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An Uncertainty Framework for Development Level Evaluation of Preschool Education in Rural and Remote Communities

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Abstract: This study proposed an uncertainty framework for evaluation of Integrated Preschool with School in Rural and Remote Communities. This evaluation has various criteria so, we used the concept of multi-criteria decision making (MCDM). There are various MCDM methods to deal with decision making problems. We used the COPRAS method to rank the alternatives. COPRAS is a MCDM method dealing with various criteria and alternatives. This study used the Plithogenic sets to deal with uncertainty and vague information. Three experts are invited to evaluate the criteria and alternatives. Case study with an empirical example with nine criteria and nine alternatives is conducted. The results show the Accessibility and Enrollment Rates criterion has the highest rate and the criterion Financial and Resource Management has the lowest rate. The sensitivity analysis is conducted to show the different criteria weights and rank of alternatives.

Keywords: Uncertainty Framework; Multi-Criteria Decision Making; Rural Preschool Education.

1. Introduction

These days, there is no question about the strategic significance of education for the advancement of a country. Nonetheless, there is a great deal of disagreement over the best strategies to advance education. Critics point to the neoliberal education policies of the 1980s, which were marked by competition for school performance and the industrialization and marketization of education. In a similar vein, the grim globalization and uncertain global economic outlook have put state welfare education initiatives with high welfare qualities under pressure. Today, public education policies in many nations face the challenges of striking a balance between neoliberal and state welfare education policies, as well as between those that prioritize economic growth and employment and those that prioritize public well-being[1], [2].

From a global standpoint, the requirement for experts in socialized mass production following the industrial revolution has compelled nations to prioritize and actively advance education. The state has progressively grown to be the biggest provider and investment in education due to the rise of pre-school education. Governments at all levels have deliberately viewed the development of rural pre-school education as one of the key strategies in the process of putting poverty alleviation policies into practice and completing the task of poverty alleviation, as this situation is more prevalent in certain underdeveloped rural areas[3], [4].

Welfare economics is where the idea of rural preschool education efficiency first emerged, and its main research areas are equity, the input-output ratio, and their interactions. Evaluation of rural preschool is an MCDM methodology.

Decision information in the external environment is becoming more ambiguous and unpredictable as objective things continue to advance. With exact numbers alone, it is challenging to adequately and accurately convey the DMs' cognitive preference for objective objects. As a result, several potent mathematical tools are constantly emerging to make these kinds of problems easier to solve. Following Zadeh's groundbreaking introduction of fuzzy set (FS) theory, a number of expanded techniques, including intuitionistic fuzzy set (IFS) and interval-valued fuzzy set (IVFS), have been widely investigated and effectively used to solve MCDM problem[5], [6]s.

However, in certain real-world scenarios, those technologies that consider membership level, non-membership, or a combination of both are unable to handle ambiguous data. To address this issue, Smarandache developed the idea of the neutrosophic set (NS), which extends the sets from a philosophical perspective and investigates the nature and origin of entities as well as their interactions with other intellectual views. To improve the evaluation accuracy of the DMs' subjective judgments, plithogenic sets—which are produced based on neutrosophic sets with a high degree of uncertainty and vagueness—have been widely used in many different fields[7], [8], [9].

The highly helpful method known as Complex Proportional Assessment (COPRAS) is typically applied to multi-attribute decision making. The primary goal of COPRAS is to determine the relative importance and usefulness of each option. To choose the best option out of all of them, this utility can be translated into the ranks of all the alternatives. Only a small number of researchers have chosen the best machining parameters using COPRAS[10], [11]. One method for making decisions that considers multiple factors is the COPRAS technique. The available options are ranked using the COPRAS technique according to several factors, including associated weight criteria. Finding a solution with the ratio to the ideal solution and the ratio with the ideal-worst solution is the fundamental goal of COPRAS[12], [13].

