

To Solve the Complex Multi-Criteria Decision Problems for Vender Selection by Analytic Hierarchy Process (AHP)

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Abstract- This paper explains the reasons for selecting the best vender to conduct business in various organizations. A special focus is on Analytical Hierarchy Process (AHP) method that is becoming increasingly important tool in different decision making situations. An efficient vendor selection process needs to be in place and of paramount importance for successful supply chain management. Analytic Hierarchy Process is presented along with sensitivity analysis. The AHP is designed to solve complex multi-criteria decision problems. It is based on the innate human ability to make sound judgments about small problems.

Keywords – Vender selection, Analytical hierarchy process, Criterion simulation.

I. INTRODUCTION

Today, many organizations are facing changes stimulated by technological innovations and customer demands. These organizations realize that the effort to obtain products in the right quantity, at the right cost, with at the right time the right quality from the right source is crucial for their survival. It begins with the realization of the need for a very good vendor; formulation and determination of decision criteria; final vendor selection; pre-qualification; and monitoring of vendors selected. Selection of vendors and evaluation are a typical multiple criteria decision making (MCDM) problem involve multiple criteria that can be both intangible and tangible. The analysis of criteria for measuring and selecting the performance of vendor has been focus of many purchasing practitioners and researchers as to provide a comprehensive view of important criteria in the vendor selection decision. Vendor selection process requires a systematic, formal and rational selection model. In this study, a comprehensive application of Analytic Hierarchy Process (AHP) for a case is presented along with sensitivity analysis to choose best vendor.

II. CRITERIA OF VENDOR SELECTION

Vendor selection is the complicated by fact that various criteria must be considered in decision making process. Analysis of the criteria for measuring and selecting the vendor's performance has been focus of many of research papers. Description of Vendor Selection Criteria: The aforementioned studies revealed that in the selecting vendors, the three main criteria (quality, service and price) and a lot of the sub-criteria are followed. Table 1 summarizes vendor selection sub-criteria and criteria that used in public sector according to literature review.

Table 1: Vendor selection criteria and sub-criteria

Criterion	Sub-Criterion
Quality	Product durability (i.e. Lifespan)
	Product reliability (e.g., Quality over a given period of time, Consistency)
	Quality systems
	Percent rejection
	Adherence to quality tools (e.g., Check sheet, Histogram, Cause and effect diagram, O _Q)
	Reputation and position in the market
Price	Competitive pricing
	Total cost
	Quantity discount
	Payment terms
	Payment procedures understanding
Service	Spare parts availability
	Handling of complaints
	Ability to maintain product/service
	After sales services (e.g., Warranties and Claims policies)
	Training aids
	Flexibility (Payment, Freight, Price reduction, Order frequency & amount)

III. THE ANALYTIC HIERARCHY PROCESS

In complex world system, human is forced to deal with more problems than resources to handle. To deal with the unstructured and complex problems, need to order priorities, to agree that the one objective outweighs another, and to make trade-offs to serve greatest common interest or the overall objective. But with the complex problems where a wide margin of the error is possible in making tradeoffs, it is always difficult to agree on which the objective outweighs the other and to reach best solution. Above difficulty proves need to a framework, so the problems can be viewed in a complex but the organized framework that allows for interdependence and the interaction among factors and yet still enables human to think about them in the simple way. AHP provides this kind of the framework.

AHP method is used for the MCDM extensively and has been successfully applied to the many practical decision-making. AHP provides relative ease but theoretically strong multi-criteria methodology for the evaluating alternatives. It enables the decision makers to use the simple hierarchy structure to deal with the complicated problem and to evaluate both qualitative and the quantitative data in the systematic methodology under the conflicting multi-criteria. AHP is the powerful decision-aiding tool that can deal with the rational, intuitive, and irrational when making the decisions considering suitability of the large number of selection factors and the alternatives. AHP is an appropriate MCDM approach for the conducting both inductive and deductive evaluation that allows consideration of several criteria and the alternatives at a time, along with benefit of the feedback mechanism and the numerical tradeoffs. It is becoming a more popular and the practical tool, because it enables decision-makers to resolve the complex problems by expediting and simplifying natural decision making processes. Basically the AHP is a method designed to examine the complex issues by breaking down complex, the unstructured problem into following four stages: constructing a hierarchy, the pair-wise comparisons, the priority vector generation and the synthesis. Evaluation is conducted by using developed pair-wise comparison judgments that result in numeric representation of the each comparison by a point estimate. Calculation of the priorities is carried out using the Eigenvector method, and synthesis is done using linear additive value function. AHP provides an effective structure for the group decision making by the imposing a discipline on groups thought the processes. AHP combines deductive and the system approaches into one integrated, the logical framework. Deductive approach focuses on parts whereas system approach concentrates on working of whole.

