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Enhanced Approach for Japanese Teaching Quality Evaluation in Higher Education under Plithogenic Sets

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Abstract: Japanese language instruction has drawn more attention in the twenty-first century, a time of frequent international interactions and the rapid advancement of knowledge. Colleges and universities are now concentrating on raising the standard of Japanese education going forward as a result. To improve teaching quality, we must strengthen the entire management of teaching quality, particularly the evaluation of instructors' instruction. However, it is challenging to translate the evaluation results into a mathematical analytical formula because there are several elements that affect the quality of instruction, and the weight of each factor changes. We proposed a multi-criteria decision making (MCDM) methodology for evaluation the Japanese teaching quality. We proposed the MCDM method under the Plithogenic sets to deal with vague and uncertainty information. We applied the steps of the MULTIMOORA method under the Plithogenic sets to rank the alternatives. This study collects seven criteria and eight alternatives to be ranked. The criteria weights are computed. The comparative analysis is performed to show the effectiveness of the proposed methodology compared with other MCDM methods. The results show the proposed methodology is effective.

Keywords: Japanese Teaching Quality Evaluation; Higher Education; MCDM; MULTIMOORA Method; Evaluation Method.

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1. Introduction

The 21st century is a time of frequent worldwide interactions and the quick creation of information. Foreign languages are now an essential tool for worldwide communication because of the impact of global globalization. Given this context, there has been a growing interest in teaching Japanese, and the curriculum's overarching objective is to help students become more proficient in the language[1], [2].

While there is few research on the Japanese teaching quality evaluation system, teachers are expected to develop students' cultural literacy, linguistic knowledge, emotional attitude, language abilities, and learning techniques during the teaching session. However, the scientific and logical nature of the educational evaluation system is one of the key elements limiting the advancement of curriculum reform[3], [4].

The primary means by which schools accomplish their educational objectives is through classroom instruction. School administrators and management can better comprehend the extent to which teaching objectives are being met, gain a thorough and accurate understanding of the school's teaching work, and enhance teaching quality by evaluating teachers' classroom instruction. The evaluation of school teaching level is a quite complicated process since the level of teaching job greatly influences the level of people training[5].

In this case, faculty members in higher education might have their yearly performance modeled and assessed using MCDM. This method offers a comparison rating of the faculty members in a fuzzy environment, which is helpful for evaluating individual performance and promoting faculty members[6], [7]. Fuzzy sets, soft sets, and their hybrid models have been widely combined with MCDM techniques to address ambiguity and uncertainty in decision-making processes[8], [9].

Smarandache created plithogenic sets as a generalization of intuitionistic, fuzzy, and crisp sets and advanced the concept of plithogeny. With set P, dominating attribute a, set of attribute values V, degree of appurtenance d, and degree of contradiction c, the plithogenic sets are represented as a quintuple of the form (P, a, V, d, c)[10], [11]. The traits and attribute values that help resolve complex decision-making processes are used to characterize lithogenic sets[12], [13].

Brauers and Zavadskas combined the Reference Point Approach and the Ratio System to introduce MOORA (Multi-Objective Optimization based on a Ratio Analysis) in 2006. To obtain a final integrative ranking based on the outcomes of these triple subordinate methods, Brauers and Zavadskas enhanced MOORA to MULTIMOORA (Multi-Objective Optimization based on Ratio Analysis plus the full Multiplicative form) by adding the Full Multiplicative Form and using Dominance Theory[14], [15]. The first group of MCDM techniques, known as Value Measurement Methods, includes the Ratio System and Full Multiplicative Form, while the second group, known as Goal or Reference Level Models, includes the Reference Point Approach[16], [17].

The following paper is organized so that the reader can understand the basic ideas behind the suggested concepts of proposed method. A thorough description of each of these ideas is given in Section 2. Section 3 presents comparative analysis. Section 4 of the article introduces results and discussion. Section 5 brings the conclusion article.

2. Japanese Teaching Quality Evaluation in Higher Education (JTQE) problem

In this section, we develop an application to rank the problem of JTQE. We applied the proposed method for ranking the alternatives and computing the criteria weights. We integrated the plithogenic set with the MULTIMOORA method to rank the alternatives.