1.1 Motivation

In summary, the plithogenic set has various advantages to deal with uncertainty information in the MCDM problems. However, few studies focus on computing criteria weights based on the plithogenic sets under uncertainty information from opinions of experts and decision makers. Validation of plithogenic MCDM method in this study is applied to in the education field.

1.2 Objective

To fill the studies gaps and overcome the limitations of previous studies, this paper proposes a MCDM model under plithogenic sets in education field. The aggregation of plithogenic numbers is computed and score function to obtain crisp values is calculated in this study. The criteria weights in this study are computed and rank of alternatives to select the best one is computed.

1.3 Novelty

The contribution and innovation of this study mainly in the field of education under uncertainty framework can be detailed below:

[1] Integrated the plithogenic numbers into one matrix instead of various decision makers and the score function is applied to obtain crisp values.
[2] The criteria weights are computed under the plithogenic numbers and normalized the crisp values.
[3] The plithogenic COPRAS method is applied in this study to solve ethe MCDM problem and rank the alternatives.
[4] The case study with an empirical example is conducted to show the validation of the proposed methodology.
[5] The sensitivity analysis is conducted in this study under ten criteria weights to show the rank of alternatives.

The reminder of this study is organized as follows: Section 2 shows the steps of the COPRAS methodology. Section 3 shows the case study results. Section 4 shows the sensitivity analysis. Section 5 shows the conclusions.

2. COPRAS Method for Plithogenic MCDM with Incomplete Weight Information

In this section, aiming to solve the decision-making problem for ranking the alternatives in this study and compute the criteria weights by rate criteria from the biggest to the smallest. We first outline the decision making methods and then discuss the steps of the proposed method to better understand and solve the MCDM problems. Figure 1 shows the steps of the proposed method.

2.1 Plithogenic Set

Plithogenic set (p, a, V, d, c), an extension of crisp values, fuzzy set, and neutrosophic sets[14], [15].

Let two Plithogenic numbers and their operations as $x = (x_1, x_2, x_3)$ and $y = (y_1, y_2, y_3)$.

Plithogenic intersection

$$\left((x_{i1}, x_{i2}, x_{i3}), 1 \leq i \leq n\right) \wedge P\left((y_{i1}, y_{i2}, y_{i3}), 1 \leq i \leq n\right) = \begin{pmatrix} (x_{i1} \wedge y_{i1}), \\ \left(\frac{1}{2}(x_{i2} \wedge y_{i2}) + \frac{1}{2}(x_{i2} \vee y_{i2})\right), \\ (x_{i3} \vee y_{i3}) \end{pmatrix}, 1 \leq i \leq n \quad (1)$$

$$\left((x_{i1}, x_{i2}, x_{i3}), 1 \leq i \leq n\right) \vee P\left((y_{i1}, y_{i2}, y_{i3}), 1 \leq i \leq n\right) = \begin{pmatrix} (x_{i1} \vee y_{i1}), \\ \left(\frac{1}{2}(x_{i2} \wedge y_{i2}) + \frac{1}{2}(x_{i2} \vee y_{i2})\right), \\ (x_{i3} \wedge y_{i3}) \end{pmatrix}, 1 \leq i \leq n \quad (2)$$

2.2 Method Description

To solve the MCDM problem the opinions of experts are expressed by the Plithogenic numbers. Then we developed a COPRAS under the Plithogenic set to analysis the criteria weights and rank the alternatives. The proposed methodology uses the MCDM methodology to compute the criteria weights and rank the alternatives. The steps of the proposed methodology are provided below.

