Exploratory Study of External Environmental Factors Influencing the Procurement Selection in Construction

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Abstract

The construction industry is one of the backbones of the economy of many countries. The industry's characterization is determined by the external environment in which it operates. Therefore, the development and the use of project procurement systems are affected by such environmental factors. These environmental factors influence the industry in various ways thus determining the procurement shares and trends. Therefore, examination of such factors influencing the procurement selection in the construction industry is critical for the successful outcome of a project as well as to the development of the industry. In this context, the aim of this paper is to examine the significant factors influencing the selection of procurement systems from external environment. Four rounds of Delphi survey were conducted to investigate the most significant factors from external environment and their level of influence on various construction procurement systems in Sri Lanka. In addition, few interviews were conducted with selected industry experts in the view of interpreting the results derived from Delphi survey. It was found that the external environment significantly influence the selection of procurement system for any kind of projects. A statistically significant consensus on the weighting of the utility values for each procurement system was obtained from 25 experts from the industry. Based on the Delphi survey results, a set of exclusive selection criteria for five factor categories was established. The five factor categories formulated from this study include 'Market condition', 'Economic condition & Fiscal policy', 'Technology', 'Socio cultural suitability' and Regulatory environment'. Further, it was also found that Market conditions have significant influence on procurement selection compared to others factors. Therefore, it can be concluded that beside the commonly considered factors in terms of key selection criteria like client's requirements and project profile, clients should take into account other factors from the operating external environment that influence the procurement selection.

Keywords: Construction Procurement, External Environment, Procurement selection, Selection Criteria.

1. Background

The construction industry of any country is recognized as an economic regulator which contributes to the national economy in large scale. Thus, the well being of the national construction industry is of paramount importance for the economic development of the country. The construction industry's uniqueness throughout the world is determined by the external environment in which it operates. The external environment consists of several sub-systems such as economical, political, financial, legal and technological [11]. Further, the construction industry is an open system therefore, it is sensitive to change. This changing nature has resulted in the industry to be in a challenging position in addressing the changes forced by the subsystems of the environment in an efficient and effective manner. Consequently, construction project procurement systems practiced in the industry have also been subjected to changes resulting in many newly innovated procurement systems that could be used to meet the clients' contemporary requirements in a dynamic construction environment. Thus, the development & the use of procurement systems are also affected by the factors from external environment. These environmental factors influence the industry in various ways thus determining the procurement shares and trends.

Client's requirements and project characteristics are two major criteria to be considered in selecting a suitable procurement system for any kind of construction projects. The selection process is an open system, which receives information from its environment, transforms and returns as an output to the environment [9]. According to Sheath et al. [12] and Chen [4], client's requirements will ultimately be influenced by the context in which they operate; and this implies that the choice of procurement selection criteria may also be influenced by the predominant environment. On the other hand, Kumaraswamy and Dissanayake [6] have concluded that the most appropriate procurement system must necessarily depend on the project scenario or project profile that can be derived from contextual conditions such as external factors related to projects. As a result, client's requirements and characteristics of the project that dominate the procurement selection are influenced by the factors from external environment. These factors may have direct or indirect influence on the formulation of selection criteria and thus on the selection of suitable project procurement system.

There is no single procurement system which is suitable for all type of clients and all projects. Each project has its own characteristics and requirements and therefore, it is crucial to match the client's needs, project characteristics and influence of external environment with the most appropriate procurement system to achieve the correct balance between priorities and risks and ensure a successful outcome. Therefore, it is crucial to examine that what factors from external environment drive the procurement system and how these factors might influence the selection of procurement systems. In this viewpoint, the aim of this paper is to identify and analyze such environmental factors which influence the selection of procurement system and their level of influence. It presents a set of exclusive selection criteria formulated based on the influence of external environment in Sri Lankan context.

2. Literature Review

Researchers have argued that identification of relevant selection factors is the first step to formalize the selection process in a systematic manner. Previous studies in construction procurement selection have identified several coherent procurement selection parameters, such as time certainty, cost certainty, speed, flexibility, responsibility, complexity, price competition, risk allocation, and quality. While these parameters are crucial to procurement selection, doubts have been cast over the accuracy of decisions generated from a limited number of parameters [3]. Most of these identified factors are related to Clients' requirements and Project characteristics. Review of past studies on procurement selection factors reveals that the number of studies associated with the factors influencing from external environment is limited compared to internal environment. Table 1 summarises the review of past studies on factors governing the procurement selection in the frame work of external environment.

