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INTEGRATED FUZZY AHP-COPRAS METHOD FOR KINDERGARTEN SELECTION PROBLEM: AN APPLICATION IN SIVAS PROVINCE *

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Abstract

Kindergartens are important institutions that contribute to the development of children in early childhood. Supporting the healthy development of their children is one of the top priorities for parents. Working parents in particular want their children to be in a safe, supportive and educational environment. Therefore, choosing a kindergarten is not only a choice of care service, but also an important investment in the child's development. However, deciding which school will be the best for their children among many alternatives becomes difficult for parents as many criteria need to be considered. In this study, the integrated fuzzy AHP-COPRAS approach was applied to select the best kindergarten in Sivas province of Türkiye. A rating scale was presented to 13 parents of children aged 2-6 regarding the criteria they consider when deciding on a kindergarten. Based on the acquired results, it was observed that four criteria—quota, distance, school bus, and medical staff – received a value of 0 and did not participate in the problem. It was determined that 5 criteria, namely remaining fee, teacher, facility, education and food, took the values of 0.03, 0.24, 0.18, 0.43, 0.13, respectively. The computations led to the conclusion that KG4 is the best option. KG1 was determined to be the option that received the lowest score.

Keywords: Kindergarten Selection, Fuzzy AHP, COPRAS, MCDM
JEL Classification: C6, C44, I21.

KREŞ SEÇİMİ PROBLEMİ İÇİN BÜTÜNLEŞİK BULANIK AHP-COPRAS YÖNTEMİ: SİVAS İLİNDE BİR UYGULAMA

Öz

Kreşler, erken çocukluk döneminde çocukların gelişimine katkı sağlayan önemli kurumlardır. Ebeveynler için çocuklarının sağlıklı gelişimini desteklemek en büyük önceliklerden biridir. Özellikle çalışan ebeveynler, çocuklarının güvenli, destekleyici ve eğitici bir ortamda bulunmasını ister. Bu nedenle kreş seçimi, sadece bir bakım hizmeti tercihi değil, aynı zamanda çocuğun gelişimine yapılan önemli bir yatırımdır. Ancak birçok alternatif arasından çocukları için en iyi okulun hangisi olacağına karar vermek, birçok kriterin göz önünde bulundurulması gerektiğinden ebeveynler için zorlaşmaktadır. Bu çalışmada, Türkiye'nin Sivas ilindeki en iyi kreşi seçmek için bütünleşik bulanık AHP-COPRAS yaklaşımı uygulanmıştır. 2-6 yaş arası çocukları olan 13 ebeveyne, kreş seçerken göz önünde bulundurdukları kriterlere ilişkin bir derecelendirme ölçeği sunulmuştur. Elde edilen sonuçlara göre, kontenjan, mesafe, servis ve sağlık personeli olmak üzere dört kriterin 0 değerini aldığı ve probleme katılmadığı görülmüştür. Kalan ücret, öğretmen, mekân, eğitim ve yemek olmak üzere 5 kriterin ise sırasıyla 0,03, 0,24, 0,18, 0,43, 0,13 değerlerini aldığı tespit edilmiştir. Hesaplamalar sonucunda KG4'ün en iyi seçenek olduğu sonucuna varılmıştır. KG1 ise en düşük puanı alan seçenek olarak belirlenmiştir.

Anahtar kelimeler: Kreş Seçimi, Bulanık AHP, COPRAS, ÇKKV
JEL Sınıflaması: C6, C44, I21.

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1. Introduction

Selecting a kindergarten is a challenging decision-making process as it requires taking into account many different criteria such as location, fee, educational program, teacher, facility and so on. In addition, each family has different priorities, making the decision process even more complicated. Multi-Criteria Decision Making (MCDM) can be defined as the process of structuring and solving decision and planning problems that involve more than one criterion. The act of solving in this regard refers to determining the best alternative from a multitude of alternatives (Aruldoss, 2013). MCDM has been shown to have a number of advantages over other methods. This method has the capacity to take into account a variety of qualitative and quantitative criteria in order to identify the optimal solution. Furthermore, it can be implemented by obtaining expert opinions and can be utilised in a range of real-life problems (Taherdoost & Madanchian, 2023). It is observed that MCDM is employed in numerous decision-making problems in the literature, including the selection of an e-learning platform (Mastalerz, 2010), the determination of the most suitable call centre location (Kavitha, C. & Vijayalakshmi, 2010), the selection of suppliers (Liu & Hai, 2005), and the selection of public-school sites (Prasetyo et al., 2018). Therefore, the application of MCDM methods in the resolution of such an issue offers the potential to identify the optimal solution by the systematic organization of this complex process for parents. In this study, an application of the integrated fuzzy Analytic Hierarchy Process (AHP) – Complex PRoportional Assessment (COPRAS) method was carried out for the selection of kindergartens by parents in Sivas province. In practice, decisions are often not certain, and fuzzy AHP enables decisions to be made with a versatile thought by taking into account intermediate possibilities (Arslankaya and Göraltay, 2019: 56). Therefore, fuzzy AHP method was used to determine criterion priorities. After prioritizing the criteria, COPRAS was applied to determine the best choice among the alternatives. The COPRAS approach permits the evaluation of both qualitative and quantitative criteria, as well as the computation of percentage values that indicate the relative superiority or inferiority of one criterion over another (Aksoy et al., 2015; Özbek and Erol, 2016). The efficacy of these methodologies was substantiated by the findings of this study on the kindergarten selection of parents residing in Sivas. As a matter of fact, determining the most suitable option can be done more easily by making it more systematic.

The continuation of the study comprises of the following sections: the literature review of the article is given in the second section, the methodology employed is elucidated, along with the formulas for the fuzzy AHP and COPRAS methods in the third section. The implementation of

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the methodology is explained in the fourth section. Furthermore, the importance of the study, the data collection methodology and the research method are discussed. The results and their interpretation are given in the fifth section. The final section involves conclusion and discusses future studies.

2. Literature Review

This section of the text provides a literature review. Section 2.1 includes studies that have employed MCDM in the context of kindergarten selection. Section 2.2 includes studies that have employed the fuzzy AHP method, and Section 2.3 includes literature on the COPRAS method.

2.1. Studies using MCDM in Kindergarten Selection

In this section, literature on studies involving MCDM methods applied to the kindergarten selection problem is included. Mamat et al. (2017) designed a system that will help decide the best institution in pre-school education and takes the usability factor into consideration. They collected data from parents through a survey and calculated the preschool score to evaluate the criteria. The survey results were used to guide the development of the entire system, which included the adoption of the AHP approach. The system's convenience was evidenced by the results of the satisfaction survey.

In the study of Karakol (2018), the evaluation of service quality of preschool education was discussed and fuzzy AHP and Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) approaches were utilised for kindergarten selection problem. The fuzzy AHP was used to ascertain the relative importance of six selection criteria. The findings indicated that the professional qualifications and experience of teachers were the most important criteria with a ratio of 0.29. The preferred one among the four kindergartens was examined with fuzzy MOORA, and the results showed that it was the kindergarten coded with the AO4 code.

