditure that considerably burdens the project funding can be eliminated. The task of managing, assessing and selecting a contractor is a very complicated decision-making process, where failure to perform it properly could cause time overrun, waste of project resources, or eventually jeopardising the project quality [2]. Such implications further reflect the critical aspect of the selection process. Therefore, this paper suggests that contractors need to be evaluated not solely according to the priced offered but rather multiple criteria that might have a direct effect to project delivery.

Contractor selection criteria have been an interest within the construction management research community [3]. Liu et al.[4] have highlighted that contractor selection criteria play a big role towards work performance and project success. Therefore, selecting the best contractor for projects is the biggest challenge during the decision-making process. This specific challenge can be overcome by yielding a review of contractor selection criteria for construction projects and its establishment as a standardised reference in the future. With the ultimate objective of developing a contractor selection framework, this paper intends to validate the findings of previous study on critical selection criteria for construction projects conducted by Rashid et al.[5]. The result of this paper will then be the basis of developing a multi-criteria contractor selection framework for public construction project in Malaysia.

II. CONTRACTOR SELECTION FOR CONSTRUCTION PROJECT

A. Construction Industry in Malaysia

Malaysia has suffered from poor performance in the construction industry, especially in the public construction sector[6]. Some of the factors that are related to the contractor selection process are the appointment of non-registered contractors, the appointment of contractors not according to regulation and contractor's experience and unreasonable contract price. In addition, Nurul et al.[6] also pointed out contractor's management, financial, technical and manpower. Furthermore, Shehu et al.[7] added that the project delivery overrun is also a problem to the industry. These will then lead to additional project spending and other various negative outcomes. Shehu et al.[7] also stressed out that project delays are predominantly caused by contractors. All of these arguments created a question mark on whether those contractors have been selected properly or whether there are some flaws in the contractor selection process.

The current contractor selection process for public construction projects is utilising the cut-off price method, which was introduced by the Malaysian Public Works Department (PWD) in 2002[8]. This method was introduced to determine and choose the most profitable bid and the most suitable contractor for contract award [9]. Halil[9] added that the cut-off price is based on statistical analysis to evaluate the bids submitted by the contractors. Bids submitted by contractors are statistically analysed together with the project cost estimated by the department. Unfortunately, after more than a decade implementing this method, the performance of public construction projects is still at an unacceptable level. Hence, it is timely to investigate a different approach in selecting contractors for construction projects.

B. Contractor Selection Criteria

There are many multi-criteria techniques that have been proposed and applied in performing contractors' pre-qualification and selection [10]. Comparing bid prices is a common practice in many organisations and often is the only criterion when selecting contractors, which is often subjected to criticisms. The lowest bidding price may not inevitably benefit the client as the quality and period of the project may be undermined [11]. Puri et al.[12] stated that bid evaluation by contractors might implicate the comparison of different criteria assessed according to different gauges, as different decision makers have different preferences.

Rashid et al.[5] have extensively identified 43 critical contractor selection criteria for the Malaysian construction projects divided into seven main categories: management capability, financial capacity, experience, resources, technical ability, environmental, health and safety (EHS), and others. Other previous literature has also highlighted various contractor selection criteria, but in a real practice setting, clients will nevertheless possess their own different criteria. Content analysis on previous related studies has yielded the generalised categorisation of contractor selection criteria into seven main categories, including management capability, financial capacity, experience, resources, technical, environmental health and safety (EHS) and others as shown in Table 2, which are discussed in the succeeding section.

III. RESEARCH METHODOLOGY

From the literature review, the identified 43 critical contractor selection criteria for the Malaysian construction projects were questioned to a random sampling of 276 Malaysian construction practitioners stratified based on the organisation types via a questionnaire survey directly distributed to the samples following the construction practitioners database obtained from the Construction Industry Development Board (CIDB) as in Table 1. The questionnaire survey was designed to apprehend the respondents' responses, where respondents were given with a statement, and then they were requested to provide their replies with variable degrees of agreement or disagreement scales. Respondents attitudes are measured using the 5-points like scale ranging from "1" (strongly disagreed) to "5" (strongly agreed). Since this paper is focusing on public construction projects in Malaysia, the sample was stratified among the local Malaysian construction industry practitioners, including engineers, architects, quantity surveyors, contractors and most importantly public agency officers, who are largely related to the delivery of public construction projects. The results analysed from questionnaire survey via Statistical Packages of Social Sciences (SPSS) as shown in Table 2 were analysed further using the Structural Equation Modeling (SEM) approach. To derive a set of contractor selection criteria for the final framework, only significant criteria will be selected. This method of criteria elimination is employed by Cheung et al.[13] in developing a model for the selection of construction procurement and Chua et al.[14] that developed procurement strategy selection in building maintenance works. However, for this preliminary study, all criteria were selected to see their impact on contractor selection, except for three criteria: time offered, price offered, and quality of parts offered. These three criteria are mandatory criteria and will be exempted from further testing.

