2003 International Symposium on Advanced Intelligent Systems
September 25-28, 2003, Jeju, Korea

A Study on Supplier Evaluation and Selection Method Based Dependency

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Abstract - **The development of information & technology and the Internet provides various connecting routes between manufacturers with consumers. These expanded routes has made it possible for customers to directly transfer their voice to manufacturers, but a research on how the manufacturers respond the customers' needs has to be further conducted. In this paper, a method in which a best supplier would be chosen based on customers' needs from the perspective of a buyer has been presented. A method that makes it possible to evaluate and choose the best supplier in accordance with consumers' requirement by analyzing customers' needs and the evaluated data also has been designed.**

1. Introduction

Advancement in modern technology has caused many businesses to transcend national boundaries and enter into the arena of cut-throat competition. Surviving in this type of business environment meant businesses had to outsource nearly everything with the exception of their own core competitiveness and this trend has become even more common with the advancement in Internet technology. In their desperate attempt to maximize their competitiveness by way of outsourcing, what suddenly became imperative for many businesses was to find the right methodology to evaluate and select suitable suppliers. From the perspectives of a manufacturer, finding the right kind of supplier would provide it with the competitiveness it needs, whereas from the perspective of a supplier, constant monitoring and evaluation by the manufacturer would provide them with the feedback they need in constantly improving upon where they may be lacking. Put simply, establishing a connection with a suitable supplier and helping the supplier attain higher level of competitiveness would naturally ensure competitiveness in overall area of the manufacturer's business.[1][2] Generally, many studies that have been conducted on the subject matter of evaluating and selecting suitable suppliers have heavily resorted to questionnaires. Among many studies that have focused on supplier evaluation standards, Dickson (1996) defined 23 different standards to be employed in both selecting and evaluating suppliers[3], while Weber et al (1991) found out that, based on 74 different studies conducted on the subject matter, priorities in evaluation standards was set in the order of product quality, supplier's ability to perform in a timely manner and the price[4]. Among some of the studies that have been conducted on the subject matter of methodology in selecting suitable suppliers, Weber and Current (1993) employed multi-purpose planning methodology in analyzing the trade-off relationship among above-mentioned factors (e.g., price, ability to perform in a timely manner and product quality)[5], whereas Pan (1989) employed linear programming in determining the exact quantity to order from the suppliers.[6] Narasimhan (1993) was the first to suggest the usage of AHP (Analytic Hierarchy Process)[7] while Ghodsy Pour and O'Brien (1998) determined the optimal quantity to order by way of incorporating both AHP and linear programming[8]. The studies I mentioned in the above are evaluation standards that are employed in selecting suitable suppliers that emphasized price, product quality and the supplier's ability to timely perform. However, in today's competitive business environment, not only should the above-mentioned factors be considered, but also should the elements of cultural compatibility, long-term planning, financial stability, technology and ability to design, managerial compatibility, geographical proximity (which are the qualitative evaluative standards) be also considered. What also need to be considered are the constantly changing consumer demands, which heavily impact product development and functional re-design of products. However, all the prior studies never focused on qualitative evaluation standards, not to mention the customer demands[9]. This study will focus on analyzing the consumer demands (which critically impact products' functional changes and developments) and suggest the methodology whereby the consumer demand gets incorporated into supplier evaluation data for the purpose of deriving the supplier evaluation standards which will help find suitable suppliers. Also, this study will try to suggest the way in which supplier evaluation standards can go beyond merely selecting suitable suppliers and move towards supplier managerial standards, which will, in turn, increase the competitiveness of the suppliers. In this type of supplier evaluation standard, both qualitative and quantitative factors will have to be considered. This is because consumer demand is a qualitative factor that cannot easily be quantified. For the purpose of determining proper weight to be given in this qualitative evaluation standard, this study has adopted Eigenvector method and Fuzzy relation. In the second chapter, this study will suggest the supplier evaluation model. In the third, it will show the evaluation model's applications. In the fourth, it will show the overall characteristics of this study and show where this study will go in the future.

