Comparative Study on Application of Utility Concept and VIKOR Method for Vendor Selection

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1. Introduction and Prior State of Art

In today's competitive manufacturing world selection of an appropriate vendor has become a great concern for various enterprises. Quality and performance appraisal of candidate vendors are indeed required to select the best one before a mass production of a new product is targeted. In most of the cases this selection procedure is based on their previous performance records which finally determine who will get the opportunity for supply contract.

Roodhooft and Konings (1996) proposed an Activity Based Costing approach for vendor selection and evaluation. This system allowed us to compute total costs caused by a supplier in a firm's production process, thereby increasing the objectivity in the selection process. The authors showed that for vendor evaluation purposes the difference between the budgeted and actual total vendor score can be decomposed in a purchaser effect, a supplier effect and a combined effect. An Activity Based Costing approach with a case study was illustrated in this paper. Charles et al. (1998) described three approaches for the selection and negotiation with vendors who were not selected. Furthermore, it described how in certain situations two multi-criteria analysis tools, multi-objective programming and data envelopment analysis, could be used together for this selection and negotiation process. The author described non-cooperative vendor negotiation strategies where the selection of one vendor results in another being left out of the solution. Ding et al. (2003) presented a simulation-optimization approach using genetic algorithm to the supplier selection problem. The problem consists in selecting a portfolio of suppliers from a set of pre-selected candidates. The proposed approach used discrete-event simulation for performance evaluation of a supplier portfolio and a genetic algorithm for optimum portfolio identification based on performance indices estimated by the simulation. Numerical results on a real-life case study were presented. Chih-Hung Tsai et al. (2003) applied the Grey relational analysis in the Grey theory (Deng, 1982) to establish a complete and accurate evaluation model for selecting vendors. This methodology significantly reduced the purchasing cost and increased the production efficiency and overall competitiveness. Kumar et al. (2004) applied a fuzzy goal programming approach for solving the vendor selection problem with multiple objectives, in which some of the parameters are fuzzy in nature. A vendor selection problem was formulated as a fuzzy mixed integer goal programming vendor selection problem that includes three primary goals: minimizing the net cost, minimizing the net rejections, and minimizing the net late deliveries subject to realistic constraints regarding buyer's demand, vendors' capacity, vendors' quota flexibility, purchase value of items, budget allocation to individual vendor, etc. Heung-Suk Hwang et al. (2005) proposed a supplier selection analysis model considering both by AHP method and integration method of analysis results. The proposed first analysis model using AHP which was a three-step decision analysis model which converts the qualitative factors of suppliers transferred into the quantitative measure reliability. Then, the integration model integrates the results of multi-analysis and selects the best supplier. The authors also developed a computer program for both the AHP model and for integration model. Bayazita and Karpakb (2005) reported that supplier selection is one of the most crucial activities performed by the organizations because of its strategic importance. A supplier selection problem is a multi-objective problem involving both quantitative and qualitative criteria. Over the years a number of quantitative approaches have been applied to supplier selection problems. Although the Analytic Hierarchy Process (AHP) has previously been implemented in supplier selection problems, in this paper for the first time a comprehensive application of AHP for a real-world case is presented along with sensitivity analysis to choose the best supplier. We proposed an AHP model to choose the best supplier and place the order quantities among them for a construction company. Sonmez (2006) reported the findings of a wide ranging literature review of supplier selection practices and models. Chen and Chen

