ELK ASIA PACIFIC JOURNAL OF MECHANICAL ENGINEERING AND RESEARCH- SPECIAL ISSUE
ISSN 2349-9368(Online);EAPJMER/ISSN.2454-2962/2016;

ELK
Asia Pacific Journals

National Conference on Futuristics in Mechanical Engineering
Madan Mohan Malaviya University of Technology

SUPPLIER SELECTION APPROACH WITH VIKOR METHOD COMBINED WITH ENTROPY WEIGHT METHOD

Josy George	**Pushkal Badoniya**
Department of Mechanical Engineering, Lakshmi Narain College of Technology, Bhopal (M.P)	Department of Mechanical Engineering, Lakshmi Narain College of Technology Exellence, Bhopal (M.P)

ABSTRACT

Supplier selection and evalution method is one in all the most important variables, that includes a direct impact on the performance of any organisation. As the organization becomes more worried about their suppliers, the direct and indirect consequences of poor decision making can become additional requirement for them. The nature of this decision is typically complicated and unstructured. On the otherhand, supplier's choice decision-making downside involves trade-offs among multiple criteria that involve each quantitative and qualitative factors, which can even be conflicting. The sole of this paper is to find a good approach of assignment weights to criteria in absence of decision maker's preference in Multi Criteria deciding issues. The VlseKriterijumskaOptimizacija I KOmpromisnoResenje (VIKOR) method combined to Entropy Weight method is presented to solve the MCDM problem. A numerical example is evakuated as an application of the proposed method.

Keywords: *VIKOR Method, Entropy Method, Supplier Selection, Multiple Criteria Decision Making (MCDM)*

INTRODUCTION

Supplier choice drawback has become one in every of the foremost necessary problems for establishing a good offer chain. It become one in every of the most important topics in production and operations management literature. The main objective of provider choice method is to scale back purchase risk, maximize overall value to the purchaser, and develop closeness and long-term relationships between buyers and suppliers. The getting manager should apprehend an appropriate technique, then use the best method from the different types to select the right supplier. Thus one in every of the necessary getting choices is that the choice and maintenance of a competent cluster of suppliers. Selecting an honest set of suppliers to figure with is crucial to a company's success.

Supplier choice may be a multiple criteria deciding (MCDM) drawback that is littered with many conflicting factors. The benefit of

ISSN 2349-9368(Online);EAPJMER/ISSN.2454-2962/2016;

MCDM techniques is that they contemplate each qualitative parameter further because the quantitative ones. MCDM includes many solution techniques such as Simple Additive Weighting (SAW), Weighting Product (WP) [4], and Analytic Hierarchy Process (AHP) [5]. In this paper a new personnel training selection problem existed in a multi-national company is presented. The technique named VlseKriterijumskaOptimizacija I KompromisnoResenje in Serbian (VIKOR) is applied to rank the suppliers. The VIKOR methodology was developed for multi-criteria optimisation of advanced systems [7]. This methodology focuses on ranking and choosing from a collection of alternatives, and determines compromise solutions fora retardant with conflicting criteria, which may facilitate the choice manufacturers to achieve a judgment. Here, the compromisere answer can be a potential resolution that's that the closest to the proper associate degreed a compromise implies that an agreement established by mutual concessions. An Entropy Weighting (EW) method is introduced for the criteria of selection.

LITERATURE SURVEY

Selection of supplier is one of the most critical activities performed by the organization because of its strategic importance. The selection process is based on their earlierperformance records. Current evaluation methods show that they are all less objective and lack accurate data processing. Traditionally used evaluation methods are based on various characteristics of good supplier measurement criteria's such as cost, quality, delivery and warranty. Grey relation is also a decision making method used under uncertainty conditions it is found to be a superior comparable approach even if small information and determine rank of the suppliers. Supplier selection problem can be solved using mathematical problem linear and nonlinear programming. For new supplier evaluation, it is very convenient to perform overall measurement based on each enterprise requirements. Supplier selection is done basing on the overall performance measure of all the suppliers. This method will significantly reduce the acquiring cost and increase the production proficiency and overall competitiveness.

The nature of supplier selection is an intricate multi criteria problem includeboth quantitative and qualitative factors which may be in conflict and may also be uncertain. The VIKOR method was developed to solve multi criteria decision making problems with inconsistentand different criteria's such as product quality, on-time delivery, price (or) cost, suppliers technological level and flexibility. The decision maker needsa solution that is the closest to the ideal and alternatives are evaluated according to the criteria's. In this paper linguistic values are utilized to assess the evaluations and weights for these criteria's. These linguistic ratings can be expressed in trapezoidal or triangular fuzzy numbers. This method is extremely adaptable and not only enable us to determine the outranking order of suppliers,

ISSN 2349-9368(Online);EAPJMER/ISSN.2454-2962/2016;

National Conference on Futuristics in Mechanical Engineering
Madan Mohan Malaviya University of Technology

additionally evaluate and rate the suppliers. These ratings can be used in combination with mathematical programming and differentmethods to deal with supplier selection in multi sourcing conditions. The entropy weight method was firstly introduced from thermodynamics to information systems. The uncertainty of signals in communication processes is called ‘‘information entropy’’. The lower is the information entropy, the higher is the weight.

