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Building services maintenance: an outsource service provider selection via scoring model

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Building services outsourcing has become popular as it gives a peace-of-mind for the firms by contracting operation and maintenance of the building services to an external expert party for an agreed period and for agreed fee. However, the main issue faced by a firm is to select the most suitable outsource. The objective of this study is to identify critical service provider selection factors, in the area of building service maintenance outsourcing in property management and, to construct a scoring model that can be used at the decision making level. We have chosen quantitative/ structured questionnaire survey research approach. Expert views helped to identify the service provider selection factors in the premises and property management sector in Sri Lanka. We deploy Fuzzy Delphi Methods (FDM) to ranking and identifying weights of the service provider selection factors. Then Analytical Hierarchy Process (AHP) model computes the weights of the screened factors by performing pair-wise comparisons. These weighted factors can be used to construct the service provider selection model.

Keywords: AHP, building maintenance, FDM, outsourcing

1. Introduction

In general, outsourcing is a cost reduction strategy that transfers primary or secondary activities of a firm, fully or partially to one or many outside contractors. Services outsourcing can be thought as a series of activities that transfers organizational non-core functions/activities to an external contractor or service provider to achieve better services at a lower cost (Graham, 1996). “Outsourcing” is analogous to "contracting-out" and in literature two terms are interchangeably used (Klammat, 2001).

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Building maintenance service outsourcing is becoming a new trend. A sound building maintenance service program ensures uninterrupted operation of all building services/ functions and equipment with proper preventive maintenance schedules, health and safety aspects in the building and clean interior and exterior at any given time (Al-Hammad, Assaf, Hassanain & Al-Nehmi, 2010). This is normally done via a maintenance service contract with a qualified supplier. The supplier selection process may depend on specific and general requirements of the firm. Assessment of the potential service provider can be a challenging task in the presence of a complex building maintenance requirements and variability of the supplier characteristics such as experience, service quality, and cost structures. The objective of this research is to identify critical service provider selection factors in the area of building service maintenance outsourcing in property management and, to construct a scoring model that can be used at the decision making level. This paper is structured in the following ways: Section 2 reviews relevant previous work. Section 3 and Section 4 of this paper consist with research methodology and conceptual framework for developing the scoring model. Section 5 discusses weights of the main factors and sub factors which are obtained using the FDM and AHP analysis and it develops scoring model.

2. Literature review

The existing literature mainly focuses on the issue of contractor selection in the area of building construction. There is less evidence about ways of prioritization of service provider selection factors for the building service maintenance outsourcing. Identification of service provider selection factors was conducted as an in-depth comparison using a set of common criteria and actions. It consists of quantitative and qualitative analysis which picks out factors that has higher impact on selection of best service provider. According to Gatahwa (2014), a service provider selection base on five factors, price of the service provider, experience of service provider, technical performance, and qualification of suitable service provider and establishment of service provider. In addition to that, Sadi et al. (2011) explains factors that influence the decision on selection of service provider and discuss and classify it under four main categories: price, technological capability, experience of service, and tender conditions. Furthermore, geographical position, perceived quality of goods and services, contractor flexibility, technical excellence, plant-specific know-how, experience and low price is also pointed out as the service provider selection factors that help to identify the proper service provider to increase the performance level of the service and reduce the risk of client.

The above literature highlights several key factors such as price/cost, technical capability, relevant experience, the current status of the service provider and service quality that have strong influence over the building maintenance service provider selection decision. Literature also explains how the following moderating factors affect the above key factors (see Table 1).

Literature review emphasizes the different service provider selection factors and how those factors are link with the service provider selection. It is obvious that extensive researches have been undertaken in the field of service outsourcing sectors. There are several attempts that have been made to identify the outsourcing section of the business, but there is a lack of comprehensive observation of service provider selection for outsourcing, they are all of great importance in guiding this service provider selection factor for the property management industry.