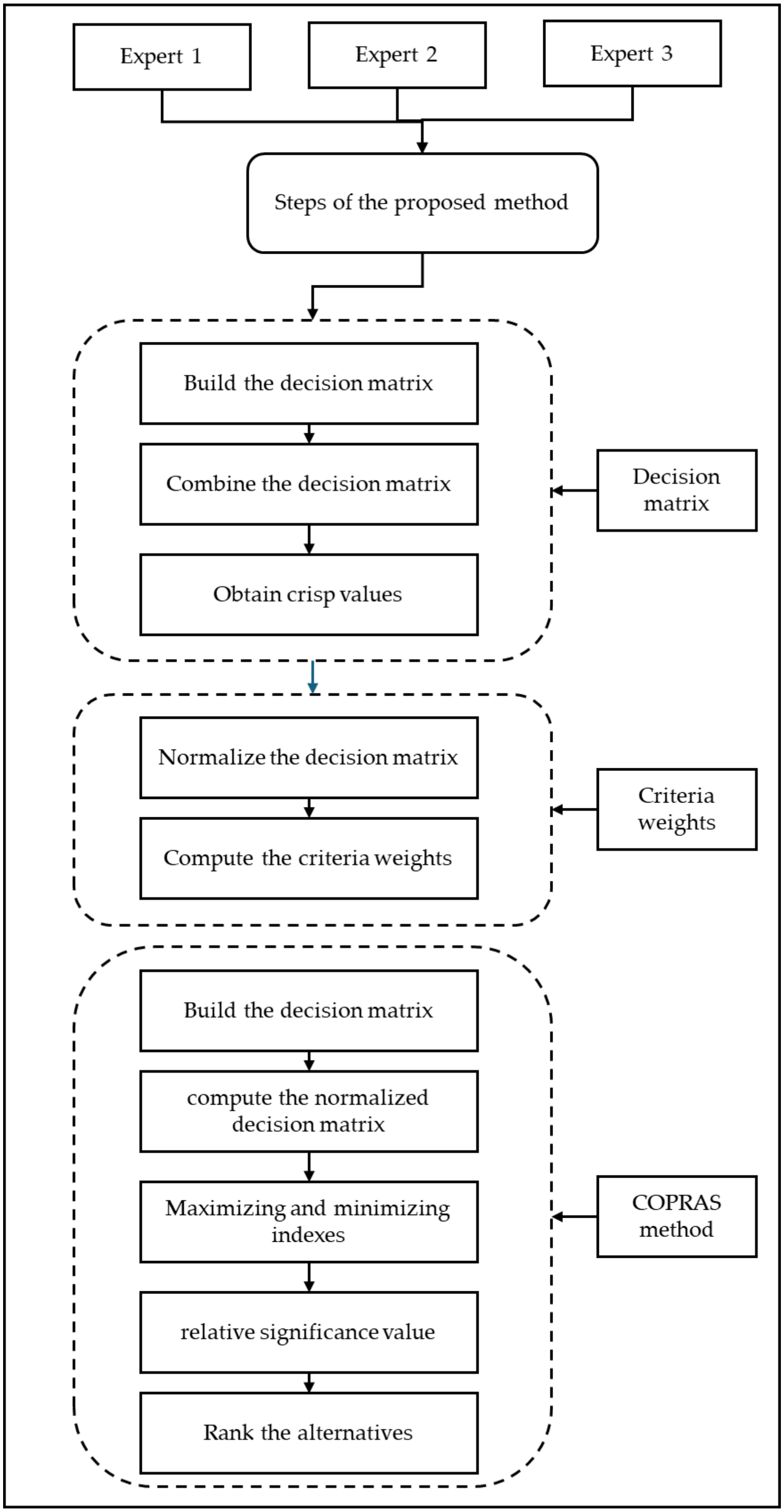
Expert 1
Expert 2
Expert 3
Steps of the proposed method
Build the decision matrix
Combine the decision matrix
Obtain crisp values
Decision matrix
Normalize the decision matrix
Compute the criteria weights
Criteria weights
Build the decision matrix
compute the normalized decision matrix
Maximizing and minimizing indexes
relative significance value
Rank the alternatives
COPRAS method

Figure 1. The conceptual framework.

2.3 The proposed methodology

The features and advantages of this study are to deal with uncertainty, compute the criteria weights and rank the alternatives. The Plithogenic set can deal with the uncertain and vague information in MCDM problems. This study combines the advantages of the Plithogenic set with COPRAS method to compute the criteria weights and rank the alternatives[16], [17].