Çemrek and Özaydın (2019), in their study, investigated the kindergarten preferences and expectations of parents residing in Eskişehir whose children attend kindergarten. For this aim, a survey consisting of 23 questions prepared by the researchers was applied to 440 families. When the results found from the data to which factor analysis was applied, it was found that the survey questions were gathered in a 5-factor structure and the education given in the kindergarten (e.g. music, theatre) had the highest weight.

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In their study, Lescauskiene et al. (2020) presented VASMA, a new criterion weighting technique and carried out an application of this technique to determine the most important criteria affecting parents' decisions in choosing a kindergarten in Vilnius. Accordingly, the most important criteria were found to be "distance from home" with C10 notation and "teachers' abilities" with C2 notation. The least important criteria are expressed as "tolerance to different cultures" with C12 notation and "distance to the bus stop" with C11 notation.

Azmi et al. (2021) collected data from 102 parents who were registered and considering enrolling in a kindergarten in the Klang Valley region of Malaysia to evaluate the criteria in kindergarten selection and analyzed the results with the Best-Worst Method. Consequently, the researchers determined that the most significant criterion was security, while the least significant criterion was brand image and fees.

Kara and Baş (2022), in their study, employed the VIKOR technique to examine the decisions of parents residing in Giresun regarding the selection of kindergarten. It was identified that the optimal alternative to the criteria defined as number of teachers, price, distance and quota is the kindergarten with the A2 code.

Özdemir and Şallı (2022) conducted a study to ascertain the relative importance of the factors considered by parents when selecting a private pre-school institution, employing the AHP method. The findings of the analysis of comparison matrices, comprising six main criteria and 34 sub-criteria, indicated that the most important criterion was foreign language education, with the second most important criterion being the staff's attitudes towards parents and children.

2.2. Studies using Fuzzy AHP

This section presents a series of studies that employ fuzzy AHP and its hybrid methodologies. Ayhan (2013) implemented a fuzzy AHP application for the purpose of selecting the most suitable supplier for a gear motor company. The study utilised fuzzy AHP for supplier selection and incorporated a literature review of MCDM problems, thereby making a significant contribution to the field.

In their article, Demirtaş et al. (2014) undertook a rigorous evaluation of the most suitable card technology for an e-purse. This evaluation involved the assessment of three distinct card technologies, with particular emphasis placed on the identification of the most critical criteria. To facilitate this analysis, the researchers employed the fuzzy AHP and ANP methods, recognised for their effectiveness in complex decision-making contexts.

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Wang Chen et al. (2016) proposed a fuzzy MCDM approach for the selection of suppliers that are environmentally sustainable. In this approach, fuzzy AHP was used to determine the importance weights of the criteria in uncertainty. Then, Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was used to evaluate the alternatives and a case study was conducted.

In their study, Efe (2016) employed the fuzzy AHP and fuzzy TOPSIS methods for the software selection process of an electronics company. In this context, the fuzzy AHP was utilised to ascertain the priority values of the criteria. Subsequently, the fuzzy TOPSIS method was employed for alternative selection. The utilisation of fuzzy numbers at all stages of the process was instrumental in mitigating uncertainty in the decision-making process.

In their article, Nazim et al. (2022) presented a comparative analysis of the fuzzy AHP and fuzzy TOPSIS methods in relation to the small and large requirements sets of an institute examination system. The conclusion drawn was that both methods produce the same set of functional requirements based on the agreement measure metric in both dataset-1 and dataset-2.

Kajla et al. (2024) aimed to identify and prioritize the critical factors affecting the adoption of blockchain technology in the banking sector. Accordingly, 3 criteria and 14 sub-criteria were determined. Data was collected using a survey. Then, fuzzy AHP was used. It was found that the most important criterion was the organizational dimension, while the least effective criterion was the technological dimension.

2.2. Studies using COPRAS

A number of studies using COPRAS and its hybrid methods are presented in this section. Adali and Işık (2016) used COPRAS and Additive Ratio ASsessment (ARAS) methods to find a solution to the air conditioning selection problem in the literature. Using these methods, he ranked air conditioning alternatives and performed a comparative analysis of the results.

Kundakcı and Işık (2016) discussed the air compressor selection problem for the spinning mill of a textile company. For this purpose, they used Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH) and COPRAS techniques. First, the MACBETH method was used to determine the weights of the criteria. Then, the COPRAS method was used to determine the ranking of the alternatives and to select the best one.

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In their paper, Organ and Yalçın (2016) assessed research assistant performance using the COPRAS approach. A numerical example is given to illustrate the usefulness and performance of the proposed method. The COPRAS method's final rating is provided.

The purpose of this study by Çakır and Karabıyık (2017) is to select the best among various cloud storage service providers operating large-scale data centers and providing storage space. Since there are many criteria in the literature and not all of them are of equal importance, the importance levels of the criteria were determined by the Stepwise Weight Assessment Ratio Analysis (SWARA) method. In the light of the criteria created, the best cloud storage service provider was selected using the COPRAS method. It was concluded that the criterion with the highest importance level was the "Security" criterion and the criterion with the lowest importance level was "Customer Service".

Buyukozkan and Gocer (2019) presented a process for evaluating alternative digital supply chain partners in their study. Here, they proposed an approach using Pythagorean fuzzy sets, AHP and COPRAS methods together. They conducted a case study in Turkey.

Acer et al. (2020) analyzed the performance of 17 individual pension companies. In this context, they determined criteria such as the number of participants, the amount of participant funds, and retirement. They performed the analysis using the entropy method together with the COPRAS method. As a result of the study, the participant fund amount emerged as the most important criterion.

A novel approach to feature selection for text classification using a pseudo-relation matrix constructed with ridge regression was presented in the study by Mohanrasu et al. (2024). The COPRAS method was then used to rank the features in order of importance. To evaluate the proposed algorithm, tests are performed on ten real text datasets.

3. Methodology

3.1. Fuzzy AHP

The AHP method, introduced by Saaty in the 1970s, is a systematic approach for resolving MCDM problems, pairwise comparisons of criteria and alternatives are carried out with crisp values (between 1 and 9). Since, it is challenging for decision-makers to make comparisons with these crisp values, the Fuzzy AHP method, which uses values within a certain range, was developed (Özbey, 2022: 36). During the decision-making phase, decision makers may employ their experiences, common sense, foresight, or knowledge by using values within certain ranges

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in pairwise comparisons in the Fuzzy AHP technique. As a matter of fact, more accurate and effective results will be obtained as a result of making decisions with a versatile thought, considering intermediate possibilities (Arslankaya and Göraltay, 2019: 56).

