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Supplier Classification Using UTADIS Method Based on Performance Criteria

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Abstract

Supplier selection process has gained importance recently, since the cost of raw materials and component parts constitutes the main cost of a product and most of the firms have to spend considerable amount of their revenues on purchasing. Although many methods have been proposed and used for supplier evaluation and selection, most of them try to rank the suppliers from the best to the worst or to choose the best supplier among others. This study focuses on supplier evaluation and selection from the point of a new perspective based on UTADIS. In this paper, auther presents a UTADIS model for suppliers'classification based on performance criterias in SAPCO company. Auther uses the information about suppliers'performance score along all criteria in SAPCO company, for categorizing the suppliers into three groups A, B and C via calculating marginal and global utilities function.

Keyword*s*: Global Utility, Marginal Utility, Suppliers Classification, UTADIS Model and Utility Thresholds.

1. Introduction

Global competition means that companies must integrate with upstream and downstream supply chain partners efficiently to increase market opportunities and competitiveness and to adapt to rapid changes in market trends and customer demands. To satisfy customer demand and to lower internal cost and risk, companies select appropriate suppliers to make more competitive products and distribute these products to customers. Therefore, in these situations the managers have been forced for focusing on purchasing decision (che 2012).

As organisations become more dependent on suppliers, the direct and indirect consequences of poor decision making become more severe (De boer et al, 2001). There are six major purchasing decision processes: (1) make or buy, (2) supplier selection, (3) contract negotiation, (4) design collaboration, (5) procurement, and (6) sourcing analysis.
The purchasing function plays important role in the strategic success of the firm through the supplier selection process (Ellram and carr, 1994).
In most industries the cost of raw materials and component parts constitutes the main cost of a product, such that in some cases it can account for up to 70% . In high technology firms, purchased materials and services represent up to 80% of total product cost. Thus the purchasing department can play a key role in an organization's efficiency and effectiveness since the department has a direct effect on cost reduction, profitability and flexibility of a company (Kilincci and Onal, 2011; Aksoy and Ozturk, 2011).
Generally in the process of supplier evaluation and selection, firms are ranked by grading with respect to various criteria, classified and best suited one/s is chosen. As a result of this classification, for example with a high classified firm a long term, less controlled, trust based commercial relationship can be established or vice versa. Consequently, managing supplier categorization has become momentous in terms of profitability, productivity and success in achieving time targets.
Although many methods have been proposed and used for supplier evaluation and selection, most of them try to rank the suppliers from the best to the worst or to choose the best supplier among others. This study focuses on supplier evaluation and selection from the point of a new perspective based on UTADIS.
The rest of the paper is organized as follows. Section 2 reviews literature in supplier evaluation and selection. In section 3 explains our framework for supplier classification. The results of framework implementation in SAPCO company are provided in section 4. Finally, section 5 points out some conclusions and provides guidelines for initiating future researches.

2. Litrature Review

Supplier selection (SS) has received considerable attention for its significant effect toward successful Logistic and supply chain management (LSCM). At least seven valuable academic surveys had well reviewed the literature on SS : Weber et al., 1991; Degraeve et al., 2000; De Boer et al., 2001; Khurrum and Bhutta, 2003; Aissaoui et al., 2007; Ho et al., 2010; Chai et al., 2013.
As reported by De Boer et al., several decision-making steps make up the vendor selection process, ranging from (1) Problem definition (2) Formulation of criteria (3) pre-qualifying suitable suppliers to (4) making a final choice.

2.1. Problem Definition: Due to shortened product life cycles, the search for new suppliers is a continuous priority for companies in order to upgrade the variety and typology of their products range. Decision makers are facing different purchasing situations that lead to different decisions. Consequently, in order to make the right choice, the purchasing process should start with finding out exactly what we want to achieve by selecting a supplier.

2.2. Formulation Of Criteria: Depending on the purchasing situation, selecting the right suppliers is influenced by a variety of factors. The analysis of this aspect has been the focus of multiple papers since the 1960's. Cardozo and Cagley (1971), Monczka et al. (1981), Chapman and Carter (1990), Tullous and Munson (1991) propose diverse empirical researches emphasizing the relative importance of different supplier attributes.

Ho et al. (2010) discovered the most popular criterion considered by the decision makers for evaluating and selecting the most appropriate supplier based on 78 journal articles collected from 2000 to 2008 . The most popular criterion is quality (68 papers or 87.18%), The second most popular criterion is delivery (64 papers or 82.05%) and The third most popular criterion is price/cost (63 papers or 80.77%).

Liao and Kao (2011) analyzed criteria that had been employed to evaluate and select supplier Since 1966. most of the articles suggest that quality, price, and delivery performance are the most important supplier selection criteria.