2. Supplier evaluation model with the subordination factor

The reason for considering the subordination factor in this study is to: 1) consider the mutual relationship among each and every individual evaluation criterion that is taken from both the product evaluation criteria which are derived from VOC data and one dimensional supplier evaluation criteria which evaluated suppliers solely from the perspective of the manufacturer; 2) determine the relationship between the two evaluative standards; and 3) conduct two dimensional supplier evaluation that reflects customer demand. The overall structure of the supplier evaluation model that took the dependency factor into consideration is as shown in figure 1 and the detail of it is as shown in the following.

2.1 Deriving the consumer demand

The advancement in Internet technology has made possible various points of contact between consumers and manufacturers such as virtual market and customer service center. By utilizing these new points of contact, manufacturers are now able to collect various kinds of information on customer demand in large quantity. Utilizing this VOC data requires

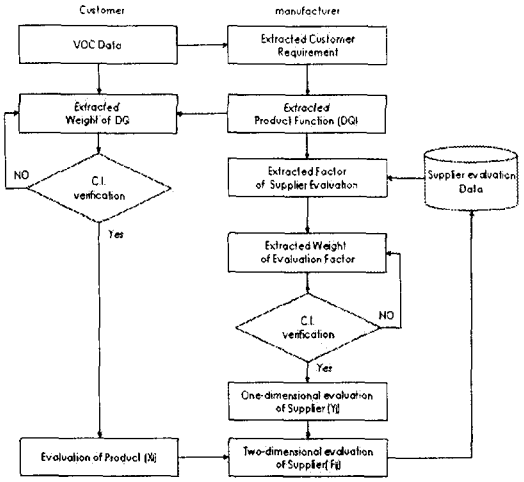

figure 1. Supplier evaluation model with the subordination factor

systematic arrangement of those data. The supplier evaluation model suggested in this study also starts from systematically arranging the VOC data. This study has adopted VOC transition sheet in order to systematically arrange the VOC data. VOC transition sheet is as shown in Table 1 and it helps in systematically arranging VOC data. The constitution of Table 1 may vary depending on the purpose of the analysis and the characteristics of the business.

Table 1. Simplified VOC Conversion Sheet

Customer verbatim	
Rewarded quality	
Converting positive term	
Customer attribute	
Quality characteristic	
Finalize VOC	

2.2 Deriving Product Evaluative Items

For the purpose of deriving quality characteristic that impacts product quality and consumers' demanded quality, this study has adopted KJ method.

This study tried to: 1) derive demanded quality by way of assorting related data among customer demands which were derived from VOC data; 2) and subsequently derive any related quality characteristic. Product evaluation criterion is demanded quality.

2.3 Setting the weights of demanded Quality

Eigenvector Method is used in AHP to set the relative weights of evaluation criterion, and this research used the method to set the weights in the product evaluation criterion drawn from the KJ method, or the weights in Demanded Quality.

Two methods of pair-wise comparison to retrieve the relative weight exist. One is to create pair-wise comparison survey based on abstract evaluation item and perform direct research to the clients. The other is to get the relative significance according to the frequency of the collected VOC data.

These two methods can be used together. In general, direct research is preferred in cases where collection and analysis of VOC are not computerized, or when the quantity of the collected VOC data insignificant. In other cases, the second method above is likely to produce more accurate result. Here the method to acquire the relative significance using the frequency of VOC data can use the equation below (1).

$$A_{ij} = (j_t)/(i_t + j_t) \quad (1)$$

i : VOC data frequency of demanded Quality i

j : VOC data frequency of demanded Quality j

t : the certain period of t subject of analysis

That is, to calculate relative significance of Demanded Quality j with respect to demanded Quality i for the certain period of t subject of analysis, VOC data frequency of demanded Quality j needs to be divided by the sum of VOC data frequency of both demanded Quality i and j. This will generate relative significance of i and j, which induces the idea of pair-wise comparison matrix. This research forms Fuzzy Subordination Matrix with relative significance performed directly to the clients, due to the fact that large VOC data weren't readily available.