Van Laarhoven and Pedrycg developed Saaty's pairwise comparison approach in 1983 and proposed a method that represents the comparison matrix with triangular fuzzy numbers and obtains priority vectors according to the logarithmic least squares method.

In the study conducted in 1996, Chang proposed a method that employs fuzzy numbers in the binary scale for comparison of fuzzy AHP The extension analysis approach is then used, that employs the fuzzy number comparison to generate the synthetic extent result of pairwise comparisons.

In the study of Kwiesielewicz that was conducted in 1998, based on the work of van Laarhoven and Pedrycz (1983), the technique of generalized pseudo-inverse was used to find the foundation for the problem's ultimate solution. Additionally, technique combining interval analysis and triangular fuzzy number computation was proposed.

3.1.1. Triangular Fuzzy Numbers

In this The AHP In general, we encounter two fuzzy numbers in applications: triangular and trapezoidal. Numbers that correspond to the thoughts of decision makers and are created by using three real numbers within the framework of fuzzy logic are referred to as triangular fuzzy numbers. (l,m,u) are triangular fuzzy numbers that l denotes the smallest value, u denotes the biggest value, and m denotes the ideal value. In line with the triangular number theory, the distances between the limit values in question (l and m and m and u) must be equal (Arslan, 2023:71, Ertuğrul, 2007:176).

If M is expressed as a fuzzy number, where $M \in F(R)$,

1) Exist $x_0 \in R$ such that $\mu_M(x_0) = 1$.

2) For any $\alpha \in [0,1]$,

$A_\alpha = [x, \mu_{A\alpha}(x) \geq \alpha]$

is a closed interval. F(R) is all fuzzy sets while R denotes the set of real numbers.

The membership function is described as below, where M is a triangular fuzzy number defined on R (Chang, 1996: 6).

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$$\mu_M(x) = \begin{cases} \dfrac{x}{m-l} - \dfrac{l}{m-l}, & x \in [\,l, m], \\ \dfrac{x}{m-u} - \dfrac{u}{m-u}, & x \in [\,m, u], \\ 0, & otherwise, \end{cases} \quad (1)$$

When $l = m = u$, it is a non-fuzzy number by method. Here $l \leq m \leq u$, where l and u refer to the lower and upper values of M, respectively and m refer to the ideal value.

Considering two triangular fuzzy numbers such as M_1 and M_2, the operations of these numbers with some arithmetic operators $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$ are shown as follows (Chang, 1996: 6).

Addition.

$(l_1, m_1, u_1) \oplus (l_2, m_2, u_2) = (\,l_1 + l_2,\ m_1 + m_2, u_1 +\ u_2)$

Multiplication

$(l_1, m_1, u_1) \odot (l_2, m_2, u_2) \approx (l_1 l_2, m_1 m_2, u_1 u_2)$

Inverse Operation

$(\,l_1, m_1, u_1)^{-1} \approx \left(\frac{1}{u_1}, \frac{1}{m_1}, \frac{1}{l_1}\right)$

3.1.2. Algorithm of Fuzzy AHP

Let $X = \{\,x_1, x_2, \dots, x_n\}$ be the set of objects and $U = \{\,u_1, u_2, \dots, u_n\}$ be the set of purposes. In accordance with the order analysis in Chang's study (1996), order analysis is carried out for every purpose after each object is captured. Thus, m order analysis values are acquired for each object. These values are presented in Equation (2) below.

$$M_{gi}^1, M_{gi}^2, \dots, M_{gi}^m, \qquad i = 1, 2, \dots, n, \quad (2)$$

Here, all M_{gi}^j $(\,j = 1, 2, \dots, m)$ are triangular fuzzy numbers.

The steps of Chang's order analysis are given below, respectively (Akman and Alkan, 2006; Chang, 1996; Ertuğrul, 2007; Karakış, 2018).

Step 1: The value of the fuzzy synthetic order according to the object i is described as in Equation (3).

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$$Si = \sum_{j=1}^{m} M_{g_i}^{j} \times \left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{g_i}^{j}\right]^{-1} \tag{3}$$

In order to calculate the value $\sum_{j=1}^{m} M_{gi}^{j}$ here, fuzzy addition operation is performed on m order analysis values as in Equation (4).

$$\sum_{j=1}^{m} M_{g_i}^{j} = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j\right) \tag{4}$$

$$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{g_i}^{j} = \left(\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i\right) \tag{5}$$

Next, the inverse of the vector is obtained as presented in Equation (6).

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{g_i}^{j}\right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i}\right) \tag{6}$$

Step 2: The degree of likelihood of the expression $M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$ for the previously described triangular fuzzy numbers M_2 and M_1 is calculated as follows.

$$V(M_2 \geq M_1) = \sup_{y \geq x}\left[\min\left(\mu_{M_1}(x), \mu_{M_2}(y)\right)\right] \tag{7}$$

This equation can also be written as in Equation 8.

$$V(M_2 \geq M_1) = \text{hgt}(M_1 \cap M_2) = \mu_{M_2}(d) \begin{cases} 1, & if\ m_2 \geq m_1 \\ 0, & if\ l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, & otherwise \end{cases} \tag{8}$$

$V(M_2 \geq M_1)$ in Equation (8) is the ordinate of the highest intersection point D between d, μ_{M_1} and μ_{M_2} and is shown as in Figure 1 below.

Figure 1. Intersection Point Between M_1 and M_2

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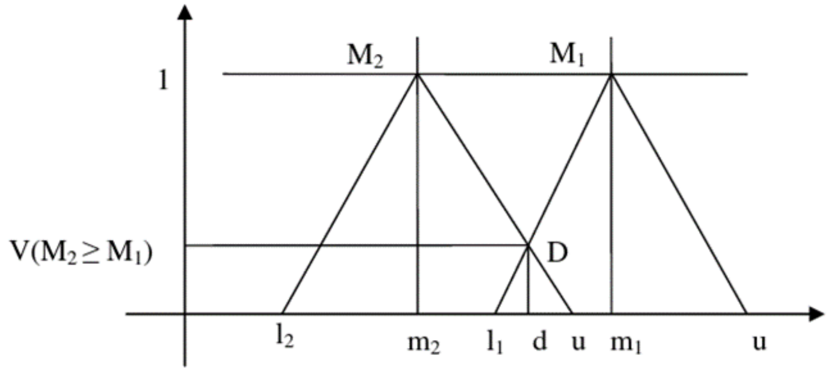

Source: (Chang, 1996).

In order to compare M_1 and M_2, both $\mathrm{V}(M_2 \geq M_1)$ and $\mathrm{V}(M_1 \geq M_2)$ values should be known.

