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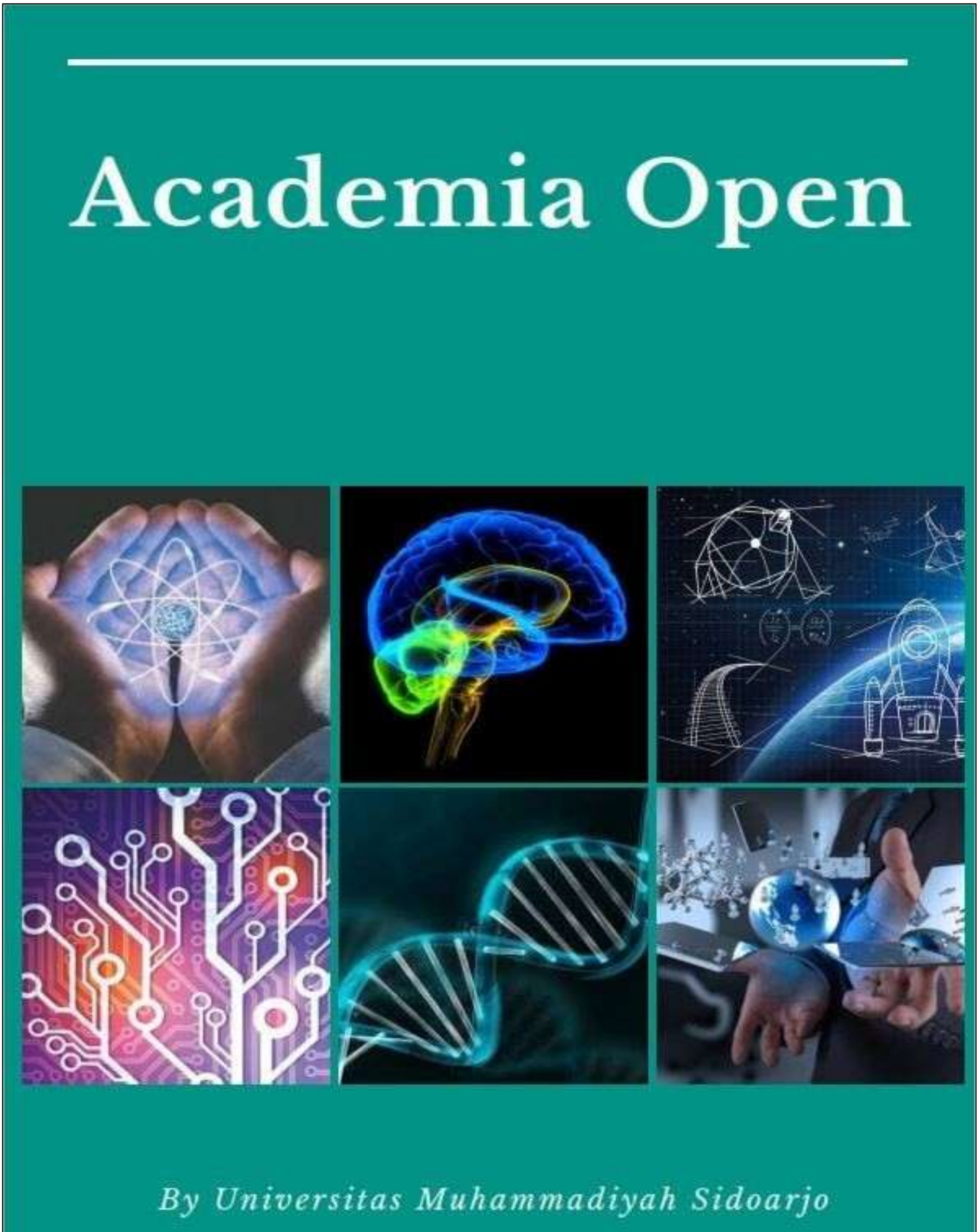

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Decision Support System for Minahasa Cultural Preservation Priorities Using SAW TOPSIS:
Sistem Pendukung Keputusan Prioritas Pelestarian Budaya Minahasa Berbasis SAW dan TOPSIS