Step 1. Problem description and determine the combined decision matrix.

Let experts evaluate the criteria and alternatives. Then we used the Plithogenic numbers to replace their opinions. Then we combine these numbers into a single matrix using the Plithogenic operations. Then we obtain crisp values.

Let $A = (A_1, \ldots, A_m), m \geq 1$ be a set of alternatives, $C = (C_1, \ldots, C_n), n \geq 1$ be a set of criteria. The sum of criteria weights must be equal 1 $0 \leq w_j \leq 1$ and $\sum_{j=1}^{n} w_j = 1$.

Step 2. Determine the comprehensive weights of criteria.

The comprehensive weights considering both subjective and objective elements are obtained by applying the modified coefficient to the objective weights of characteristics based on the integrated plithogenic set assessment matrix, which is derived by merging the initial subjective weights that were provided. The degree of consistency between the attribute and other attribute evaluation data is used to calculate the adjustment coefficient of weight.

Then we normalize the crisp values in the decision matrix to compute the criteria weights.

Step 3. Determine the order of alternatives based on COPRAS method under plithogenic set.

The COPRAS method is an MCDM method. It can be used to rank the alternatives. In this stage, we applied the COPRAS method to rank the alternatives and select the optimal one.

We started with the crisp values of the decision matrix.

Normalize the decision matrix.

$$r_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \tag{3}$$

Weighted normalized decision matrix.

We compute the normalized decision matrix as:

$$q_{ij} = w_j * r_{ij} \tag{4}$$

Maximizing and minimizing indexes for positive and negative criteria.

$$S_{+i} = \sum_{j=1}^{g} q_{ij}\,; i = 1, .., m; j = 1, \dots, n \tag{5}$$

$$S_{+i} = \sum_{j=g+1}^{n} q_{ij}\,; i = 1, .., m; j = 1, \dots, n \tag{6}$$

The relative significance value.

$$U_i = S_{+i} + \frac{\min S_{-i} \sum_{i=1}^{m} S_{-i}}{S_{+i} \sum_{j=1}^{m} \frac{\min S_{-i}}{S_{-i}}} \tag{7}$$

$$U_i = S_{+i} + \frac{\sum_{i=1}^{m} S_{-i}}{S_{+i} \sum_{j=1}^{m} \frac{1}{S_{-i}}} \tag{8}$$

Final order of alternatives.

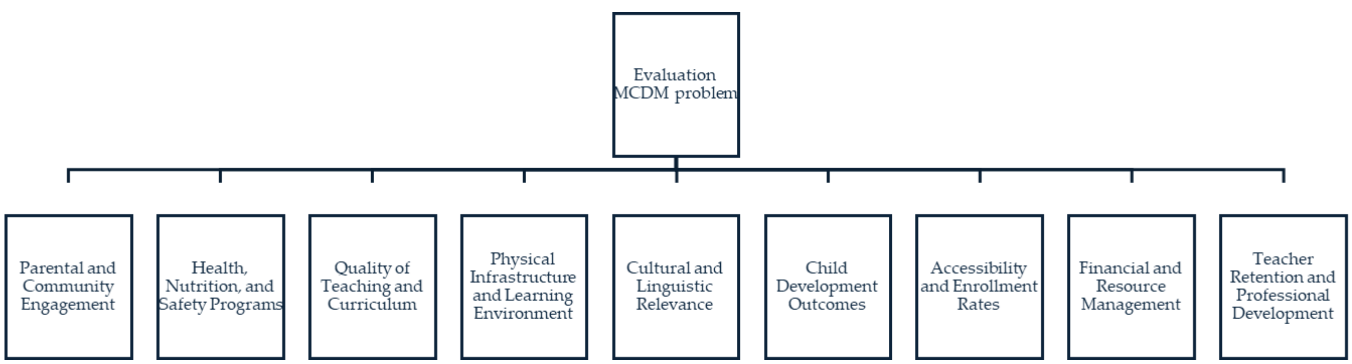

Figure 2. The set of criteria.