Step 3: The degree of probability that a convex fuzzy number is larger than k convex fuzzy numbers is outlined below.

$$V(M \geq M_1, M_2, \dots, M_k) = V[(M \geq M_1) \text{ ve } (M \geq M_2)] ve \dots ve\ (M \geq M_k)$$

$$= \min V(M \geq M_i), \quad i = 1, 2, \dots, k \tag{9}$$

For $k = 1, 2, \dots, n; k \neq i$, assuming $d'(A_i) = \min V(S_i \geq S_k)$, the weight vector is written as follows. Here $A_i (i = 1,2, .. \text{n})$ comprises of n elements.

$$W' = \left(d'(A_1), d'(A_2), \dots, d'(A_n)\right)^T \tag{10}$$

Step 4: Through normalization, the normalized weight vector is shown as in equation X. W in the equation is a non-fuzzy number.

$$W = \left(d(A_1), d(A_2), \dots, d(A_n)\right)^T \tag{11}$$

3.2. COPRAS

Let COPRAS method stands for "Complex PRoportional ASsessment" and it was introduced by Zavadskas and Kaklauskas (Zavadskas et al. 1994; Zavadskas and Kaklauskas, 1996). For multi-criteria evaluation, both maximizing and minimizing criterion values are used in this approach (Podvezko, 2011). The COPRAS method offers a solution proportional to the best solution. The significance and level of utility of the alternatives taken into consideration are assumed to be directly and proportionately correlated by this method (Yazdani et al., 2011). The most important advantages of the COPRAS method are that it shows to what extent they are

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better or worse than each other by comparing them with percentage values and that it is easy to apply (Özbek and Erol, 2016). Additionally, with this method, evaluation can be made for both qualitative and quantitative criteria (Aksoy et al., 2015).

The following are the steps in the COPRAS method (Zavadskas, 2007; Özdağoğlu, 2013; Sarıçalı and Kundakcı, 2016):

Step 1. Creating the Decision Matrix

In the first step of the COPRAS method, the decision matrix D consisting of xij values is created as shown in Equation (12).

$$D = \begin{matrix} A_1 \\ A_2 \\ A_3 \\ . \\ . \\ A_m \end{matrix} \begin{bmatrix} x_{11} & x_{12} & x_{13} & . & x_{1n} \\ x_{21} & x_{22} & x_{23} & . & x_{2n} \\ x_{31} & x_{32} & x_{33} & . & x_{3n} \\ . & . & . & . & . \\ . & . & . & . & . \\ x_{m1} & x_{m2} & x_{m3} & . & x_{mn} \end{bmatrix} \quad (12)$$

Step 2. Creating the Normalized Decision Matrix

The normalized decision matrix is created using the formula shown in Equation (13).

$$x_{ij}^{*} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \forall j = 1,2,\ldots,n \quad (13)$$

Step 3. Creating the Weighted Normalized Decision Matrix

Using the weights of the criteria, a D' weighted normalized decision matrix with dig elements is created and the formula shown in Equation (14) is used for this process.

$$D' = d_{ij} = x_{ij}^{*}.w_j \quad (14)$$

Step 4: Calculation of Maximizing and Minimizing Index for Each Alternative

Maximizing index indicates situations where it is better to get a higher value while achieving the goal; the minimizing index indicates situations where it is better to take a lower value while achieving the goal. The sum of the values in the weighted normalized decision matrix is calculated for both indices. While the sum of the values in the weighted normalized decision matrix of the maximizing index, shown as Si+, is calculated with the formula shown in equation (15); the sum of the values in the weighted normalized decision matrix of the minimizing index, denoted by Si-, is calculated with the formula shown in equation (16).

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$$S_{i+} = \sum_{j=1}^{k} d_{ij} \qquad j = 1,2,\dots,k \qquad \text{maximizing index} \tag{15}$$

$$S_{i-} = \sum_{j=k+1}^{n} d_{ij} \qquad j = k+1, k+2,\dots,n \qquad \text{minimizing index} \tag{16}$$

Step 5. Calculating Relative Importance Weights

Using the formula in Equation (17), the relative importance weight expressed as *Qi* is calculated for all alternatives. The alternative with the highest *Qi* value is considered the best alternative.

$$Q_i = S_{i+} + \frac{\sum_{i=1}^{m} S_{i-}}{S_{i-}.\sum_{i=1}^{m} \frac{1}{S_{i-}}} \tag{17}$$

Step 6. Determining the Highest Relative Importance Weight

Using Equation (18), the highest relative importance value, indicated by Q_{max}, is found.

$$Q_{max} = maximum\{Q_i\} \ \forall i = 1,2,\dots,m \tag{18}$$

Step 7. Finding Performance Index for Alternatives

The Performance Index, expressed as pi, is found using Equation (19).

$$P_i = \frac{Q_i}{Q_{max}}.100\% \tag{19}$$

The alternative with a P_i value of 100 is the optimal alternative. Arranging the P_i values in order of largest to smallest yields the alternative preference ranking.

4. Application

4.1. Purpose and Significance of The Research

The value of the study lies in its ability to identify the most suitable kindergarten according to the criteria desired by parents in their kindergarten selection. Hence, the opportunities and support provided to children during the pre-school education period make significant contributions to later periods of life (Girgin et al., 2011: 66). Since pre-school education plays a critical role in the cognitive, social and emotional development of the individual, it can be said that choosing the right kindergarten will directly affect both the future success of children and social development.

On the other hand, choosing a kindergarten is a complex process and requires a systematic approach. This research provides a scientific and objective method by minimising subjective

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judgements in the decision-making process. The integration of fuzzy AHP and COPRAS methods makes the multi-criteria decision-making process in kindergarten selection more transparent, consistent and systematic, providing parents with a reliable guide. The best decision for families is therefore the peace of mind that their child will be cared for in a suitable and safe environment.

When the literature is examined, it is seen that fuzzy AHP and COPRAS methods have been applied separately or integrated in many studies. However, there is no study on kindergarten selection by using these methods in an integrated manner. It can be said that the study is unique in this respect.

4.2. Criteria

In addressing the kindergarten selection problem, 9 criteria were identified through a comprehensive review of the extant literature. The first criterion, 'Fee', refers to the annual fee of the kindergarten, and is one of the criteria frequently considered since it is directly related to the budgets of families. The second criterion, indicated as the ‘Teacher’, refers to the qualifications and experience of the teacher. These abilities play a pivotal role in the child's development and ensure that they receive appropriate guidance and care. The ‘Quota’ criterion pertains to the number of students accepted by the kindergarten, thereby influencing the level of individual attention each child receives. The ‘Distance’ criterion refers to the distance between the kindergarten and the students' homes or workplaces. It is a significant aspect, as it impacts daily convenience and emergency accessibility. The ‘School Bus’ criterion indicates whether the kindergarten has a school bus service. The availability of a school bus service can provide safe and efficient transportation, which should be evaluated on the basis of safety measures and reliability. The ‘Facility’ criterion includes provisions for the kindergarten's infrastructure, encompassing classrooms, designated play areas, and sanitation standards. Additionally, it addresses the structural integrity of the buildings. Facility features contribute to the overall learning and comfort of children. The ‘Education’ criterion refers to the content of the education provided, including foreign language education and the use of different techniques. The education programme offered should align with developmental goals, incorporating structured activities that promote cognitive, social and emotional growth. ‘Food’ criterion refer to providing food services that are appropriate for the age of the students and ensure that they receive the essential nutrition. The ‘Medical Staff’ criterion refers to the presence of appropriate health personnel in the kindergarten. The presence of such staff is indicative of the kindergarten's preparedness to respond to health emergencies and to provide

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first aid when necessary. 9 criteria, along with their respective sources, are presented in Table 1.