2.3. Pre-Qualification Of Supplier: pre-qualification is the process of reducing the set of all suppliers to a smaller set of acceptable suppliers. pre-qualification is sorting process rather than a ranking process (De Boer et al., 2001; Aissaoui et al., 2007). In the survey proposed by De Boer (2001), four different decision methods are mentioned for pre-qualification of potential suppliers

1. Categorical methods
2. Data Envelopment Analysis (DEA)
3. Case-Based-Reasoning (CBR) systems
4. Cluster Analysis (CA)

Categorical Methods: Basically, categorical methods are qualitative models. Based on historical data and the buyer's experience current or familiar suppliers are evaluated on a set of criteria. Timmerman (1986) proposed a categorical method to sort suppliers into three classes by considering historical data (De Boer et al., 2001).

Data Envelopment Analysis (DEA): Another method that aids decision makers in classifying the suppliers into a group of efficient suppliers and a group of inefficient ones is the DEA (Aissaoui et al., 2007). DEA is a mathematical programming technique that calculates the relative efficiencies of multiple decision-making units (Sen et al., 2008).

For example: Narasimhan et al. (2001) applied DEA model to evaluate alternative suppliers for a multinational corporation in the telecommunications industry.

Garfamy (2006) applied DEA to measure the overall performances of suppliers based on total cost of ownership concept.

Case-Based-Reasoning (CBR) Systems: CBR systems fall in the category of the so-called artificial intelligence (AI) approach. Basically, a CBR system is a software-driven database which provides a decision-maker with useful information and experiences from similar, previous decision situations (Aamodt and Plaza, 1994).

Choy and Lee (2002) presented a generic model using the CBR technique for supplier selection. The model was implemented in a consumer products manufacturing company, which had stored the performance of past suppliers and their attributes in a database system.

Faez et al. (2009) applied fuzzy CBR to evaluate suppliers. Having applied fuzzy set theory in the proposed model, the vague nature of some selection criteria has been incorporated by utilizing the linear membership function of fuzzy type to quantify the vagueness in decision parameters.

Cluster Analysis (CA): Unlike classification and prediction, which analyze class-labeled data objects, Clustering analyzes data objects without consulting a known class label. The objects are clustered or grouped based on the principle of maximizing the intraclass similarity and minimizing the interclass similarity (Han et al., 2012).

Bottani and Rizzi (2008) applied CA and AHP to cluster, assess and rank viable suppliers.
Mehdizade (2009) present a new approach for a particle swarm optimization (PSO) algorithm to clustering suppliers under fuzzy environments into manageable smaller groups with similar characteristics.
Azadnia et al. (2011) proposed an integrated approach of clustering and multi criteria decision making methods in order to solve sustainable supplier selection problem.

2.4. Final Selection: at this stage, the ultimate supplier(s) are identified and orders are allocated among them while considering the system's constraints and taking into account a multitude of quantitative and/or qualitative criteria (Aissaoui et al., 2007). Chai et al. (2013) provided a systematic literature review on articles published from 2008 to 2012 on the application of DM techniques for supplier selection. 26 DM techniques are identified from three perspectives:
(1) Multi-Criteria Decision Making (MCDM) techniques
(2) Mathematical Programming (MP) techniques
(3) Artificial Intelligence (AI) techniques
MCDM: MCDM is a methodological framework that aims to provide decision makers a knowledgeable recommendation amid a finite set of while being evaluated from multiple viewpoints, called criteria. we can classify them into four categories: (1) multiattribute utility methods such as AHP and ANP, (2) outranking methods such ELECTRE and PROMETHEE; (3) compromise methods such as TOPSIS and VIKOR, and (4) other MCDM techniques such as SMART and DEMATEL. For example: levary (2008) applied AHP for evaluating and ranking of potential suppliers. Lin (2012) integrated FANP with FMOLP in selecting the best suppliers for achieving optimal order allocation under fuzzy conditions.
Sevkli (2010) extended ELECTRE for SS when triangular fuzzy values provided the decision information. Chen et al. (2011) integrated PROMETHEE with the extended fuzzy concept and studied a case of information system (IS) outsourcing under triangular fuzzy environments.
Chen and Wang (2009) provided a fuzzy VIKOR for the application of IS/ IT outsourcing projects.
Chou and Chang (2008) proposed a fuzzy integrated SMART decision model for a strategy-aligned SS.
Buyukozkan and Cifci (2012) used DEMATELas well as the strength of the interdependence to generate the mutual relationships of interdependencies among criteria. Dalalah, Hayajneh, and Batieha (2011) modified DEMATEL to deal with fuzzy rating and evaluations by converting the relationship between the causes and effects of the criteria into an intelligible structural model.
MP Techniques: MP is a general term in DM research. For selections applications, They specify the following six MP techniques: Data Envelopment Analysis (DEA), Linear Programming (LP), Nonlinear Programming (NLP), Multiobjective Programming (MOP), Goal Programming (GP), Stochastic Programming (SP).
Saen (2010) proposed effective DEA-based decision models to handle imprecise data in the SS process by considering such undesirable outputs as the uncertainty factor.
Kenan et al. (2013) presented an integrated approach, of fuzzy multi attribute utility theory and multi-objective programming, for rating and selecting the best green suppliers according to economic and environmental criteria and then allocating the optimum order quantities among them.