2.4 Product Evaluation

Product evaluation, as one of many ways of collecting VOC data, can be conducted simultaneously with research on Consumer Satisfaction Index (CSI). By utilizing product evaluation items and their respective weights, questionnaires will be created and and research may be conducted in the same manner as in CSI research.

$$X_i = w(x)_i \times A_i \qquad i = 1, \cdots, m \quad (2)$$

X_i : Deriving evaluation points of each product evaluation item for weight

$w(x)_i$: Weight of each product evaluation item

A_i : Evaluation Points of each product evaluation item

2.5 Deriving Supplier Evaluation Items

Supplier Evaluation Items may be derived based on 2 different kinds of information namely, demanded quality and previously obtained results from supplier evaluation. The reason for considering these two different information in determining the suppliers evaluation items is because the evaluation items regarding the existing suppliers must effectuate proper changes in reaction to ever-constantly changing consumer demand. This relates to the final two dimensional supplier evaluation.

2.6 Determining proper weights to be assigned to each supplier evaluation item

Determining respective weights to be assigned to each item of supplier evaluation, just as in determining the same on product evaluation items, utilizes Eigenvector method. Proper weights will be determined via pairwise comparison questionnaires to experts both inside and outside the company.

2.7 One dimensional supplier evaluation

One dimensional supplier evaluation means evaluating the suppliers from the perspective of the manufacturer, without considering consumers evaluation on the final products. This will be evaluated by a competent institute of evaluation based both on the previously derived supplier evaluation items and weights assigned to each item of supplier evaluation.

$$Y_j = w(y)_j \times B_j \qquad j = 1, \cdots, n \quad (3)$$

y_j : Deriving evaluation points of each Supplier Evaluation item for weight

$w(y)_j$: Weight of each Supplier Evaluation item

B_j : Evaluation Points of each Supplier evaluation item

2.8 2-Dimensional Supplier Evaluation

2-Dimensional Supplier Evaluation accomplishes the Supplier evaluation, which reflects the Customer Demand through the correlation of the Service Evaluation Item and Supplier Evaluation Item that have been evaluated earlier. These are decided by specialists with reference to Evaluation Item that have been abstracted based on VOC data, that is, detailed Quality characteristics of the demanded Quality. The abstraction of the correlation done by specialist this way is calculated by Fuzzy Relation.

Service and Supplier Evaluation Result found in the

way based on Fuzzy Relation can be used to acquire the Supplier Evaluation Result, which takes customer demand into consideration. Here can be result of the evaluation for each item respectively and if all these are added up, evaluation result about the supplier can be found.

$$F_{ij} = (X_i + Y_j) \times C_{ij} \quad (4)$$

$$E = \sum_i \sum_j F_{ij} \quad (5)$$

3. Case Study: Manufacturer S

Manufacturer by the initial S is a domestic corporation. In this study, I tried to evaluate S manufacturer's entire evaluation process it utilizes in both evaluating and selecting one of its suppliers which supplies one of the parts necessary in manufacturing S manufacturer's Internet TV products based on Evaluative model that specifically takes subordination factor into consideration. Though the evaluative model used by this study was not directly applied to S manufacturer (thus, the study was conducted based on insufficient data), the convenience with which this evaluative model can be employed has received recognition.

3.1 Deriving evaluation points of each product evaluation item for weight from the consumer's pespective

Based on consumer demand derived from VOC data on S manufacturer's Internet TV and in reliance on KJ method, I was able to derive demanded quality to classify product evaluation items into 9 different elements. Based on this item and via pairwise comparison per each item, I first determined their respective weight to be assigned and then obtain evaluations from the consumers, ultimately to ascertain product evaluations which incorporates respective weight points, as in Table 2.