(2006) applied the process incapability index to develop an evaluation model that assesses the quality performance of suppliers. The model simplifies the evaluation of suppliers, facilitates their effective selection, and provides insights into the process situation of suppliers who may enter into a long-term partnership with a company. Kubat and Yuce (2006) suggested integrating Analytic Hierarchy Process (AHP), Fuzzy AHP and Genetic Algorithm (GA) to determine best suppliers. Fuzzy set was utilized linguistic factor to organize criteria and sub criteria weight, with pair wise compare with fuzzy AHP; it was recommended to be utilized to organize all factors and which assigned weighting for related factor. Finally, a hypothetical supplier selection problem was solved by proposed (GA) algorithm. Xiao et al. (2006) proposed a new approach for online supplier selection, based on state of the art literature and existing industry practices. One important aspect of developing collaborations was to locate and select suitable partners, especially for OEMs (Original Equipment Manufacturers) who often need to initiate collaborations with their suppliers. This resulted in a desire for effective and efficient supplier selection. With the development of information technologies, especially internet technologies, OEMs could now source and select suppliers on the internet, on an international scale. Chandra Mouli KVV et al. (2006) proposed a methodology for selection of vendors and quantities to be ordered based on transportation cost criteria. Particle swarm optimization (PSO) technique was used in constrained handling to arrive an optimal solution. A case study of an automobile components manufacturing company was presented to illustrate the methodology. Gencer and Gürpinar (2007) considered supplier selection as a multi criteria decision problem. A model aiming the usage of analytic network process (ANP) in supplier selection was developed owning to the evaluation of the relations between supplier selection criteria in a feedback systematic in an electronic company. Tahriri et al. (2008) highlighted different selection methods concerning supplier selection. The advantages and disadvantages of selection methods, especially the Analytic Hierarchy Process (AHP) were illustrated and compared in their work. Ketata et al. (2008) proposed a new approach based on the integration of the fuzzy logic with the classical multi-criteria methods on the one hand and taking into account the concept of supplier reliability for resolving a supplier selection and evaluation problem on the other hand. The first approach called “Method with Constraints” (MC) consists of combination of the “Fuzzy Analytical Hierarchy Process” (FAHP) with the “Goal Programming” (GP) methods. This method reflects the idea of supplier reliability and at the same time the quantitative and qualitative factors. Considering the fuzzy constraints, the authors proposed the second approach called “Method with Fuzzy Constraint” (MCF) which consists of combination of the FAHP with the “Fuzzy Goal Programming” (FGP) methods. Omid Jadidi et al. (2008) proposed a method based on TOPSIS concepts in grey theory to deal with the problem of selecting suppliers. The method calculates the weighted connection between each of the alternatives sequence and the positive and negative referential sequence to compare the ranking of grey numbers and select the most desirable supplier. The authors demonstrated that the method was a good means of evaluation, and it was also more optimal than the two methods. Taghavifard and Mirheydari (2008) suggested an algorithm for the evaluation and selection of suppliers. At the beginning, all the needed materials and services used by the organization were identified and categorized with regard to their nature by ABC method. Afterwards, in order to reduce risk factors and maximize the organization's profit, purchase strategies were determined. Then, appropriate criteria were identified for primary evaluation of suppliers applying to the organization. The output of this stage was a list of suppliers qualified by the organization to participate in its tenders. Subsequently, considering a material in particular, appropriate criteria on the ordering of the mentioned material were determined, taking into account the particular materials' specifications as well as the organization's needs. Finally, for the purpose of validation and verification of the proposed model, it was applied to Mobarakeh Steel Company (MSC), the qualified suppliers of this Company are ranked by the means of a Hierarchical Fuzzy TOPSIS method. The obtained results show that the proposed algorithm is quite effective, efficient and easy to apply.

Many of the methodologies reported in literature rely on subjective or qualitative data based on human judgment which may prone to be incorrect. In this evaluation process, both quantitative and qualitative performance parameters are converted into numeric score using some appropriate scale (Likert Scale). The numeric scores of each criteria multiplied by individual priority weight are added together to compute an overall performance index. However, his method doesn’t consider exact values of quantitative performance indices; which may lead to misleading result. To overcome this shortcoming, in the present reporting two Multi-Criteria Decision Making (MCDM) approaches have been used to utilize exact numeric values of quantitative parameters as well as scaled numeric scores of qualitative performance parameters. Utility concept and VIKOR method have been highlighted to solve this problem. The results thereof obtained have also been compared. Moreover, comparison has been made on efficiency of the aforesaid methods with that of existing grey relation analysis available in literature for vendor evaluation.

2. Utility Concept

A candidate vendor is generally evaluated on the basis of certain quality attributes, may be conflicting in nature. Therefore, a combined measure is required to estimate its overall performance, which must take into account the relative contribution of individual quality characteristics. In this work, a methodology based on utility concept has been applied for selecting the appropriate vendor.

Utility can be defined as the usefulness of a product or a process in reference to the levels of expectations to the consumers, [Kumar, P. (2000)]. The overall usefulness of a process/product can be represented by a unified index termed as utility which is the summation of the individual utilities of various quality characteristics. The methodological basis for utility approach is to transform the estimated response of each quality characteristic into a common index, [Walia et al. (2006)].