Table 1. Service provider selection main factor and sub factors

Main Factor	Price	Technical Performance	Experience	Service Provider Status	Quality of Service
Sub Factors	Low Price	Current level of technology availability and usage	Relevant experience	Management Hierarchy and Governance	Service charter
	Discount	Ability to update technologies and skills	Evidence for experience	Company Financial Position	Maintenance strategy
	Tax Involvement	Availability of expertise	Skill level of employees	Accessibility	Process quality
	Value added service	Flexibility in technology		Human Resource	Quality standard
	Spare part cost	Diversity and adaption of Technology		Reputation and Brand Image	

1.1 Conceptual framework

During the literature review 5 main factors and 22 sub-factors were identified. Figure 1 shows service provider selection model was developed based on the preliminary research findings.

According to the basic mathematical tools, weighted service provider selection score ($\boldsymbol{M}$) can be defined as follows:

$$\boldsymbol{M} = \boldsymbol{\omega_1} + \boldsymbol{\omega_2} + \boldsymbol{\omega_3} + \boldsymbol{\omega_4} + \boldsymbol{\omega_5} \quad (01)$$

Where $\boldsymbol{\omega_1}, \boldsymbol{\omega_2}, \boldsymbol{\omega_3}, \boldsymbol{\omega_4}$ and $\boldsymbol{\omega_5}$ represent weights of price parameter, technical performance parameter, experience of service provider parameter, service provider status parameter and quality of service parameter respectively.