Hsu et al. (2010) used fuzzy quality data for supplier selection and applied Non-Linear Programming for ranking suppliers.

Yu et al. (2012) applied fuzzy multi-objective planning for vendor selection.

Kull and Talluri (2008) provided an evaluation model that integrated AHP with GP for selecting suppliers. This model was applied to a case on product life cycle.

AI Techniques: Several AI techniques have been used in supplier selection such as: Genetic Algorithm(GA), Neural Network (NN), Rough Set Theory (RST), Grey System Theory (GST), Case Based Reasoning (CBR), Ant Colony Algorithm (ACA), …

Yeh and Chung (2011) developed an optimum mathematical planning model for green partner selection, which involved four objectives such as cost, time, product quality and green appraisal score.

Tseng et al. (2011) applied GST and fuzzy set theory for ranking suppliers by considering green supply chain management criterion.

Tsai, Yang, and Lin (2010) aimed to utilize an attribute-based ant colony system for supplier evaluation.

3) Evaluation Method

In this section, some essentials of the UTADIS are briefly described as follows:

Utilites Additives Discriminates Method (Utadis)

UTADIS is one of the MCDA classification methods. UTADIS combines a utility function–based framework with the preference disaggregation paradigm.The problems addressed by UTADIS involve the sorting of the alternatives into *q* predefined groups defined in an ordinal way:

$c_1 > c_2 > \cdots > c_q$

where C_1denotes the group consisting of the most preferred alternatives and C_q denotes the group of the least preferred alternatives. the objective of the UTADIS method is to develop a criteria aggregation model used to determine the classification of the alternatives and it represents the overall performance of each alternative along all criteria. Formally, the criteria aggregation model is expressed as an additive utility function:

$$U(g) = \sum_{i=1}^{n} p_i u_i(g_i) \qquad \text{Eq. (3.1)}$$

Where:

$g = (g_1, g_2, \dots, g_n)$ is the vector of the evaluation criteria.

p_i is a scaling constant indicating the significance of criterion.

$u_i(g_i)$ is the marginal utility function of criterion.

The global utility of an alternative specified through eq. (3.1) represents a measure of the overall performance of the alternative considering its performance on all criteria. The global utilities range in the interval [0, 1]. The classification is performed by comparing the global utility of each alternative with a cut–off point defined on the utility scale between 0 and 1. Alternatives with global utilities higher than the utility cut–off point are assigned into group C_1 whereas alternatives with global utilities lower than the cut–off point are assigned into group C_2.

General Framework

The objective of the UTADIS method is to develop a criteria aggregation model and a set of utility thresholds that minimize the classification error rate. The error rate refers to the differences between the estimated classification defined through the developed model $\hat{C}$ and the pre–specified classification C for the alternatives of the reference set.

Essentially, σ_j represents the magnitude of the classification error for alternative X_j. The error σ_j^+ indicates that to classify correctly a misclassified alternative X_j that actually belongs into

group C_k ,its global utility should be increased by $u_k - U(g_i)$ Similarly, the errors σ_j^- indicates that to classify correctly a misclassified alternative X_j that actually belongs into C_k,
its global utility should be decreased by $U(g_i) - u_{k-1}$. So the classification rule rewrites in the form of the following constraints:

$$U(g_i) + \sigma_j^+ \geq u_1 \quad , \quad \forall X_j \in C_1$$

$$\left.\begin{array}{l} U(g_i) + \sigma_j^+ \geq u_k \\ U(g_i) - \sigma_j^- < u_{k-1} \\ U(g_i) - \sigma_j^- < u_{q-1} \end{array}\right\} \quad \forall X_j \in C_k \, (k = 2,3,..,q-1)$$

These constraints constitute the basis for the formulation of a mathematical programming problem used to estimate the parameters of the additive utility classification model (utility thresholds, marginal utilities, criteria weights).
The additive utility function (3.1) has two unknown parameters to be specified: (a) the criteria weights and (b) the marginal utility functions. It leads to the formulation
of a nonlinear programming problem. To overcome this problem, the additive utility function (3.1) is rewritten in a simplified form:

$$U(g) = \sum_{i=1}^{n} \acute{u}_i(g_i) \qquad \text{Eq.(3.2)}$$

Nevertheless, the latter requires only the specification of the marginal utility functions. This is achieved through the modeling of the marginal utilities as piece–wise linear functions through a process that is graphically illustrated in Figure 3.1.