If X_i is the measure of effectiveness of an attribute (or quality characteristics) i and there are n attributes evaluating the outcome space, then the joint utility function can be expressed as:

$$U\left(X_1, X_2, \ldots\ldots\ldots\ldots\ldots\ldots, X_n\right) = f\left(U_1\left(X_1\right).U_2\left(X_2\right)\ldots\ldots\ldots\ldots\ldots\ldots U_n\left(X_n\right)\right) \tag{1}$$

Here $U_i\left(X_i\right)$ is the utility of the i_{th} attribute.

The overall utility function is the sum of individual utilities if the attributes are independent, and is given as follows:

$$U\left(X_1, X_2, \ldots\ldots\ldots\ldots\ldots\ldots, X_n\right) = \sum_{i=1}^{n} U_i\left(X_i\right) \tag{2}$$

The attributes may be assigned weights depending upon the relative importance or priorities of the characteristics. The overall utility function after assigning weights to the attributes can be expressed as:

$$U\left(X_1, X_2, \ldots\ldots\ldots\ldots\ldots\ldots, X_n\right) = \sum_{i=1}^{n} W_i.U_i\left(X_i\right) \tag{3}$$

Here W_i is the weight assigned to the attribute i. The sum of the weights for all the attributes must be equal to 1.

A preference scale for each quality characteristic is constructed for determining its utility value. Two arbitrary numerical values (preference number) 0 and 9 are assigned to the just acceptable and the best value of the quality characteristic respectively. The preference number P_i can be expressed on a logarithmic scale as follows:

$$P_i = A \times \log\left(\frac{X_i}{X_i^{'}}\right) \tag{4}$$

Here X_i is the value of any quality characteristic or attribute i , $X_i^{'}$ is just acceptable value of quality characteristic or attribute i and A is a constant. The value A can be found by the condition that if $X_i = X^*$ (where X^* is the optimal or best value), then $P_i = 9$.

Therefore,

$$A = \frac{9}{\log \frac{X^*}{X_i^{'}}} \tag{5}$$

The overall utility can be expressed as follows:

$$U = \sum_{i=1}^{n} W_i.P_i \tag{6}$$

Subject to the condition: $\sum_{i=1}^{n} W_i = 1$ (7)

Among various quality characteristics types, viz. Lower-the-Better, Higher-the-Better, and Nominal-the-Best, the utility function would be Higher-the-Better type. Therefore, if the quality function is maximized, the quality characteristics considered for its evaluation will automatically be optimized (maximized or minimized as the case may be).

Application of utility concept has been found in literature in optimizing multiple quality characteristics of a process or product. In this case individual responses are converted into corresponding utility values. These have been accumulated further to compute overall utility index. The overall utility index serves as the representative of multiple objective functions which has been maximized (optimized) finally.

As vendor selection is nothing but a Multi-Criteria Decision Making (MCDM) problem; it is, therefore, felt that utility concept can be applied fruitfully to convert multiple quality and performance attributes into an equivalent single quality index which would be helpful for comparison of a group of vendors and to select the best one amongst the group.

3. VIKOR Method

The MCDM method is very popular technique widely applied for determining the best solution among several alternatives having multiple attributes or alternatives. A MCDM problem can be represented by a decision matrix as follows:

$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ . \\ . \\ . \\ . \\ A_m \end{array} \begin{bmatrix} \underline{Cx_1} & \underline{Cx_2} & . & . & . & . & \underline{Cx_n} \\ x_{11} & x_{12} & . & . & . & . & x_{1n} \\ x_{21} & x_{22} & . & . & . & . & x_{2n} \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ x_{m1} & x_{m2} & . & . & . & . & x_{mn} \end{bmatrix} \quad (8)$$

Here, A_i represents ith alternative, $i = 1, 2, ..., m$; Cx_j represents the jth criterion, $j = 1, 2, ..., n$; and x_{ij} is the individual performance of an alternative. The procedures for evaluating the best solution to an MCDM problem include computing the utilities of alternatives and ranking these alternatives. The alternative solution with the highest utility is considered to be the optimal solution. The following steps are involved in VIKOR method [Opricovic, S. and Tzeng, G.-H., 2007]:

Step 1: Representation of Normalized Decision Matrix

The normalized decision matrix can be expressed as follows:

$$F = \left[f_{ij} \right]_{m \times n} \quad (9)$$

Here, $f_{ij} = \dfrac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$, $i = 1, 2, ..., m;$ and x_{ij} is the performance of alternative A_i with respect to the jth criterion.