TABLE I: DEMOGRAPHIC DATA OF RESPONDENTS

Item	*Details*	*N*	*Percentage*
Gender	Male	182	65.9
	Female	94	34.1
Age	20 – 29 years old	41	14.9
	30 – 39 years old	146	52.9
	40 – 49 years old	65	23.5
	More than 49 years old	24	8.7
Organisation Type	Government agency	92	33.3
	Consultant	126	45.7
	Contractor	49	17.8
	Others	9	3.2

Partial Least Square Structural Equation Modeling (PLS-SEM)

As mentioned above, Time, Quality and Cost are the three main criteria in selecting contractor and therefore, will not be tested further. The significance of other six categories: Management Capability (MC), Financial Capacity (FC), Experience (EX), Resources (RS), Technical (TC), and Environmental, Health and Safety (EHS) will be tested as this research hypotheses, H1 to H6 respectively. Before continuing with the hypotheses testing, the measurement model was assessed through the Partial Least Square Structural Equation Modelling (PLS-SEM). This is to align with the two steps approach suggested by Anderson and Gerbing[15]. Figure 1 shows the model of this paper with structural dimensions.

A. Normality/Validity Analysis and Hypothesis Testing

Using the statistical method and graphical test, an analysis of the normality of each variable was conducted. Skewness was used to determine the degree of asymmetry of a distribution around its mean. Meanwhile, the kurtosis values showed the sharpness of the peak or flatness of the normal distribution. Positive kurtosis indicates a relatively peaked distribution while negative kurtosis indicates a relatively flat distribution. Data can be considered normal if both skewness and kurtosis fall between +3 and -3[16].

Next, the content of the model will be tested for its validity, namely the content validity and convergent validity, as well as the hypothesis. Hair et al.[17]defined content validity as the extent of items in measuring the construct. In other words, the designed items for a particular construct should be higher loaded on their respective compared on their loading on other constructs. The convergent validity, on the other hand, is the degree to which a group of variables converges in measuring a specific concept [17]. As suggested by Hair et al.[17], to establish the convergent validity, three criteria should be tested simultaneously, namely the factor loadings, composite reliability (CR), and average variance extracted (AVE). Loading of more than 0.7 is an acceptable level according to the multivariate analysis literature [17].The values of Cronbach'salpha are above 0.7, which exceed the recommended level of 0.7 [17, 18].

As for the hypothesis testing, the type of hypothesis involved here is the hypothesis for measurement model, namely H1 to H6 is indicator of Management Capability (MC), Financial Capacity (FC), Experience (EX), Resources (RS), Technical (TC) and Environmental, Health and Safety (EHS), respectively.

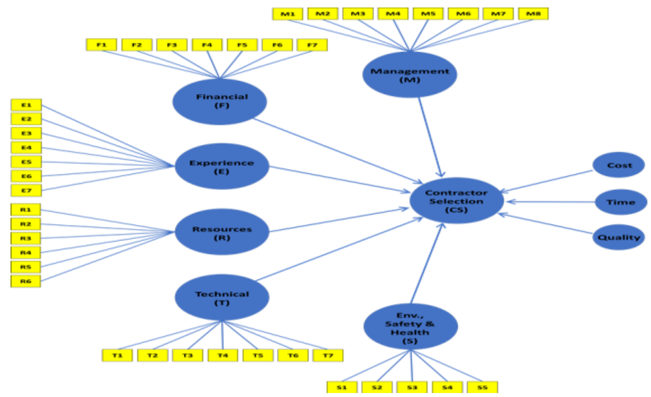

Figure 1: Structural Model for SEM Analysis

TABLE II: SUMMARY RESULTS OF QUESTIONNAIRE SURVEY ON CONTRACTOR SELECTION CRITERIA ADOPTED FROM RASHID ET AL. [5]