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Abstract

General Background The rapid development of digital technology requires structured systems to support sustainable cultural heritage preservation through data-driven approaches. **Specific Background** In Minahasa, cultural assets such as ceremonies and traditional clothing face challenges due to limited analytical systems for prioritization, as existing platforms mostly function as static repositories. **Knowledge Gap** Previous studies rarely integrate multiple Multi-Criteria Decision Making methods simultaneously in cultural preservation contexts, and cross-validation between SAW and TOPSIS remains limited. **Aims** This study aims to design and implement a web-based Decision Support System to determine preservation priorities of Minahasa cultural heritage using SAW and TOPSIS methods. **Results** The system, developed using the waterfall model and validated through testing, shows consistent ranking results, with the Waruga Traditional Funeral Ceremony identified as the highest priority, followed by Kabasaran Traditional Clothing, while minor variations appear in mid-ranked alternatives. **Novelty** The study introduces a comparative integration of SAW and TOPSIS within a web-based system to evaluate ranking consistency and sensitivity in cultural heritage decision-making. **Implications** The findings provide a quantitative and transparent model that supports objective policy formulation and promotes sustainable, data-driven cultural preservation strategies for local governments.

Highlights:

- Consistent ranking results across dual multi-criteria algorithms
- Waruga ceremony identified as highest preservation priority
- Web-based system supports transparent policy formulation

Keywords: Decision Support System; Cultural Heritage; Minahasa; SAW Method; TOPSIS Method

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Introduction

The rapid growth of digital technology has transformed how cultural information is preserved and disseminated [1] . In Indonesia, traditional cultural assets such as ceremonies, clothing, and musical arts are gradually losing recognition due to the lack of integrated digital preservation systems [2] . This situation poses a challenge for regional governments, including the Minahasa Regency, to develop digital solutions that ensure sustainable cultural management [3] . Conventional cultural documentation websites generally act only as static information repositories without providing analytical functions to support decision-making in cultural preservation [4] . Therefore, integrating Decision Support Systems (DSS) into web-based cultural platforms has become essential for prioritizing cultural objects objectively and efficiently [5] .

As, Sumardjo (2021) [6] emphasizes in his latest work, “cultural artifacts constitute texts to be read; they contain historical and hermeneutic meanings that reveal the ways of life of past human communities” (p.150), we recognize that cultural artifacts are not merely objects but texts that must be interpreted to understand the historical and cultural contexts they represent. This aligns with the viewpoint of Fiksiwan (2025), who advocates for understanding culture as an evolving dialogue between history and imagination, stressing the importance of dynamic interpretation in preserving local heritage [7] .

In this study, the concept of Minahasa Cultural Heritage is defined within a clear and operational boundary to ensure analytical feasibility and methodological rigor. Referring to cultural preservation frameworks, Minahasa Cultural Heritage in this research encompasses selected tangible and intangible cultural elements that are actively practiced, documented, and recognized by the local community and cultural authorities.

This research focuses on traditional ceremonies, rituals, traditional clothing, and cultural practices that have masurable attributes and are linked to conservation policies. Abstract cultural narratives such as myths or folktales were not examined because they are difficult to measure objectively. Assessment was based on criteria such as cultural significance, frequency of practice, accessibility, cost, and supporting facilities. This delimitation allows cultural heritage to be treated as a set of peioritized cultural assets rather than as an undifferentiated cultural totality.

According to, Minahasa cultural heritage is approached as a structured cultural system consisting of selected priority elements, rather than as exhaustive representation of all Minahasa cultural expressions. This selective preservation perspective aligns with practical heritage management strategies, where limited resources require cultural authorities to prioritize cultural elements that have the highest social, historical, and sustainability value for the community.

A DSS provides a structured mechanism to evaluate and rank alternatives based on multiple criteria and quantitative parameters [8] . In the field of Multi-Criteria Decision Making (MCDM), several methods such as Simple Additive Weighting (SAW) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) have been extensively used for ranking and evaluation processes [9] , [10] . The SAW method offers simplicity in computation and transpararency in results interpretation, while TOPSIS focuses on measuring

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the relative distance of each alternative to the ideal solution [11]. Combining both methods allows a more robust analysis by validating the consistency of ranking results [12].