2.1 Flowchart of JTQE

The flowchart of the JTQE problem is given in Figure 1.

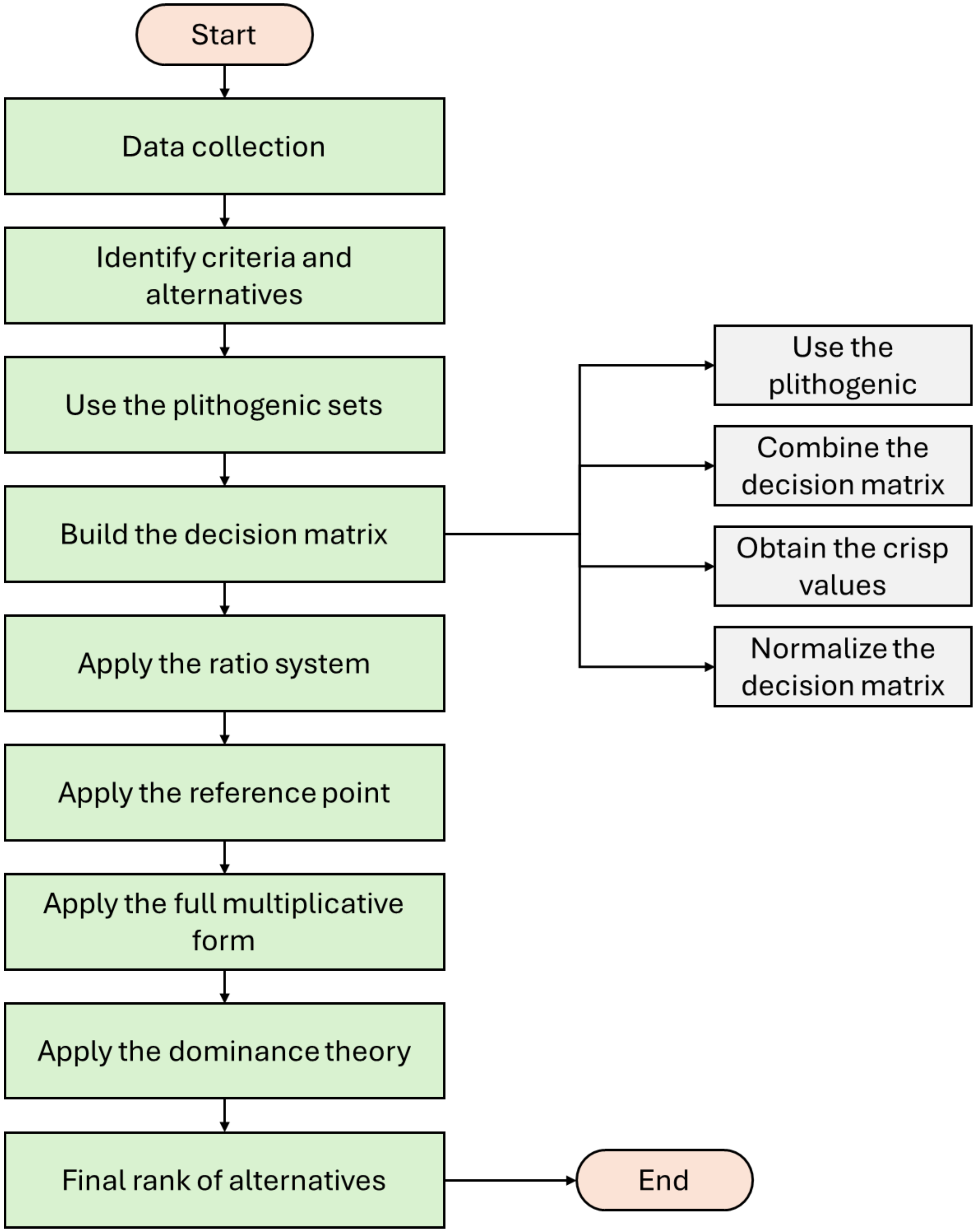

Figure 1. The flowchart of JTQE problem.