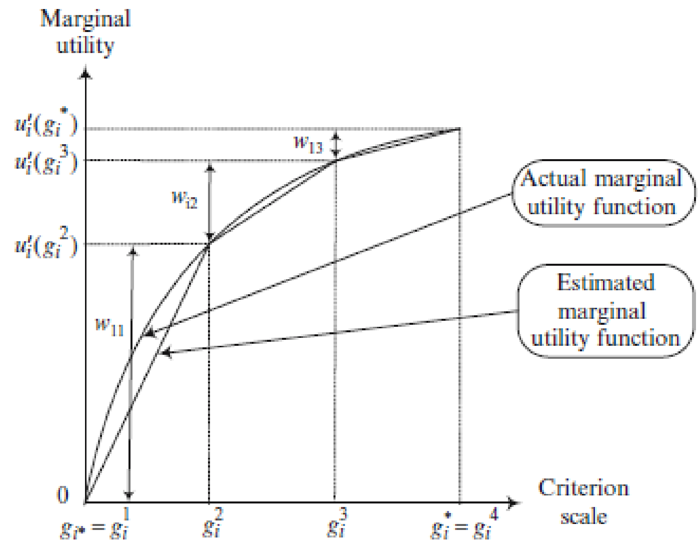

Figure 3.1. piece-wise linear form of marginal utility function

we should define $a_i - 1$ equal subintervals and estimating the marginal utilities at the break–points $g_i^2, \ldots, g_i^{a_i}$. The marginal utility at the break-point g_i^h is written as follows:

$$u'_i(g_i^h) = \sum_{t=1}^{h-1} w_{it}$$

Where w_{it} are the parameters that must be estimated in order to specify the marginal value function.

$$w_{it} = u'_i(g_i^{h+1}) - u'_i(g_i^h)$$

With this modeling, the marginal value function of any alternative X_j on the criterion g_i is expressed as follows:

$$u'_i(g_{ji}) = \sum_{t=1}^{r_{ji}-1} w_{it} + \frac{g_{ji} - g_i^{r_{ji}}}{g_i^{r_{ji}+1} - g_i^{r_{ji}}} w_{i,r_{ji}} \qquad \text{Eq.(3.3)}$$

where r_{ji} $(1 \le r_{ji} \le a_i - 1)$ denotes the subinterval $\left[g_i^{r_{ji}}, g_i^{r_{ji}+1}\right]$.The global utility of the alternative X_j is also expressed in terms of the unknown parameters w:

$$U(g_j) = \sum_{i=1}^{n}\left(\sum_{t=1}^{r_{ji}-1} w_{it} + \frac{g_{ji}-g_i^{r_{ji}}}{g_i^{r_{ji}+1}-g_i^{r_{ji}}} w_{i,r_{ji}}\right) \quad \text{Eq.(3.4)}$$

Therefore, the problem is written as the following linear programming problem: (Doumpos and Zopounidis, 2002).

$$\text{Min} \sum_{k=1}^{q}\left[\frac{\sum_{\forall x_j \in c_k}\left(\sigma_j^+ + \sigma_j^-\right)}{m_k}\right]$$

St:

$$\sum_{i=1}^{n}\left(\sum_{t=1}^{r_{ji}-1} w_{it} + \frac{g_{ji}-g_i^{r_{ji}}}{g_i^{r_{ji}+1}-g_i^{r_{ji}}} w_{i,r_{ji}}\right) - u_1 + \sigma_j^+ \ge \delta_1, \qquad \forall x_j \in c_1$$

$$\sum_{i=1}^{n}\left(\sum_{t=1}^{r_{ji}-1} w_{it} + \frac{g_{ji}-g_i^{r_{ji}}}{g_i^{r_{ji}+1}-g_i^{r_{ji}}} w_{i,r_{ji}}\right) - u_k + \sigma_j^+ \ge \delta_1, \qquad \forall x_j \in \{c_2, \dots, c_{q-1}\}$$

