Service Supplier Selection using Analytic Hierarchy Process

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Abstract

This paper argues the use of Analytic Hierarchy Process in service supplier selection process. The literature has evidence of important criteria for supply supplier selection process. However, there is a dearth of studies on service supplier selection process. To address this gap, this paper firstly systematically reviews the existing procurement literature; secondly, it argues for the use of alternative methods research to address questions related to ranking of selection criteria; and thirdly, it proposes and illustrates the use of Analytic Hierarchy Process to analyse the identified criteria. The paper concludes with limitations and further research directions.

Keywords: Service Supplier Selection, Analytic Hierarchy Process (AHP)

Introduction

Supplier selection problem is not a fresh topic for supply chain researchers. There are multiple studies available in the area of supplier selection (e.g., Ho, Xu, & Dey, 2010; Chen, Lin, & Huang, 2006; Kahraman, Cebeci, & Ulukan, 2003; De Boer, Labro, & Morlacchi, 2001; Ghodsypour & O'Brien, 1998, 2001; Choi & Hartley, 1996; Nydick, & Hill, 1992; Ellram, 1990; Spekman, 1988). However, there are scant studies on service supplier selection process, performance measurement and management. In today's dynamic business environment, the customers are highly demanding, orders have shorter lead times and strict quality parameters which necessitate developing and managing service suppliers for smooth operations. Now, smooth operations are only possible when there is less downtime of key machines, all lifting equipment are in proper condition, labours are happy. and fleet management is perfect.

All these key outsourced service suppliers of high risk services require careful selection, close performance and relationship management. This is where most of the organisational resources should be employed (CIPS, 2013). Key service supplier failure can bring significant losses and therefore it is essential to identify the critical factors that drive performance and take necessary proactive action.

In any engineering company the following services are generally outsourced to save costs and time, and increase efficiency.

Annual Maintenance: These include annual maintenance of boiler, press, EOT crane, air conditioner, and other machinery and equipment.

Repairing: Repairing services generally involve giving calls to service engineers for identifying the problem. Either the spare parts are provided by service provider or may only replace of faulty parts subject to purchase of the parts by firm directly from market.

Transportation: Transportation services are provided by logistics companies and are generally used for employee transportation, inbound and outbound material movement.

Design: These services are outsourced when organisation do not have competent draughtsman. Contract is generally done based on per hour/per set basis.

Testing/ Calibration: These include testing of raw material, finished goods from outside testing agencies.

Secondly calibration of equipment is also outsourced from agencies.

Labour contract: This is a very important service and generally includes several types of labour services such as rolling, bending, fabrication, machining, blasting, painting, hand lining, molding, material handling, construction, Information technology support etc. Firms generally frame an agreement for any type of labour services to be outsourced with complete technical and commercial terms and conditions.

The current study illustrates the potential service supplier selection problem which has been ignored so far by supply chain researchers.

The purpose of the paper is firstly, to conduct a systematic literature review and identify critical factors for service supplier selection; and secondly, to analyse and rank final critical factors using AHP technique. This paper is structured into eight additional sections. The next section presents the systematic literature review which helps to understand the progress in supplier selection process. The third section presents the critical factors. Fourth section presents the research framework and methodology. Fifth section presents the data analysis and results. Sixth section presents the discussion of findings. Seventh section presents the managerial implications. Finally, the conclusions, limitations and future research directions are presented.

Literature Review

There are several studies on supplier selection using both qualitative and quantitative research methods (eg., Ho *et al.*, 2010; De Boer *et al.*,2001; Ghodsypour & O'Brien, 1998; Choi & Hartley, 1996; Barbarosoglu & Yazgac,1997; Ellram, 1990; Spekman, 1988). But these studies have been centered mainly on supply suppliers. In this dynamic business scenario, it is imperative that most of the noncore jobs are outsourced to bring down costs and meet the sales order delivery schedule. Procurement managers envisage significant savings in outsourcing these jobs. Service supplier selection is a multi criteria decision making problem which includes both qualitative and quantitative factors. Hence it is essential that procurement managers understand the tradeoffs between these tangible and intangible factors. They must also decide which service suppliers are the best and how much service should be procured from each supplier.