Previous research has implemented these methods in diverse domains such as tourism site evaluation, scholarship selection, and employee performance appraisal, demonstrating their adaptability and reliability in multi criteria environments [13,[14]. However, studies applying SAW and TOPSIS to cultural preservation decision-making remain limited, particularly for local heritage management systems [15]. Previous research has generally focused on commercial or administrative contexts, such as determining tourist destinations or selecting candidates based on relaviley uniform quantitative indicators. The objects assessed are economic and easily measurable, so the parameters tend to be stable, in contrast, cultural heritage preservation has more complex symbolic, historical, and social demnsions, requiring a combination of quantitative analysis and public policy considerations. These differences in the characteristics of decision objects have not been widely discussed in previous literature.

Furthermore, most previous studies have used a single MCDM method in isolation without cross-validation between methods to test the consistency of ranking results. This study strengthens scientific contributions by simultaneously integrating SAW and TOPSIS in a single web based sistems, allowing for comparative analysis on the stability of alternative cultural rankings. This approach provides methodological value that has not been widely explored in the context of local cultural heritage management.

This research fills that gap by designing and implementing a web based decision support system that integrates SAW nad TOPSIS to determine the preservation priority of Minahasa cultural heritage. The system incorporates criteria such as cultural significance, accessibility, frequency of practice, cost, and supporting facilites to produce ranking recommendantions that can assist the Minahasa Tourism and culture office in formulating preservation policies.

This study aims to design a DSS to determine cultural preservation priorities, apply the SAW and TOPSIS methods to a dynamic web system, and analyze the consistency of ranking results. The system was developed using the waterfall model through the stages of analysis, design, implementation, and testing [16]. The results are expected to support the digitalization of cultural management and local heritage preservation policies in Minahasa [17].

Metod

This study employed a quantitative descriptive approach through the design and implementation of a web-based decision support system (DSS). The development process followed the Waterfall model, consisting of four sequential stages: analysis, design, implementation, and testing. The main objective of the method was to produce a multi-criteria evaluation system capable of prioritizing Minahasa cultural elements objectively using the Simple Additive Weighting (SAW) and Technique for order preference by Similarity to ideal solution (TOPSIS) algorithms.

The research degan with a qualitative phase aimed at identifying relevant decision criteria through interviews with local cultural experts and a structured literature reviews. This qualitative process was

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conducted to ensure that the selected criteria accurately represent the contextual characteristics of Minahasa cultural heritage.

Subsequently, the study proceeded to a quantitative phase, in wich the identified criteria were processed mathematically using the Simple Additive Weighting (SAW) and Tehnique for order preference by similarity to ideal solution (TOPSIS) methods. Quantitative calculations were applied to obtain weighted scores and ranking results for each cultural object, and a comparative analysis between SAW and TOPSIS was conducted to assess the consistency and reliability of the recommendation outcomes.

A. Decision Support System (DSS)

A Decision Support System is an information system that assists decision-makers in solving semi-structured problems by combining data, analytical models, and user-friendly interfaces [18] . DSS is characterized by its ability to handle multi-criteria problems and provide alternative rankings objectively [19] . In this research, DSS serves as the backbone for determining cultural preservation priorities by integrating quantitative analysis into a web environment.

B. Simple Additive Weighting (SAW)

The Simple Additive Weighting method is one of the most widely used Multi-Criteria Decision Making (MCDM) approaches due to its computational efficiency [20] . SAW works by normalizing decision matrix values, multiplying each normalized criterion value by its assigned weight, and summing all weighted values to obtain the final score of each alternative [21] . Mathematically, it can be expressed as:

$$\boldsymbol{V_i = \sum_{j=1}^{n} W_j\, R_{ij}}$$

where $\boldsymbol{V_i}$denotes the total value of alternatives $\boldsymbol{i}$, $\boldsymbol{W_j}$is the weight of criterion $\boldsymbol{j}$, and$\boldsymbol{R_{ij}}$ is the normalized score. The highest $\boldsymbol{V_i}$represents the best alternative.

