Supplier selection and evaluation using multicriteria decision analysis

Stratos Kartsonakis[1], Evangelos Grigoroudis[2], Michalis Neofytou[3]

[1]School of Production Engineering and Management, Technical University of Crete, Chania, Greece, e-mail: ekartsonakis30@gmail.com
[2]School of Production Engineering and Management, Technical University of Crete, Chania, Greece, e-mail: vangelis@ergasya.tuc.gr
[1]School of Production Engineering and Management, Technical University of Crete, Chania, Greece, e-mail: micneophytou@gmail.com

Abstract. The supplier selection and evaluation is a very sensitive and crucial process for all companies and organizations. The supplier nowadays functions as an associate partner and the relationship between him and the company must be based on a mutual trust. Despite this fact the main method of selecting a supplier is depending on the cost neglecting other important factors. This paper presents a new method based on the multicriteria decision analysis and gives a new dynamic perspective to the problem with emphasis to on a continuous evaluation process to the problem. The proposed model was implemented in a food industry and the results are being discussed.

Keywords: Supplier Selection, Supplier Evaluation, Multicriteria Decision Analysis, UTA II method.

1 Introduction

One of the most common and at the same time, most crucial issue that modern companies face is the supplier's selection and evaluation. This particular process can affect the overall performance of any industry, not only from the aspect of cost, but also for the final product and the reputation of the company. So when it comes to the final decision, the purchase manager has to consider many factors that shape the profile of a proper supplier. Some of the criteria that are being widely examined are the price, the quality and the delivery time. As the selection progress can become very complex, a solid method to improve the supplier performance is by developing a robust buyer-supplier relationship. This relationship must be built with mutual trust and cooperation and demands from the buyer to work with a small number of suppliers. In order for this relationship to be successful, a regular examination of a supplier's performance must be held. There is no point in organizing a process for the selection of a supplier without including a well-based evaluation system. This not only helps the buyer to keep track of the supplier's performance, but also functions as a tool for the supplier himself, to improve and evolve his products and services.

Many approaches have been applied to this problem but most of them focus on the selection process (Ho et al., 2014).

This research escapes from traditional approaches and launches a different aspect to this problem that focuses on a constant evaluation model. Specifically the proposed model was based on a UTA-II method (Siskos, 1980) that it has never been implemented to these kinds of problems. The methodology discussed at this article proposes 2 evaluation systems and 1 selection system for new suppliers. As many industries have established their supplying sources, it would be more efficient to create evaluation systems that could filter the performances of the suppliers (Mummalaneni et al., 1996). The proposed model was successfully tested in a food industry and in this article, the results are being discussed.

2 Proposed Approach

The first step to create the purposed model was by categorizing all the products and services that the company is being supplied. In this way it becomes easier for the buyer to decide the evaluation criteria from a few categories rather than by examining the numerous products. Afterwards 3 systems were created. For each system, different criteria were selected.

The first system, concerns the evaluation of a single supply. For every product that the company buys, the supplier manager should grade the product in the selected criteria. By implementing the UTA-II method, the weights of each criterion are estimated (Siskos et al., 2005). So the total score of a supply is estimated using an additive value function of the following form:

$$U_i = \sum_{j=1}^{n} p_j u_{ij} .$$

(1)

where U_i is the score of the i-th supply, p_j is the weight of the j-th criterion, and u_{ij} is the score of the i-th supply on the j-th criterion.

Let's suppose that a supply is being evaluated on four criteria. Table 1 shows the performance scores u_{ij} for this particular supply. Assuming that the estimated criteria weights are $p_1 = 0.25$, $p_2 = 0.25$, $p_3 = 0.30$, and $p_4 = 0.20$, the score (value) of this supply is $U_A = 0.25 \times 8 + 0.25 \times 7 + 0.30 \times 9 + 0.20 \times 10 = 8.45$.

Table 1. Example of a supply evaluation (0-10 scale).

Supply	Criterion 1	Criterion 2	Criterion 3	Criterion 4
A	8	7	9	10

The second system refers to the annual supplier evaluation. The evaluation procedure is similar to the supply's evaluation process. In this system the buyer

evaluates the performance of a supplier in an one year period. The criteria that should be used must be able to describe the supplier's actions.

The second system though is not enough to give a clear view of the supplier's efficiency. The proposed model suggests that the total score of a supplier will be calculating by adding the average score of the supplies that a vendor made with the score of the vendor's annual evaluation:

$$U_i^{global} = a\overline{U}_i + (1-a)U_i^{year}. \tag{2}$$

where U_i^{global} is the overall score of the i-th supplier, $\overline{U}_i$ is the average scores of the yearly supplies by the i-th supplier, U_i^{year} is the annual evaluation score of the ith supplier, and a is a weighting factor that aggregates the supplier annual evaluation and the average scores of supplies.

