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A VIKOR-QFD METHOD FOR SUPPLIER SELECTION BASED ON AHP FOR OBJECTIVE WEIGHTING

Soroush Avakh Darestani[1]*, Samaneh Sajadi[1]
[1] Faculty of Industrial and Mechanical Engineering, Qazvin Branch, Islamic Azad University, Qazvin, Iran.
*(corresponding Author: Soroush Avakh Darestani, E-mail: avakh@qiau.ac.ir)

ABSTRACT
Todays, Quality and customer Orientation is one of the competitive serious challenges .Maintain and expand domestic and foreign markets, entails providing quality products and services through partnerships with suppliers and improve security needs of customers in the design and manufacturing of products and services. Quality Function Deployment, as a total quality management tool Feasibility to provide requirements for the manufacturing and service industries. Thus this paper first identifies the features purchased product should have to meet customer needs And then seek to establish criteria to evaluate suppliers in order to the final rank and optimal selection of indicators via VIKOR method also by using AHP criteria weight and in the end, To prove the effectiveness of the method, a case study is expressed.

KEYWORDS: Analytic Hierarchy process, Life, Function Deployment, Quality Vikor, Supplier selection.

INTRODUCTION

In increasingly competitive markets, customer satisfaction is a vital corporate objective. Key elements to increasing customer satisfaction include producing consistently high quality products and providing high quality customer service. In addition, the intensive global competition among manufacturers to coordinate and respond quickly the industry value chain from suppliers to customers has made customer supplier relationship management important in the new business era. In such circumstances the decision making in each business plays a key role in the cost reduction.(Rajesh and Malliga,2013) Currently, The integration of different supply networks of resource networks and the ability to make quick and precise decisions often have a competitive advantage compared to other competitors or other networks(Choy *et al*.,) In addition , increasing significance of the purchasing function, purchasing decisions become more important and More complex transformations such as Globalization of trade and the Internet, led to enlarge a purchaser's choice set and Change customer preferences(Rajesh and MaLliga,2013).Because of these developments strongly insist on a more systematic and transparent approach to purchasing decision making, particularly about supplier selection. As a result, effective supplier selection process is essential for the success of each organization (Chan *et al*, 2008). Contemporary literature Research indicates a wide range of methods and techniques have been proposed so far to choose the right supplier selection includes qualitative, quantitative and integrated methods which is presented, in Table 1 briefly. However, experts believe, that there is not a unique optimal method for evaluating suppliers in practice.

Weber *et al*. (1991) reviewed 74 supplier selection articles from 1966 to 1991 and showed that more than 63% of them were in multi-criteria environment. De Boer *et al*. (2001), at first, The importance and complexity of buying decisions are discussed and then Decision methods for identifying the problem and formulating criteria and evaluating suppliers is presented. William Ho *et al*. (2010), reviewed 78 journal articles between 2000 and 2008. Which include numerous individual and integrated approaches to solve the supplier selection problem? They realized that the most prevalent individual approach is DEA, and the most popular integrated approach is AHP–GP., they discovered that price or cost is not the most widely adopted criterion. Instead, the most popular criterion used for evaluating the performance of suppliers is quality, followed by delivery, price or cost, and so on. Bevilacqua *et al.* (2006), proposed fuzzy-QFD. In this paper, a new method called the House of quality (HOQ) in the supplier selection process was introduced. The study by identifying the features that the purchased product should have, in order to meet customer requirements, started then seek to establish Evaluation Criteria in order to create a final ranking based on the fuzzy suitability index (FSI). Shamshadi *et al*. (2011), suggested integrated fuzzy vikor approach for supplier selection. They used Shannon entropy to determine the weights. William Ho *et al*. (2010), in his suggestions for future work stated that although the method has been presented can deal with multiple criteria, but, the weightings of supplier evaluating criteria depend a lot on business priorities and strategies. In cases where the weightings are allocated without considering the ‘‘voice” of company stakeholders, the suppliers selected Suppliers may not provide what the company really needs. Thus the hierarchical QFD methodology, which integrates the AHP and QFD, is developed.by (Rajesh and Maliga, 2013) in which by considering the ‘‘voice” of company stakeholders in HOQ and the importance of evaluating criteria is