C. Technique for Order Preference by Similarity to ideal solution (TOPSIS)

The TOPSIS method evaluates each alternative based on its geometric distance from the positive ideal solution and the negative ideal solution [22]. The process includes data normalization, weighting, determining the postitive and negative ideal solutions, and calculating the relative clossness value $C_i$for each alternative.

$$\boldsymbol{C_i = \frac{D_i^-}{D_i^+ + D_i^-}}$$

Where $\boldsymbol{D_i^+}$is the distance of alternative $\boldsymbol{i}$from the positive ideal, and $\boldsymbol{D_i^-}$is its distance from the negative ideal. A higher$\boldsymbol{C_i}$ indicates a better alternative. TOPSIS provides a reliable comparison mechanism to validate the SAW ranking results [23] .

D. System Development Model (Waterfall)

The system was developed using the Waterfall model, which ensures a structured and sequential flow of software engineering activities [24] . The stages include:

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Requirements Analysis – identifying user needs and cultural preservation criteria;

System Design – designing databases, user interfaces, and algorithmic flow;

Implementation – coding the system using PHP, MySQL, HTML, CSS, and Bootstrap;

Testing – evaluating system performance and algorithm accuracy using test data.

E. Data Collection and Criteria

Primary data were collected from Minahasa cultural documentation and expert validation. The criteria used include cultural significance, accessibility, practice frequency, cost, and supporting facilities, each given a weight determined by expert judgment. Both SAW and TOPSIS utilized these criteria to generate quantitative rankings [25] , [26] .

The final system integrates all stages of DSS development into a responsive web interface that supports ranking visualization and comparison of SAW–TOPSIS results. This integration demonstrates how computational decision-making can strengthen cultural policy formulation at the regional level [27] .

Result And Discussion

A. Research Results

This section presents the implementation and testing results of the web-based Decision Support System (DSS) for determining the preservation priority of Minahasa cultural heritage. The development outcome is divided into several parts: system interface results, the process of data normalization and ranking using SAW and TOPSIS, and comparison analysis between the two methods.

1. Results of the Simple Additive Weighting (SAW) Method

This subsection presents the results of the calculation using the Simple Additive Weighting (SAW) method that has been implemented in the system. The SAW method was chosen due to its ability to provide a simple yet effective result by summing the utility values of each criterion that have been normalized and multiplied by their respective weights. The calculation steps implemented in the system include:

a. Retrieving normalized criterion weights so that the total weight equals 1.
b. Constructing an initial value table (X) containing the assessment of each cultural object against the determined criteria.
c. Normalizing the values for each criterion according to their type, whether benefit or cost.
d. Calculating the final score (Si) by summing the multiplication results of weights and normalized values for each object.
e. Ranking the cultural objects based on their Si values from highest to lowest to determine preservation priority.

The following figures show the results displayed by the system:

2. Criteria and Weights

At the initial stage, the criteria used and their respective weights were defined as follows:

Table 1*List of Criteria and Weight Configuration in the DSS*

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Code	Criterion Name	Type	Weight
C1	Cultural Significance	Benefits	0.3500
C2	Accessibility	Benefits	0.2000
C3	Frequency of Practice	Benefits	0.2000
C4	Visit Cost	Cost	0.1000
C5	Supporting Facilities	Benefits	0.1500

The weights have been normalized so that their total equals 1.0000, as required by the SAW method. Benefit-type criteria indicate that higher values represent better performance, while cost-type criteria indicate that lower values are preferable.

3. Initial Value Table (X)

At this stage, the system displays the raw values (X) of each cultural object for each criterion. These values serve as the input before the normalization process. The table represents the decision matrix, showing the performance of each object across the five criteria—C1 (Cultural Significance), C2 (Accessibility), C3 (Frequency of Practice), C4 (Visit Cost), and C5 (Supporting Facilities). Higher scores in benefit criteria indicate better performance, while lower scores in cost criteria are considered superior

4. Computation Notification

After all the values are entered, the calculation process is executed by clicking the "Calculate SAW" button. The system then displays a notification confirming that the computation has been successfully completed for all cultural objects, as shown in Figure 1.