Step 2: Determination of Ideal and Negative-Ideal Solutions:

The ideal solution A^* and the negative ideal solution A^- are determined as follows:

$$A^* = \left\{ (\max f_{ij} \,|\, j \in J)\, or\, (\min f_{ij} \,|\, j \in J'), i = 1, 2, ..., m \right\} = \left\{ f_1^*, f_2^*, ... f_j^*, ... f_n^* \right\} \quad (10)$$

$$A^- = \left\{ (\min f_{ij} \,|\, j \in J)\, or\, (\max f_{ij} \,|\, j \in J'), i = 1, 2, ..., m \right\} = \left\{ f_1^-, f_2^-, ... f_j^-, ... f_n^- \right\} \quad (11)$$

where, $J = \left\{ j = 1, 2, ..., n \middle| f_{ij}, if \ desired\ response\ is\ l\arg e \right\}$

$$J' = \left\{ j = 1, 2, ..., n \middle| f_{ij}, if \ desired\ response\ is\ small \right\}$$

Step 3: Calculation of Utility Measure and Regret Measure

The utility measure and the regret measure for each alternative are given as

$$S_i = \sum_{j=1}^{n} w_j \frac{\left(f_j^* - f_{ij} \right)}{\left(f_j^* - f_j^- \right)} \quad (12)$$

$$R_i = \underset{j}{Max} \left[w_j \frac{\left(f_j^* - f_{ij} \right)}{\left(f_j^* - f_j^- \right)} \right] \quad (13)$$

where, S_i and R_i, represent the utility measure and the regret measure, respectively, and w_j is the weight of the jth criterion.

Step 4: Computation of VIKOR Index

The VIKOR index can be expressed as follows:

$$Q_i = \upsilon \left[\frac{S_i - S^*}{S^- - S^*} \right] + (1 - \upsilon) \left[\frac{R_i - R^*}{R^- - R^*} \right] \tag{14}$$

where, Q_i , represents the ith alternative VIKOR value, $i = 1, 2, ..., m$; $S^* = \underset{i}{Min}(S_i)$; $S^- = \underset{i}{Max}(S_i)$; $R^* = \underset{i}{Min}(R_i)$; $R^- = \underset{i}{Max}(R_i)$ and υ is the weight of the maximum group utility (usually it is to be set to 0.5). The alternative having smallest VIKOR value is determined to be the best solution.

4. Procedure Adopted in VIKOR Method for MCDM

Step 1: Estimation of quality loss

Taguchi defined quality loss estimates for responses using Lower-the-better (LB) and Higher-the-better (HB) criterion are given bellow.

(a) For a lower-the-better (LB) attribute:

$$L_{ij} = k_1 \times \frac{1}{r} \sum_{k=1}^{r} y_{ijk}^2 \tag{15}$$

(b) For a lower-the-better (LB) attribute:

$$L_{ij} = k_2 \times \frac{1}{r} \sum_{k=1}^{r} \frac{1}{y_{ijk}^2} \tag{16}$$

Here, L_{ij} is the quality loss associated with the jth attribute in the ith experimental run; y_{ijk} is the observed kth repetition datum for the jth attribute in the ith experimental run; r is the number of repetitions for each experimental run. k_1, k_2 are quality loss coefficients, $i = 1, 2, ..., m$; $j = 1, 2, ..., n$; $k = 1, 2, ..., r$.

Step 2: Calculation of normalized quality loss (NQL) for individual attributes in each experimental run. The NQL can be obtained as follows:

$$f_{ij} = \frac{L_{ij}}{\sqrt{\sum_{i=1}^{m} L_{ij}^2}}, \; i = 1, 2, ..., m; \; j = 1, 2, ..., n. \tag{17}$$

Here f_{ij} represents the NQL of the jth attribute in the ith experimental run.

Step 3: Evaluation of ideal and negative-ideal solutions.

