Comparison of MOORA and WASPAS in the Banyuwangi Nature Tourism Selection DSS

Eka Febiasterina Dyapradita [1], I Gusti Ayu Agung Diatri Indradewi [2], Gede Surya Mahendra[3]

[1,2,3] Information System Study Program, Faculty of Engineering and Vocational, Universitas Pendidikan Ganesha
[1] eka.febiasterina@undiksha.ac.id, [2] indradewi@undiksha.ac.id, [3] gmahendra@undiksha.ac.id

Abstract

This study compares two multi-criteria Decision Support System (DSS) methods, Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) and Weighted Aggregated Sum Product Assessment (WASPAS), for ranking natural tourism destinations in Banyuwangi Regency, Indonesia. Using a quantitative design, survey data were collected from 50 respondents who assessed 48 destinations using five criteria like facilities, entrance fee, safety, travel distance, and cleanliness. The analysis followed the CRISP-DM framework from business understanding through evaluation and interpretation. The MOORA method applied vector normalization and benefit cost optimization, while the WASPAS method combined weighted sum and weighted product models to produce preference scores. Results show that Bangsring Underwater emerged as the most competitive destination overall, achieving preference values of 0.1932 using MOORA and 0.6837 using WASPAS for Decision Maker 1. Sensitivity testing across ten weight variation scenarios indicated that WASPAS showed stronger individual level dominance, ranking the top alternative first in 8 of 10 scenarios, while MOORA ranked first in 7 of 10 scenarios. However, when extended to all respondents, MOORA demonstrated higher population level robustness and slightly higher average accuracy at 51.61% than WASPAS at 50.32%. These findings indicate a trade-off between stability and responsiveness. MOORA is preferable for generalized tourism planning involving diverse stakeholders, while WASPAS is better suited for adaptive or personalized recommendation contexts.

Keywords: DSS, MOORA, WASPAS, Tourism, Banyuwangi

1. Introduction

Tourism has become one of the fastest-growing industries worldwide, particularly in regions rich in natural beauty and cultural heritage, such as Banyuwangi, Indonesia [1], [2]. The selection of optimal tourist destinations is critical for both local authorities and tourists, as it involves a variety of criteria including accessibility, attractiveness, and environmental impact [3], [4]. However, decision-making in tourism planning is often complicated by the subjective nature of these criteria, which can lead to inconsistent and less effective choices [5], [6]. While the ideal solution is to incorporate multiple decision factors in a systematic and objective manner, the reality of traditional decision-making processes often results in bias and inefficiencies [7], [8]. This highlights a significant gap in tourism decision-making processes that can be addressed through more robust and transparent methodologies.

The use of Decision Support Systems (DSS) has been proposed as a solution to this issue, offering a more systematic, objective, and data-driven approach to decision-making [9], [10]. DSS allows for the integration of multiple criteria, making it a valuable tool for addressing the complexity inherent in tourism destination selection [11]. The application of DSS is increasingly important, as it provides decision-makers with insights into the most suitable destinations based on both qualitative and quantitative data, thus improving the accuracy and reliability of tourism decisions [12], [13]. Among the various methods available for DSS, Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) and Weighted Aggregated Sum Product Assessment (WASPAS) are two of the most widely used. Both methods allow for the consideration of multiple criteria simultaneously and are known for their ability to handle complex decision-making problems [14]. MOORA is particularly recognized for its ability to provide stable and consistent outcomes, even under varying conditions, making it a reliable choice for decision-making in tourism [15], [16]. On the other hand, WASPAS is known for its ability to generate highly accurate results, particularly when the data is subject to change or uncertainty [17], [18].

This study aims to compare the performance of these two methods in the context of tourism destination selection in Banyuwangi. By conducting a series of sensitivity and accuracy tests, the study seeks to evaluate the stability,

consistency, and accuracy of MOORA and WASPAS [19], [20], [21]. The research will not only highlight the strengths and weaknesses of each method but also offer insights into which method is more suitable for different types of decision-making scenarios in tourism management. The benefits of this research are significant. First, it provides a deeper understanding of the effectiveness of MOORA and WASPAS in tourism decision-making. Second, it offers practical guidance for local authorities in Banyuwangi and other similar regions, helping them make more informed decisions about tourism planning. Finally, the findings contribute to the growing body of knowledge in DSS, offering valuable insights into the application of optimization methods in the tourism sector.