Figure 1 *Alert SAW Calculation Successful*

5. SAW Ranking Table

Once the computation is completed, the system presents the results in a ranking table consisting of the cultural object name, category, final score (Si), and rank. The table displays the seven cultural objects with the highest scores.

Based on the SAW calculation results, the Waruga Traditional Funeral Ceremony obtained the highest score with Si = 0.9063, placing it first in the ranking. This indicates that the cultural object achieved the best overall performance across all criteria, particularly in Cultural Significance (C1) and Frequency of Practice (C3), which had relatively large weights. The next rank was the Kabasaran Traditional Costume of Minahasa,

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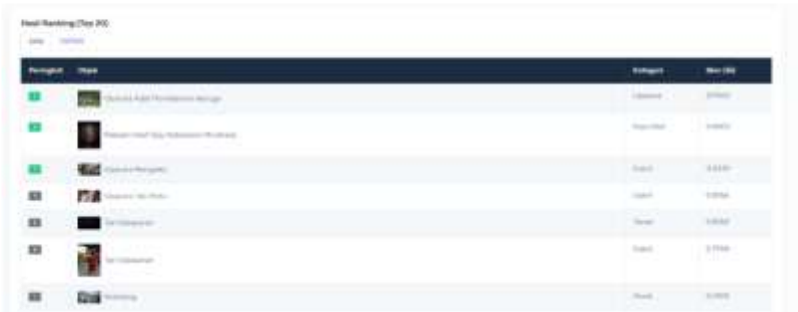
with a score of Si = 0.8652, also showing excellent performance. Other cultural objects such as Mengley Ceremony and Toki Pintu Ceremony occupied the third and fourth positions, indicating that they are still significant and have good accessibility and supporting facilities.

Therefore, these results can serve as a recommendation for prioritizing cultural preservation or promotion, as objects with the highest scores represent those with greater urgency and potential for development.

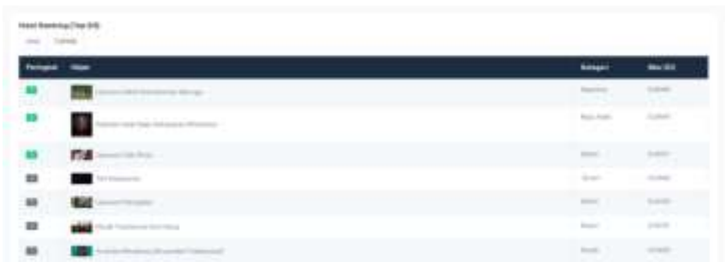
Figure 2*SAW Ranking Table based on the score (Si) of cultural objects*



6. Results of the TOPSIS Method

This subsection presents the results of the calculation using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method, which was also implemented in the system. The calculation process followed the theoretical stages described in Chapter 2, including normalization of the decision matrix, weighting, determination of positive (A^+) and negative (A^-) ideal solutions, calculation of distances (D^+ and D^-), and the calculation of preference values (CC_i) to determine the ranking of alternatives.

Figure 3*TOPSIS Ranking Table based on CC_i value*



The system displays the results in a ranking table showing the rank, cultural object name, category, and the CC_i value representing each object's relative closeness to the ideal positive solution.

Compared to the SAW results in the previous subsection, the top-ranked objects remain the same, although there are slight differences in the subsequent ranking order. This variation is expected, as the TOPSIS method considers the geometric distance to ideal solutions, producing results that are more proportional to the value distribution across criteria. These results reinforce the conclusion that the Waruga

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Traditional Funeral Ceremony is the most outstanding cultural object overall, as it consistently occupies the top position in both methods.

B. Comparative Analysis of SAW and TOPSIS Methods

At this stage, a comparative analysis was conducted to evaluate the ranking results generated by both methods. The two approaches produced preference scores and rankings for each cultural object, as summarized in Table 2.