Table 1 presents the selected studies on service supplier management.

Table 1: Some of the Selected Studies on Service Supplier Management

Author(s), year	Theme of Study
Masrom, Skitmore, and Bridge, 2013	Identified determinants of contractor satisfaction
Amirkhanyan, Kim, and Lambright, 2013	Performance assessment of services
Aydin and Kahraman, 2011	Fuzzy AHP application to supplier selection
Straub, 2010	Competencies required of contractors offering performance based maintenance services to end customers
Brochner, 2010	Innovation technologies in construction
Lai and Pang, 2010	Measuring performance for building maintenance providers
Palvia, 2010	Analyse performance of offshore IS suppliers
Robinson and Scott, 2009	Service delivery and performance management
Matsumura, Monden, Morisaki, and Matsumoto, 2008	Analyse factors of defect correction
Aryichandra and Frolick, 2008	Critical success factors in business performance management
Arditi and Lee, 2004	Service quality performance of design/build contractors
Kim and Chung, 2003	Critical success factors for IS outsourcing
Yasamis, Arditi, and Mohammadi, 2002	Assessing Contractor quality performance
Weber, 2000	Supplier selection and negotiation
Baker and Faulkner, 1991	Strategies for managing service suppliers

Identification of Critical Factors for Service Supplier Selection

The five key criteria of service supplier selection are as under:

Cost: The cost criterion is the most important criterion in service vendor selection. The cost depends upon the scope of job, frequency of services, distance of travel, major or minor modifications at site, qualification and experience of service engineers representing service supplier firm, size of supplier firm and credit terms.

Quality: One of the important criteria in service vendor selection is quality management. Considering commitment to quality leads to continuous improvement in supplier selection. Evaluation of quality process adopted by service suppliers need to be done before the supplier registration process. All certifications on quality management, six sigma and process need to be evaluated to mitigate future risks. This is supported by previous studies such as Kannan and Tan (2005), Lin *et al*. (2005), Sarkis and Talluri, (2002), and Verma and Pullman (1998).

Delivery: The delivery criterion is important considering the shorter lead time of sales orders. For instance, breakdown of a hydraulic press may hamper the production. The repairing of cylinder and replacement of seals may take two weeks' time. This commitment of delivery is noted by the planner and production re-scheduling is done. In case there is any delay from the committed date will ultimately lead to significant production losses and wastage of resources. Therefore, delivery lead times or committed delivery dates must not be changed by service suppliers.

Management and Organisation: The management and organisation criterion deals with the overall discipline of the service supplier firm. Important sub-dimensions are flexibility, innovation, IT infrastructure, understanding urgency, priorities of customer jobs, trials, training, and support to customers.

Financial Health: The financial health of service supplier must be stable in all respect. Moreover, the non-financial parameters must also be assessed before going ahead with supplier registration in SAP system.

After conducting review of existing literature, the researcher identified 20 critical sub-criteria which have been refined using five procurement experts' opinion and narrowed down to 13 sub-criteria which are relevant in the Indian context. The 13 sub-criteria are presented under sub-criteria column in Table 2.

Table 2: Criteria for Service Supplier Selection

Criteria	Sub Criteria	Sub sub-criteria
Cost (CO)	Direct Cost (DC)	Net Price
		Delivery cost
	Indirect cost (IC)	Ordering cost
		Inspection cost
		Handling cost
		Capital investment
Quality (QL)	Rejects (RJ)	Percentage of incoming rejects
		Warranty
	Service Quality (SQ)	No of calls per month/quarterly/annually
		Customer Focus
	Regulatory concerns (RC)	ISO 9000
		ISO 14000
		Compliance with industrial norms
Delivery (DL)	Compliance with schedule (CS)	Delivery variability
		Mean time to repair
		On time arrival
	Compliance with quantity (CQ)	Proper counting and measurement
		Parts availability
Management and Organisation (MO)	Responsiveness (RE)	Average time to respond
		Average ring time
		Average time to answer
		Average wait time
	Behaviour (BE)	Honesty
		Friendly Attitude
		Flexibility
		Reliability
	Performance (PM)	Frequency of checks
		No of rework
		Continuity
		Past performance record
	Risk Management (RM)	Understand urgency
		Delay and consequential losses
		Spare parts in stock
		Priority of jobs
		IT infrastructure
		Managing volume and variety
		Compliance with SLA terms and conditions
		Free trial, training and development support