The urgency of this research is underscored by the increasing importance of sustainable tourism management and the need for effective decision-making tools in this rapidly expanding industry. As the demand for tourism continues to rise, local authorities must have access to the best possible tools to ensure that their decisions are both effective and sustainable. This research addresses that need by offering a comparative analysis of two widely-used DSS methods, providing a framework for more accurate and reliable tourism planning decisions.

2. Research Methods

This study utilizes a quantitative approach to assess and compare the effectiveness of the MOORA (Multi-Objective Optimization on the Basis of Ratio Analysis) and WASPAS (Weighted Aggregated Sum Product Assessment) methods in selecting natural tourism destinations in Banyuwangi. The research follows the CRISP-DM (Cross-Industry Standard Process for Data Mining) methodology to ensure a structured and replicable process for data collection, analysis, and evaluation [22], [23]. This methodology ensures that the study is grounded in a structured, replicable approach, enabling a robust analysis of the MOORA and WASPAS methods. The results contribute valuable knowledge for improving decision-making in the tourism sector, particularly in the context of Banyuwangi's tourism management.
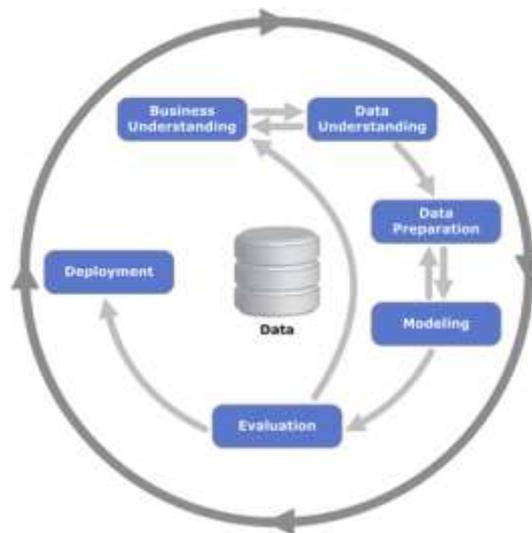

Figure 1. CRISP-DM Framework

1. Business Understanding

   The main objective of this research is to evaluate the performance of MOORA and WASPAS methods in ranking tourism destinations in Banyuwangi. The study addresses the challenge of selecting optimal destinations based on multiple criteria, including accessibility, attractiveness, and environmental sustainability. By comparing the stability, consistency, and accuracy of these methods, the study aims to provide insights into the most suitable decision support system for tourism management, contributing to more effective and objective tourism planning.

2. Data Understanding

   Data for this research is gathered through a survey of 50 respondents, each providing input on criteria such as accessibility, attractiveness, and environmental impact. The survey data helps identify key factors that influence tourists' preferences for selecting a destination. This dataset forms the foundation for applying the

MOORA and WASPAS methods to rank the tourism destinations, ensuring that the criteria are weighted according to the preferences of the respondents. The analysis provides a comprehensive understanding of the decision factors that should be prioritized in tourism planning.

3. Data Preparation

Once the data is collected, it is processed and organized for use in both the MOORA and WASPAS models. The raw data is cleaned and the criteria are assigned appropriate weights based on the survey responses. This stage ensures that the data is in a usable format, and any inconsistencies or missing values are addressed. The processed data serves as the input for the modeling phase, which enables a fair and structured comparison of the two decision support systems.

4. Modeling

The modeling phase involves applying the MOORA and WASPAS methods to the prepared data. The MOORA method calculates a ratio for each tourism destination based on the weighted criteria, providing a stability-focused ranking. In contrast, the WASPAS method aggregates the weighted criteria using a sum-product approach, generating rankings that are highly sensitive to variations in input data. Both methods are applied to the dataset, and the results are analyzed to assess which method provides more consistent and accurate rankings for tourism destination selection.