$$\sum_{i=1}^{n}\left(\sum_{t=1}^{r_{ji}-1} w_{it} + \frac{g_{ji}-g_i^{r_{ji}}}{g_i^{r_{ji}+1}-g_i^{r_{ji}}} w_{i,r_{ji}}\right) - u_{k-1} - \sigma_j^- \le -\delta_2, \qquad \forall x_j \in \{c_2, \dots, c_{q-1}\}$$

$$\sum_{i=1}^{n}\left(\sum_{t=1}^{r_{ji}-1} w_{it} + \frac{g_{ji}-g_i^{r_{ji}}}{g_i^{r_{ji}+1}-g_i^{r_{ji}}} w_{i,r_{ji}}\right) - u_{q-1} - \sigma_j^- \le -\delta_2, \qquad \forall x_j \in c_q$$

$$\sum_{i=1}^{n}\sum_{t=1}^{a_i-1} w_{it} = 1$$

$$u_k - u_{k+1} \ge s, \qquad 1 \le k \le q-1$$

$$\sigma_j^+, \sigma_j^- \ge 0 \qquad \forall j = 1,2,\dots,m$$

$$w_{it} \ge 0 \qquad \forall i = 1,2,\dots,n, \qquad \forall t = 1,2,\dots,a_i - 1$$

4. Empirical Study

So far as the research purpose is concerned, the current study is an example of applied research and, respecting the research methodology, it is a descriptive study. The problem is classifing suppliers and this research has been conducted in SAPCO company in Iran. For evaluating suppliers, SAPCO company categorizes it's suppliers into three groups A, B and C to managing them easier. In this paper, auther presents a model for suppliers'classification based on performance criterias. For this purpose, auther uses the information about suppliers'performance score along all criteria.

The alternatives in this model are SAPCO company' s suppliers. The reference set that is used as training sample consists of 90 suppliers that 30 suppliers pertain to category A, 30 suppliers pertain to category B and 30 suppliers pertain to category C. So in this model, alternatives categorize in three groups and we have two utility thresholds.

The criterion that have been considered in this paper are as follows:

Quality

1. Returned parts from iran khodro
2. Returned parts from isaco
3. Car's edith
4. ISO/TS certification
5. Supplier quality system
6. Proportion of confirmation

Delivery

7. Stop production line
8. Timely delivery of kanban's order

9. Preparation of ISACO needs

Price

10. Deviation from target price parts
11. Warrantly costs

Decision variables are as follows:

W_{it} : Utility of criterion i in subinterval t

σ_j^+ : Type ɪ error classification

σ_j^- : Type п error classification

U_i : Utility thresholds i

δ_1, δ_2 : Constant variables that chose a small positive value

After formation of referece set and specifying criterion, auther calculates additive and global utility function and prepares the mathematical programming model as have been said in section 3. Auther uses WINQSB software to solve the problem. Afetr solving the model, all error variables σ_j^+ , σ_j^- are zero so there will be instability in model. To overcome this problem, the post-optimality stage performed in the UTADIS method focuses on the investigation of the stability of the criteria weights.

Because we have 11 criteria and two thresholds, we should have 13 new linear programs during post-optimality stage. Finally the additive utility model used to perform the classification of the alternatives is formed from the average of all solutions obtained during the post-optimality stage and first solution obtained before post-optimality stage.

The average of all solutions obtained during the post-optimaliy stage and first UTADIS model (totally 14 models), have been summrized in the following table 4.1.

Table 4.1. value of variables W_{it} and

Value of variable W_{11}	0.0995	Value of variable W_{12}	0	Value of variable W_{13}	0
Value of variable W_{14}	0	Value of variable W_{15}	0.00069	Value of variable W_{16}	0.0038
Value of variable W_{17}	0	Value of variable W_{18}	0	Value of variable W_{19}	0
Value of variable W_{110}	0.0001	Value of variable W_{21}	0.04282	Value of variable W_{22}	0
Value of variable W_{23}	0	Value of variable W_{24}	0.00612	Value of variable W_{25}	0
Value of variable W_{26}	0	Value of variable W_{27}	0	Value of variable W_{28}	0.0190
Value of variable W_{29}	0.0047	Value of variable W_{210}	0.00366	Value of variable W_{31}	0.1367
Value of variable W_{32}	0	Value of variable W_{33}	0	Value of variable W_{34}	0
Value of variable W_{35}	0	Value of variable W_{36}	0	Value of variable W_{37}	0
Value of variable W_{38}	0	Value of variable W_{39}	0	Value of variable W_{310}	0.0079
Value of variable W_{41}	0.0076	Value of variable W_{42}	0	Value of variable W_{43}	0
Value of variable W_{44}	0	Value of variable W_{45}	0	Value of variable W_{46}	0
Value of variable W_{47}	0	Value of variable W_{48}	0	Value of variable W_{49}	0.0001
Value of variable W_{410}	0.0687	Value of variable W_{51}	0.02252	Value of variable W_{52}	0.0227
Value of variable W_{53}	0	Value of variable W_{54}	0	Value of variable W_{55}	0
Value of variable W_{56}	0	Value of variable W_{57}	0	Value of variable W_{58}	0.0019
Value of variable W_{59}	0.0033	Value of variable W_{510}	0.00051	Value of variable W_{61}	0.0343
Value of variable W_{62}	0.0341	Value of variable W_{63}	0	Value of variable W_{64}	0
Value of variable W_{65}	0	Value of variable W_{66}	0	Value of variable W_{67}	0