2.2 Algorithm of MULTIMOORA Method

MULTIMOORA uses three subordinate ranking techniques—the Ratio System, Reference Point Approach, and Full Multiplicative Form—as well as the vector normalizing technique to produce similar ratings. Since each of the three ranking techniques has advantages and disadvantages, MULTIMOORA employs many strategies. To make the MULTIMOORA approach easier to understand, we describe these three subordinate ranking methods in this section.[14], [15]

Creating a decision matrix and weight vector is the initial step in solving an MCDM problem. As a result, the decision matrix for MULTIMOORA is initially created using the ratings x_{ij} of the problem's m candidate options in relation to n criteria.

Step 1. Build the decision matrix.

The decision matrix is built by a set of experts and decision makers to evaluate the criteria and alternatives.

Step 2. Combine the plithogenic numbers.

We apply the plithogenic operator to combine these numbers.

Step 3. Apply the plithogenic score function to obtain crisp values.

$$S(A) = \frac{(2+T-I-F)}{3} \tag{1}$$

Step 4. Normalize the decision matrix.

Prior to being included in an MCDM model, the ratings of alternatives on the problem's many criteria should be normalized because they may have different dimensions. MCDM techniques have used a variety of normalization strategies. The most reliable option for use in MULTIMOORA is normalization. The following is a representation of vector normalization:

$$y_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m}(x_{ij})^2}} \tag{2}$$

The Ratio System, a completely compensating paradigm, is helpful in situations where the problem involves "independent" criteria. The Full Multiplicative Form, an incompletely compensatory model, is a useful tool in situations where "dependent" requirements are present. As a non-compensatory model, the Reference Point Approach provides a "conservative" way to compare the Full Multiplicative Form and the Ratio System. Although the Reference Point Approach does not permit it, the Ratio System and Full Multiplicative Form both offer the chance to make up for an alternative's subpar performance on one criterion by its performance on other criteria (the amount of compensation associated with the two approaches is not equal).

Ratio system

The ratio system is a fully compensating model that employs the arithmetic weighted aggregation operator. It implies that the same degree of high values could fully offset small, normalized values of an alternative. Stated differently, an alternative that performs poorly on certain criteria and well on the other criteria can be replaced by one that performs moderately on all criteria. The weighted normalized ratings are added for beneficial criteria and subtracted for non-beneficial criteria in the following manner to calculate the Ratio System's utility:

$$u_i = \sum_{j=1}^{g} w_j y_{ij} - \sum_{j=g+1}^{n} w_j y_{ij} \tag{3}$$

Reference point

$$r_j = \{\max y_{ij}, j \leq g; \min y_{ij}, j > g\} \tag{4}$$

According to the Reference Point Approach, the option with the lowest value across all criteria is the best one. As a non-compensatory model, this method first identifies the alternative ratings that perform the poorest across all criteria, and then it chooses the best overall value (i.e., the lowest value) from these worst ratings. The Min-Max Metric is the foundation of the Reference Point Approach. The general theory of Murkowski Metric, the foundation of various decision analysis techniques found in literature, including Goal Programming, is where the Min-Max Metric got its start. First, the Maximal Objective Reference Point (MORP) Vector is defined as follows to determine the utility:

The distance is computed as follows:

$$d_{ij} = |w_j r_j - w_j y_{ij}| \tag{5}$$

We compute the utility reference point as:

$$z_i = \max d_{ij} \tag{6}$$

The best alternative is computed based on the lowest value in utility reference point.

Full Multiplicative Form

The utility of full multiplicative form is computed as follows:

$$e_i = \prod_{j=1}^{g} (y_{ij})^{w_j} / \prod_{j=g+1}^{n} (y_{ij})^{w_j} \tag{7}$$

The alternatives are ranked based on the largest value of utility degree.

2.2 Application of MULTIMOORA Method

We applied the steps of the proposed methodology to rank the alternatives and compute the criteria weights. This study collected seven criteria and eight alternatives as shown in Figure 2.