prioritized with respect to the degree of achieving the stakeholder requirements using AHP, alternative suppliers are evaluated based on the ranked criteria and compared with each other using AHP again to make an optimal selection. As well as (Dursan and Karsak, 2013) were considered QFD approach based on Fuzzy MCDM. Therefore, companies have different approaches to solving the supplier selection problem based on the specific needs of their company so this makes it difficult to find the best way to evaluate and select the impressive suppliers (Keskin *et al*.2010).
In this paper, According to the relationship between the decision criteria to choose a goods supplier and needs customers' and the impact of them Combination of both customer demands and requirements of the manufacturer using quality function deployment is intended that start by studding of the market and identifying the needs of customers and In its process, try to incorporate the identification of needs and requirements of customers in all stages of production. The criteria are weighted using Analytical Hierarchy Process. AHP compared with other multi-criteria decision making methods produces better results because of interoperability and providing possible paired comparisons. Finally, vikor approach for ranking and selecting the best supplier suggested. As the results of QFD are not intended for use as anything more than a general guideline for choosing priority items, Thus, integration with the operational research tool, vikor makes the QFD technique more acceptable to decision makers rather than using the same as a general guideline (Bhattacharya *et al*.2010).

Table 1.The Supplier Selection approach

Category	Method	Author	Category	Method	Author
Qualitive Factor approach	AHP	Chan and Chan(2004) Ho *et. al* (2010)	Quantitive Factor approach	GA	**Karpak *et al*.(2001)**
	ANP	Sarkis and Talluri (2002)		MOP	**Dahel(2003)**
	DEA	Weber (1996) Wu *et al*. (2007)		LP	**Talluri and Narasimhan(2005)**
	FUZZY AHP	Kharaman *et al*.(2003) Chan and kumer(2007)	Integerated Factor approach	AHP-MOP	**Xia and Wu(2007)**
	FUZZY, TOPSIS	Shahanaghi andYazdian(2009)		DEA-MOP	**Talluri *et al*.(2008)**
	FUZZY,VIKOR	Shemshadi *et al*.(2011)		FUZZY TOPSIS-MCGP	**Lio and Kao(2011)**
	Fuzzy QFD	Bevilacqua *et al*.(2006)		AHP-QFD	**Rajesh and Malliga(2013)**

MATERIALS AND METHODS

Note that the global market situation has changed. Training and Customer demand become important. Nowadays, the buyer, is not responsible for the accuracy of defects in goods, the seller is. Rapid responses to changes (Market, technology, economics) Production and agile design, are important. Thus, the Presence importance of QFD is clear.

Quality Function Deployment

Quality Function Deployment (QFD) as one of new methods of quality engineering, start from the study of market and identification of products customers, then analyze needs and requirements of customers and try to incorporate it in all stages of production so product specifications are obtained according to the Customer Comments. This assessment would minimize necessary change and development decisions at the beginning of the design phase and reforms across the entire product development process (Karsak *et al*.2003) So is not only applicable to turned on customer requirements to technical specifications of the product, even, In all other analyzes of several interdependent factors, simultaneously, must be considered in the decision, it is useful. Customer satisfaction, quality improvement according to what the customer wants, teamwork promote, substantially reducing launch costs, reducing changes during the design process, increase productivity, quality and engineering science and less engineering changes are the QFD benefits . HOQ is one of the most famous and oldest method of implementing Quality Function Deployment in fact it is a tool for translating customer requirements into technical specifications (Karsak, 2004). In this way, the priority of customer demands performed through marketing and by himself.Some knows HOQ the foundation of QFD (Hauser and Clausing, 1988). Sometimes is referred the best technique of total quality management and development of quality

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functions. HOQ cause to discipline involved ones with the project decisions that have been associated with some sort of group cohesion. This method is similar to home in appearance which is displayed in Fig 1. The following steps are the algorithm of QFD method:

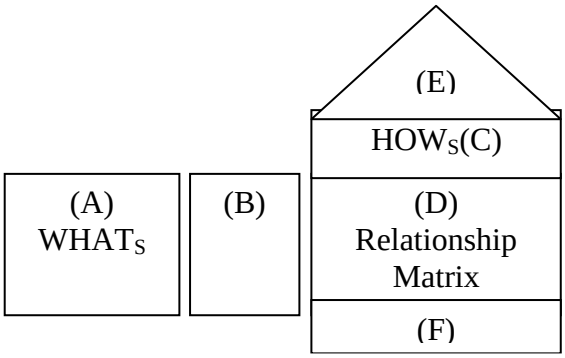

Fig.1. House of quality.

Step 1: Identify the WHATs. The wanted benefits in a product or service in the customer's own words are customer needs and are usually called customer attributes (CA) or ''WHATs'', area (A) in Fig. 1. In assigning priorities to WHATs, it is necessary to balance efforts in order to accomplish those needs that add value to the customer. The priorities are usually indicated in the area designated as (B) in Fig.1.
Step 2: Determination of HOWs. Engineering characteristics are specified as the ''HOWs'' of the HOQ and also called measurable requirements. HOWs are identified by a multidisciplinary team and positioned on the area marked as (C) on the matrix diagram, Fig.1.
Step 3: Preparation of the relationship matrix (D). A team judges which WHATs impact which HOWs and to what degree.
Step 4: Elaboration of the correlation matrix. The physical relationships among the technical requirements arespecified on an array known as ''the roof matrix'' and identified as (E) in Fig.1.
Step 5: Action plan. The weights of the HOWs, identified as area (F), are placed at the base of the quality matrix. These weights are one of the main outputs of the HOQ, and are determined by

Weight (HOW) i = V (HOW)i1 X imp(WHAT1) + …..+ V (HOW)in X imp (WHATn) (1)

Where V (HOW) in is the correlation value of HOWi with WHATn, and imp (WHATn) represents the importance or priority of WHATn.

Analytical Hierarchy Process
As mentioned, in this paper for weighting criteria AHP method is used, which was invented by Thomas Saaty, because of the nice mathematical properties of the method and the fact that the required input data are rather easy to obtain. The AHP has attracted the interest of many researchers. This method is based on paired comparisons. The decisional provide the hierarchical structure of the decision making problem. It shows the factors to compare and competing evaluate alternatives in making decision. The decision matrix, which is based on Saaty's nine-point scale, (Table.2), is constructed. The decision maker uses the fundamental 1–9 scale defined by Saaty to assess the priority score. In this context, the assessment of 1indicates equal importance, 3 moderately more, 5 strongly more, 7 very strongly and 9 indicates extremely more importance. The values of 2, 4, 6, and 8 are allotted to indicate compromise values of importance. The next step involves the comparison in pairs of the elements of the constructed hierarchy to set their relative priorities with respect to each of the elements. The eigenvalues of this matrix are needed to be calculated which would give the relative weights of criteria.Finally the alternative with the
highest weight coefficient value should be taken as the best alternative.

Table 2. The numerical assessments and their linguistic meanings

Numerical assessment	Linguistic meaning
1	Equal important
3	Moderately more important
5	Strongly more important
7	Very strongly important
9	Extremely more important
2,4,6,8	Intermediate values of importance

Vikor means Multi-criteria optimization and compromise solution is one of the useful methods In deciding and The best option choice (Opricovic and T Zeng, 2002).Vlsekriterijumska Optimizacija I Kompromisno Resenje (i.e. VIKOR) method was developed by Opricovic in 1998 for multi-criteria optimization of complex systems (Opricovic, 1998) .This model based on consensus method and conflicting criteria have been developed and generally used to solve discrete problems. A practical solution is a compromise solution that is closest to the ideal solution. (Opricovic and Tzeng, 2004). Compromise is the answer that obtained based on mutual compromise between criteria (Opricovic and Tzeng, 2007). In fact, parameters are not weighted in this model, but also criteria weighted through other methods then ranking the alternatives then, by evaluating alternatives based on independent criteria.
The following steps are the algorithm of VIKOR method:
Step1.using AHP, ANP... to determine weights with respect to importance of criteria.
step2.-Determine the best f^*_j and the worst f^-_j values of all criterion ratings, j = 1, 2. . . n.using Eqs.(2)