Value of variable w_{68}	0	Value of variable w_{69}	0	Value of variable w_{610}	0.0140
Value of variable w_{71}	0.1016	Value of variable w_{72}	0	Value of variable w_{73}	0
Value of variable w_{74}	0	Value of variable w_{75}	0	Value of variable w_{76}	0
Value of variable w_{77}	0	Value of variable w_{78}	0	Value of variable w_{79}	0
Value of variable w_{710}	0.0000	Value of variable w_{81}	0.01119	Value of variable w_{82}	0
Value of variable w_{83}	0	Value of variable w_{84}	0	Value of variable w_{85}	0.0031
Value of variable w_{86}	0.0038	Value of variable w_{87}	0.00033	Value of variable w_{88}	0.0002
Value of variable w_{89}	0.0019	Value of variable w_{810}	0.04291	Value of variable w_{91}	0.0356
Value of variable w_{92}	0.0000	Value of variable w_{93}	0	Value of variable w_{94}	0
Value of variable w_{95}	0	Value of variable w_{96}	0	Value of variable w_{97}	0
Value of variable w_{98}	0	Value of variable w_{99}	0	Value of variable w_{910}	0
Value of variable w_{101}	0.0343	Value of variable w_{102}	0	Value of variable w_{103}	0.0257
Value of variable w_{104}	0	Value of variable w_{105}	0	Value of variable w_{106}	0
Value of variable w_{107}	0	Value of variable w_{108}	0	Value of variable w_{109}	0.0703
Value of variable w_{1110}	0	Value of variable w_{111}	0.06890	Value of variable w_{112}	0
Value of variable w_{113}	0	Value of variable w_{114}	0	Value of variable w_{115}	0
Value of variable w_{116}	0	Value of variable w_{117}	0.05431	Value of variable w_{118}	0
Value of variable w_{119}	0.0008	Value of variable w_{1110}	0.00890		
Value of variable u_1	0.7365	Value of variable u_2	0.63317		

After determining the value of W_{it} and thresholds, the model classification'accuracy have been checked. For checking the accuracy of model, the global utilities of suppliers in a reference set should be calculated and compared with thresholds. Alternatives with global utilities higher than the U_1, are assigned into group A, alternatives with global utilities between U_1 and U_2 are assigned into group B and alternatives with global utilities lower than the U_2 are assigned into group C. Finally the estimated classifications defined through the developed model are compared with the prespecified classification for the alternatives of the reference set and calculated the model's accuracy.
The model wasn't able to classify correctly two suppliers among 90 suppliers in a reference set. These two suppliers pertain to category A (supplier numbered 4) and category C (supplier numbered 85). The model's accuracy have been calculated 0.977.
At last, auther tests model with test samples, that selected them random among the all suppliers. Among the 30 suppliers pertain to the test samples, the model wasn't able to predict correctly the classification of two suppliers that pertain to group A (supplier numbered 5) and group C (supplier numbered 29). Type I error rate calculated 0.1 and type II error rate calculated also 0.1. These error rate are acceptable.

5.Conclusion And Suggestions

The study aimed to present the UTADIS model by using the information in SAPCO company for classifing the suppliers. The average of all solutions obtained during the post-optimality stage and the first solution have been calculated and specified the value of thresholds and W_{it}. Criteria weight is formed from sum of W_{it}'s value for each criteria. The comparison

between the results of this research and SAPCO company's information is presented as the following table 5.1.
Author suggests SAPCO company to use this model for classifing new suppliers and company can determine suppliers'performance level by calculating the global utility function for them and ranking them by the scores that obtained from the global utility.