Japanese Teaching Quality Evaluation in Higher Education	
	Teaching of Japanese Writing Systems
	Incorporation of Technology in Japanese Language Learning
	Proficiency in Teaching Japanese Grammar and Syntax
	Development of Japanese Listening and Speaking Skills
	Student Assessment and Feedback Mechanisms of Japanese
	Utilization of Authentic Japanese Materials and Resources
	Integration of Japanese Culture and Societal Contexts

Figure 2. The seven criteria of this study.

Three experts are evaluated the criteria and alternatives are given in Table 1. Then we combine the plithogenic numbers into a single matrix. Then we obtain crisp values. Then we apply the steps of the MULTIMOORA method under the plithogenic sets.

Table 1. The decision table.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
A_1	(0.40, 0.70, 0.50)	(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)	(0.65, 0.30, 0.45)
A_2	(0.65, 0.30, 0.45)	(0.40, 0.70, 0.50)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.95, 0.05, 0.05)	(0.95, 0.05, 0.05)
A_3	(0.65, 0.30, 0.45)	(0.65, 0.30, 0.45)	(0.65, 0.30, 0.45)	(0.40, 0.70, 0.50)	(0.65, 0.30, 0.45)	(0.40, 0.70, 0.50)	(0.80, 0.10, 0.30)

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

Then we normalize crisp values to obtain the criteria weights. The criteria weights results show as: w1= 0.14568974, w2= 0.138605331, w3= 0.147314866, w4= 0.146706465, w5= 0.13945791, w6= 0.140668997, w7= 0.141556692.

Then we obtain the normalization matrix as shown in Table 2. Then we obtain the results of the ratio system, reference point, and full multiplicative form. Then we apply the dominance theory to obtain the final rank as shown in Figure 3.

Table 2. The normalization matrix.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
A_1	0.327246784	0.139104	0.32762	0.26819	0.316917	0.35284	0.383968
A_2	0.455320078	0.363696	0.310741	0.417741	0.489426	0.437572	0.490106
A_3	0.200552121	0.363469	0.379867	0.338942	0.387416	0.428887	0.385892
A_4	0.380440264	0.397234	0.44384	0.374226	0.334131	0.20334	0.199733

A_5	0.319966372	0.372368	0.244477	0.44801	0.204288	0.472705	0.383968
A_6	0.402622286	0.306165	0.398138	0.159914	0.47491	0.164782	0.383968
A_7	0.396875407	0.440415	0.319575	0.416217	0.165551	0.320393	0.164077
A_8	0.280435283	0.363469	0.366608	0.31483	0.321887	0.32479	0.319022

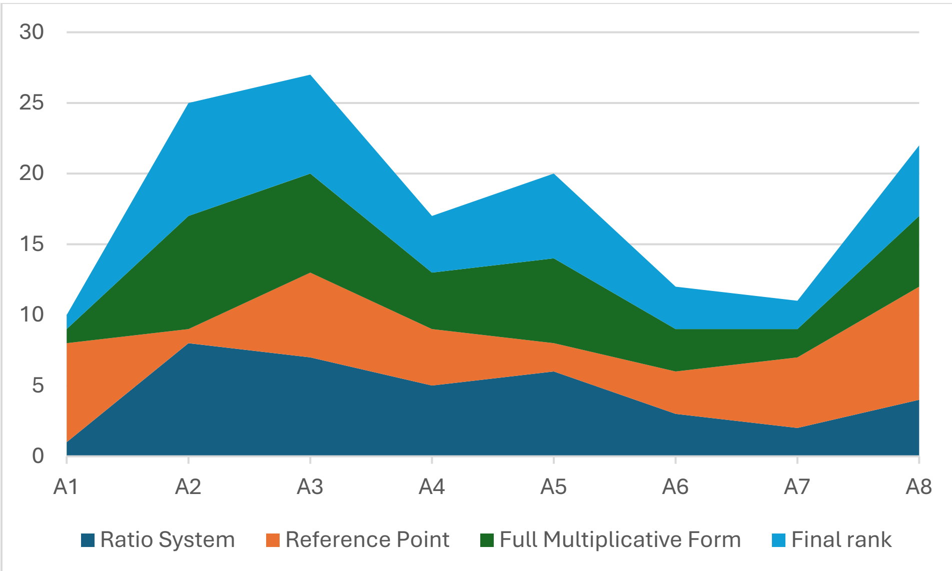

Figure 3. The final rank.