3.2 Deriving the Weight Evaluation Points of Supplier Evaluation Items from Manufacturer's Perspective

Based on above-said product evaluation item, existing supplier evaluations and by utilizing KJ method, one can select supplier evaluation items. The reason one must select supplier evaluation items only after considering product evaluation items and based on pre-existing supplier evaluation outcomes is put the suppliers selected from pre-existing evaluative items to a test via product evaluation items so as to select more suitable evaluation items. 11 items shown in the Table 3 represent the supplier evaluative items derived in the manner discussed in the above. These evaluative items can vary depending on the change in consumer demands and will continue to do change in connection with product evaluation items. Proper weight to be assigned to each of the pre-determined supplier evaluation items can be obtained via pairwise comparison conducted by competent experts. And one can obtain evaluation points for each supplier and ultimately ascertain the evaluation points that specifically took respective weights into consideration.

3.3 2 dimensional evaluation of supplier in consideration of consumer demands

I tried to represent the mutual relationship between the previously obtained product evaluation outcomes X_i and manufacturer's evaluation of suppliers Y_j as a number in between 0 and 1 (by using Fuzzy Relation). This is shown in Table 4. As shown in Table 4, in case each evaluative point is designated as the highest possible point, each supplier subject to the evaluation scored 62.71% in comparison to the highest possible point attainable. If you see the two dimensional supplier evaluation that reflects consumer demands, as shown in Table 4, you will see which areas need to be strengthened in order to improve the overall supplier evaluation points. Table 6 indicates how two dimensional

Table 2. The Evaluation Points of Product Evaluation Items for Weight

DQ	Quality Attribute	Weight	Points	X_i	NO
Defect	defect	0.05	8	0.4	C1
Performance	Screen	0.13	8	1.04	C2
	Voice	0.09	7	0.63	C3
	D.P.I	0.11	9	0.99	C4
Cost	Cost	0.15	8	1.2	C5
Design	Design	0.08	9	0.72	C6
Easy/Simple	Easy/Simple	0.22	9	1.98	C7
Service	Kindness	0.09	8	0.72	C8
	Process	0.08	9	0.72	C9
Sum		1.00	0.72	8.4	

Table 3. The Evaluation Points of Supplier Evaluation Items for Weight

Index	Items	Weight	Point	Y_j
Quality	S1	0.04	8	0.32
	S2	0.21	7	1.47
	S3	0.09	7	0.63
	S4	0.18	8	1.44
Cost	S5	0.14	6	0.84
	S6	0.12	7	0.84
delivery	S7	0.05	8	0.4
	S8	0.05	8	0.4
service	S9	0.03	7	0.21
	S10	0.06	8	0.48
	S11	0.03	8	0.24
Sum		1.00	82	7.27

S1 : Rejection rate in the incoming quality control
S2 : Rejection rate from customers
S3 : Time liss in the production line
S4 : Remedy for quality problems
S5 : Cost reduction
S6 : Pricing structure
S7 : Compliance with due date
S8 : Compliance with quantity
S9 : Level of Cooperation and information exchange
S10 : Technological and R&D capability
S11 : Production facility and capacity

supplier evaluation points vary depending on changes in each individual item when it is assumed that evaluation point is raised by one point in 10 different areas of business with the exception of one regarding demanded quality (derived from VOC data) and 11 supplier evaluation items (based on the pre-existing supplier evaluation data). The extent of improvement after 1 point has been raised represented the ability to handle the returned products and the product defects. This indicates to the suppliers that it is possible to get better evaluations simply by way of beefing up their ability to handle returned products and product defects, thereby provide the suppliers with proper short-term managerial goals which will in turn maximize their competitiveness.