Table 5.1. comparison between the results of the research and SAPCO company's information

		SAPCO company's information	**Results of the research**
Criterion weights	Returned parts from iran khodro	0.125	0.10413
	Returned parts from isaco	0.105	0.07639
	Car's edith	0.05	0.14470
	ISO/TS certification	0.025	0.07656
	Supplier quality system	0.055	0.05109
	Proportion of confirmation	0.075	0.08250
	Stop production line	0.16	0.10175
	Timely delivery of kanban's order	0.06	0.06375
	Timely delivery of non-kanban's order	0.03	0
	Preparation of ISACO needs	0.03	0.03570
	Deviation from target price parts	0.135	0.13043
	Warrantly costs	0.105	0.13297
	Export	0.045	0
Utility thresholds	The first utility threshold (U_1)	0.9	0.73650
	The second utility threshold (U_2)	0.75	0.63317

Based on the limitations of this study, the following suggestions can be followed by future authors:

- Considering a reference set including unequal numbers of samples.
- Considering environmental performance of suppliers because of the importance of green supply chian.
- Using cluster analysis at first to determine different clusters, then use the UTADIS method for presenting a classification model based on the predefined clusters.
- Using MHDIS method that is kind of classification techniques for classifing suppliers.
- Using ELECTRE-TRE method for presenting supplier classification model.

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References

Aamodt, A., & Plaza, E. (1994). Case- based reasoning: foundational issues methodological variations and system approaches. Artificial Intelligence Communications, 7(1), 39-59.

Aissaoui, N., haouari, M., & Hassini, E. (2007). Supplier selection and order lot sizing modeling: A review. Computers & Operations Research, 34(12), 3516-3540.

Aksoy, A., & Ozturk, N. (2011). Supplier selection and performance evaluation in just-in-time production environments. Expert Systems with Applications, 38(5), 6351-6359.

Azadnia, A.H., Ghadimi, P., Saman, M.Z.M., Wong, K.Y., Sharif, S. (2011). Supplier selection: A hybrid approach using Electre and fuzzy clustering. In proceedings of Informatics Engineering and Information Science. International Conference, part п. Kuala lumpur: Springer, 663-676.

Bottani, E., & Rizzi, A. (2008). An adapted multi-criteria approach to suppliers and products selection-An application oriented to lead-time reduction. International Journal of Production Economics, 111(2), 763-781.

Buyukozkan, G., & Cifci, G. (2012). A novel hybrid MCDM approach based on fuzzy DEMATEL, fuzzy ANP and fuzzy TOPSIS to evaluate green suppliers. Expert Systems with Applications, 39(3), 3000–3011.

Cardozo, R.N., & Cagley, J.W. (1971). Experimental study of industrial buyer behaviour. Journal of Marketing Research, 8(3), 34-329.

Chai, J., Liu, J.N.K., & Ngai, E.W.T. (2013). Application of decision-making techniques in supplier selection: A systematic review of literature. Expert Systems with Applications, 40(10), 3872-3885.

Chapman, S.N., & Carter, P.L. (1990). Supplier/customer inventory relationships under just-in-time. Decision Sciences, 21(1), 35–51.

Che, Z.H. (2012). Clustering and selecting suppliers based on simulated annealing algorithms. Computers and Mathematics with Applications, 63(1), 228-238.

Che, Z.H. (2012). Clustering and selecting suppliers based on simulated annealing algorithms. Computers and Mathematics with Applications, 63(1), 228-238.

Chen, L. Y., & Wang, T. C. (2009). Optimizing partners choice in IS/IT outsourcing projects: the strategic decision of fuzzy VIKOR. Int.J. production economics, 120(1), 233-242.

Chen, Y. H., Wang, T. C., & Wu, C. Y. (2011). Strategic decisions using the fuzzy PROMETHEE for IS outsourcing. Expert systems with applications, 38(10), 13216-13222.

Chou, S. Y., Chang, Y. H. (2008). A decision support system for supplier selection based on a strategy-aligned fuzzy SMART approach. Expert systems with applications, 34(4), 2241-2253.

Choy, K.L., & Lee, W.B. (2002). A generic tool for the selection and management of supplier relationships in an outsourced manufacturing environment: the application of case based reasoning. Logistics Information Management, 15(4), 235-253.

Dalalah, D., Hayajneh, M., & Batieha, F. (2011). A fuzzy multi-criteria decision making model for supplier selection. Expert Systems with Applications, 38(7), 8384–8391.

De boer, L., Labro, E., & Morlacchi, P. (2001). A review of methods supporting supplier selection. European Journal of Purchasing & Supply Management, 7(2), 75-89.

De boer, L., Labro, E., & Morlacchi, P. (2001). A review of methods supporting supplier selection. European Journal of Purchasing & Supply Management, 7(2), 75-89.

Degraeve, Z., Labro, E., & Roodhooft, F. (2000). An evaluation of vendor selection models from a total cost of ownership perspective. European Journal of Operational Research, 125(1), 34-58.