3. Case Study

In this section, to illustrate the effectiveness and feasibility of the proposed methodology, an application concerning with a set of criteria and alternates to compute the criteria weights and rank the alternatives.

This study invited three experts to evaluate the criteria and alternatives. We collected nine criteria and nine alternatives. Figure 2 shows the set of criteria.

Step 1. Problem description and determine the combined decision matrix.

Three experts use plithogenic linguistic terms to evaluate the criteria and alternatives. Then we replace these terms by plithogenic numbers as shown in Tables 1-3. Then we combine them by using the operations of plithogenic sets using Eqs. (1 and 2). Then we obtain crisp values.

Table 1. The plithogenic numbers by E1.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
A_1	(0.95, 0.05, 0.05)	(0.65, 0.30, 0.45)	(0.95, 0.05, 0.05)	(0.80, 0.10, 0.30)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.10, 0.75, 0.85)
A_2	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.80, 0.10, 0.30)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.25, 0.60, 0.80)	(0.10, 0.75, 0.85)	(0.95, 0.05, 0.05)
A_3	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.10, 0.75, 0.85)	(0.80, 0.10, 0.30)
A_4	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.80, 0.10, 0.30)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.65, 0.30, 0.45)
A_5	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)
A_6	(0.40, 0.70, 0.50)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.65, 0.30, 0.45)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)
A_7	(0.80, 0.10, 0.30)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)
A_8	(0.95, 0.05, 0.05)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.10, 0.75, 0.85)	(0.95, 0.05, 0.05)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)
A_9	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.40, 0.70, 0.50)

Table 2. The plithogenic numbers by E2.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
A_1	(0.10, 0.75, 0.85)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.80, 0.10, 0.30)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.10, 0.75, 0.85)
A_2	(0.95, 0.05, 0.05)	(0.10, 0.75, 0.85)	(0.80, 0.10, 0.30)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.10, 0.75, 0.85)	(0.10, 0.75, 0.85)	(0.95, 0.05, 0.05)
A_3	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.65, 0.30, 0.45)	(0.95, 0.05, 0.05)	(0.10, 0.75, 0.85)	(0.80, 0.10, 0.30)
A_4	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.10, 0.75, 0.85)	(0.10, 0.75, 0.85)	(0.25, 0.60, 0.80)	(0.80, 0.10, 0.30)	(0.10, 0.75, 0.85)	(0.10, 0.75, 0.85)
A_5	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.10, 0.75, 0.85)	(0.40, 0.70, 0.50)	(0.65, 0.30, 0.45)	(0.95, 0.05, 0.05)	(0.95, 0.05, 0.05)
A_6	(0.65, 0.30, 0.45)	(0.95, 0.05, 0.05)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.10, 0.75, 0.85)	(0.95, 0.05, 0.05)	(0.80, 0.10, 0.30)	(0.80, 0.10, 0.30)
A_7	(0.80, 0.10, 0.30)	(0.80, 0.10, 0.30)	(0.40, 0.70, 0.50)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.80, 0.10, 0.30)	(0.65, 0.30, 0.45)	(0.65, 0.30, 0.45)
A_8	(0.95, 0.05, 0.05)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.10, 0.75, 0.85)
A_9	(0.10, 0.75, 0.85)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.95, 0.05, 0.05)