Table 1. Sources of the Research Criteria

Criteria	Source
Fee	Muslihudin et al. (2019), Kara and Baş (2022), Özdemir and Şallı (2022), Azmi et al. (2021), Lescauskiene et al. (2020), Çemrek and Özaydın (2019), Karakış (2018), Mamat et al. (2017)
Teacher	Kara and Baş (2022), Özdemir and Şallı (2022), Azmi et al. (2021), Lescauskiene et al. (2020), Karakış (2018), Çemrek and Özaydın (2019)
Quota	Kara and Baş (2022)
Distance	Muslihudin et al. (2019), Kara and Baş (2022), Azmi et al. (2021), Lescauskiene et al. (2020), Çemrek and Özaydın (2019), Karakış (2018)
School Bus	Çemrek and Özaydın (2019)
Facility	Muslihudin et al. (2019), Özdemir and Şallı (2022), Azmi et al. (2021), Lescauskiene et al. (2020), Karakış (2018), Mamat et al. (2017), Çemrek and Özaydın (2019)
Education	Özdemir and Şallı (2022), Çemrek and Özaydın (2019)
Food	Özdemir and Şallı (2022), Çemrek and Özaydın (2019)
Medical Staff	Çemrek and Özaydın (2019)

4.3. Research Group

The participants of the study were parents living in Sivas province of Turkey with children between the ages of 2-6 and actively involved in the decision-making process of kindergarten selection. With the selection of Sivas province, the study was evaluated in a local context. The sample of the research was formed by using simple random sampling method. Simple random sampling ensures that a sample of n units is selected from a population of N units by giving all samples of n units equal chance of selection (Orhunbilge, 2000). 13 parents who participated in the study completed the survey. Considering the scale and scope of the study, it can be said that a sample of 13 families is sufficient. The 13 families were selected to show variety in terms of demographic factors such as income level and education level, and in this respect, they have the feature of being a sample.

While determining the kindergarten alternatives, the institutions that were on the preference lists of the 13 families participating in the study were taken into consideration. Thus, the study was shaped based on field data.

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4.4. Data Collection Tools

Within the framework of the research, firstly, a scale was prepared that allows parents to make a pairwise comparison of each criterion in order to determine the significance of the criteria they consider when choosing a kindergarten. In the scale, kindergarten selection criteria are determined as fee, teacher, quota, distance, school bus, location, education, food and medical staff. Parents were asked to compare each criterion and indicate how important it was (equal importance, weak importance, moderate importance, more importance and absolute importance).

Secondly, within the scope of the study, participants were asked to evaluate alternative kindergartens determined according to the criteria. Evaluation criteria were determined as very low (1), low (2), moderate (3), well (4) and very well (5).

In order to apply the scale prepared to evaluate the criteria to the parents within the scope of the study, ethics committee confirmation was acquired from Istanbul Gedik University Ethics Committee Commission at its meeting dated 28.03.2024 and numbered 2024/3.

4.5. Research Method

The purpose of identifying the priority order of the criteria in the kindergarten selection problem, the data acquired from the participants were calculated with the fuzzy AHP method. Following the collection of the participants' opinions regarding the alternative kindergartens, the most suitable alternative was identified through the use of the COPRAS method. Thus, an integrated method was applied to the kindergarten selection problem.

5. Findings

5.1. Determination of Criterion Weights with Fuzzy AHP

In the study, 13 parents were asked to assess the importance level of 9 criteria determined for the kindergarten selection problem by making pairwise comparisons. Accordingly, participants were encouraged to use a linguistic scale containing 5 levels: equal importance, weak importance, moderate importance, more importance and absolute importance (Organ & Kenger, 2018: 273; Vatansever & Uluköy, 2013: 282). Afterwards, the data collected from the participants were recovered from linguistic variables using the scale in Table 2 and transferred to a matrix in the shape of triangular fuzzy numbers.

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Table 2. Triangular Fuzzy Number Correspondence of Linguistic Variables

Equal Importance			Weak Importance			Moderate Importance			More Importance			Absolute Importance		
1	1	1	2	3	4	4	5	6	6	7	8	9	9	9

Source: (Organ & Kenger, 2018: 273;Vatansever & Uluköy, 2013: 282)

13 matrices were created with the data acquired in consequence of pairwise comparison of each participant's criteria. Then, the final pairwise comparison matrix to be used in the study was obtained by taking the geometric average of the data. Afterwards, synthetic addition process was applied and triangular fuzzy was created for each criterion and shown in Table 3. Here, small values in the triangular fuzzy number indicated by l, "m" denotes median and ideal values, and "u" denotes large values. In Table 4, the normalized synthetic total values of the criteria computed by division the values obtained by the synthetic addition process by the total values are given. Equations (3-6) were employed in the construction of these tables.

Table 3. Triangular Fuzzy Numbers of Criteria Obtained by Synthetic Sum

Criteria	l	m	u
Fee	12.77	14.23	16.29
Teacher	16.63	18.65	20.67
Quota	7.19	8.02	8.88
Distance	7.36	8.33	9.40
School Bus	3.53	3.86	4.31
Facility	14.88	17.16	19.46
Education	20.15	22.89	25.82
Food	14	16.14	18.3
Medical Staff	5.44	6.12	6.93
TOTAL	101.93	115.39	130.06

Table 4. Normalized Triangular Fuzzy Numbers of Criteria

Criteria	l	m	u
Fee	0.10	0.12	0.16
Teacher	0.13	0.16	0.20
Quota	0.06	0.07	0.09
Distance	0.06	0.07	0.09
School Bus	0.03	0.03	0,04
Facility	0.11	0.15	0.19
Education	0.15	0.20	0.25
Food	0.11	0.14	0.18

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Medical Staff	0.04	0.05	0.07
TOTAL	0.78	1.00	1.28

In the subsequent stage, the synthesis values obtained through the application of Equations (7) and (8) are compared, and the precedence values of the criteria are defined. These values are given in Table 5.