Criteria	Sub Criteria	Sub sub-criteria
Financial Health (FL)	Financial measures of financial health (FM)	Working capital management
		Total Assets
		Total Liabilities
		Total Equities
	Non financial measures of financial health (NF)	Important Accounts
		Turnover among long term employees
		Workforce reductions
		Frequent changes in supplier's source

Research Framework and Methodology

Research methodology is the most critical step in any research study. The research design is different for both qualitative and quantitative methods. Here multi-criteria decision making based analytical hierarchy process has been used to analyse and rank the critical factors under evaluation. Fig. 3 presents the framework for the present study.

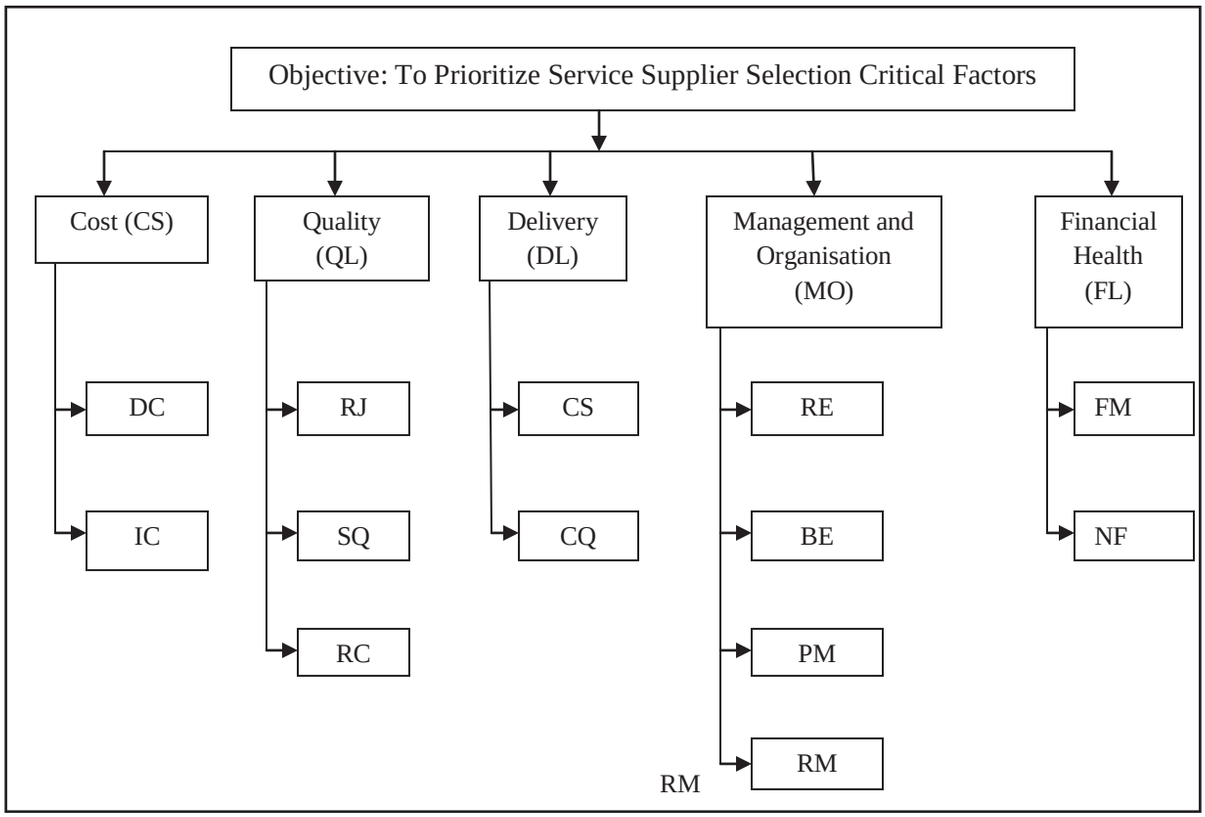

Fig. 1. AHP based Hierarchical Model to Evaluate Critical Factors of Service Supplier Selection