Table 2*Comparative Analysis of SAW and TOPSIS Methods*

Rank	SAW (Score Si)	Category	TOPSIS (Score Ci)	Category
1	Waruga Traditional Funeral Ceremony (0.9063)	Ceremony	Waruga Traditional Funeral Ceremony (0.8084)	Ceremony
2	Kabasaran Traditional Costume (0.8652)	Traditional Clothing	Kabasaran Traditional Costume (0.6969)	Traditional Clothing
3	Mengaley Ceremony (0.8339)	Gallery	Toki Pintu Ceremony (0.6591)	Gallery

The comparative results demonstrate that both methods identify the Waruga Traditional Funeral Ceremony as the cultural object with the highest priority for preservation. However, slight ranking variations in other objects indicate that each method offers unique perspectives—SAW emphasizes additive weighting, while TOPSIS highlights relative proximity to ideal conditions. The consistency of results across both algorithms strengthens the validity of the decision support system in providing objective cultural preservation recommendations .

C. Discussions

1. Interpretation of Findings

The results from applying the simple additive weighting (SAW) and technique for order preference by similarity to ideal solution (TOPSIS) methods indicate consistent prioritization of cultural objects based on their preservation value. Both methods identified the Waruga Traditional Funeral Ceremony as the top-ranking cultural heritage object. This consistency indicates that the criteria and weighting system applied within the decision support system were reliable and effectively represented the real-world significance of each cultural element.

The high score achieved by the Waruga Ceremony reflects its strong cultural significance and frequent practice within the community. The ceremony is not only an essential symbol of Minahasa heritage but also a tangible manifestation of the region's ancestral and identity. The dominance of this object under both algoritmhs suggest that the combination of cultural significance (C1) and frequency of practice (C3) the two criteria with the highest weights plays a decisive role in determining overall priority.

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Meanwhile, the Kabasaran Traditional costume was ranked second under both models, reinforcing its relevance as an iconic and recognizable element of local culture. Its accessibility and frequent use in cultural events contribute positively to its score. In contrast, objects such as Mengley and Toki Pintu Ceremonies, although still significant, received slightly lower scores due to lesser frequency and limited supporting facilities. These variations indicate that even within the same cultural domain, differences in accessibility and public engagement can meaningfully affect preservation priorities.

In this study, Minahasa cultural heritage is represented by several cultural elements still practiced and recognized in the community, including the waruga traditional funeral ceremony, Kabasaran traditional clothing, the Menyey ceremony, and the Toki Pintu ceremony. These elements were selected for their historical, social, and symbolic values and for representing diverse Minahasan cultural expressions. They are used a alternatives in the decision support system and evaluated based on specific criteria to determine preservation priorities.

Although both methods produce the same top ranking, there are slight differences in the positions of the mid ranked alternatives. This difference can be explained methodolically by the mathematical characteristivs of each method. SAW uses a linear aggregation approach that directly sums normalized scores, so each criterion contributies proportionally to its weights. In contrast, TOPSIS calculates relative distances from both positive and negative ideal solution, so alternatives with extrame variations on a particular criterion may experience shifts in ranking even though their total scores are relatively similar.

The practical implications of this difference are important for policymakers. If the policy objective is stability and transparency in decision justification, SAW results are easier to communicate because the contribution of each criterion is explicitly risks or facility shortages the TOPSIS approach provides greater sensitivity to inequalitaties between criteria. Thus, slight differences in ranking are not inconsistencies, but rather a reflection of different evaluative perspectives.

2. Comparison with Previous Studies

The results of this research align with several previous studies that have applied multi-criteria decision- making (MCDM) methods for cultural or community-based prioritization.

According to Damanik (2023) [5] and Syafiatun & Santi (2022) [6], the SAW method effectively provides transparent and consistent ranking outcomes because of its straightforward normalization and additive process. This is evident in the current research, where each criterion contributed proportionally to the overall score. Similarly, Yatusifa et al. (2024) [10] and Hidayat et al. (2025) [15] emphasizes that SAW is particularly suitable for systems requiring balanced decision-making between qualitative and quantitative attributes such as evaluating cultural objects based on both significance and cost.