Table 5. Comparison Matrix According to Priority Values of Criteria

Criteria	Fee	Teacher	Quota	Distance	School Bus	Facility	Education	Food	Medical Staff
Fee	1.00	0.52	1.00	1.00	1.00	0.64	0.06	0.76	1.00
Teacher	1.00	1.00	1.00	1.00	1.00	1.00	0.57	1.00	1.00
Quota	0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.00	1.00
Distance	0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.00	1.00
School Bus	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
Facility	1.00	0.83	1.00	1.00	1.00	1.00	0.42	1.00	1.00
Education	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Food	1.00	0.70	1.00	1.00	1.00	0.88	0.30	1.00	1.00
Medical Staff	0.00	0.00	0.44	0.37	1.00	1.00	0.00	0.00	1.00

Afterwards, the defuzzification process was performed for the criteria and the defuzzified values of the criteria were found. According to the clarified values, the weights of the criteria were calculated and the ranking process was carried out. Hence, the conclusions of the study indicated that the education criterion was the most important factor, followed by the teacher criterion, the venue criterion, the food criterion, and finally, the fee criterion. The computations led to the determination that the other criteria's weights were zero. In this sense, it was concluded that they had no effect on the determination of alternatives. The conclusions of the computations are displayed in Table 6.

Table 6. Weights and Rankings of Criteria

Criteria	Defuzzified Values	Weight	Rank
Fee	0.06	0.03	5
Teacher	0.57	0.24	2
Quota	0.00	0.00	
Distance	0.00	0.00	
School Bus	0.00	0.00	
Facility	0.42	0.18	3

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Education	1,00	0.43	1
Food	0.30	0.13	4
Medical Staff	0.00	0.00	

5.2. Determination of Alternatives with COPRAS

In consequence of the participants' evaluations, it was revealed that the 5 criteria included in the problem, namely wage, teacher, facility, education and food, had values of 0.03, 0.24, 0.18, 0.43, 0.13, respectively. Then, the common opinion of the participants about the alternatively selected kindergartens was taken and presented with the decision matrix in Table 7 below.

Table 7. Decision Matrix

Weights	0.03	0.24	0.18	0.43	0.13
	Fee	**Teacher**	**Facility**	**Education**	**Food**
KG1	1	2	5	3	4
KG2	3	3	3	4	4
KG3	3	4	2	4	4
KG4	5	4	4	4	5
KG5	2	4	3	3	5
TOTAL	14	17	17	18	22

Normalization was performed by applying Equation (13) and Equation (14), respectively, and the normalized decision matrix was created. The obtained values are presented in Table 8.

Table 8. Weighted Normalized Decision Matrix

Weights	0.03	0.24	0.18	0.43	0.13
	min	**max**	**max**	**max**	**max**
	K1	K2	K3	K4	K5
KG1	0,00	0.03	0.05	0.07	0.02
KG2	0.01	0.04	0.03	0.10	0.02
KG3	0.01	0.06	0.02	0.10	0.02
KG4	0.01	0.06	0.04	0.10	0.03
KG5	0.00	0.06	0.03	0.07	0.03

The total weighted normalized values for each alternative were obtained by applying Equation (15) and Equation (16), respectively, using benefit and cost criteria as the bases. The outcomes are shown in Table 9.

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Table 9. Total Weighted Normalized Values

Alternatives	SUM+	SUM-
KG1	0.18	0.00
KG2	0.19	0.01
KG3	0.20	0.01
KG4	0.22	0.01
KG5	0.19	0.00

Then, relative importance values were created using Equation (17) and are given in Table 10.

Table 10. Relative Importance Values

Alternatives	Q_i
KG1	0.19
KG2	0.20
KG3	0.20
KG4	0.23
KG5	0.19

After finding the highest relative importance value of Q_{max} using Equation (18), Performance Index values expressed as P_i were computed using Equation (19) and are indicated in Table 11.

Table 11. Performance Index

Alternatives	P_i
KG1	82.88
KG2	87.09
KG3	88.71
KG4	100
KG5	86.23

When the obtained P_i values are ranked from largest to smallest, it is understood that the KG4 alternative is the best among the alternatives, and the KG1 alternative is the worst.

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6. Results and Recommendations

A number of methodologies have been suggested in the literature for the purpose of conducting MCDM processes. In this research, integrated fuzzy AHP and COPRAS methods were used to detect parents' priorities in choosing a kindergarten and to identify the most suitable option. This study was carried out in a local context by limiting it to Sivas province and a certain number of families (13) could be reached. Since decision-making methods such as fuzzy AHP and COPRAS are techniques that can be applied with expert opinion or a limited number of participants, this number can be said to be sufficient.

The selection of kindergartens is limited to 9 criteria: fee, teacher, quota, distance, service, facility, education, food and healthcare provider. Importance weights and ranking for parents were investigated using fuzzy AHP method. The obtained results showed that 4 criteria (quota, distance, service and healthcare provider) were not included in the problem with a value of 0. It was determined that the remaining 5 criteria - remaining fee, teacher, facility, education and food - took the values of 0.03, 0.24, 0.18, 0.43, 0.13, respectively. Thus, it was found that the most important criterion was education (0.43), followed by teacher (0.24) and facility (0.18). Food (0.13) and fee (0.03) were identified as less important criteria. The fact that parents prioritise education in the selection of kindergarten reveals that they attach great importance to the quality of their children's education and that this factor is decisive in the selection of kindergarten. The importance given to the teacher shows that kindergartens should make more efforts to improve the quality of teachers, while the importance given to the facility shows that kindergartens should improve their physical infrastructure and provide a safer and more suitable environment for children. Kindergartens can make their physical facilities, playgrounds and landscaping more favourable. On the other hand, the low weighting of the fee indicates that parents are ready to make financial sacrifices for the education and general welfare of their children. Hence, parents prefer a higher cost but high-quality kindergarten rather than a low cost but poor-quality kindergarten.

Based on the weight values obtained with Fuzzy AHP, the most suitable alternative from 5 kindergartens selected from Sivas was determined by the COPRAS method. Following the completion of the calculations and a detailed review of the characteristics of the various options, it was realized that the optimal choice was KG4. The alternative with the lowest score was identified as KG1.

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More parents can be reached to increase data in future studies. In addition, sub-criteria can be added to the criteria discussed and the two-stage Fuzzy AHP method can be applied. Different methods in the literature can be used to sort fuzzy numbers. The method can be applied in different provinces and educational institutions.