Code	*Indicator*	*Mean*	*SD*	*Code*	*Indicator*	*Mean*	*SD*
MC1	Client-contractor relationship	2.79	0.62	RS1	Equipment, tools and machinery	3.55	0.55
MC2	Reputation	2.42	0.58	RS2	Technical manpower	3.86	0.52
MC3	Project management system	3.97	0.68	RS3	Projects in hand	2.61	0.64
MC4	Company management system	3.74	0.61	RS4	Number of staff	2.71	0.65
MC5	Client satisfaction	2.22	0.51	RS5	Progress of existing projects	2.52	0.62
MC6	Experience in business	3.16	0.50	RS6	Vehicle	2.59	0.64
MC7	Risk management system	3.12	0.52	TC1	Company registration	3.51	0.61
MC8	Political consideration	2.45	0.62	TC2	Staff qualification	3.74	0.60
FC1	Company yearly turnover	2.44	0.75	TC3	Quality management system	4.05	0.42
FC2	Financial guarantee	3.97	0.60	TC4	Project manager competency	4.20	0.52
FC3	Company asset	2.68	0.73	TC5	Technology and work method	3.81	0.59
FC4	Company liability	2.34	0.68	TC6	Quality control	4.14	0.47
FC5	Cash in hand	4.63	0.63	TC7	Quality assurance	3.49	0.63
FC6	Financial management system	4.04	0.72	EHS1	Safety and health management system	2.64	0.65
FC7	Credit facility	3.91	0.64	EHS2	Environmental management system	2.54	0.65
EX1	Past achievement in job performance	3.04	0.56	EHS3	Safety and health competency	2.55	0.78
EX2	Past failure in job performance	2.41	0.68	EHS4	Environmental competency	2.53	0.71
EX3	Past similar job scope	3.40	0.55	EHS5	Accident rate	2.08	0.68
EX4	Familiarity with work location	3.60	0.64	TIME	Time completion offered	4.55	0.56
EX5	Size of past projects	2.64	0.73	QUA	Products quality offered	4.59	0.59
EX6	Staff experience in industry	3.46	0.67	COST	Price offered	4.58	0.58
EX7	Number of past projects	2.39	0.66				

IV. RESULT AND DISCUSSION

The analysiswas carried out using the SPSS and SmartPLS software. The significance of each factor on contractor selection through the developed model was determined. In order to ensure the strength of each factor is reliable and consistent, the model needs to be evaluated on various angles. For the purposes of this paper, the evaluation process involves three basic steps: data normality, evaluation of the outer model and discriminant validity and hypothesis testing. Data normality is tested using Skewness and Kurtosis method, which shows that all the variable constructs are normally skewed with a degree of asymmetry of a distribution between 0.80 and 0.90 and normal kurtosis which fall between 0.76 and 0.65 which is under the value ranged within -3 to +3. As for the evaluation of the outer model and discriminant validity, the output, namely the construct loading, Cronbach salpha, Composite Reliability (CR), the Average Variance Extracted (AVE), are summarised in Table 2.

TABLE III: RESULT OF OUTER MODEL AND DISCRIMINANT VALIDITY ANALYSIS

Construct	*Loading*	*Cronbach's Alpha*	*Cr*	*Ave*	*Construct*	*Loading*	*Cronbach's Alpha*	*Cr*	*Ave*
Management Capability (MC)		0.86	0.9	0.55	Resources (RS)		0.89	0.92	0.7
MC1	0.69				RS1	0.81			
MC2	0.82				RS2	0.83			
MC3	0.79				RS3	0.88			
MC4	0.75				RS4	0.85			
MC6	0.69				RS5	0.84			
MC7	0.77				RS6	0.78			
MC8	0.66				Technical (TC)		0.85	0.89	0.53
Financial Capacity (FC)		0.92	0.94	0.75	TC1	0.87			
FC1	0.91				TC2	0.57			
FC2	0.88				TC3	0.76			
FC3	0.86				TC4	0.75			
FC4	0.85				TC5	0.76			
FC7	0.83				TC6	0.74			
Experience (EX)		0.81	0.86	0.51	TC7	0.60			
EX1	0.79				Env, Health and Safety (EHS)		0.77	0.85	0.59
EX2	0.85				EHS2	0.78			
EX3	0.62				EHS3	0.72			
EX4	0.52				EHS4	0.77			
EX5	0.80				EHS5	0.81			
EX6	0.63								
EX7	0.80								

As for the hypothesis testing, the conceptual model was tested by SEM causal model. The model includes the endogenous dependent observed variables related to Management, Financial, Experience, Resources, Technical, and Environmental, Health and Safety. Table 3 shows the results of the causal model testing. Overall, the analysis revealed that all variables are valid due to its indicators' parameter estimates and their statistical significance. The t-value of all variables ranges from 3.94 to 14.59 with attained levels of significance at 0.05.