Furthermore, the integration of the TOPSIS method in this study corroborates the findings of Setiawan & Haiqal (2021) [4] and Wulandari et al. (2023) [9], who reported that TOPSIS yields results that are more geometrically proportional by considering both the positive and negative ideal solution. The slight

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difference in ranking between SAW and TOPSIS in this study supports that conclusion, as TOPSIS provides greater sensitivity to variation across criteria.

Previos comparative research, such as by Lauryn et al. (2023) and Prasetyo et al. (2024), also demonstrated that SAW and TOPSIS often produce parallell outcomes for high priority alternatives, although TOPSIS tends to refine middle ranking postions due to its relative distance based approach. This was precisely observed in the current research, where the top-ranked object remained constant, while minor shifts occurred among the subsequent cultural items.

However, unlike previous studies that generally focused on the commercial or administrative sectors, this research addresses the complexity of symbolic and historical values that are not entirely linear. In a cultural context, an object with a low frequency of practice does not necessarily mean it is less historically important. Therefore, analyzing the differences in ranking between methods becomes more than a technical issue; it opens up space for reflection on how preservation policies should balance actual popularity with long-term historical value.

Additionally, the practical implementation through a web-based system, as discussed by Fauziah et al. (2024) [8] and Angi et al. (2025) [13], enhances accessibility for decision-makers and cultural institutions. These studies also highlight that digitizing local heritage data facilitates long-term preservation efforts by providing objective analytical tools a goal that this research successfully demonstrates.

3. Author's Perspective

From the authors' perspective, the application of MCDM techniques particularly SAW and TOPSIS proves to be highly relevant in supporting the prioritization of cultural heritage preservation in the Minahasa region. Both methods complement each other: SAW offers clarity in interpreting influence criteria, while TOPSIS provides mathematical robustness by accounting for relative ideal distances.

This combination allows the system not onlt to deliver consistent rankings but also to support policy level decision making with evidence based result. Moreover, integrating these methods within a web based information system ensures that cultural preservation decisions can be managed efficiently and transparently by local authorities or community organizations.

This research also opens up opportunity for further research through the application of dynamic weighting involving stakeholder input or levels of cultural urgency. Furthermore, methods such as combination of AHP SAW or fuzzy TOPSIS could be explored to increase sensitivity to subjective factors. Overall, these findings confirm that the implementation of decision support systems can support digital transformation in the preservation of Indonesia cultural heritage, particularly in Minahasa.

With this enriched analysis, it can be emohasized that the research contribution lies not only in the technical implementation of the SAW and TOPSIS methods, but also in a critical understanding of the dynamics of differences in results between methods and their implication for the formulation of more adaptive and value based preservation policies. This reflective approach strengthens the research's academic

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postion as a study that is not only applicable but also conceptual in the realm of digital cultural heritage management.

Conclusion

This study successfully developed a web-based decision support system (DSS) for determining the priority of Minahasa cultural heritage preservation using the Simple Additive Weighting (SAW) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methods. The implementation of both algorithms provided consistent and objective ranking results, with the Waruga Traditional Funeral Ceremony identified as the highest-priority cultural object in both methods.

The research results show that cultural significance and frequency of practice significanly influence rankings due to their significant weighting. A comparison of SAW and TOPSIS demonstrates their complementaity, with SAW being simpler and more transparent, while TOPSIS provides a more proportional assessments using an ideal solution approach.

The research also supports the digital transformation of cultural preservations thorugh a data driven decision making model that can be implemented by local goverments or cultural institutions. The combination of SAW and TOPSIS has proven effective in determining preservation priorities and can serve as a basis for more measurable budgeting, preservations programs, and prioritizing cultural activies.

With a web based system, the deicison making process becomes more transparent, documented, and easily updated to reflect the dynamics of cultural conditions on the ground. Looking ahead, this research opens up opportunities for further development, such as integrating dynamic weighting based on stakeholder participation, adding socio economic variables and tourism potential, and testing hybrid methods to increase the sensitivity and accuracy of the rankings. Thus, future research will not only expand the scope of cultural objects but also strengthen the validity of the system in supporting sustainable and adaptive cultural preservation policies to adapt to changing times.

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