METHODOLOGY PROPOSED

In this paper, the weights of each criterion are calculated using Entropy method. After that, VIKOR is utilized to rank the alternatives.

Entropy method to determine the weight of each indicators

In most of MCDM problems is required to have the relative importance of the criteria. This relative significanceshows the importance of each criterion in regardto other criteria for decision making. There are two different methods to acquirethese weights: subjective and objective weights one of the most appropriatemethods to obtain the relative significanceis entropy. Entropy weights are the measures of uncertainties in the information formulated using probability theory and this information content in the attribute values of the alternatives, evaluating each attributes usefulness in detecting differences in the data

Step - I: Calculate p_{ij}(the i^{th} schemes j^{th}indicator values proportion).

$$p_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}$$

r_{ij} is the i^{th} schemes j^{th} indicator value

Step - II: Compute e_j value by using formula

$$e_j = -k \sum_{i=1}^{m} p_{ij} . \ln p_{ij}$$

Where

$$k = \frac{1}{\ln m}$$

m is the number if assessment schemes.

Step - III: Caluculate weight w_j(j^{th}indicators weight)

$$w_j = \frac{1 - e_j}{\sum_{j=1}^{n} (1 - e_j)}$$

n is the number of indicator, and $0 \leq w_j \leq 1$,

In entropy method, the smaller the indicators entropy value ej is, the bigger the variation extent assessment value of indicators is, the more the amount of information provided, the greater the role of the indicator in the comprehensive evaluation, the higher its weight should be.

VIKOR Method

The VIKOR method introduced by Opricovic in 1998 is an effective technique in multi criteria decision making (MCDM) which is madefrom the compromise programming method in solving problems with inconsistentcriteria. This method lies in significantthe positive and negative ideal solution. The positive ideal solution showsthe alternatives with highest value while the negative ideal solution meansthe

alternatives of lowest values. It provides a maximum group utility for the majority and a minimum of individual regret for the opponent. The compromise solution is a practicalsolution which is closest to the positive ideal solution and farthest from the negative ideal solution.

CONCLUSIONS

(i) Supplier selection is a broad comparison of suppliers utilizing a typical arrangement of criteria and measures to recognize suppliers with the highest potential for meeting a firm's needs consistently and at a satisfactory cost. Selecting the right suppliers much reduces the purchasing costs and improves corporate competitiveness, therefore supplier selection one of the most important decision making problems.

(ii) Supplier selection is considered as a key problem that is generally considered as an MCDM. The planned analysis work has focused on problems and complexities in applying VIKOR methodology to planet issues like provider choice issues in provide chain management.

(iii) The VIKOR method with Entropy method, VIKOR Method supports subjective and objective weights, where subjective weights are obtained directly from the decision makers while objective weights are determined based on Entropy method. Finally, proposed a numerical example to illustrate an application of the proposed method. The results may vary with respect to expert opinions.

REFERENCES

[1] DharunKumar.P, Mani Bharathi Karthikeyan.S, Application of grey relation model in a supplier selection process, International journal of scientific &Engineering Research volume 5, issue 5, **May-2014**,

[2] G Peide Liu and Xin Zhang, Research on the supplier selection of a supply chain based on entropy weight and improved ELECTRE-III method, International Journal of Production Research Vol. 49, No. 3, 637–646, 1 **February 2011**

[3] C.L. Hwang and K. Yoon, Multiple Attributes Decision Making Methods and Applications, Berlin, Heidelberg: Springer, **1981**.

[4] T.L. Saaty, The Analytic Hierarchy Process, McGraw-Hill, NewYork,**1980**.

[5] Peide Liu and Xin Zhang, Research on the supplier selection of a supply chain based on entropy weight and improved ELECTRE-III method, International Journal of Production Research Vol. 49, No. 3, 637–646, **2011.**

[6] Reza KianiMavi, Mark Goh, Neda KianiMavi, Supplier selection with Shannon entropy and fuzzy TOPSIS in the context of supply chain risk management, Procedia - Social and Behavioral Sciences 216 – 225, 235 **2016**.

[7] Jitendra Kumar, TarunSoota, Ganga Sagar Singh Topsis and Vikor approaches to machine tool selection, J. Sci. Res. Adv. Vol 2, No.3,125-130, **2015**.