Table 3. The plithogenic numbers by E3.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
A_1	(0.95, 0.05, 0.05)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.80, 0.10, 0.30)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.10, 0.75, 0.85)
A_2	(0.10, 0.75, 0.85)	(0.95, 0.05, 0.05)	(0.80, 0.10, 0.30)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.10, 0.75, 0.85)	(0.95, 0.05, 0.05)
A_3	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.10, 0.75, 0.85)	(0.80, 0.10, 0.30)
A_4	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.10, 0.75, 0.85)	(0.25, 0.60, 0.80)	(0.80, 0.10, 0.30)	(0.25, 0.60, 0.80)	(0.65, 0.30, 0.45)
A_5	(0.50, 0.40, 0.60)	(0.10, 0.75, 0.85)	(0.65, 0.30, 0.45)	(0.95, 0.05, 0.05)	(0.10, 0.75, 0.85)	(0.40, 0.70, 0.50)	(0.95, 0.05, 0.05)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)
A_6	(0.65, 0.30, 0.45)	(0.95, 0.05, 0.05)	(0.50, 0.40, 0.60)	(0.80, 0.10, 0.30)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.95, 0.05, 0.05)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)
A_7	(0.80, 0.10, 0.30)	(0.80, 0.10, 0.30)	(0.40, 0.70, 0.50)	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.25, 0.60, 0.80)	(0.10, 0.75, 0.85)	(0.65, 0.30, 0.45)	(0.25, 0.60, 0.80)
A_8	(0.95, 0.05, 0.05)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.10, 0.75, 0.85)	(0.95, 0.05, 0.05)	(0.80, 0.10, 0.30)	(0.10, 0.75, 0.85)
A_9	(0.10, 0.75, 0.85)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.95, 0.05, 0.05)

Step 2. Determine the comprehensive weights of criteria.

We used the normalized opinions of experts to compute the criteria weights. As

W=(0.115638051, 0.118522883, 0.119418196, 0.118739547, 0.101092946, 0.09967489, 0.123297502, 0.093307968, 0.110308017).

We show the criterion 7 has the highest score and criterion 8 has the lowest score.

Step 3. Rank the alternatives.

Normalize the decision matrix using Eq. (3) as shown in Table 4.

Table 4. The normalized decision matrix.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
A_1	0.138099	0.137093	0.150426	0.143311	0.142166	0.117725	0.07293	0.064986	0.023274
A_2	0.121702	0.111307	0.142496	0.121038	0.116074	0.109651	0.03997	0.027514	0.162849

A_3	0.109285	0.110668	0.076566	0.098823	0.126086	0.136506	0.136646	0.027514	0.154265
A_4	0.094514	0.106625	0.146394	0.10198	0.059488	0.073837	0.127414	0.09105	0.104366
A_5	0.101474	0.079611	0.128683	0.14278	0.051471	0.099829	0.119632	0.15087	0.141451
A_6	0.110227	0.145556	0.106575	0.125469	0.159369	0.082808	0.137502	0.140059	0.118474
A_7	0.147155	0.132547	0.075299	0.092046	0.109224	0.125758	0.087974	0.145821	0.09374
A_8	0.155343	0.107544	0.098262	0.07573	0.093955	0.09087	0.139919	0.159667	0.054519
A_9	0.022201	0.069049	0.075299	0.098823	0.142166	0.163016	0.138013	0.192519	0.147063

Weighted normalized decision matrix is computed using Eq. (4) as in Table 5.

Table 5. The weighted normalized decision matrix

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
A_1	0.015969	0.016249	0.017964	0.017017	0.014372	0.011734	0.008992	0.006064	0.002567
A_2	0.014073	0.013192	0.017017	0.014372	0.011734	0.010929	0.004928	0.002567	0.017964
A_3	0.012638	0.013117	0.009143	0.011734	0.012746	0.013606	0.016848	0.002567	0.017017
A_4	0.010929	0.012638	0.017482	0.012109	0.006014	0.00736	0.01571	0.008496	0.011512
A_5	0.011734	0.009436	0.015367	0.016954	0.005203	0.00995	0.01475	0.014077	0.015603
A_6	0.012746	0.017252	0.012727	0.014898	0.016111	0.008254	0.016954	0.013069	0.013069
A_7	0.017017	0.01571	0.008992	0.010929	0.011042	0.012535	0.010847	0.013606	0.01034
A_8	0.017964	0.012746	0.011734	0.008992	0.009498	0.009057	0.017252	0.014898	0.006014
A_9	0.002567	0.008184	0.008992	0.011734	0.014372	0.016249	0.017017	0.017964	0.016222

Maximizing and minimizing indexes for positive and negative criteria are computed using Eq. (5)

The relative significance value is computed using Eq. (7)

Final order of alternatives in Table 6. We show alternative 6 is the best and alternative 4 is the worst.