Doumpos, M., & Zopounidis, C. (2002). Multicriteria decision aid classification methods. Kluwer Academic Publishers, 73, 1-5, 77-100.

Ellram, L. M., & Carr, A.S. (1994). Strategic purchasing: A history and review of thw literature. International Journal of Purchasing and Materials Management, 26(4), 8-14.

Faez, F., Ghodsypour, S.H., & Obrien, C. (2009). Vendor selection and order allocation using an integrated fuzzy case-based reasoning and mathematical programming model. Int.J.Production Economics, 121(2), 395-408.

Garfamy, R.M. (2006). A data envelopment analysis approach based on total cost of ownership for supplier selection. Journal of Enterprise Information Management, 19(6), 662-678.

Han, J., Kamber, M., & Pei, J. (2012). Data mining concepts and techniques third edition, Morgan Kaufmann.

Ho, W., Xu, X., & Dey, P.K. (2010). Multi-criteria decision making approaches for supplier evaluation and selection: A literature review. European Journal of Operational Research, 202(1), 16-24.

Hsu, B., Chiang, C. Y., & Shu, M. H. (2010). Supplier selection using fuzzy quality data and their applications to touch screen. Expert systems with applications, 37(9), 6192-6200.

Kannan, D., Khodaverdi, R., Olfat, L., Jafarian, A.,& Diabat, A. (2013). Integrated fuuzy multi criteria decision making method and multi-objective programming approach for supplier selection and order allocation in a green supply chain. Journal of cleaner production, 47, 355-367.

Khurrum, M., & Bhutta, S. (2003). Supplier selection problem: Methodology literature review. Journal of International Technology and Information Management, 12(2), 53-71.

Kilincci, O., & Onal, S.A. (2011). Fuzzy AHP approach for supplier selection in a washing machine company. Expert Systems with Applications, 38(8), 9656-9664.

Kull, T. J., & Talluri, S. (2008). A supply risk reduction model using integrated multicriteria decision making. Ieee transactions on engineering management, 55(3).

Levary, R. R. (2008). Using the analytic hierarchy process to rank foreign suppliers based on supply risks. Computers & industrial engineering, 55(2), 535-542.

Liao, Ch.N., & Kao, H.P. (2011). An integrated fuzzy TOPSIS and MCGP approach to supplier selection in supply chain management. Expert Systems with Applications, 38, 10803-10811.

Lin, R.H. (2012). An integrated model for supplier selection under a fuzzy situation. International Journal of Production Economics, 138(1), 55-61.

Mehdizadeh, E. (2009). A fuzzyclustering pso algorithm for supplier base management. International Journal of Management Science and Engineering Science, 4(4), 311-320.

Monczka, R.M., Giunipero, L.C., & Reck, R.F. (1981). Perceived importance of supplier information. Journal of purchasing and Materials Management, 17, 9-21.

Narasimhan, R., Talluri, S., & Mendez, D. (2001). Supplier evaluation and rationalization via Data Envelopment Analysis: An empirical examination. Journal Of Supply Chain Management, 37(2), 1523-2409.

Saen, R. F. (2010). Developing a new data envelopment analysis methodology for supplier selection in the presence of both undesirable outputs and imprecise data. International Journal of Advanced Manufacturing Technology, 51(9–12), 1243–1250.

Sen, C.G., Sen, S., & Basligil, H. (2008). Pre-selection of suppliers through an integrated fuzzy analytic hierarchy process and max-min methodology. International Journal Of Production Research, 48(6), 1603-1625.

Sevkil, M. (2010). An application of the fuzzy ELECTRE method for supplier selection. International Journal of production research, 48(12), 3393-3405.

Tsai, Y. L., Yang, Y. J., & Lin, C. H. (2010). A dynamic decision approach for supplier selection using ant colony system. Expert systems with applications, 37(12), 8313-8321.

Tseng, M., Lin, R., & Chiu, A. (2011). Green supply chain management with lingistic preferences and incomplete information. Applied Soft Computing, 11(8), 4894-4903.

Tullous, R., & Munson, J.M. (1991). Trade-offs under uncertainty: implications for industrial purchasers. International Journal of Purchasing and Materials Management, 27, 24–31.

Weber, Ch. A., Current, J. R., & Benton, W. C. (1991). Vender selection criteria and methods. European Journal of Operational Research, 50(1), 2-18.

Yeh, W. C., & Chuang, M. C. (2011). Using multi-objective genetic algorithm for partner selection in green supply chain problems. Expert systems with applications, 38(4), 4244-4253.

Yu, M., Goh, M., & Lin, H. (2012). Fuzzy multi-objective vendor selection under lean procurement. European journal of operational research, 219, 305-311.