5. Evaluation

The evaluation phase focuses on comparing the performance of MOORA and WASPAS through sensitivity and accuracy tests. The stability and consistency of MOORA are observed to be superior, as it produces reliable rankings even with changes in input data. On the other hand, WASPAS shows higher accuracy under specific conditions, especially when the data is subject to fluctuation. These results are documented and discussed, providing a clear understanding of the advantages and limitations of each method in real-world tourism decision-making scenarios.

6. Deployment

While this research does not involve the deployment of a decision support system in a real-world setting, the results provide actionable insights for local authorities in Banyuwangi. The findings offer guidance on which method, is more suitable for different decision-making scenarios in tourism planning. The research also paves the way for future studies on DSS applications in tourism management, contributing to the development of more effective decision-making tools for sustainable tourism.

3. Results and Discussions

3.1. Business Understanding Result

The business objective of this research was to identify the most suitable natural tourism destination in Banyuwangi Regency using a data-driven decision support system. The complexity of tourism destination selection arises from the need to simultaneously consider multiple, often conflicting criteria, such as cost, accessibility, safety, and environmental quality. The application of Decision Support Systems (DSS) was validated as an appropriate solution due to its ability to structure complex decisions and reduce subjectivity. The study successfully operationalized this objective by translating stakeholder preferences into measurable criteria and decision models. The results confirmed that DSS-based approaches can effectively support tourism planning and policy formulation. Furthermore, the research demonstrated that methodological choice significantly influences ranking outcomes, reinforcing the importance of method comparison.

3.2. Data Understanding Result

The dataset consisted of evaluations from 50 respondents, including surveyors and professional tour guides, covering 48 natural tourism destinations in Banyuwangi Regency. Respondents assessed destinations based on five predefined criteria: Facilities, Entrance Fee, Safety, Travel Distance, and Cleanliness. The data reflected both objective and perceptual dimensions of tourism quality. Initial exploration showed sufficient variability across destinations, indicating suitability for multi-criteria analysis. No extreme outliers were detected that would distort ranking outcomes. The diversity of respondents ensured heterogeneous preference representation, strengthening external validity. Table 1 summarizes the criteria and their attributes.

Table 1. Criteria Data

Code	Criterion	Attribute	Criteria Weighting Sample from Decision Maker 1
C1	Facilities	Benefit	20%
C2	Entrance Fee	Cost	20%
C3	Safety	Benefit	20%
C4	Travel Distance	Cost	20%
C5	Cleanliness	Benefit	20%

3.3. Data Preparation Result

During data preparation, raw questionnaire responses were validated, cleaned, and transformed into a structured decision matrix. Missing or inconsistent entries were eliminated to ensure data integrity. Each respondent provided individual weights for the five criteria, which were then normalized so that the total weight equaled one. This process preserved preference diversity while enabling comparability across respondents. The preparation stage also involved classifying criteria into benefit and cost categories, directly affecting normalization formulas in subsequent modeling. The final decision matrix was standardized to ensure compatibility with both MOORA and WASPAS algorithms. Table 2 illustrates an example of prepared data for selected destinations.

Table 2. Alternative Data Sample for Decision Maker 1

No.	Alternative ID	Alternative	C1	C2	C3	C4	C5
1	Alt1	Kawah Ijen	3,2	30000	2,66	35	4
2	Alt6	Telunjuk Raung	1	5000	1,66	41	1,33
3	Alt7	Air Terjun Kembar Legomo	3	5000	2,66	50	3,33
4	Alt11	De Djawatan	4,2	7500	3,66	33	4,33
5	Alt21	Pantai Pulau Merah	3,8	10000	2,66	70	3,33
6	Alt33	Pantai Boom Marina	3	7500	2,33	1,5	2,66
7	Alt36	Grand Watu Dodol	2,2	7500	2,33	16	3
8	Alt37	Bangsring Underwater	3,8	5000	4	22	4,33
9	Alt39	Konversi Mangrove Teluk Pangpang Wringinputih	2,6	5000	2,66	45	3
10	Alt44	Grand Harvest Pool	3,8	55000	3	17	3,66