Table 1: Review of past studies

Factors	Authors						
	W	H	KD	AM	C	R	L
Market competitiveness	✓	✓	✓	✓		✓	✓
Technical feasibility	✓	✓		✓		✓	✓
Regulatory feasibility	✓	✓		✓		✓	✓
Material availability	✓	✓	✓				✓
Availability of experienced Contractor	✓		✓	✓	✓	✓	✓
Weather & natural disaster	✓	✓					✓
Political constraints	✓	✓				✓	✓
Cultural differences	✓	✓				✓	✓
Industrial actions	✓	✓				✓	✓
Objection from neighbour	✓	✓				✓	✓
Labour productivity	✓	✓	✓			✓	✓
Objection from local lobby groups	✓	✓				✓	✓

W – Walker (1989), H –Hughes (1989), KD – Kumaraswamy and Dissanayaka (2001), AM – Alhazmi and McCaffer (2000), C. - Chan et al. (2001), R – Rowlinson (1999), L – Luu et al., (2003)

Findings from literature reveals that factors such as Market competitiveness, Technical feasibility, Regulatory feasibility, Availability of experienced Contractor and Labour productivity have been identified by several studies compared to others. Walker [13] and Hughes [5] identified a series of construction-related environmental influences pertinent to the project level, and these include political, financial, economical, sociological, legal, institutional, competitive, cultural, technological, environmental, physical and aesthetical aspects. They further signify that for instance, ''market's competitiveness and contractor's availability'',

‘‘labour productivity’’ and ‘‘material availability’’ may be associated with the competitive and economical aspects; while the ‘‘regulatory feasibility’’ and ‘‘technology feasibility’’ synchronises the legal, technological, environmental and physical aspects. In this regard, all the external environmental factors are inter-related and have direct or indirect relationship with the factors from project’s internal environment.

3. Methodology

Delphi technique was adopted as the main research method in this study. Delphi method is a highly formalized method of communication that is designed to extract the maximum amount of unbiased information from a panel of experts. It is conducted by rounds interspersed with group opinion and information feed back in the form of relevant statistical data [2]. Therefore, it was considered that it would be appropriate to adopt the Delphi technique for formulating a set of exclusive criteria in terms of external environment. Delphi method adopted in this study consisted of four rounds which targeted to derive the expert opinion on factors which affect the procurement selection. At the completion of the fourth round, utility values for significant factors were derived against various types of procurement systems which are commonly used in construction industry. The following Table 2 summarizes the formats of Delphi survey conducted for this study. In addition to the Delphi survey, few interviews were conducted with selected industry experts in view of interpreting the results derived from Delphi survey.

Table 2: Format of Delphi survey

	Round 1	**Round 2**	**Round 3**	**Round 4**
Instrument	Questionnaire 1	Questionnaire 2	Questionnaire 3	Questionnaire 4
Data base for Questionnaire	Literature review	Results from round one	Results of factor analysis carried out for round two results	Results from round three
Purpose	To gather a set of specific selection criteria for construction procurement	To identify the level of importance of each selection criteria	To assess the suitability of each factor against various procurement system	To reconsider and reassess the suitability of each factor against various procurement system
Duration	Two weeks	Eight weeks	Four weeks	Five weeks
Number of experts responded	35	35	30	25

4. Results and Analysis

The factors suggested by the panel of experts in the round one were carefully analyzed and a list of factors was formed for the Sri Lankan context. The list includes the factors suggested by the experts and the factors identified from comprehensive literature survey. Factors which conveyed

similar meanings were combined and rephrased. Altogether 21 factors were consolidated to form a list of factors for the second round of Delphi.

4.1 Results of Delphi round two

The results from round two were subjected to several analysis which are included under main two steps as follows;

Step 01 – Identification of Significant Factors

- A mean weighted rating for each factor was computed to derive an indication of the importance of each factor.
- The Severity Index was calculated to rank the factors based on their significance on procurement selection.
- Coefficient of Variation (COV) was computed which expresses the standard deviation as a percentage of the mean to compare the relative variability of different responses.

