Application of SWARA and TOPSIS Methods for Supplier Selection in a Casting Unit

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Abstract— **Supplier selection is the process of selecting the most suitable supplier for a company from the market. It is one of the most important activities of purchasing. By ensuring the right supplier, a company can reduce the various risks involved in the purchasing decision. Over the years the challenges involved with selecting the right supplier for a firm which can satisfy all the need has become a key step in ensuring the long term success of a firm. This paper addresses a new methodology for supplier selection comprising of SWARA and TOPSIS. This paper also discusses about their practical application in the case of supplier selection. The case study presented takes a look into the real life scenario of a supplier selection process which took place in a casting unit. "Continuous rejection of important raw materials" was the problem faced by the company, by conducting a supplier selection process using the combination of SWARA and TOPSIS the company was able to overcome the crisis. The use of the MCDM tools ensured that, in the selection process the company policies were satisfied in selecting the best suitable supplier in the respective field.**

Keywords— *SWARA (Step Wise Weight Assessment Ratio Analysis), TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), and MCDM (Multi Criteria Decision Making), (AHP) analytic hierarchy process, (ANP) analytic network process*

I. INTRODUCTION

Supplier selection and evaluation process is considered one of the most important responsibilities of purchasing manager. In today's marketing conditions it is almost impossible to produce high quality, low cost products without a satisfactory set of suppliers. The supplier evaluation process is meant to minimize purchase risk and to maximize the overall efficiency of supplier. The supplier selection is one of the most critical activities for ensuring the long term sustainability of an industry. An effective purchasing department of a business firm can enhance the profitability of a firm, by eliminating the risks involved with supplier selection. In this paper a methodology comprising of the combined use of SWARA and TOPSIS is proposed. Both SWARA and TOPSIS are MCDM tools that can be used for supplier selection in any industry involving the selection of suppliers from the market in any respective field.

II. LITERATURE REVIEW

Supplier selection is considered as a problem which considers various criteria at the same time [1]. The supplier is to be selected on how much order quantity to be assigned at a time. The supplier selection process is the procedure of dealing with the growing number of potential suppliers, growing number of

attributes, increasing number of situational contexts [2]. The supplier selection process has gone under massive changes in the last fifty years [2]. These changes have been beneficial to both the suppliers and the supplier clients. The suppler selection process becomes long term cooperation in partnership between the client and the supplier [2]. Keeping the changes that had happened to the market over the past decade supplier selection is of great importance, the right supplier selection methods are the key for a firm's long term sustainability in market. The analysis of various criteria for the supplier selection process has been the subject for many academics over time, and the selection of suitable criteria depends on the purchasing situation on hand and the company's policies [2]. The supplier selection process is a multi-criteria decision making problem. So in order to conduct an evaluation on this topic, a tool is necessary which can handle the multi-criteria nature of the problem. One such tool is SWARA (step wise weight assessment ratio analysis) this tool was introduced in the later part of 2000, towards the end, some other methods include analytic hierarchy process (AHP), analytic network process (ANP). Weight assessment is the most critical part of the MCDM (multi-criteria decision making) problems [2]. It comprises both qualitative and quantitative factors. In SWARA the experts in the respective field has a very important role to play in determining the weights of the selected criteria. The expert uses his own implicit knowledge to rank the suppliers. Also, each expert can choose the importance of each criteria [3]. Once analyzed, the expert can reach on a solution giving the most important criteria to rank higher than the others. The main attraction of this method is that it has the ability to estimate the expert's opinion about the importance ratio of the criteria in the process of weight determination. The SWARA is simple, means that experts can easily work together as a team [3]. This method unlike analytic hierarchy process (AHP), analytic network process (ANP) is flexible, means it is easy to obtain on conclusions on problems where the priorities to the weights can be varied on the companies polices.

TOPSIS is a MCDM ranking method introduced in 1992; the basic principle behind this method is that the chosen alternative must have the shortest distance from the ideal solution and the farthest distance from the negative-ideal solution [5]. The TOPSIS method has a goal based approach [6]. The output of the analysis is graded based on the similarity to the ideal solution. For an option which is more similar to the ideal solution has the higher rank compared to

the option which is less similar to ideal solution. This is a method compares a set of alternatives by identifying weights for each criterion. The TOPSIS method allows trade-offs between criteria, where a poor result in one criterion can be negated by a good result in other criterion. This provides more realistic form of modeling than non-compensatory methods which include or exclude alternative solutions in the case of decision making. Referring the journals it is found that a combined methodology of SWARA and TOPSIS can be used for supplier selection in any company which deals with multiple suppliers at the same time.