3. Comparative Analysis

This section shows the comparative analysis between the proposed methodology and other MCDM methods to show the effectiveness of the proposed methodology. The proposed methodology and other MCDM methods show the best alternative is A2 and alternative 1 is the worst. The results show the our methodology is effective compared to other MCDM methods. Figure 4 shows the comparative analysis results.

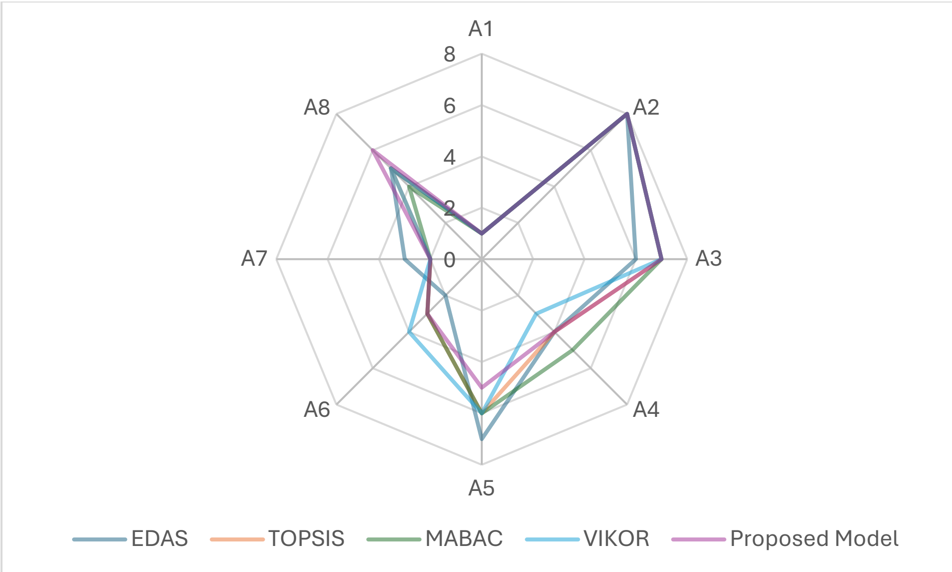

Figure 4. The rank of comparative study.

4. Results and Discussion

In the rank of alternatives, we applied three elements of the MULTIMOORA method such as ratio system, reference points and full multiplicative form. In the ratio system, we show the alternative 2 is the best and followed by the alternative 3 and alternative 5. The alternative 1 is the worst and followed by the alternative 7.

In the reference point, we show the alternative 8 is the best and followed by the alternative 1 and alternative 3. The alternative 2 is the worst and followed by the alternative 6.

In the full multiplicative form, we show the alternative 2 is the best and followed by the alternative 3 and alternative 5. The alternative 1 is the worst and followed by the alternative 7.

In the final rank, we show the alternative 2 is the best and followed by the alternative 3 and alternative 5. The alternative 1 is the worst and followed by the alternative 7.

5. Conclusions

Although many teachers are aware of the significance of implementing cultural literacy considering the ongoing progress of the new curriculum reform, they typically assume that it refers to the Japanese cultural background or certain aspects of Japanese nonverbal behavior. Some teachers do not even incorporate characteristics into cultural literacy lessons, and they are not well understood. Assessing the quality of Japanese instruction is particularly important because teachers usually grasp certain speech act aspects as grammatical knowledge right away while teaching Japanese courses. One of the most important steps in motivating educators to raise the standard of instruction and education is assessing their effectiveness as teachers. This study used the MULTIMOORA method under the Plithogenic sets to deal with the vague and uncertainty information. Three experts and decision makers are evaluating the criteria and alternatives. They used the Plithogenic numbers to be evaluated the criteria and alternatives. We used the Plithogenic operators to combine the Plithogenic numbers. We normalize the crisp values to obtain the criteria weights. Then we applied the MULTIMOORA method under the Plithogenic sets to rank the alternatives. The results showed that the alternative 2 is the best and alternative 1 is the worst. We compared our model with other MCDM methods. The results show our model is effective.

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