3.4. Modeling Result

The modeling phase applied both MOORA and WASPAS methods to the prepared dataset. MOORA calculations involved vector normalization followed by optimization through benefit–cost differentiation, producing preference values. WASPAS combined weighted sum and weighted product models into aggregated Qi scores. Modeling results showed that Bangsring Underwater achieved the highest score in most scenarios for MOORA, and Pantai Boom Marina for WASPAS. Table 3 presents comparative ranking outcomes.

Table 3. Alternative Data Sample for Decision Maker 1

No.	Alternative ID	Alternative	Preferences Value		Ranking	
			MOORA	WASPAS	MOORA	WASPAS
1	Alt1	Kawah Ijen	0,0473	0,4159	8	9
2	Alt6	Telunjuk Raung	-0,0019	0,3279	10	10
3	Alt7	Air Terjun Kembar Legomo	0,0822	0,5206	5	4
4	Alt11	De Djawatan	0,1676	0,6068	2	3
5	Alt21	Pantai Pulau Merah	0,0496	0,459	7	7
6	Alt33	Pantai Boom Marina	0,1355	0,7087	3	1
7	Alt36	Grand Watu Dodol	0,1018	0,4664	4	6
8	Alt37	Bangsring Underwater	0,1932	0,6837	1	2
9	Alt39	Konversi Mangrove Teluk Pangpang Wringinputih	0,0765	0,4981	6	5
10	Alt44	Grand Harvest Pool	0,0141	0,4383	9	8

3.5. Evaluation Result

The evaluation phase employed sensitivity testing and accuracy testing to examine the robustness and predictive capability of the MOORA and WASPAS methods under varying preference conditions. Sensitivity testing was conducted by systematically adjusting criterion weights across ten predefined scenarios for each respondent, starting from an equal-weight baseline of 0.20 per criterion. The primary objective was to observe ranking stability and dominance frequency under controlled perturbations. Both methods identified Bangsring Underwater as the most competitive alternative after the evaluation; however, their dominance intensity and stability differed.

For Respondent 1, WASPAS demonstrated higher dominance consistency compared to MOORA. WASPAS ranked Bangsring Underwater as the top alternative in 8 out of 10 scenarios, while MOORA achieved first rank in 7 out of 10 scenarios. This difference is further reflected in the geometric mean of rankings, where a lower value

indicates stronger dominance. For sensitivity ranking based on Decision Maker 1, WASPAS is better than MOORA.

Table 4. Sensitivity Ranking Geometric Mean for Decision Maker 1

No.	Alternative ID	Alternative	Sensitivity Ranking Geometric Mean	
			MOORA	WASPAS
1	Alt1	Kawah Ijen	6,71	7,5
2	Alt6	Telunjuk Raung	9,24	9,17
3	Alt7	Air Terjun Kembar Legomo	5,23	4,2
4	Alt11	De Djawatan	2,14	2,61
5	Alt21	Pantai Pulau Merah	7	6,77
6	Alt33	Pantai Boom Marina	2,53	2,38
7	Alt36	Grand Watu Dodol	4,82	7,08
8	Alt37	Bangsring Underwater	1,23	1,15
9	Alt39	Konversi Mangrove Teluk Pangpang Wringinputih	6,61	5,75
10	Alt44	Grand Harvest Pool	7,51	6,39

When the analysis was extended to all 50 respondents, a different pattern emerged. MOORA produced lower average rankings for a larger number of respondents, indicating superior robustness at the population level. This suggests that MOORA is less sensitive to individual preference fluctuations, while WASPAS is more responsive to weight changes in specific cases.