$$f_i^*=\max(f_{ij}) \qquad f_i^-=\min(f_{ij}) \qquad (2)$$

Where f^*_i is the positiv[illegible]on for the jth criteria. If one associates all f_i^*, it will has the optimal combination, which gets the highest scores similar as f^-_i.
Step 3. Compute the values of S_j and R_j, i =1, 2, . . . m using Eqs. (3)

$$S_j = \sum_{i=1}^{n} w_i \cdot \frac{f_i^* - f_{ij}}{f_i^* - f_i^-}; \qquad R_j = \max_i \left[w_i \cdot \frac{f_i^* - f_{ij}}{f_i^* - f_i^-} \right] \quad (3)$$

where Sj denotes the distance rate of jth alternative to the positive ideal solution, and Rj represents the distance rate of jth alternative to the negative ideal solution. Also, w_i are the weights of criteria, which are expressed in their relative importance.
Step 4. Compute the values of Q_j j = 1,2, . . . , m using Eq. (4):

$$Q_j = v \cdot \frac{S_j - S^-}{S^* - S^-} + (1-v) \cdot \frac{R_j - R^-}{R^* - R^-} \qquad (4)$$

Where $S^- = \max_j Sj$, $S^* = \min_j Si$, $R^- = \max_j R_j$, $R^* = \min_j R_j$ and v is the weight of the strategy of "the majority of criteria'' (or ''the maximum group utility"), suppose that v = 0.5.
Step 5. Rank the alternatives. According to the values of Q_j calculated in step (4), we can rank the alternatives and make decision.

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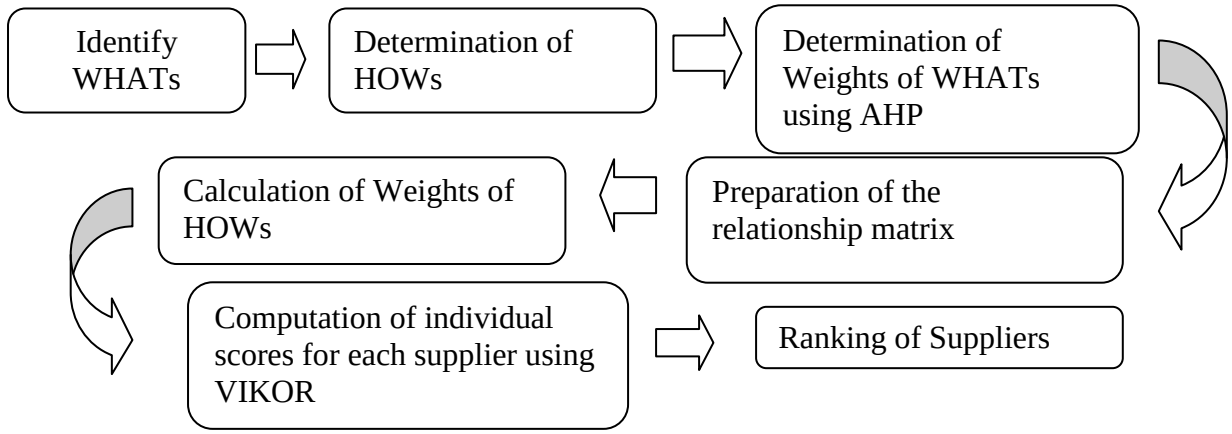
VIKOR QFD Methodology



RESULTS AND DISCUSSION

In this study we have compared five suppliers who are supplied necessary component of the car manufacturer. In the first stage, Experts is considered cost, quality and delivery according to customer requirements. Experience, technical capability, geographic area, Flexibility, financial stability and warranty is supposed to evaluate suppliers. Then using the scale shown in Table 3 the team was asked to compare the criteria. Results are shown in Table 4 and 5.