A smaller NQL is preferred, so the ideal and negative-ideal solutions which represent the minimum and maximum NQL of all experimental runs are as follows:

$$A^* = \left\{ \min f_{ij} \middle| i = 1, 2, ..., m \right\} = \left\{ f_1^*, f_2^*, ..., f_j^*, ..., f_n^* \right\} \tag{18}$$

$$A^- = \left\{ \max f_{ij} \middle| i = 1, 2, ..., m \right\} = \left\{ f_1^-, f_2^-, ..., f_j^-, ..., f_n^- \right\} \tag{19}$$

Step 4: Calculation of the utility and regret measures for each response in each experimental run using equation (5) and (6) respectively.

Step 5: Calculation of VIKOR index of the ith experimental run. Substituting S_i and R_i into equation (7) yields the VIKOR index of the ith experimental run as follows. A smaller VIKOR index produces better multi-response performance.

Step 6: Determination of optimal parametric combination

The multi-attribute quality scores for each alternative can be determined from the VIKOR index obtained in step 5. The best one is finally determined, in view of the fact that a smaller VIKOR value indicates a better quality.

5. Data Analysis

Since the evaluation factors are much dependent on the enterprise environment, the top management of the enterprise may invite the members of the department of purchasing, production control and quality control to sit together and decide the appropriate evaluation factors and measurement parameter for vendor evaluation.

Traditionally, quality, price, delivery date, quantity and services are chosen to be typical evaluation factors. The measured for this five evaluation factors are shown in Table 1. Regarding the services of evaluation factors the corresponding measured parameter are determined by (a) Operated as better methods for better methods for defects elimination and active involvement of vendors with customers (b) Delivery speed (c) Service Condition. A qualitative given by a review committee, then convert this qualitative ranking scale of 1 to 5 (Larger-the-Better). It is assumed that five vendors are able to supply certain raw materials. The delivery record is rearrange by purchasing staff as shown in Table 2. Using the data from Table 2 an evaluation matrix can be formed. It is noted that evaluation factors factor are indicated in attribute column each vendor is comparative series [Chih-Hung Tsai et al. (2003)].

Table 1 Evaluation Factors and Measure Parameters for Vendor Selection

Measure Vendors	**Quality**	**Price**	**Delivery date**	**Quantity**	**Services**
Measure parameters	Defects	Quotation	Delay rate	Shortage rate	Score
Quantify criteria	$\frac{rejects}{gross\ \ no.of\ \ batches}$	Unit price	$\frac{no.of\ \ delays}{gross\ \ no.of\ \ ship}$	$\frac{no.of\ \ short}{gross\ \ no.of\ \ ship}$	Five classification levels

Table 2 Measurement Value for Each Evaluation Attribute (Delivery Data for a Period of Two Years)

Measure Vendors	**Quality (Defects)**	**Price (unit price)**	**Delivery date (Delay rate)**	**Quantity (Shortage rate)**	**Services (Score)**
A	0.15	12	0.15	0.05	2
B	0.22	10	0.25	0.08	4
C	0.15	8	0.15	0.05	5
D	0.08	13	0.30	0.15	4
E	0.12	9	0.05	0.20	3

Results of Utility Concept

The utility functions chosen in the present study are as follows: for defects, unit price, delay date and shortage rate LB (Lower-the-Better) criteria and for services score HB (Higher-the-Better) criteria have been selected. Therefore, while selecting utility function; for defects, unit price, delay date and shortage rate (corresponding to LB criteria) their maximum observed value (from Table 2) has been considered as just acceptable value; whereas minimum observed value has been treated as the best (desired) value. In case of services score (corresponding to HB criteria) their minimum observed value (from Table 2) has been considered as just acceptable value; whereas maximum observed value has been treated as the most expected value. The main advantage of using utility concept is to combine multiple objectives (criteria attribute) into a single quality index (overall utility degree) which facilitates the MCDM problem easy to solve.

Table 3 Utility Values of Individual Attributes

Measure Vendors	**Individual Utility Indices**				
	Quality	**Price**	**Delivery date**	**Quantity**	**Services**
A	1.0222	0.2968	0.5223	1.3500	0.0000
B	0.0000	0.9727	0.1374	0.8923	1.3616
C	1.0222	1.8000	0.5223	1.3500	1.8000
D	2.7000	0.0000	0.0000	0.2802	1.3616
E	1.6178	1.3633	1.3500	0.0000	0.7965

Vendors performance data related to Table 2 have been explored to calculate utility values of individual quality attributes by using Equations (4-5). These individual utility measures have been furnished in Table 3. The overall utility index has been computed using Equation (6-7); tabulated in Table 4. In this computation priority weightage of individual quality features are assumed as indicated in the study of Chih-Hung Tsai et al. (2003). From Table 4 the individual candidate vendors can be ranked according to their overall utility degree.