Depending on the overall score each supplier, will be enlisted in a different category. Three categories were created:

- authorized suppliers
- under superintendence suppliers
- unauthorized suppliers

As the score will dynamically change, it is possible for a supplier to enter to a different category through time. But if it becomes an unauthorized one, it will not be selected again.

The final system refers to the selection of new suppliers and adopts a threshold-type procedure. Again the supply's manager gives a score in each of the selected criteria, but this time each criterion has a score limit (threshold). If the score exceeds the chosen limit then the examined supplier is approved. Otherwise it will not selected and becomes inadequate.

3 Evaluation Criteria

A set of evaluation criteria were selected for each one of the aforementioned evaluation systems. After examining the criteria that were used in other approaches and in cooperation with the Quality Manager of the food industry, the criteria that were selected are the following:

Supply evaluation criteria:
1. Price
2. Quality of product/service
3. Cooperation
4. Responsiveness to customer needs
5. Delivery time

Annual supplier evaluation criteria:
1. Cost
2. Cost reduction performance
3. Quality

4. Cooperation
5. Reliability
6. Delivery time
7. Guarantee

Selection of new supplier criteria:
1. Reliability
2. Cooperation
3. Free products for trial
4. Quality accreditation & audit
5. Payment
6. Guarantees

The criteria were selected in a way that could express the strengths and weaknesses of each supplier. As a result the company would have a whole better view of their performance. So it was really important the criteria to fulfill the company's requirements. Some of the selected criteria have been applied to many researches such as cost, quality, and delivery time and other have been used in a smaller scale like cooperation (Chan et al., 2007) and quality accreditation and audit (Karpak et al., 2001). Furthermore, some other criteria that are being introduced in this research were not implemented in the examined researches but they were crucial for the food industry. Those were the guarantee that expresses the prerequisites that a supplier would have if a problem with the order come up. The other one was the criterion of reliability that expresses the fame that a supplier has.

4 Application to a Food Industry

The proposed model was implemented in a food industry, which needed an improved supplier evaluation system. Having chosen the evaluation criteria we tested the proposed model to all the suppliers that the company has cooperated with one-year period. The proposed model was built in Microsoft Office Excel. The specific program was chosen because it is widely known with a friendly user interface. Tables 2-3 present some indicative results of the evaluation of a supply, where the company cooperated with three different suppliers.

The evaluation of a supply takes place in this way: The assessor (the person that made the order) opens the Excel, where the database of all the suppliers and the products that the company is being provided, is held. As soon as she/he chooses the product and the supplier that she/he wants to evaluate she/he gets immediately information of the supplier's overall score, its annual evaluation score and the average score of its past supplies. Then what must she/he does is to simply evaluate the product that she/he received in the 5 determined criteria. When she/he does that she/he receives the score of the supply and also the state of the supply.

As the example of Table 2 concerns, it is obvious that the food industry is not satisfied with the price of the laptops from all the 3 suppliers. It also is clearly dissatisfied by Supplier C who got a really poor evaluation. At this point it should be mentioned that if a supply receives a score 5 or lower the company may not accept it

and ask for a refund. Supplier B did not receive a good score at the criteria of cooperation and delivery time.

Table 2. Example of the evaluation of 3 different supplies.

Supplier	Product	Price	Quality	Cooperation	Responsiveness	Delivery time
A	Laptop	6	9	9	9	9
B	Laptop	4	9	6	9	5
C	Laptop	5	5	5	5	5

Table 3. Example of the evaluation of 3 different suppliers.

Supplier	Annual evaluation	Average score of supplies	Overall score	State of supplier
A	8.12	8.02	8.07	Authorized
B	8.08	6.26	7.17	Under superintendence
C	5.04	5.00	5.02	Unauthorized

Similarly to the aforementioned example, the evaluation of other products or suppliers may be applied. The food industry in this way can have all the necessary and continuously updated information that it wants from the suppliers and keep track of their performances in detail. The evaluation takes no time and the feedback that the company gets is really valuable. The annual evaluation of a supplier and the selection of new supplier work likewise.

5 Conclusions

The proposed model differs from other researches due to the fact that functions as a tool for the company because it gives the ability to continuously update the provided information. The process of the constant evaluation of a supply offers the ability to the Supplier Manager to keep track of a vendor's performance through the year. But the proposed model functions not only as a performance measurement tool for the supplier, but it helps the Supply Manager to find the best supplier for the next order. As the scores change automatically, she/he can check who has the best overall score at this time and pick the better one. Moreover the selection of the right criteria gives the opportunity to the buyer to track the weaknesses of a supplier. For instance a vendor may have a good score in delivery time and a low one in the quality. So the company will have the ability to take the right measures the next time it will trust the same supplier.

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