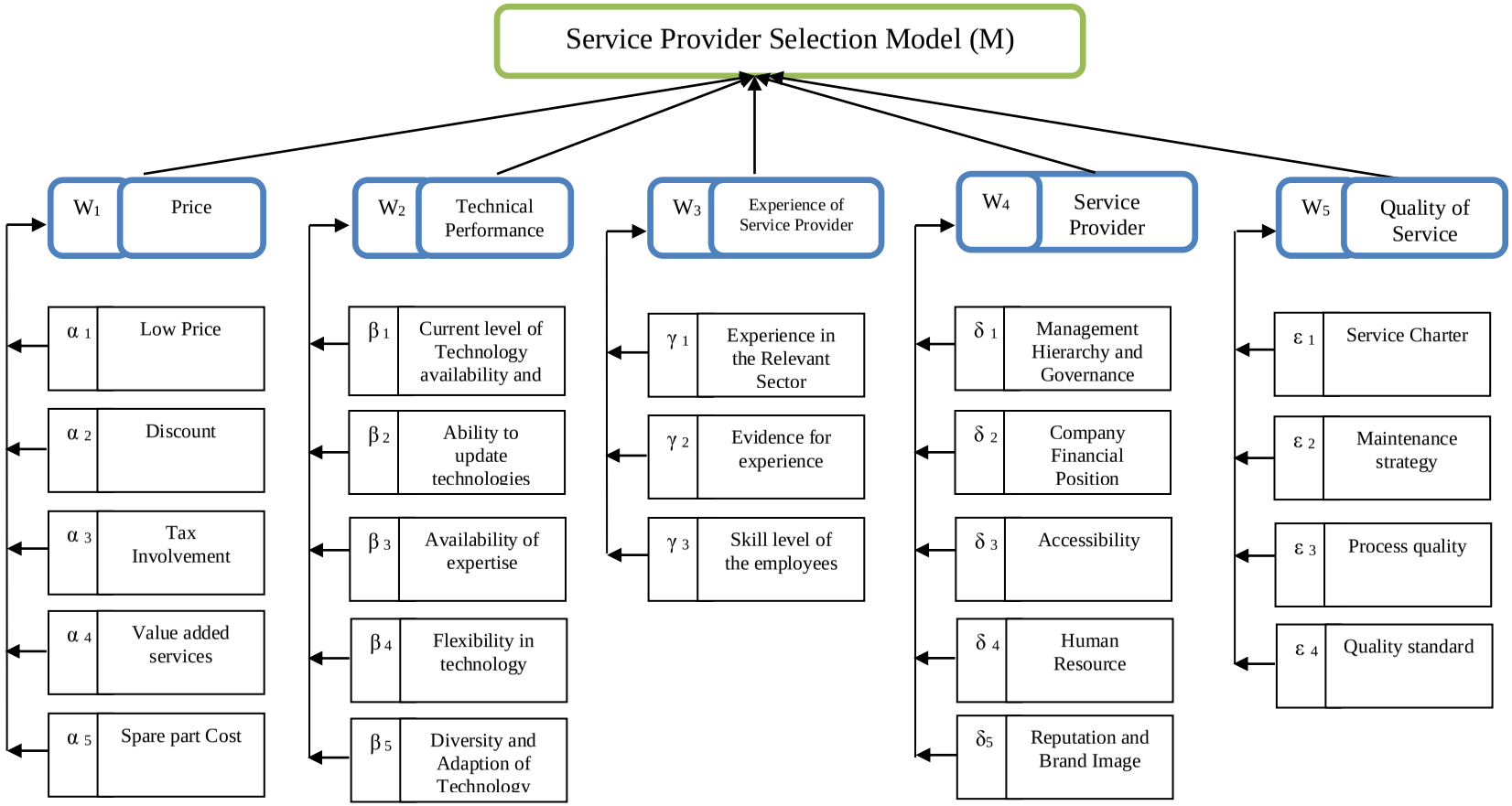

Figure 1. Service provider selection model

Similarly, we define weights of the sub parameters ($\boldsymbol{\alpha_i}$) of each main parameter ($\boldsymbol{\omega_i}$) as in the following ways: For example, price parameter can be written as the sum of the weights of low price ($\boldsymbol{\alpha_1}$), discount ($\boldsymbol{\alpha_2}$), tax involvement ($\boldsymbol{\alpha_3}$), value added services ($\boldsymbol{\alpha_4}$) and spare parts costs ($\boldsymbol{\alpha_5}$) respectively.

$$\boldsymbol{\omega_1 = \alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 + \alpha_5} \quad (02)$$

3. Research design and methodology

Quantitative approach tends to relate to positivism and seek to gather factual data and to study relationships between facts and how such facts and relationships accord with theories and the findings of any research executed previously (Pinsonneault & Kraemer, 2015). Survey method has been identified and preliminary questionnaire was conducted among 34 expertise in property management sector and to check and justify the service provider selection factors which were identified through the literature survey. Based on the result of the preliminary findings main questionnaire was developed and conducted among the 12 expertise in the property management sector.

Main questionnaire was designed as two sections. Both sections focus on the same target of deriving the weights for the main factors and sub factors. Questionnaire was delivered to the experts in the property management sector and sample size was selected according to the minimum requirements of each analysis method. First part of the questionnaire consists with questions related to Fuzzy Delphi technique with linguistic scale and second part consists with questions of pair wise comparison of the main factors and sub factors for the analysis of AHP.

3.1 Fuzzy Delphi Method

Bouzon, Govindan, Rodriguez & Campos's (2007) Fuzzy Delphi Method (FDM) is mostly used to prioritize and rank the factors. Kannan, Govindan, Kaliyan & Haq, (2014) explained that, quantitative values are inadequate for models of practical situations of the real-world due to the imprecision, vagueness and the subjective nature of human thinking, judgment, and preferences. Therefore, in order to overcome the above problem, Fuzzy set theory was proposed by Zadeh (1965) to deal with the vagueness of human thought and expression in making decisions. Set theory had been combined with Delphi method to crate the Fuzzy Delphi method by Ishikawa et al. (1993). The following procedure was followed for ranking and identifying weights of the service provider selection factors.

Step 01: Identification of service provider selection factors from the literature review.

Step 02: Confirmed factors are included in the questionnaire and get the opinion of the expert panel.