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References

Acer, A., Genç, T. ve Dinçer, E. (2020). Türkiye'de faaliyet gösteren bireysel emeklilik şirketlerinin performansının Entropi ve COPRAS yöntemi ile değerlendirilmesi. *İstanbul Gelişim Üniversitesi Sosyal Bilimler Dergisi*, *7*(1), 153-169. https://doi.org/10.17336/igusbd.560975

Adali, E. A. ve Işık, A. T. (2016). Air conditioner selection problem with COPRAS and ARAS methods. *Manas Sosyal Araştırmalar Dergisi*, *5*(2), 124-138. https://dergipark.org.tr/en/download/article-file/577434

Akman, G., ve Alkan, A. (2006). Tedarik Zinciri Yönetiminde Bulanık AHP yöntemi kullanılarak tedarikçilerin performansının ölçülmesi: Otomotiv Yan Sanayiinde bir uygulama. *İstanbul Ticaret Üniversitesi Fen Bilimleri Dergisi*, *5*(9), 23-46. https://dergipark.org.tr/en/download/article-file/199475

Aksoy, E., Ömürbek, N. ve Karaatlı, M. (2015). AHP temelli MULTIMOORA ve COPRAS yöntemi ile Türkiye Kömür İşletmeleri'nin performans değerlendirmesi. *Hacettepe üniversitesi iktisadi ve idari bilimler fakültesi dergisi*, *33*(4), 1-28. https://doi.org/10.17065/huiibf.10920

Arslan, T. (2023). *Türk Armatör Şirketlerinde Gemi Adamı Seçim Kriterlerinin Bulanık Ahp Yöntemi ile Analizi*. Yüksek Lisans Tezi, Zonguldak Bülent Ecevit Üniversitesi, Zonguldak.

Arslankaya, D. ve Göraltay, K. (2019). Çok Kriterli Karar Verme Yöntemlerinde Güncel Yaklaşımlar. (İksad Yayıncılık).

Aruldoss, M., Lakshmi, T. M. and Venkatesan, V. P. (2013). A survey on multi criteria decision making methods and its applications. *American Journal of Information Systems*, *1*(1), 31-43. DOI:10.12691/ajis-1-1-5

Ayhan, M. B. (2013). A fuzzy AHP approach for supplier selection problem: A case study in a Gear motor company. *arXiv preprint arXiv:1311.2886*. https://doi.org/10.48550/arXiv.1311.2886

Azmi, F. A. N., Ramlan, R. and Sorooshian, S. (2021). Preschool Selection Criteria Amongst Parents using Best Worst Method (BWM). Proceedings of the International Conference on Industrial Engineering and Operations Management Monterrey, Mexico, November 3-5, 2021. https://ieomsociety.org/proceedings/2021monterrey/297.pdf

Bal E. (2019). *Ebeveynlerin okul öncesi eğitim kurumları ile ilgili görüşleri: Seçme nedenleri ve kurumdan beklentileri* [Yayımlanmamış yüksek lisans tezi]. Yıldız Teknik Üniversitesi.

Buyukozkan, G. and Gocer, F. (2019). A novel approach integrating AHP and COPRAS under Pythagorean fuzzy sets for digital supply chain partner selection. *IEEE Transactions on Engineering Management*, *68*(5), 1486-1503. DOI: 10.1109/TEM2019.2907673

Chang, D. Y. (1996). Applications of the extent analysis method on fuzzy AHP. *European journal of operational research*, *95*(3), 649-655. https://doi.org/10.1016/0377-2217(95)00300-2

Çakır, E. ve Karabıyık, B. K. (2017). Bütünleşik SWARA-COPRAS yöntemi kullanarak bulut depolama hizmet sağlayıcılarının değerlendirilmesi. *Bilişim Teknolojileri Dergisi*, *10*(4), 417-434. https://doi.org/10.17671/gazibtd.296094

Çemrek, F. ve Özaydın, Ö. (2019). Okul Öncesi Eğitimde Ailelerin Kreş Tercihleri Ve Kreşlerden Beklentileri: Eskişehir Örneği . Eskişehir Osmangazi Üniversitesi Sosyal Bilimler Dergisi , Eskişehir Osmangazi Üniversitesi Sosyal Bilimler Dergisi Armağan Özel Sayısı , 559-575. https://doi.org/10.17494/ogusbd.548532

Demirtaş, N., Özgürler, Ş., Özgürler, M. ve Güneri, A. F. (2014). Selecting e-Purse Smart Card Technology via Fuzzy AHP and ANP. *Journal of Applied Mathematics*, *2014*(1), 619030. https://doi.org/10.1155/2014/619030

Efe, B. (2016). An integrated fuzzy multi criteria group decision making approach for ERP system selection. *Applied Soft Computing*, *38*, 106-117. https://doi.org/10.1016/j.asoc.2015.09.037

Ertuğrul, İ. (2007). Bulanik Analitik Hiyerarşi Süreci Ve Bir Tekstil Işletmesinde Makine Seçim Problemine Uygulanması. *Hacettepe Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, *25*(1), 171-192. https://dergipark.org.tr/en/pub/huniibf/issue/7874/103462

Girgin, A., Kurnaz, A., ve Zobu, O. (2011). Erken çocukluk eğitimi ve aile eğitiminin önemi. *I. Türkiye Çocuk Hakları Kongresi Yetişkin Bildirileri Kitabı*, *1*, 66-74.

Gürol, M. A. (2007). Türkiye'de İş Yaşamındaki Kent Kadınının Açmazı: Kariyer-Aile. *Karamanoğlu Mehmetbey Üniversitesi Sosyal Ve Ekonomik Araştırmalar Dergisi*, *2007*(3), 144-150. https://dergipark.org.tr/tr/pub/kmusekad/issue/10225/125734

Kajla, T., Sood, K., Gupta, S., Raj, S. and Singh, H. (2024). Identification and prioritization of the factors influencing blockchain adoption in the banking sector: integrating fuzzy AHP with TOE framework. *International Journal of Quality & Reliability Management*, *41*(8), 2004-2026. DOI:10.1108/IJQRM-03-2023-0079

Kara, M. A. ve Baş, E. Ebeveynlerin Kreş Seçimi Üzerine Çok Kriterli Karar Verme: VIKOR Yöntemi ile Giresun Örneği Üzerinde Bir Uygulama. *Karadeniz Sosyal Bilimler Dergisi*, *14*(27), 68. https://doi.org/10.38155/ksbd.1135524

Karakış, E. (2018). Bulanık Ahs Ve Bulanık Moora Yöntemleri İle Okul Öncesi Eğitimi Hizmet Kalitesi Değerlendirmesi Ve Anaokulu Seçimi. *Cumhuriyet Üniversitesi İktisadi ve İdari Bilimler Dergisi*, *19*(2), 184-198. http://esjournal.cumhuriyet.edu.tr/tr/download/article-file/586318

Kavitha, C. and Vijayalakshmi, C. (2010, December). Implementation of fuzzy multi criteria decision technique to identify the best location for call center. In *Trendz in Information Sciences & Computing (TISC2010)* (pp. 21-27). IEEE. DOI: 10.1109/TISC.2010.5714600

Kundakcı, N. and Işık, A. (2016). Integration of MACBETH and COPRAS methods to select air compressor for a textile company. *Decision Science Letters*, *5*(3), 381-394. https://gcris.pau.edu.tr/handle/11499/9790

Kwiesielewicz, M. (1998). A note on the fuzzy extension of Saaty's priority theory. *Fuzzy Sets and systems*, *95*(2), 161-172. https://doi.org/10.1016/S0165-0114(96)00329-6