Table 6. The rank of alternatives.

	Rank
A_1	7
A_2	2
A_3	5
A_4	1
A_5	8
A_6	9
A_7	4
A_8	3
A_9	6

4. Sensitivity Analysis

A sensitivity analysis is a rerun of the initial study or meta-analysis that replaces arbitrary or ambiguous decisions with alternative choices or ranges of values. For instance, sensitivity analysis can entail conducting the meta-analysis twice: once with all studies and again with only those that are unquestionably known to be eligible if the eligibility of some of the studies is questionable due to their incomplete information. "Are the findings robust to the decisions made in the process of obtaining them?" is the question posed by a sensitivity analysis.

This section shows the rank of alternatives under different criteria weights. We change the criteria weights by ten different cases as shown in Figure 3. Then we rank the alternatives under different criteria weights. We show the rank of alternatives is stable under different criteria weights. Figure 4 shows the rank of alternatives.

Figure 3. The criteria weights under different cases.

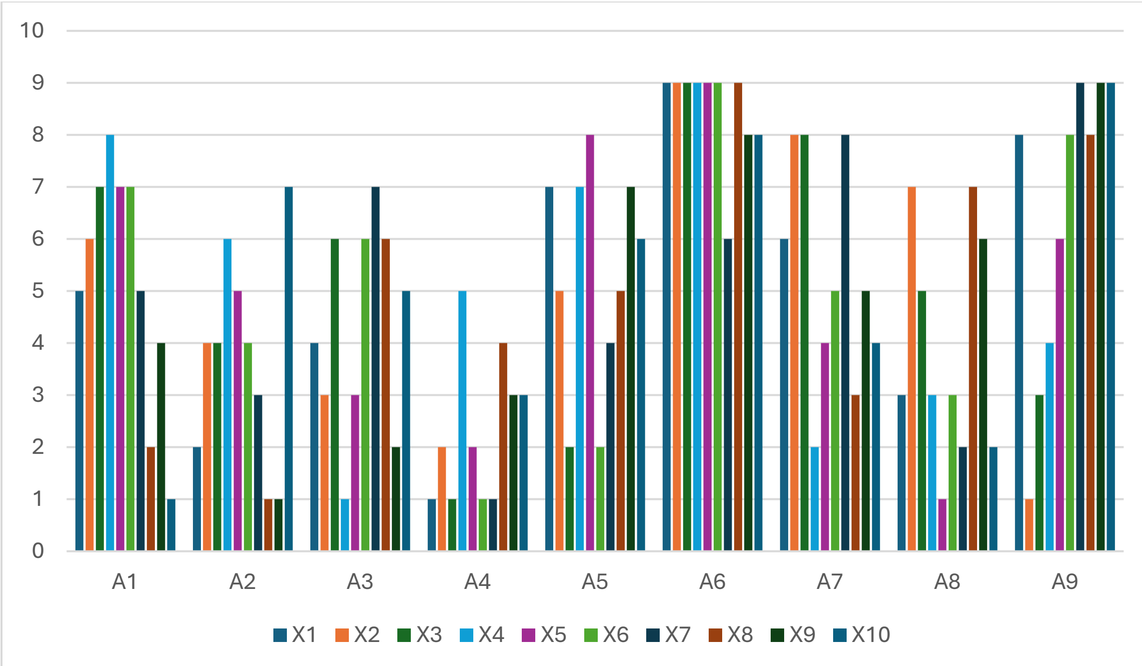

Figure 4. The rank of alternatives under different weights.