Sept 03: Fuzzy set theory is used by asking the participants to give a three-point estimate (i.e., the pessimistic, moderate, and

optimistic values). Mainly it focuses to assign the fuzzy weight for each factor for service provider selection.

As per above basis triangular fuzzy number (TFN) is defined as TFN = (l, m, u) where l, m and u represent minimum (04), geometric mean (05) and the maximum (06), respectively. Therefore, the evaluation value of j^{th} factor according to the i^{th} expert opinion is as follows:

$$\omega_{ij} = \left(l_{ij}, m_{ij}, u_{ij}\right) \forall\ i = 1,2,3, \dots \& j = 1,2,3, .. \quad (03)$$

ω_{ij} is the fuzzy number of j^{th} factor and the respective fuzzy weights are: $\omega_j = \left(l_j, m_j, u_j\right)$. The following equations compute the above weights:

$$\boldsymbol{l_j = Min_i(l_{ij})} \quad (04)$$

$$\boldsymbol{m_j = \frac{1}{n}\sum_{i=1}^{n} m_{ij}} \quad (05)$$

$$\boldsymbol{u_j = Max_i\left(u_{ij}\right)} \quad (06)$$

Step 04: Defuzzification: The goal of defuzzification analysis is to convert the triangular fuzzy numbers into an exact value so the factors can be analyzed and ranked. Simple Centre of Gravity method was used to defuzzify the fuzzy weight ω_j of each element to a definite value denoted as S_j. The basic formula is as follows:

$$\boldsymbol{S_j = \frac{l_j + m_j + u_j}{3}} \qquad (\boldsymbol{j = 1, 2, 3 \dots . n}) \quad (07)$$

Step 05: According to the value defined through the defuzzification all the factor can be rank form the top to bottom of value.

3.2 Analytical Hierarchy Process

Weights are mathematical figures of the factor and Impact of weight of each factor has to be defined with respect to the effect to the organization expectation. According to the explanation of Saaty (1980), Analytical Hierarchy Process (AHP) decision-making approach based on the multiple criteria decision-making (MCDM) techniques.

Step 01: First step of the AHP is to develop decision model for the projected problem.

Step 02: As the second step of AHP process weights or priorities has to be identified. Pair wise comparison of the AHP analysis is done based on the finding of the questionnaire.

$$A = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ a_{21} & 1 & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & 1 \end{bmatrix}, \text{Where } a_{ji} = \frac{1}{a_{ji}} \quad j, i = 1,2,3 \dots \quad (08)$$

Step 03: Perform Consistency calculation of matrix A is used to check Judgment inconsistencies. Consistency ratio (CR) has been calculated based on the following equations (09) to identify the consistency of weights.

$$\text{Consistency ratio (CR)} = \frac{\text{Consistency Index(CI)}}{\text{Random Index (RI)}} \quad (09)$$

Suppose λ_{max} denotes maximal Eigen value of A

$$\text{CI} = \frac{(\lambda_{max} - n)}{(n-1)} \quad (10)$$

4. Analysis and discussion

According to the preliminary survey findings all the main factors were accepted to use in the decision model for service provider selection. And also 19 sub-factors were accepted and 3 sub-factors were rejected from the decision model. It would have been better to consider the practices of sustainability as another sub parameter as it is considered as an important factor in green building concepts. However, this study does not consider the sustainability parameter.

Initially weights of the models were developed based on the Fuzzy Delphi analysis which focused to avoid the fuzziness of the expert opinion. Secondly the AHP analysis method was used to identify the weights of the model as direct method to get the expert opinion. Then the discussion focuses on the level of the success compared to above two methods. Further, it justifies the suitable model for the service provider selection for building maintenance service outsourcing.

Data collated from the same group of expertise was analysed based on the two analysis method namely FDM & AHP. Based on the research findings following Table 2 have been developed to consider about the comparison of the service provider selection decision model according to the two types of analysis method.