[8] Yufeng WANG, Ming DAI. Safety assessment based on information entropy and unascertained theory. Shanxi Coal, (5):8-10, **2009**

ISSN 2349-9368(Online);EAPJMER/ISSN.2454-2962/2016;

National Conference on Futuristics in Mechanical Engineering
Madan Mohan Malaviya University of Technology

Step - I: The structure of matrix

D =

	X_1	X_2	…	X_j
A_1	X_{11}	X_{12}	…	X_{1j}
A_2	X_{21}	X_{22}	…	X_{2j}
.	.	.	…	.
.	.	.	…	.
A_i	X_{i1}	X_{i2}	…	X_{ij}

Step - II: Assign weights to each inndicators to entropy method which is introduced each indicators weights.

Step - III: Make indicators value being dimensionless, establish decision-making matrix.

The cost type indicators:

$$V_{ij} = \left(\frac{\min x_{ij}}{x_{ij}}\right)$$

The benefit type indiators:

$$V_{ij} = \left(\frac{x_{ij}}{\max x_{ij}}\right)$$

Step - IV: Calculate each indicators positive ideal solution and negative ideal solution

$$f_i^* = \left[\left(\max f_{ij} \mid i \epsilon I_2\right), \left(\min f_{ij} \mid i \epsilon I_2\right)\right]$$

$$f_i^- = \left[\left(\min f_{ij} \mid i \epsilon I_1\right), \left(\max f_{ij} \mid i \epsilon I_2\right)\right]$$

I_1 is a benefit type indicator set, I_2 is a cost type indicator set

Step - V: Calculate the utility measure and regret measure for all the alternatives.

(a) Utility measure

ISSN 2349-9368(Online);EAPJMER/ISSN.2454-2962/2016;

$$S_i = \sum_{i=1}^{n} \left(w_i \left(f_i^* - f_{ij} \right) / \left(f_i^* - f_i^- \right) \right)$$

(b) Regret measure

$$R_i = max \left[\left(w_i \left(f_i^* - f_{ij} \right) / \left(f_i^* - f_i^- \right) \right) \right]$$

Step - VI: Calculate the value of VIKOR index for each alternative

$$Q_j = v(S_i - S^*)/(S^- - S^*) + (1 - v)(R_j - R^*)/(R^- - R^*)$$

Where $S^* = \min S_j$, $S^- = \max S_j$, $R^* = \min R_j$, $R^- = \max R_j$, Usually, the value of v is taken as 0.5. However, v can take any value from 0 to 1.

Step - VII: Calculate the value of VIKOR index for each alternative, according to S, R and Q separately to rank the schemes, we get 3 rank tables.

For given attribute weights, propose a compromis solution, alternative A1, which is the best ranked by the measure Q, if the following two conditions are satisfied:

Condition 1: 'Acceptable advantage' $Q(A_2)-Q(A_1) \geq (1/(N-1))$

A_2 is the second best alternative in the ranking by Q

Condition 2: Acceptable stability in decision making. Alternative $A1$ must also be the best ranked by S and/or R. This compromise solution is stable within a decision-making process, which could be: voting by majority rule.

(when $v > 0.5$ is needed) or "by consensus" (when $v = 0.5$) or "with veto" (when $v < 0.5$). If one of the conditions is not satisfied, then a set of compromise solutions is proposed, which conists of: –

Alternatives $A1$ and $A2$ if only condition 2 is not satisfied.

Alternatives $A1, A2, \ldots, Am$ if condition 1 is not satisfied;

Am is determined by the relation $Q(A_m) - Q(A_1) \geq (1/(N-1))$ for maximum M (the positions of these alternatives are "in closeness").

NUMERICAL ILLUSTRATION

A numerical example to illustrate as an application of the proposed method in the previous section. For a company that wants select its supplier, there are four supplier's S_i (i=1,2,3,4) selected as alternatives against five attributes Q_j(j=1,2,3,4,5) suppose the following criteria and characteristics as the most important items to focus: Price (Q_1), Product Quality (Q_2), Delivery

ISSN 2349-9368(Online);EAPJMER/ISSN.2454-2962/2016;

Time (Q_3), Service Quality (Q_4), Reputation Risk (Q_5). Q_2, Q_3, Q_4 are the benefit attributes and Q_1, Q_2 are the cost attributes the smaller value being better.