Table 4 Overall Utility Indexes

Vendors	**Overall Utility Index**	**Ranking**	**Ranking [Tsai et al. (2003)]**
A	3.1912	5	4
B	3.3640	4	5

C	6.4945	1	1
D	4.3418	3	3
E	5.1276	2	2

Results of VIKOR method

Quality loss estimates for individual attributes have been calculated using equations (15 and 16). For defects, unit price, delay date and shortage rate LB (Lower-the-Better) criteria and for services score HB (Higher-the-Better) criteria have been selected. Normalized quality loss estimates (NQL) have been determined using equation (17) and shown in Table 5. Table 6 represents utility measure of individual attributes (criterion). Individual attribute weights have been used as 0.30, 0.20, 0.15, 0.15 and 0.20 respectively [Chih-Hung Tsai et al. (2003)]. Utility and regret measure for each alternative have been tabulated in Table 7. VIKOR INDEX of each alternative (candidate vendor) has been presented in Table 8. The appropriate alternative indicates smallest VIKOR INDEX. From Table 8 the individual candidate vendors can be ranked according to their VIKOR INDEX.

Table 5 Normalized Quality Loss Estimates (NQL)

Vendors	Quality	Price	Delivery date	Quantity	Services
A	0.3748	0.5444	0.1971	0.0538	0.8613
B	0.8063	0.3781	0.5476	0.1377	0.2153
C	0.3748	0.2420	0.1971	0.0538	0.1378
D	0.1066	0.6390	0.7886	0.4842	0.2153
E	0.2399	0.3063	0.0219	0.8607	0.3828

The ideal and negative-ideal solutions which represent the minimum and maximum NQL of all alternatives are as follows:

$$A^* = \left\{\min f_{ij} \middle| i = 1,2,3,4,5\right\} = \left\{f_1^*, f_2^*, f_3^*, f_4^*, f_5^*\right\} = \{0.1066, 0.2420, 0.0219, 0.0538, 0.1378\}$$

$$A^- = \left\{\max f_{ij} \middle| i = 1,2,3,4,5\right\} = \left\{f_1^-, f_2^-, f_3^-, f_4^-, f_5^-\right\} = \{0.8083, 0.6390, 0.7886, 0.8607, 0.8613\}$$

Table 6 Utility Measures of Individual Criteria Attribute

Vendors	Quality	Price	Delivery date	Quantity	Services
A	0.1147	0.1524	0.0343	0.0000	0.2000
B	0.2991	0.0686	0.1029	0.0156	0.0214
C	0.1147	0.0000	0.0343	0.0000	0.0000
D	0.0000	0.2000	0.1500	0.0800	0.0214
E	0.0570	0.0324	0.0000	0.1500	0.0677

Table 7 Utility Measures (S_i) and Regret Measures (R_i) of Individual Alternatives

Vendors	S_i	R_i
A	0.5013	0.2000
B	0.5076	0.2991
C	0.1489	0.1147
D	0.4514	0.2000
E	0.3071	0.1500

Table 8 VIKOR Index of Individual Alternatives

Vendors	VIKOR Index	Ranking	Ranking [Tsai et al. (2003)]
A	0.7225	4	4
B	1.0000	5	5
C	0.0000	1	1
D	0.6530	3	3
E	0.3162	2	2

6. Conclusions

In the present study, application feasibility of two MCDM approaches: utility concept and VIKOR method has been highlighted to solve multi-criteria decision making problems through a case study of vendor selection. The result thereof has been compared to that of grey relation technique. The results of aforesaid techniques are very much compatible to one another. The prediction (vendor ranking) of grey relation theory exactly matches with that of VIKOR method. However, the result of utility concept slightly differs with that of rest of the techniques. But when one is more concerned with selecting the most efficient vendor other than ranking of a group of vendors all the techniques provide reliable means for selecting the best one amongst the group. Moreover, it has been found the utility theory is quite straight forward and free from computational complexity compared to grey relation theory as well as VIKOR method. The study demonstrates the effectiveness of the said MCDM techniques in solving such a vendor selection problem.

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