IV. AHP STEPS

AHP approach, as applied to vendor selection problem, consists of following five steps:

1. Specify set of criteria for evaluating vendor's proposals, and then construct the decision hierarchy by breaking down decision problem into the hierarchy of its elements.
2. Obtain pair-wise comparisons of relative importance of criteria in achieving goal, and compute priorities or the weights of criteria based on these information's.

3. Obtain the measures that describe extent, to which each vendor achieves criteria, then determine whether input data satisfy consistency test; if not, redo pair-wise comparisons.
4. Using information in the step 3, obtain pair-wise comparisons of relative importance of vendors with respect to criteria, and compute corresponding priorities.
5. Using results of steps the 2 and 4, a final priority vector of the each vendor is obtained by synthesizing all priority vectors to achieve goal of hierarchy.

V. MODEL VALIDATION AND RESULT

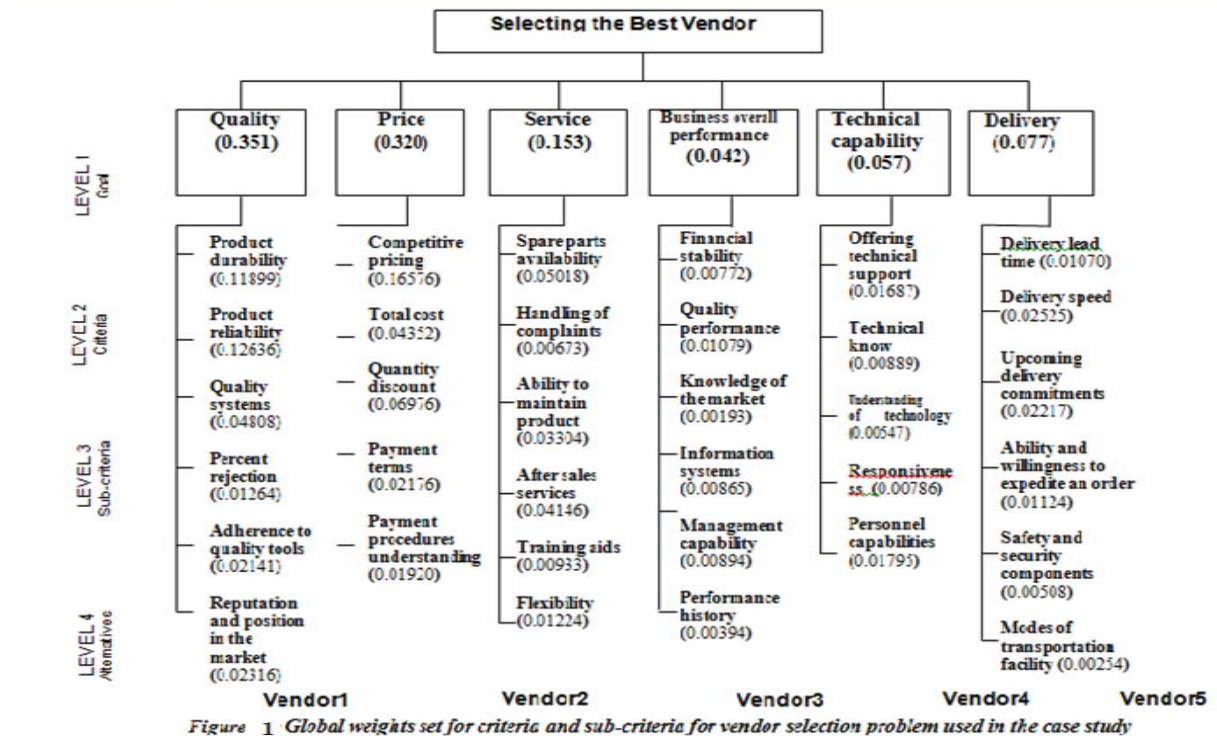
Structuring the Hierarchy

Goal is to choose best machine vendor for the **authorities. The goal is placed at top of hierarchy. Hierarchy descends from more general criteria in second level to the sub-criteria in third level to alternatives at bottom or the fourth level. General criteria level involved the six

Major criteria: quality, service, cost, business overall performance, delivery and technical capability. Decision-making team considered five machine vendors for decision alternatives, and located them on bottom level of hierarchy.