III.   RESERCH METHODOLOGY

In this paper a combined methodology of SWARA and TOPSIS is proposed for supplier selection. The SWARA is used to find out the weights of the criteria which is selected by the team of experts, the TOPSIS method is used to find out the ranks of the suppliers in the various category. SWARA is a method in which an expert will use his or her own implicit knowledge, information and experiences. Also, it is not complicated and time consuming [7].the most important criterion is given rank 1, and so on. For identifying the various criteria for supplier selection a team of experts are to be formed, this team is put together within the company with the number of experts are decided by the company, on forming the team various criteria can be found out and the supplier selection problem can be formulated.
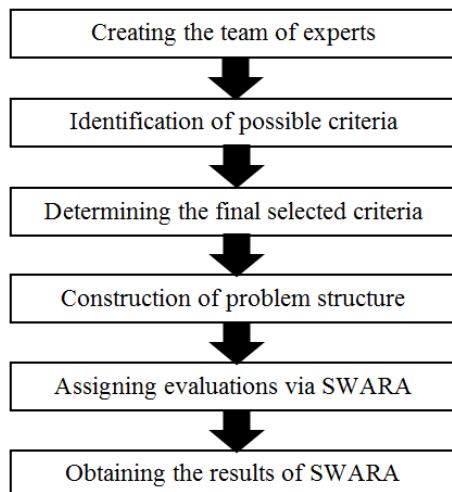

Fig.1 Methodology for SWARA

TOPSIS method assumes that we have **m** alternatives (options) an **n** attributes/criteria and we have the score of each option with respect to each criterion. Let x_{ij} score of option i with respect to criterion j

We have a matrix $X = (x_{ij})$ m×n matrix.

Let J be the set of benefit attributes or criteria (more is better)

Let J' be the set of negative attributes or criteria (less is better)

The TOPSIS Method can be done in the following steps

- Step 1 : Construct normalized decision matrix

    This step will transform various attribute dimensions into non-dimensional attributes which allows comparisons across criteria

- Step 2: Construct the weighted normalized decision matrix.

- Step 3: Determine the ideal and negative ideal solutions.

- Step 4: Calculate the separation measures for each alternative.

- Step 5: Calculate the relative closeness to the ideal solution

IV.   CASE STUDY

The above mentioned methodology has been applied to a real case study. The study was conducted in a company located in India. Company is a casting unit which produces castings to various suppliers across the nation and abroad as well. The company has over 300 employees and it is a major player in the casting industry in India, recently they were facing problems with continuous rejections of important raw materials for the casting. On primary analysis it was found that the quality of raw materials purchased not up to the mark. Therefore the company decided to conduct the supplier selection program, to evaluate and select the best supplier that suits their requirements. In order for this supplier selection process the methodology of SWARA and TOPSIS where selected. They considered methodologies like AHP and ANP but taking into consideration of the company policies they decided to go with SWARA. As a result a team of experts where selected within the company comprising of people who are having great knowledge in terms of various properties of the raw materials. The selected team includes managers from various departments across the company. The team identified the criteria for supplier selection. The criteria found were again investigated and sub criteria for each main criteria found out.

In order to evaluate these criteria, the Experts developed a questionnaire which would evaluate the criteria and sub criteria. The questions prepared where to highlight on each sub criteria under the respective criteria. After preparing the questionnaire. The experts gathered the list of suppliers and they started analysing each supplier under each category of raw materials which were facing the problem of rejection.

The questionnaires were distributed among the expert's themselves and each expert can give his opinion on every supplier. The questionnaire where primarily focusing on giving the experts opinion on different criteria, asking them to r rate each supplier from best to worst in a 5 point scale. Under the given criteria. The responses where collected and SWARA analysis where performed on the criteria selected. The points which are awarded for the scale is [excellent (5), very good (4), good (3), satisfactory (2), poor (1)]

V. RESULTS AND DISCUSSIONS

The supplier selection process is a multi-criteria decision problem. several factors contribute to selecting the criteria for defining the best suited supplier for a company. In the case study presented, it deals with a real time supplier selection process in a casting unit.

The company after conducting the initial assessment found that a supplier selection process will improve to reduce the rejection of their raw materials, in order to carry out the suggested methodology a combined technique of SWARA and TOPSIS were selected. From the output of the SWARA method the corresponding weights to the selected criteria was found out. The criteria selection for each company depends upon their marketing strategies and company policies.

The input to the TOPSIS analysis is obtained from the corresponding output of SWARA analysis, the TOPSIS analysis shown the ranking order of the suppliers taken into consideration. The company conducted analysis for all raw materials which were facing rejection problems. And the best supplier is found out under the respective categories. the rank obtained for a raw material XYZ is shown below, the suppliers are S1,S2,S3,S4.

supplier	Rank obtained
S1	0.7670
S2	0.4521
S3	0.6943
S4	0.4672

Table 1. Rank obtained for raw material XYZ

The results shows that the supplier S1 is the best supplier and the supplier S2 is the worst among the lot.

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