

Sewing Machine Selection for a Textile Workshop by Using EDAS Method

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Extensive Summary

Introduction

In organisations, managers have to make many quick decisions in their daily lives to adapt to the dynamic market. Particularly, the managers who work in the purchasing department of the businesses have to make the necessary decisions purchasing the machine, raw materials and equipment to be bought for the operation. These managers consider many criteria that will assist to compare many alternatives during this decision-making phase. In many decision making problems, decision making is not depended on a single criterion. In the most of the decision-making problem, more than one criterion is considered in the decision-making process. These types of decision-making problems, which are influenced by more than one criterion, are called multi-criteria decision making (MCDM) problems.

In multi-criteria decision making (MCDM) problems, there are often conflicting criteria in selecting alternatives. Hence, traditional methods can not provide realistic solutions to such problems. In order to solve multi-criteria decision making (MCDM) problems, MCDM methods were utilised in the literature. There are many MCDM methods proposed to solve MCDM problems in the literature. The methods widely used in the literature are; Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), Fuzzy Analytic Hierarchy Process (FAHP) and Fuzzy Analytic Network Process (FANP) (pairwise comparison based methods), ELECTRE, PROMETHEE (outranking methods), MOORA, TOPSIS, VIKOR, COPRAS and ARAS (distance based methods). As mentioned earlier, the purchasing department is a place where decision making is intensively experienced. In particular, the purchase of a new high-tech machine is an important decision-making problem. The purchase of such machines is an important cost item for businesses. If business is not satisfied with a machine and business desires to change this machine, this changing of the machine will bring a separate financial burden to the business. Therefore, the criteria to be considered before

purchasing should be analysed in a good way and the machine alternatives should be evaluated by means of MCDM methods according to these criteria.

In this study, a new method developed as an alternative to the previously mentioned MCDM methods, EDAS (Evaluation based on Distance from Average Solution) method will be used. The EDAS method, which was developed in 2015, is a new method. The EDAS method considers the average solution of criterion when evaluating alternatives. The EDAS method will be used in this study to select a sewing machine for a textile workshop. The most important aim of this study is to introduce the EDAS method to the Turkish literature.

Methodology

In this study, crisp EDAS will be used to select a sewing machine for a textile workshop. The EDAS method will be summarised in 6 steps;

Step 1: Structure the decision matrix (Y).The following equation shows the decision matrix. Y_{ij} in equation 1 shows the performance of the i th alternative in the j th criterion.

$$Y = [Y_{ij}]_{n \times m} = \begin{bmatrix} Y_{11} & Y_{12} & \dots & Y_{1m} \\ Y_{21} & Y_{22} & \dots & Y_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ Y_{n1} & Y_{n2} & \dots & Y_{nm} \end{bmatrix} \tag{1}$$

Step 2: The average matrix (AV) is generated as shown in the following equation, calculating the average of the values of all the criteria.

$$AV = [AV_j]_{1 \times m} \tag{2}$$

AV_j shown in equation 2 shows the average solution of the j th criterion and is calculated by the following equation.

$$AV_j = \frac{\sum_{i=1}^n Y_{ij}}{n} \tag{3}$$

Step 3: The positive distance from average (PDA) and the negative distance from average (NDA) matrixes are calculated for each criterion. The calculation of these values varies depending on types of criteria (beneficial/non-beneficial).

$$PDA = [PDA_{ij}]_{n \times m} \tag{4}$$

$$NDA = [NDA_{ij}]_{n \times m} \tag{5}$$

If j th criterion is beneficial, the following formula will be used in calculations;

$$PDA_{ij} = \frac{\max(0, (Y_{ij} - AV_j))}{AV_j} \tag{6}$$

$$NDA_{ij} = \frac{\max(0, (AV_j - Y_{ij}))}{AV_j} \tag{7}$$

If j th criterion is non-beneficial, the following formula will be used in calculations;

$$PDA_{ij} = \frac{\max(0, (AV_j - Y_{ij}))}{AV_j} \tag{8}$$

$$NDA_{ij} = \frac{\max\{0, (v_{ij} - \bar{v}_j)\}}{\bar{v}_j} \quad (9)$$

In equations, PDA_{ij} and NDA_{ij} indicates the positive and negative distance of i th alternative from average solution according to j th criterion, respectively.

Step 4: The values of SP_i and SN_i are calculated for all alternatives. SP_i denotes the weighted total positive value of the i th alternative and SN_i denotes the weighted total negative value of the i th alternative.

$$SP_i = \sum_{j=1}^m w_j \times PDA_{ij} \quad (10)$$

$$SN_i = \sum_{j=1}^m w_j \times NDA_{ij} \quad (11)$$

Step 5: For all alternatives, SP_i and SN_i are normalized by the following equations.

$$NSP_i = \frac{SP_i}{\max_i(SP_i)} \quad (12)$$

$$NSN_i = 1 - \frac{SN_i}{\max_i(SN_i)} \quad (13)$$

NSP_i and NSN_i , which are indicated in equation 12 and equation 13 represent the normalized weighted total positive and negative values of the i th alternative, respectively.

Step 6: In the final step, the appraisal score (AS) for each alternative are calculated with the following equation.

$$AS_i = \frac{1}{2} \times (NSP_i + NSN_i) \quad (14)$$

In the equation 14, AS_i takes values between 0 (inclusive) and 1 (inclusive). Alternatives is ranked with respect to their appraisal scores. The alternative with the greatest appraisal score is determined as the best alternative.

Findings and Discussion

Managers working in the business have to decide many times in their daily business lives to be able to adapt to the dynamic structure of the market. Especially, managers who work in the purchasing departments of businesses have to make the necessary decisions to purchase machines, materials and equipment. These managers compare the features and brands of the machines to be purchased before the purchase. In this decision-making process, they have to compare several machine alternatives with respect to their specifications (criteria). These types of problems are called multi-criteria decision-making (MCDM) problems. In the literature a number of MCDM methods have been proposed to solve such problems. Some of them can be listed as follows; pairwise comparison methods (AHP, ANP, FAHP and FANP), outranking methods (ELECTRE, PROMETHEE), distance based methods (MOORA, TOPSIS, VIKOR, COPRAS and ARAS).

As an alternative to above mentioned methods, EDAS (Evaluation based on Distance from Average Solution) method was used in this study. The aim of using this method is to be wanted to contribute to Turkish literature as there is no related article about this method in Turkish literature. The EDAS method was used to select the best

sewing machine for a textile workshop. Eight machines were evaluated with respect to 4 criteria and empiric (objective) data were used. Criteria were equally weighted and taken as 0.25. If sewing machines is ranked with respect to their appraisal scores (obtained in EDAS), the results are Machine 2> Machine 1> Machine 4> Machine 6> Machine 3> Machine 7> Machine 8> Machine 4. According to the results of EDAS method, Machine 2 is the sewing machine with the best performance. Other machines could not perform as good as Machine 2 in the criteria.

EDAS method is used with empiric data in this study. It has been observed that the EDAS method works well with empiric data. In the literature, this method was combined with fuzzy and grey numbers and participated in calculations in subjective data. This method can be transformed into group decision making by combining group decision methods in future studies. In addition, this new method can be used to solve problems such as supplier performance evaluation and supplier selection, personnel selection, warehouse location selection, strategy selection, project selection and other MCDM problems. This method can be combined with other MCDM methods to create a more robust integrated model. For example, in this study, weights were given equally and randomly and no method was used to obtain the weights of criteria. Future studies can be solved this problem using one of the methods to obtain weight.