Table 3. Comparison Matrix

Criteria	Cost	Delivery	Quality
Cost	1	0.50	0.14
Delivery	2	1	0.17
Quality	7	6	1
sum	10	7.50	1.31

Table 4. Normalized Matrix

Criteria	Cost	Delivery	Quality	sum
Cost	0.10	0.07	0.11	0.28
Delivery	0.20	0.13	0.13	0.46
Quality	0.70	0.80	0.76	2.26
sum	1	1	1	3

Table5: Weights of WHATs

Cost	Delivery	Quality
0.09	0.15	0.75

The impact of each ‘‘HOW’’ on each ‘‘WHAT’’ were recorded as linguistic variable High, Medium and Low. The numerical values of 9, 3 and 1 were assigned to high, medium and low respectively shown in table 6 and From the constructed House of Quality the relative weights of the How’s (Criteria) are calculated, table 7.

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Table 6. R*elationship matrix*

	How's						
What's	Importance	Experience	Financial stability	Technical Capability	Flexibility	Geographical position	warranty
Quality	0.75	M		H	H		
Cost	0.09	L	M			M	
Delivery	0.15	L		M	L	H	H

Table 7. HOQ (Weights of HOWs)

	How's							
What's	Importance	Experience	Financial stability	Technical Capability	Flexibility	Geographical position	warranty	TOTAL
Quality	0.75	2.26		6.76	6.76			15.78
Cost	0.09	0.09	0.28			0.28		0.65
Delivery	0.15	0.15		0.46	0.15	1.36	1.36	3.48
TOTAL		2.5	0.28	7.22	6.91	1.64	1.36	19.91
Relative Weight		12%	2%	36%	35%	8%	7%	

The next stage of the decision process, decision makers are asked to compare the alternatives according to each criterion independently to design decision matrix which is shown in Table 8 then we multiply the importance of criterion to normalized matrix, table 9 give the result. The best f_i* and the worst f_i- are determined using Eqs (2) ,is shown in Table10 and the values of S ,R,Q for all alternatives.

Table8: Suppliers scores for each Criteria.

	Experience	Financial stability	Technical Capability	Flexibility	Geographical position	warranty
Relative Weight	12%	2%	36%	35%	8%	7%
S1	55	90	15	64	22	54
S2	64	33	24	13	80	31
S3	22	78	12	74	11	71
S4	46	37	70	69	39	11
S5	11	44	43	12	90	78

Table9: The weighted matrix

	C1	C2	C3	C4	C5	C6
S1	0.068	0.013	0.061	0.185	0.14	0.030
S2	0.079	0.005	0.09	0.038	0.049	0.175
S3	0.028	0.011	0.05	0.021	0.006	0.041
S4	0.056	0.005	0.288	0.199	0.024	0.006
S5	0.013	0.006	0.176	0.035	0.056	0.044

Table10: Positive and Negative ideal solution for ith criteria

F_i*	**0.079**	**0.013**	**0.288**	**0.199**	**0.14**	**0.175**
F_i^-	0.013	0.005	0.05	0.021	0.006	0.006

Table11: The values of S, R and Q

Suppliers	S_i	R_i	Q_i
S1	0.389	0.289	0.36
S2	0.556	0.252	0.73
S3	0.778	0.303	0
S4	0.184	0.07	1
S5	0.609	0.23	0.58

Table12: Ranking of Suppliers

Ranck	1	2	3	4	5
Suppliers	S4	S2	S5	S1	S3

CONCLUSION

Customer satisfaction is the main goal in today's competitive markets. Key elements in customer satisfaction are quality products and services to clients. In a production system that focuses on better quality and lower cost suppliers play an important role. As you mentioned in this paper, VIKOR-QFD approach was used to select the best supplier. The method uses quality function deployment to consider voice of customers and VIKOR offers a methodology to rank alternatives. Weights of WHATs are calculated using AHP. To test efficacy of this method, it is applied to a supplier selection process for a car components company. There are lots of Methods to combine with quality function deployment for ranking suppliers method such as SAW in future research.

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