Table 2 reveals that main factors get almost the same ranking from the two-analysis approach for the service provider selection. Since ranking is the same, average value of the weight percentages has been considered for the explanations. Therefore, it can be considered as the basic theory for selecting the service provider for the services outsourcing. According to the results, Price and Technical performance are ranked respectively in 1st and 2nd positions. When average weight percentages are considered price factor has to be weight near to 37% and technical performance has to be considered around 28 %. Quality of the service has become the 3rd ranker of the both analysis approach and it has near 18% weight percentage. Fourth and fifth ranks were obtained respectively factors are getting respectively by the experience of the service provider and service provider status. In the same

way experience of the service provider get a weight percentage around 11% while service provider states get around 6% weight percentage. With reference to the above explanations, Equation (01) for the weighted service provider selections score (M) can be written:

$$M = 37\ \% + 28\% + 11\% + 6\% + 18\% \quad (11)$$

Table 2. Comparison of main factors

Main Factor	Fuzzy Delphi analysis		AHP analysis		Weights difference	Rank difference	Avg Weight %
	Weight (%)	Rank	Weight (%)	Rank			
Price – ω_1	32	1	41	1	-9	0	37
Technical Performance – ω_2	25	2	31	2	-7	0	28
Experience of Service Provider – ω_3	13	4	10	4	3	0	11
Service Provider Status – ω_4	8	5	5	5	3	0	6
Quality of Service – ω_5	22	3	13	3	9	0	18

Table 3 explains the weight differences and rank differences of the sub factors with respect to the main factor. As a summary of Table 3, all the Sub factors obtained the same ranking from both analysis methods and, almost the same weight averages were received. Decision model was developed by the rank of each factor and average weights of the two approaches.

5. Conclusions and implications

Decision model for the service provider selection was developed based on the above identified factors. This objective was achieved through the expert surveys done in order to gather the data and analysing the data with Fuzzy Delphi methodology and AHP analysis. Fuzzy Delphi and AHP based decision models computes the relative weights of the key parameters and sub parameters. Since all the factors got the same ranking decision model developed with average weights. Final ranking of service provider selection was performed by taking average weights of the two approaches.

The empirical novelty (contribution) of this research is identifying the service provider selection factor for building service maintenance outsourcing in Sri Lanka. The final outcome of this research study is a preparation of decision model that can be used to select the service provider for building service maintenance out sourcing.

Table 3. Compassion of sub factors

Sub Factors	Fuzzy Delphi analysis		AHP analysis		Weights difference	Rank difference	Avg Weight %
	Weight (%)	Rank	Weight (%)	Rank			
			Price				
Low Price – α_1	57	1	74	1	-17	0	65
Value added services – α_2	22	2	15	2	7	0	19
Spare parts Cost – α_3	21	3	11	3	10	0	16
			Technical performance				
Current level of Technology availability and usage – β_1	32	1	46	1	-14	0	39
Ability to update technologies and Skills – β_2	21	3	20	3	1	0	20
Availability of expertise - β_3	26	2	22	2	4	0	24
Flexibility in technology – β_4	13	4	7	4	6	0	10
Diversity and Adaption of Technology – β_5	8	5	5	5	3	0	7
			Experience of service provider				
Experience in the Relevant Sector – γ_1	46	1	53	1	-7	0	50
Evidence for experience – γ_2	34	2	32	2	2	0	33
Skill level of the employees – γ_3	20	3	15	3	5	0	17
			Service provider status				
Management Hierarchy and Governance – δ_1	25	3	25	3	0	0	25
Company Financial Position – δ_2	28	2	31	2	-3	0	30
Human Resource – δ_3	15	4	7	4	8	0	10
Reputation and Brand Image – δ_4	32	1	37	1	-5	0	35
			Quality of service				
Service Charter - ε_1	32	1	37	1	-5	0	35
Maintenance strategy – ε_2	27	2	29	2	-2	0	28
Process quality – ε_3	15	4	10	4	5	0	12
Quality standard – ε_4	26	3	24	3	2	0	25

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