5. Conclusions

Evaluation of Rural and Remote Communities preschool is a MCDM problem due to it having various criteria. This study proposed decision making model for evaluating this MCDM problem to compute the criteria weights and rank the alternatives. The COPRAS method is a MCDM method used to rank alternatives. This method is used under the Plithogenic sets to deal with uncertainty and vague information. Nine criteria and nine alternatives are used in this study to be evaluated by three experts and decision makers. We used the Plithogenic numbers to evaluate the criteria and alternatives. Then we combine these numbers using the Plithogenic operations. Then we obtain crisp values. The results show the alternative 6 has the highest rate and alternative 4 has the lowest rate.

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References

[1] J. A. Temple, "Rural gaps in participation in early childhood education," *J. Agric. Appl. Econ.*, vol. 41, no. 2, pp. 403–410, 2009.

[2] M. M. Tang, Z. Zeng, and Q. Lan, "How to evaluate the efficiency of rural preschool education resources and its regional differences in China," *Sci. Rep.*, vol. 14, no. 1, p. 22705, 2024.

[3] H. Yue, "Balanced allocation method of preschool education resources based on coordinated development of urban and rural areas," *Kuram ve Uygulamada Egit. Bilim.*, vol. 18, no. 6, pp. 3599–3609, 2018.

[4] Q. Zhao, "Research on the influence of computer information technology on rural preschool education," in *Journal of Physics: Conference Series*, IOP Publishing, 2021, p. 32066.

[5] F. Smarandache, "Plithogeny, plithogenic set, logic, probability, and statistics," *arXiv Prepr. arXiv1808.03948*, 2018.

[6] P. K. Singh, "Complex plithogenic set," *Int. J. Neutrosophic Sci.*, vol. 18, no. 1, pp. 57–72, 2022.

[7] F. Smarandache, *Plithogeny, plithogenic set, logic, probability, and statistics*. Infinite Study, 2017.

[8] S. Sudha, N. Martin, and F. Smarandache, *Applications of Extended Plithogenic Sets in Plithogenic Sociogram*. Infinite Study, 2023.

[9] F. Smarandache, "An overview of Plithogenic set and symbolic Plithogenic algebraic structures," 2023.

[10] A. R. Mishra, M. Alrasheedi, J. Lakshmi, and P. Rani, "Multi-criteria decision analysis model using the q-rung orthopair fuzzy similarity measures and the COPRAS method for electric vehicle charging station site selection," *Granul. Comput.*, vol. 9, no. 1, p. 23, 2024.

[11] N. Agarwal and D. K. Tayal, "A new model based on the extended COPRAS method for improving performance during the accreditation process of Indian Higher Educational Institutions," *Comput. Appl. Eng. Educ.*, vol. 31, no. 3, pp. 728–754, 2023.

[12] H. Taherdoost and A. Mohebi, "A Comprehensive Guide to the COPRAS method for Multi-Criteria Decision Making," *J. Manag. Sci. Eng. Res.*, vol. 7, no. 2, pp. 1–14, 2024.

[13] D. Kang *et al.*, "A novel MCDM approach to selecting a biodegradable dynamic plastic product: a probabilistic hesitant fuzzy set-based COPRAS method," *J. Environ. Manage.*, vol. 340, p. 117967, 2023.

[14] F. Smarandache, "Plithogeny, plithogenic set, logic, probability and statistics: a short review," *J. Comput. Cogn. Eng.*, vol. 1, no. 2, pp. 47–50, 2022.

[15] P. K. Singh, *Plithogenic set for multi-variable data analysis*. Infinite Study, 2020.

[16] E. K. Zavadskas, A. Kaklauskas, F. Peldschus, and Z. Turskis, "Multi-attribute assessment of road design solutions by using the COPRAS method," *Balt. J. Road Bridg. Eng.*, vol. 2, no. 4, pp. 195–203, 2007.

[17] A. Alinezhad, J. Khalili, A. Alinezhad, and J. Khalili, "COPRAS method," *New methods Appl. Mult. Attrib. Decis. Mak.*, pp. 87–91, 2019.

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