Table 2: The vendors names and their products

No.	Name	È	Product
	Vendor no. 1	Modern Center for Electronics	Sharp
	Vendor no. 2	Qaraman	Konica Minolta
	Vendor no. 3	CopyMax	Xerox
	Vendor no. 4	Al-Jazeera	Canon
	Vendor no. 5	Gaza Strip	Olivetti



Criterion	Local Weight (1)	Sub-criterion	Local Weight (2)	Local Weight (3)					Global Weight (4)				
				S. no.1	S. no.2	S. no.3	S. no.4	S. no.5	S. no.1	S. no.2	S. no.3	S. no.4	S. no.5
Quality	0.351	Product durability	0.339	0.486	0.087	0.142	0.043	0.242	0.0578	0.0103	0.0169	0.0051	0.0288
		Product reliability	0.360	0.480	0.146	0.091	0.037	0.246	0.0606	0.0184	0.0115	0.0046	0.0310
		Quality systems	0.137	0.248	0.268	0.246	0.124	0.114	0.0119	0.0129	0.0118	0.0059	0.0055
		Percent rejection	0.036	0.401	0.243	0.072	0.136	0.148	0.0051	0.0033	0.0010	0.0017	0.0018
		Adherence to quality tools	0.061	0.311	0.311	0.191	0.096	0.091	0.0066	0.0066	0.0039	0.0019	0.0020
Price	0.320	Reputation and position in the market	0.060	0.497	0.087	0.138	0.054	0.224	0.0118	0.0019	0.0034	0.0011	0.0053
		Competitive pricing	0.518	0.061	0.260	0.434	0.154	0.091	0.0102	0.0434	0.0720	0.0259	0.0152
		Total cost	0.136	0.056	0.271	0.431	0.153	0.089	0.0023	0.0118	0.0187	0.0066	0.0038
		Quantity discount	0.218	0.055	0.284	0.446	0.083	0.131	0.0040	0.0201	0.0316	0.0059	0.0093
		Payment terms	0.068	0.442	0.056	0.268	0.151	0.084	0.0098	0.0013	0.0059	0.0034	0.0018
Service	0.153	Payment procedures	0.060	0.331	0.208	0.254	0.109	0.098	0.0063	0.0039	0.0050	0.0022	0.0018
		Spare parts availability	0.328	0.374	0.101	0.164	0.067	0.294	0.0189	0.0052	0.0082	0.0033	0.0149
		Handling of complaints	0.044	0.436	0.051	0.087	0.164	0.262	0.0029	0.0002	0.0005	0.0010	0.0017
		Ability to maintain product/service	0.210	0.417	0.095	0.158	0.058	0.272	0.0139	0.0031	0.0053	0.0021	0.0091
		After sales services	0.271	0.428	0.058	0.263	0.112	0.139	0.0177	0.0024	0.0111	0.0045	0.0057
Business overall performance	0.042	Training aids	0.061	0.060	0.096	0.146	0.413	0.285	0.0006	0.0009	0.0015	0.0039	0.0027
		Flexibility	0.080	0.453	0.054	0.283	0.128	0.082	0.0056	0.0007	0.0036	0.0015	0.0009
		Financial stability	0.184	0.466	0.281	0.046	0.074	0.132	0.0036	0.0022	0.0003	0.0005	0.0009
		Quality performance	0.257	0.261	0.260	0.261	0.137	0.081	0.0029	0.0029	0.0030	0.0016	0.0010
		Knowledge of the market	0.046	0.407	0.061	0.298	0.145	0.089	0.0007	0.0001	0.0006	0.0003	0.0001
Information systems	0.206	0.081	0.453	0.262	0.150	0.053	0.0008	0.0039	0.0023	0.0014	0.0005		
Management capability	0.213	0.461	0.246	0.047	0.151	0.095	0.0041	0.0022	0.0005	0.0014	0.0009		
Performance history	0.094	0.456	0.051	0.151	0.086	0.256	0.0019	0.0001	0.0005	0.0002	0.0009		

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VI. CONCLUSIONS

The main objective of the research identifying the major selection criteria and the development of a Vendor Selection Model (VSM) was accomplished. The VSM model was implemented for solving the complicated selection problem, in a practical way by comparing prospective vendors in terms of selection criteria. The VSM concept is concerned with the selecting a capable and competent vendor based on several criteria to supply the required materials (Photo copy machines) within a given time, with an appropriate price and with the required quality. The implementation proved that the VSM model is a consistent, practical, and effective selection tool for selecting the best vendor.

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