Table 5. 2 dimensional Evaluation Points of Supplier

Division	Perfect level	Supplier
Points	80.28	50.34
Rate(%)	100%	62.71%

4. Conclusion and Future Directions for Further Studies.

There are three characteristics of the supplier evaluation method suggested by this study. One, consumer demand, which was previously never

Table 4. 2 dimensional Evaluation Points of Evaluation Items to Supplier

Product \ Supplier			Items	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	Sum
			Weight	0.04	0.21	0.09	0.18	0.14	0.12	0.05	0.05	0.03	0.06	0.03	67.00
			Points	8	7	7	8	6	7	8	8	7	8	8	216
Items	Weight	Points	X_i \ Y_j	0.32	1.47	0.63	1.44	0.84	0.84	0.4	0.4	0.21	0.48	0.24	7.27
C1	0.05	8	0.4	0.85	0.75	0.43	0.52	0.34	0.23	0.01	0.16	0.22	0.54	0.63	5.27
C2	0.13	8	1.04	0.91	0.83	0.34	0.55	0.21	0.31	0.02	0.15	0.43	0.59	0.71	8.82
C3	0.09	7	0.63	0.89	0.87	0.41	0.48	0.33	0.38	0.15	0.08	0.52	0.61	0.74	7.22
C4	0.11	9	0.99	0.82	0.85	0.38	0.49	0.24	0.25	0.09	0.13	0.49	0.63	0.69	8.54
C5	0.15	8	1.2	0.31	0.22	0.43	0.21	0.86	0.91	0.23	0.11	0.86	0.20	0.75	9.18
C6	0.08	9	0.72	0.01	0.03	0.03	0.11	0.12	0.13	0.02	0.02	0.68	0.53	0.34	2.38
C7	0.22	9	1.98	0.08	0.07	0.08	0.26	0.17	0.31	0.00	0.00	0.85	0.76	0.48	7.67
C8	0.09	8	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C9	0.08	9	0.72	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.00	0.37	0.00	0.00	1.25
합계	1.00	76	10.40	4.43	8.30	3.18	7.09	4.16	4.82	0.71	0.81	5.75	5.82	5.25	50.34

Table 6. The sensitivity analysis of Supplier Evaluation Items

Index	Items	Points	Rate(%)
Quality	S1	50.49	0.31
	S2	51.10	1.51
	S3	50.53	0.38
	S4	50.89	1.09
Cost	S5	50.66	0.63
	S6	50.64	0.60
delivery	S7	50.36	0.05
	S8	50.37	0.06
service	S9	50.47	0.25
	S10	50.57	0.46
	S11	50.47	0.26

considered, is now being considered in the process of evaluating and selecting suppliers. Put in another way, consumer demand, which is a critical factor to be considered in product development and design, is now being reflected in supplier evaluation. Second, the fact that consumer demand is constantly being considered means that the kind of supplier evaluation standard which enables the manufacture to find the most suitable supplier as the consumer demand constantly changes is now possible. This way, consumer demand and a wealth of accumulation of supplier evaluation data will all be considered together so as to provide the kind of supplier evaluation standard that will help find the most suitable supplier whenever product needs to go through modifications or when new products need to be manufactured.

Third, this type of supplier evaluation standard will enable will provide the suppliers with managerial goals which will help them be more competitive. Put in another way, the suggested supplier evaluation standard will become the supplier's own standard and the supplier will be provided with the opportunities to effectively respond to consumer demands, thereby resulting in improvement in their competitiveness. Put simply, the suggested supplier evaluation standard will inject the element of consumer demand into each and every phase of product design, manufacturing and consumption, thereby ensuring the kinds of products that are more geared towards consumer satisfaction and competitiveness. In this study, I have suggested a supplier evaluation model that is geared towards consumer-oriented and made applications based on data from S manufacturer. What I feel is necessary in this field of study is to go beyond consumer demands by also considering suppliers' demands and analyzing supplier's characteristics in attempting to evaluate the suppliers. Through this type of evaluation, suppliers will be fully aware of where they are now and where they need to be in the future, which will translate into their competitiveness and also help any related manufacturers strengthen their competitiveness.

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