Lescauskiene, I., Bausys, R., Zavadskas, E. K. and Juodagalviene, B. (2020). VASMA weighting: Survey-based criteria weighting methodology that combines ENTROPY and

WASPAS-SVNS to reflect the psychometric features of the VAS scales. *Symmetry*, *12*(10), 1641. https://doi.org/10.3390/sym12101641

Liu, F. H. F. and Hai, H. L. (2005). The voting analytic hierarchy process method for selecting supplier. *International journal of production economics*, *97*(3), 308-317. https://doi.org/10.1016/j.ijpe.2004.09.005

Mamat, A. R., Rasid, N. H. A., Ahmad, F., Abd Rawi, N., Mohamed, M. A., Awang, W. S. W. and Ghazali, F. (2017, October). Pre school selection system using Analytic Hierarchy Process (AHP): Implementation and usability study. In *2017 IEEE 2nd International Conference on Automatic Control and Intelligent Systems (I2CACIS)* (pp. 7-12). IEEE. DOI: 10.1109/I2CACIS.2017.8239024

Mastalerz, M. W. (2010, April). Electre method for choosing an e-learning platform. In *2010 Proceedings of VIth International Conference on Perspective Technologies and Methods in MEMS Design* (pp. 168-171). IEEE. https://ieeexplore.ieee.org/document/5499295

Mohanrasu, S. S., Janani, K. and Rakkiyappan, R. (2024). A COPRAS-based Approach to Multi-Label Feature Selection for Text Classification. *Mathematics and Computers in Simulation*, *222*, 3-23. https://doi.org/10.1016/j.matcom.2023.07.022

Nazim, M., Mohammad, C. W. and Sadiq, M. (2022). A comparison between fuzzy AHP and fuzzy TOPSIS methods to software requirements selection. *Alexandria Engineering Journal*, *61*(12), 10851-10870. https://doi.org/10.1016/j.aej.2022.04.005

Orhunbilge, N. (2000). Örnekleme yöntemleri ve hipotez testleri. Avcıol Basım Yayın.

Organ, A. and Kenger, M. D. (2018). Bütünleşik bulanık AHP-bulanık MOORA yaklaşımının market personeli seçimi problemine uygulanması. *Anemon Muş Alparslan Üniversitesi Sosyal Bilimler Dergisi*, *6*(ICEESS'18), 271-280. https://dergipark.org.tr/en/download/article-file/546514

Organ, A. and Yalçın, E. (2016). Performance evaluation of research assistants by COPRAS method. *European Scientific Journal*, *12*(10), 102-109. https://core.ac.uk/download/pdf/328025543.pdf

Özbek, A. ve Erol, E. (2016). COPRAS ve MOORA yöntemlerinin depo yeri seçim problemine uygulanması. *Ekonomi İşletme Siyaset ve Uluslararası İlişkiler Dergisi*, *2*(1), 23-42. https://dergipark.org.tr/en/download/article-file/389621

Özbey, A.U. (2022). *Bulanık AHP VE Bulanık TOPSİS Yöntemleri Kullanarak Alt Yüklenici Seçim Kararını İyileştirme*. Yüksek Lisans Tezi, Doğuş Üniversitesi, İstanbul.

Özdağoğlu, A. (2013). Çok ölçütlü karar verme modellerinde normalizasyon tekniklerinin sonuçlara etkisi: COPRAS örneği. *Eskişehir Osmangazi Üniversitesi İktisadi ve İdari Bilimler Dergisi*, *8*(2), 229-255. https://dergipark.org.tr/en/download/article-file/65417

Özdemir, A. ve Şalli, D. (2022). Ebeveynlerin özel okul öncesi kurum seçimlerine ilişkin tercihlerinin çok kriterli karar verme yöntemleri ile stratejik analizi. *Abant İzzet Baysal Üniversitesi Eğitim Fakültesi Dergisi*, *22*(3), 1277-1294. https://dergipark.org.tr/en/download/article-file/875980

Podvezko, V. (2011). The comparative analysis of MCDA methods SAW and COPRAS. *Engineering Economics*, *22*(2), 134-146. http://dx.doi.org/10.5755/j01.ee.22.2.310

Prasetyo, D. H., Mohamad, J. and Fauzi, R. (2018). A GIS-based multi-criteria decision analysis approach for public school site selection in Surabaya, Indonesia. *Geomatica*, *72*(3), 69-84. https://doi.org/10.1139/geomat-2018-0017

Sariçali, G. and Kundakci, N. (2016). AHP ve COPRAS yöntemleri ile otel alternatiflerinin değerlendirilmesi. *International Review of Economics and Management*, *4*(1), 45-66. https://dergipark.org.tr/tr/download/article-file/286589

Taherdoost, H. and Madanchian, M. (2023). Multi-criteria decision making (MCDM) methods and concepts. Encyclopedia, 3(1), 77-87. https://doi.org/10.3390/encyclopedia3010006

Wang Chen, H. M., Chou, S. Y., Luu, Q. D. and Yu, T. H. K. (2016). A fuzzy MCDM approach for green supplier selection from the economic and environmental aspects. *Mathematical Problems in Engineering*, *2016*(1), 8097386. https://doi.org/10.1155/2016/8097386

Van Laarhoven, P. J. and Pedrycz, W. (1983). A fuzzy extension of Saaty's priority theory. *Fuzzy sets and Systems*, *11*(1-3), 229-241. https://doi.org/10.1016/S0165-0114(83)80082-7

Vatansever, K. ve Uluköy, M. (2013). Kurumsal kaynak planlaması sistemlerinin bulanık ahp ve bulanık moora yöntemleriyle seçimi: Üretim sektöründe bir uygulama. *Manisa Celal Bayar Üniversitesi Sosyal Bilimler Dergisi*, *11*(2), 274-293. https://dergipark.org.tr/tr/download/article-file/45812

Yazdani, M., Alidoosti, A. and Zavadskas, E. K. (2011). Risk analysis of critical infrastructures using fuzzy COPRAS. Economic research-Ekonomska istraživanja, 24(4), 27-40. https://doi.org/10.1080/1331677X.2011.11517478

Zavadskas, E. K., Kaklauskas, A. and Sarka, V. 1994. The new method of multicriteria complex proportional assessment of projects, Technological and Economic Development of Economy 1(3): 131–139. https://www.researchgate.net/publication/285902199

Zavadskas, E. K and Kaklauskas, A. (1996). Multicriteria Evaluation of Building (Pastatų sistemotechninis įvertinimas). Vilnius: Technika. https://doi.org/10.1080/13921525.1998.10531385

Zavadskas, E. K., Kaklauskas, A., Peldschus, F. and Turskis, Z. (2007). Multi-attribute assessment of road design solutions by using the COPRAS method. https://journals.rtu.lv/index.php/BJRBE/article/viewFile/1822-427X.2007.4.195%E2%80%93203/2261