AHP Technique

The AHP is based on the experience gained by its developer, T.L. Saaty, while directing research projects in the US Arms Control and Disarmament Agency. The AHP has found use in business, government, social studies, R&D, defense and other domains involving decisions in which choice, prioritisation or forecasting is needed. Owing to its simplicity and ease of use, the AHP has found ready acceptance by busy managers and decision-makers. It helps structure the decision-makers' thoughts and can help in organizing the problem in a manner that is simple to follow and analyze. Broad areas in which the AHP has been applied include alternative selection, resource allocation, forecasting, business process re-engineering, quality function deployment, balanced scorecard, benchmarking, public policy decisions, healthcare, and many more. Basically the AHP helps in structuring the complexity, measurement and synthesis of rankings. These features make it suitable for a wide variety of applications. The AHP has proved a theoretically sound and market tested and accepted methodology.

Data Analysis and Results

Based on the ratings obtained through five procurement expert's inputs, AHP matrices are developed and subsequent steps are followed as per Satty (1988, 1990, 1994, 2008). The framework of AHP is presented where the critical factors are structured hierarchically that includes three levels: objective- to prioritise service supplier selection critical factors; in second level the five key dimensions are presented: cost, quality, delivery, management and organisation, and financial health which have been analysed. Table 3 shows the pair wise comparison matrix indicating weights provided by procurement experts to individual dimensions.

Table 3: PWCM of Criteria

Criteria	CS	QL	DL	MO	FL	Priority Matrix	Rank
CS	1	1/9	1/7	1/5	1/7	0.02610	5th
QL		1	5	7	2	0.47328	1st
DL			1	5	4	0.26315	2nd
MO				1	1/7	0.05668	4th
FL					1	0.18077	3rd

Maximum Eigen Value= 5.87883

CI= 0.219707

From the analysis shown in Table 3, "Quality (0.47328)" was the most important dimension of service supplier selection, followed by "Delivery (0.26315)", "Financial health (0.18077)", "Management and Organisation (0.05668)", and "Cost (0.02610)".

In the next step, other constructs in each dimension of service supplier selection have been ranked. Table 4 evaluates the constructs under dimension "Cost" had been checked for hierarchy.

Table 4: PWCA of Cost Dimension

Constructs under Cost	DC	IC	Priority Matrix	Rank
DC	1	1/3	0.25	2nd
IC		1	0.75	1st

Maximum Eigen Value= 2

CI= 0

'Indirect costs (0.75)' had been observed most important construct in "Cost" followed by 'Direct costs (0.25)'.

Table 5 evaluates the constructs under dimension "Quality" checked for hierarchy.

Table 5: PWCA of Quality Dimension

Constructs under Quality	RJ	SQ	RC	Priority Matrix	Rank
RJ	1	1/2	1/2	0.1958	3rd
SQ		1	2	0.4933	1st
RC			1	0.3108	2nd

Maximum Eigen Value= 3.05362

CI= 0.0268108

'Service quality (0.4933)' had been observed most important construct in "Quality" followed by 'Regulatory concern (0.3108)' and 'Rejections (0.1958)'.

Table 6 evaluates the constructs under dimension "Delivery" checked for hierarchy.

Table 6: PWCA of Delivery Dimension

Constructs under Delivery	CS	CQ	Priority Matrix	Rank
CS	1	2	0.6666	1st
CQ		1	0.3333	2nd

Maximum Eigen Value= 2

CI= 0

'Compliance to schedule (0.6666)' had been observed most

important construct in "Delivery" followed by 'Compliance to quantity (0.3333)'.