TABLE IV: RESULT OF CAUSAL MODEL TESTING

Casual Path	***Hypothesis***	***β-Value***	***t-Value***	***Supported***
Management Capability (MC)	H1	0.18	3.94	Yes
Financial Capacity (FC)	H2	0.24	8.76	Yes
Experience (EX)	H3	0.25	9.37	Yes
Resources (RS)	H4	0.29	14.59	Yes
Technical (TC)	H5	0.28	8.14	Yes
Environmental, Health and Safety (EHS)	H6	0.17	9.7	Yes

V. CONCLUSION

This paper aims to validate the findings of the previous study of critical selection criteria for construction projects conducted by Rashid et al. [5], and it has successfully achieved this aim. SPSS and SmartPLS have been used to test the validity and reliability of the items as well as hypotheses testing on the model. Data normality has been tested using Skewness and Kurtosis method, which shows that all the variables are normally skewed withan acceptable range of degree of asymmetry and normal kurtosis. The analysis reveals that each construct has a strong relationship with the selection of contractor for public construction projects in Malaysia. This validates the result of previous descriptive analysis that was done on the same set of data. Nevertheless, it is suggested that a fewmoreanalysesneed to be done on the model such as the structural relationship and overall model fitness. Like any other study, this paper has a limited scope of contractor selection in the context of public construction projects in Malaysia. Furthermore, this paperdoes not cater to fuzziness and uncertainty associated with contractor performance, which may hamper the application during the contractor selection. It is also suggested that other studies are tobe conducted by comparing the differences in both public and private construction sector to create a model of best practices for the whole construction industry.

ACKNOWLEDGMENT

The authors would like to express their sincere gratitude to the Ministry of Education Malaysia, Universiti Teknologi Malaysia (UTM) and Razak Faculty of Technology and Informatics for providing the financial support for this paper to be published.

VI. REFERENCES

[1] Aje I. The impact of contractors' prequalification on construction project delivery in Nigeria. Engineering, Construction and Architectural Management 2012; 19: 159–172.

[2] Movahedian Attar A, Khanzadi M, Dabirian S, et al. Forecasting contractor's deviation from the client objectives in prequalification model using support vector regression. International Journal of Project Management 2013; 31: 924–936.

[3] San Cristóbal JR. Contractor Selection Using Multicriteria Decision-Making Methods. Journal of Construction Engineering and Management 2012; 138: 751–758.

[4] Liu L, Zhou Y, Zhu H. A conceptual framework for vendor selection based on supply chain risk management from a literature. Journal of System and Management Sciences 2011; 1: 1–8.

[5] Rashid I, Ismail S, Mohamed Z, et al. Contractor Selection Criteria : a Study on Malaysian Public Construction Projects. International Journal of Engineering & Technology2018; 7: 65–70.

[6] Nurul AJ, Aminah MY, Syuhaida I, et al. Public construction projects performance in Malaysia. Journal of Southeast Asian Research 2016; 2016: 1–29.

[7] Shehu Z, Endut IR, Akintoye A. Factors contributing to project time and hence cost overrun in the Malaysian construction industry. Financial Management of Property and Construction 2014; 19: 55–75.

[8] Besawa Jagar Singh BS, Abdul Hamid AR, Yahya EUB. Selection of Contractors for Minor Works by Quotation. SEPKA 2014. National Seminar on Civil Engineering Research.

[9] Halil FM. Contractor's perception of the use of statistical approach in the tender evaluation at the Public Works Department, Malaysia.American Journal of Applied Sciences 2007; 4: 1084–1089.

[10] Alzober W, Yaakub AR. Integrated Model for MCDM: Selection Contractor in Malaysian Construction Industry. Applied Mechanics and Materials 2014; 548–549: 1587–1595.

[11] Jaskowski P, Biruk S, Bucon R. Assessing contractor selection criteria weights with fuzzy AHP method application in group decision environment. Automation in Construction2010; 19: 120–126.

[12] Puri D, Tiwari S. Evaluating The Criteria for Contractors ' Selection and Bid Evaluation. International Journal of Engineering Science Invention 2014; 3: 44–48.

[13] Cheung S, Lam T, Leung M, et al. An analytical hierarchy process based procurement selection method. Construction Management & Economics 2001; 19: 427–437.

[14] Chua S, Lin J, Ali AS, et al. Analytic Hierarchy Process Decision-Making Framework for Procurement Strategy Selection in Building Maintenance Work. Journal of Performance of Constructed Facilities2015; 29(2).

[15] Anderson JC, Gerbing DW. Structural Equation Modeling in Practice: A Review and Recommended Two-Step Approach. Psychological Bulletin. Epub ahead of print 1988. DOI: 10.1037/0033-2909.103.3.411.

[16] Ramahrishnan, S., Elakkiya, B., Geetha, R., Vasuki, P., & Mahalingam, S. (2014). Image encryption using chaotic maps in hybrid domain. International Journal of Communication and Computer Technologies, 2(5), 44-48..

[17] Hair JF, Black WC, Babin BJ, et al. Multivariate Data Analysis. Vectors. Epub ahead of print 2010. DOI: 10.1016/j.ijpharm.2011.02.019.

[18] Shah, a., sanghvi, k., sureja, d., & seth, a. (2018). Insilico drug design and molecular docking studies of some natural products as tyrosine kinase inhibitors. International journal of pharmaceutical research, 10(2).