Table 1: The Value of Criterion

Selection Criteria → / Alternatives ↓	Q_1	Q_2	Q_3	Q_4	Q_5
Supplier 1	95	55	70	90	90
Supplier 2	90	90	85	85	80
Supplier 3	85	69	90	85	80
Supplier 4	85	83	85	80	60

Table 2: Criterion Parametric values

Selection Criteria → / Alternatives ↓	Q_1	Q_2	Q_3	Q_4	Q_5
Supplier 1	95	55	70	90	90
Supplier 2	90	90	85	85	80
Supplier 3	85	69	90	85	80
Supplier 4	85	83	85	80	60
$\sum_{i=1}^{m} x_{ij}$	355	297	330	340	310
$\sqrt{\sum_{i=1}^{m} x_{ij}^2}$	177.69	150.91	165.68	170.15	156.52

Table 3: Normalized Matrix

SC → / A ↓	Q_1	Q_2	Q_3	Q_4	Q_5
Supplier 1	0.5346	0.3644	0.4225	0.5290	0.5750
Supplier 2	0.5065	0.5964	0.5130	0.4996	0.5111

ISSN 2349-9368(Online);EAPJMER/ISSN.2454-2962/2016;

National Conference on Futuristics in Mechanical Engineering
Madan Mohan Malaviya University of Technology

Supplier 3	0.4784	0.4572	0.5432	0.4996	0.5111
Supplier 4	0.4784	0.5500	0.5130	0.4702	0.3833

Table 4: Proportional Matrix A

SC → / A ↓	Q_1	Q_2	Q_3	Q_4	Q_5
Supplier 1	0.2676	0.1852	0.2121	0.2647	0.2903
Supplier 2	0.2535	0.3030	0.2576	0.2500	0.2581
Supplier 3	0.2394	0.2323	0.2727	0.2500	0.2581
Supplier 4	0.2394	0.2795	0.2576	0.2353	0.1935
$\sum_{i=1}^{n}(p_{ij}.\ lnp_{ij})$	-1.3852	-1.3695	-1.3820	-1.3854	-1.3760
k	0.7213	0.7213	0.7213	0.7213	0.7213
e_j	0.9992	0.9879	0.9969	0.9994	0.9926

Table 5: Proportional Matrix B

e_j	e_1	e_2	e_3	e_4	e_5
	0.9992	0.9879	0.9969	0.9994	0.9926
$d_j = 1 - e_j$	0.0008	0.0121	0.0031	0.0006	0.0074
$w_j = \frac{1-e_j}{\sum_{j=i}^{n} 1-e_j}$	0.0325	0.5052	0.1279	0.0260	0.3083
Weight	w_1	w_2	w_3	w_4	w_5

Table 6: Weight Normalized Matrix

SC → / A ↓	Q_1	Q_2	Q_3	Q_4	Q_5
Supplier 1	0.8947	0.6111	0.7778	1.0000	0.6667

ISSN 2349-9368(Online);EAPJMER/ISSN.2454-2962/2016;

National Conference on Futuristics in Mechanical Engineering
Madan Mohan Malaviya University of Technology

Supplier 2	0.9444	1.0000	0.9444	0.9444	0.7500
Supplier 3	1.0000	0.7667	1.0000	0.9444	0.7500
Supplier 4	1.0000	0.9222	0.9444	0.8889	1.0000

Table 8: Positive & Negative Ideal Solutions

F*	1.0000	1.0000	1.0000	1.0000	1.0000
F-	0.8947	0.6111	0.7778	0.8889	0.6667

Table 9: Utility & Regret Measure

SC → A ↓	$(w_i (f_i^* - f_{ij})/(f_i^* - f_i^-))$				
Supplier 1	0.0325	0.5052	0.1279	0.0000	0.3083
Supplier 2	0.0172	0.0000	0.0320	0.0130	0.2313
Supplier 3	0.0000	0.3031	0.0000	0.0130	0.2313
Supplier 4	0.0000	0.1010	0.0320	0.0260	0.0000

Table 10: The Evaluation Value of Each Supplier

Si	0.9740	0.2934	0.5474	0.1590
Ri	0.5052	0.2313	0.3031	0.1010
Qi	1.0000	0.2436	0.4883	0.0000

Table 11: Rank the Supplier by VIKOR

	Supplier 1	Supplier 2	Supplier 3	Supplier 4
Si	4	2	3	1
Ri	4	2	3	1
Qi	4	2	3	1

According to condition1

$Q(A_2)-Q(A_1) \geq (1/(N-1))$

$0.2436-0 \geq (1/(4-1))$

ISSN 2349-9368(Online);EAPJMER/ISSN.2454-2962/2016;

0.2436 < 0.333 (not satisfied)

According to condition 2

$Q(A_m) - Q(A_1) \geq (1/ (N - 1))$ where, $\boldsymbol{m_i}$ = Initial mass and $\boldsymbol{m_f}$ =Final mass

1.0000-0 ≥ (1/ (4-1))

1>0.333 (satisfied)

So the final ranking of the supplier according to VIKOR method ombined with entropy weight based model is $S_4 > S_2 > S_3 > S_1$.