Table 7 evaluates the constructs under dimension "Management and Organisation" checked for hierarchy.

Table 7: PWCA of Management and Organisation Dimension

Constructs under Management and Organisation	RE	BE	PM	RM	Priority Matrix	Rank
RE	1	1/3	1/5	1/7	0.0559	4th
BE		1	1/7	1/5	0.0951	3rd
PM			1	2	0.5039	1st
RM				1	0.3449	2nd
Maximum Eigen Value= 4.24645						
CI= 0.0821499						

'Performance (0.5039)' had been observed most important construct in "Management and Organisation" followed by 'Risk management (0.3449)', 'Behaviour (0.0951)', and 'Responsiveness (0.0559)'.

Table 8 evaluates the constructs under dimension "Financial Health" checked for hierarchy.

Table 8: PWCA of Financial Dimension

Constructs under Financial	FM	NF	Priority Matrix	Rank
FM	1	4	0.80	1st
NF		1	0.20	2nd
Maximum Eigen Value= 2				
CI= 0				

'Financial measures (0.80)' had been observed most important construct in "Financial Health" followed by 'Non-financial measure (0.20)'.

Discussion of Findings

Table 9 has been prepared by evaluating overall weight of each critical factor by considering local weight of critical factors and multiplying it by respective global dimension's weight.

Table 9: Calculation and Ranking of CFs of Service Supplier Selection

Dimension S. N	Dimension of CFs of Service supplier selection	Final weight of dimensions	Rank	CFs S.N.	Identified CFs of Service supplier selection	Local weight of CFs	Overall weight of CFs	Overall ranking of CFs
1	Cost	0.0261	5th	1.1	DC	0.25	0.00653	11th
				1.2	IC	0.75	0.01958	9th
2	Quality	0.47328	1st	2.1	RJ	0.1958	0.09267	5th
				2.2	SQ	0.4933	0.23347	1st
				2.3	RC	0.3108	0.14710	3rd
3	Delivery	0.26315	2nd	3.1	CS	0.6666	0.17542	2nd
				3.2	CQ	0.3333	0.08771	6th
4	Management and Organisation	0.05668	4th	4.1	RE	0.0559	0.00317	13th
				4.2	BE	0.0951	0.00539	12th
				4.3	PM	0.5039	0.02856	8th
				4.4	RM	0.3449	0.01955	10th
5	Financial	0.18077	3rd	5.1	FM	0.80	0.14462	4th
				5.2	NF	0.20	0.03615	7th

Managerial Implications

It becomes difficult for procurement managers to deal with multiple factors and selecting the right supplier for service job. This study will assist procurement managers in understanding the interrelationships between critical factors of service supplier selection. It will be easier to understand what each critical success factor will help to achieve and also prepare the action plan.

Conclusions, Limitations and Future Research Directions

The purpose of the study is to identify the critical factors for selection of key service suppliers. Here systematic literature review has been done to identify the critical factors which have been refined using five experts' opinion. These experts are senior procurement managers working in firms located in West Bengal, Delhi, and Bangalore having more than 15 years of experience and professional members of CII, ORSI, and IRI. Finally, 13 critical factors have been used to develop the AHP matrix and ranking. Important observation from the current study is that quality of service is the most important criteria in selection of service suppliers. Service quality of suppliers must be evaluated, followed by regulatory concerns criteria and rejections criteria.

Managerial implications have been provided. This research study can provide food for procurement managers involved in buying services.

Every research study has certain limitations and present study also suffers from certain limitations. The study is based on AHP method where experts' opinion has been used to refine the critical factors. Also experts' opinion has been used to develop the AHP matrices. It may happen that the experts' opinion is biased. Therefore, author proposes some of the research directions to extend/ validate the present study. Firstly, fuzzy AHP may be used to remove the vagueness and uncertainties associated with AHP. Secondly, structural equation modeling technique may be used to statistically validate the AHP model. Thirdly, other MCDM technique such as ANP, ISM/TISM may be used to compare the present AHP model.

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