Table 3 presents the results of the data analysis which is the indication of relative importance of each factor. Out of 21 factors, 14 factors were assigned by mean ratings of higher than the neutral point 2, and each of them maintained a Severity Index of more than 65%. This indicates that these 14 factors significantly affect the selection of procurement system. Remaining 7 factors which gained mean rating of less than 2 and Severity Index of less than 65% were removed for the third round of Delphi.

Step 02 – Factor Analysis

Unimportant factors identified from step one analysis were disregarded and only the significant factors were considered as eligible factors for factor analysis. Factor analysis was performed to elicit the underlying relationships among the eligible factors affecting the procurement selection and to reduce the factors into a small number of components [8]. The factor analysis was carried out using SPSS package. The first stage of factor analysis was to determine the strength of relationship amongst the factors affecting the procurement selection based on their Correlation Coefficients.

Table 3: Results of round two (Indication of the level of importance)

Factors	SI	M	SD	COV
Market competitiveness	76.67	2.30	0.868	0.3775
Technological feasibility	73.33	2.20	0.876	0.3983
Regulatory feasibility	66.67	2.00	1.095	0.5477
Availability of experienced Contractor	78.89	2.37	0.930	0.3929
Education of Contractors	72.22	2.17	0.785	0.3622
Availability of materials	66.67	2.00	1.033	0.5164
Cultural differences	66.67	2.00	1.155	0.5774
Government as a policy maker	66.67	2.00	0.966	0.4830
Government as a major Client	70.00	2.10	0.928	0.4419
Finance for the project : Donors	77.78	2.33	0.974	0.4173
Finance for the project : Aids	75.56	2.27	0.962	0.4245
Economic condition of the country	72.22	2.17	1.030	0.4752
Information Technology	66.67	2.00	1.033	0.5164
Environmental issues	66.67	2.00	0.966	0.4830
SI- Severity Index, M- Mean, SD - Standard Deviation, COV – Coefficient of Variation				

Based on the principle component method, the factor solutions with eigenvalues greater than 1 were produced. Varimax orthogonal rotation was employed to transform the factor matrix produced by un-rotated principle component matrix into one that is easier to interpret. The extracted five factor categories were grouped using Varimax orthogonal rotation. The Table 4 shows the key factor categories and associated variables based on varimax orthogonal rotation.

Table 4: Factor Analysis grouping using Varimax Orthogonal Rotation

No	Factors	Associated Variables
1	Market condition	• Market competitiveness • Availability of experienced Contractors • Availability of material
2	Economic condition and the fiscal policy	• Economic condition of the country • Source of finance: Donor/Aid • Government as a policy maker • Government as a major client
3	Technology	• Technological feasibility • Information Technology
4	Socio cultural suitability	• Cultural differences • Education of Contractors • Environmental issues
5	Regulatory environment	• Regulatory feasibility

4.2 Results of Delphi round three

In the third round of Delphi, experts were asked to provide the utility values for each factor against various procurement systems. A wide range of variants under each main categories of procurement system were adopted. The utility values were defined using a score starting from 10 to 110, in which 10 represents 'low suitability' and 110 represents 'high suitability' . The analysis was based on the utility values provided by the experts. The means of the utility values were computed for the responses. To obtain a measure of consistency, Coefficient of Concordance (w) of utility values were calculated using SPSS package in order to measure the rate of agreement. Coefficient of Concordance (w) ranges between 0-1 where, 0 represents 'No agreement' and 1 represents 'Complete agreement'. In this study, a concordance coefficient of 1 indicates that all experts ranked the procurement options identically (Chan *et al*., 2001, p. 704).

Further, significance rate was calculated to gain the significance level of each factor. The significance level (α) is based on the asymptotic distribution of a test statistic. Typically, a value which is less than 0.05 is considered as significant. The asymptotic significance is based on the assumption that the data set is large. If the data set is small or poorly distributed, this may not be a good indication of significance.

The results revealed that the mean utility values provided for the five factors were sufficiently consistent at significance level of 0.05 or smaller. Compared to other related factors, market competition is having a considerable level of correlation among the participants. There is a considerable level of significance for the factors other than the socio cultural suitability, which scored 0.258 (> 0.05). This shows the less significance of the socio cultural suitability. Even though, significance level for the Socio cultural suitability is low, based on its influence on industry practice, it was considered to be appropriate selection criteria particularly for Sri Lankan industry.

4.3 Results of Delphi round four

The consistency of the experts' utility values was again tested by calculating the Kendall coefficient of concordance using SPSS package. Table 5 portrays the average utility values of five main factor categories against various procurement systems. Summary of the comparison of results obtained from round 3 and 4 are given in the following Table 6.

The re-assessment of utility values at fourth round made considerable improvement in the significance level. The socio cultural suitability was changed in to the significant level of 0.021(<0.05) which shows the higher level of significance. Economic condition and the fiscal policy were changed from 0.041 to the 0.012; this also indicates the increased level of significance. The significance level of Technology, Regulatory environment and Market condition for the project were increased to the maximum from the 0.011 and 0.001 respectively.

Table 5: Average utility values of factor categories against various procurement systems – Results of round four

Selection Factors	Construction Procurement Systems											
	Separated			Integrated					Management Oriented		Collaborative	
	Measure & Pay	Lump Sum	Prime Cost	Design & Build	Package Deal	Turnkey	Develop & Construct	PFI	Const. Mgt.	Mgt. Cont.	Partnering	Joint Venture
Market competition for the project	73.61	68.87	59.13	77.00	68.39	70.78	67.20	65.64	59.78	58.83	54.57	57.61
Economic condition and the fiscal policy	55.57	69.13	55.78	69.09	53.88	55.57	56.87	66.51	64.57	63.92	71.56	73.04
Technology	53.91	53.48	47.83	78.04	63.17	71.87	64.43	65.75	62.83	61.39	73.04	74.78
Socio cultural suitability	54.65	53.70	61.87	50.22	49.13	49.04	45.00	58.61	59.57	60.04	59.30	61.43
Regulatory environment	54.35	52.91	51.39	59.57	59.35	62.35	64.57	69.91	66.74	63.70	65.66	68.04
PFI - Private Finance Initiatives, Const.Mgt. - Construction Management, Mgt. Cont. – Management Contract												

Table 6: Comparison of Concordance Coefficient in Delphi round 3 & round 4

Factors	Concordance of Coefficient (W)			Significance Level	
	R-3	R-4	I (%)	R-3	R-4
Market condition	0.105	0.160	52.38	0.001	0.000
Economic condition & the fiscal policy	0.074	0.096	29.73	0.041	0.012
Technology	0.089	0.172	93.26	0.011	0.000
Socio cultural suitability	0.049	0.135	175.51	0.258	0.021
Regulatory environment	0.089	0.147	65.17	0.011	0.000
R- Round, I - Improvement					

On the other hand, the correlation between the respondents' view with regards to the external environmental factors was also increased. This indicates that the respondents possess closer opinion on the factors influencing the procurement selection. Significant change occurred for the socio cultural suitability, which changed from 0.049 to 0.135. Further, changes have been occurred to other factors such as Technology, Regulatory environment, Market condition and Economic condition & fiscal policy.

5. Conclusions

This study has formulated a list of 14 selection factors through four rounds of comprehensive Delphi survey, and these factors cover various aspects of the external environment. As some factors are interrelated, attempts were made to consolidate related factors using factor analysis. A five-factor solution for the formulation of procurement selection criteria was derived. These five factor categories include "Market condition" (Factor 1); "Economic condition and the fiscal policy" (Factor 2); "Technology" (Factor 3); "Socio cultural suitability" (Factor 4) and "Regulatory environment" (Factor 5). Further, it was also found that Market conditions have significant influence on procurement selection compared to others factors. Except the factor 5, all other factors include related variables which reflect the influence of various aspects of the external environment. Therefore, it can be concluded that beside the commonly considered factors in terms of key selection criteria like client's requirements and project profile, clients should take into account other factors from the operating external environment that influence procurement selection.

Pautz *et al*. [10] stated that the lack of structured procedures, based on good information, for the selection of construction procurement system sometimes inhibits the opportunity for clients to choose a procurement option in a fully informed manner. Therefore, in order to establish procurement selection procedures, clients should formalize a set of suitable procurement selection parameters based on their needs, objectives, project requirements and influence of external environments. The selection criteria established and the utility values derived by this

study provides a solid base for clients in initial decision making on the selection of appropriate procurement system for any kind of building projects in the construction industry.

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