Accuracy testing evaluated the agreement between system-generated rankings (predicted class) and user-defined preferred alternatives (actual class). Accuracy was calculated as the percentage of correctly matched alternatives within the top-ranked results. For Respondent 1, WASPAS achieved a higher accuracy score than MOORA, indicating better alignment with the respondent's explicit preferences.

Across all respondents, accuracy values for both methods ranged between 20.00% and 80.00%, with no single method consistently outperforming the other. This variability highlights the trade-off between stability and adaptability in multi-criteria decision-making. For average, MOORA get 51,61% accuracy point, but WASPAS get 50,32%.
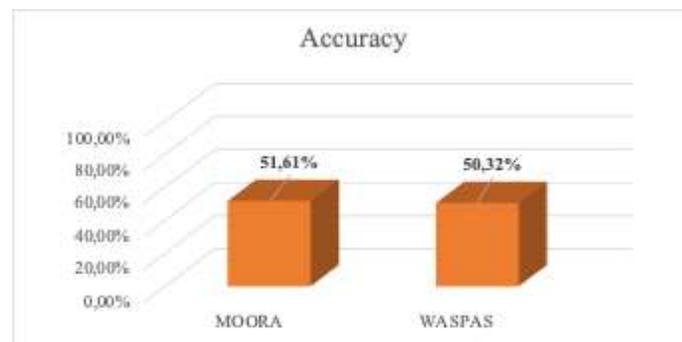

Figure 2. Average Accuracy Between MOORA and WASPAS

Overall, the evaluation confirms that MOORA excels in stability and consistency, making it more suitable for generalized decision support in tourism destination selection involving heterogeneous stakeholders. In contrast, WASPAS demonstrates higher responsiveness and accuracy in specific individual cases, particularly where preference structures are sharply differentiated. These complementary strengths suggest that method selection should be aligned with decision-making context: MOORA for policy-level planning and WASPAS for personalized or adaptive recommendation systems.

3.6. Deployment Result

Although no operational DSS application was deployed, the research results provide clear guidance for implementation. Local governments and tourism stakeholders can adopt the WASPAS-based DSS model to support strategic destination prioritization. MOORA may still be applied in contexts requiring simpler computation and higher interpretability. The study also establishes a replicable methodological framework for other regions. These results support future system integration into web-based or mobile tourism platforms. Deployment feasibility is strengthened by the structured CRISP-DM approach used in this study.

3.7. Discussion

The results of this study demonstrate that the application of MOORA and WASPAS yields both convergent and divergent decision-making outcomes in tourism destination selection. Numerically, Bangsring Underwater consistently achieved the highest performance across methods, with preference values of 0.1932 (MOORA) and 0.6837 (WASPAS) for Decision Maker 1, confirming its superior overall competitiveness. This consistency indicates that destinations with balanced performance across benefit and cost criteria tend to dominate multi-criteria evaluations.

Sensitivity analysis further reveals methodological differences in robustness. WASPAS showed stronger dominance at the individual level, ranking Bangsring Underwater first in 8 out of 10 scenarios with a geometric mean rank of 1.15, compared to 7 out of 10 scenarios and a geometric mean of 1.23 for MOORA. This suggests that WASPAS is more responsive to weight variations, making it advantageous for personalized decision contexts. However, when extended to all 50 respondents, MOORA demonstrated superior population-level robustness by producing lower average rankings for a larger number of decision makers.

Accuracy testing reinforces this trade-off. Although WASPAS achieved higher accuracy for specific individuals (e.g., 40.00% vs. 20.00% for Decision Maker 1), MOORA achieved a higher overall average accuracy (51.61%) compared to WASPAS (50.32%). These numerical findings indicate that MOORA provides greater consistency across heterogeneous stakeholders, while WASPAS excels under sharply differentiated preferences. Therefore, method selection should be context-dependent, balancing stability and adaptability in tourism decision support systems.

4. Conclusion

This study concludes that Decision Support Systems based on multi-criteria decision-making methods are effective tools for selecting natural tourism destinations in Banyuwangi Regency. The application of MOORA and WASPAS successfully addressed the complexity of tourism destination selection by integrating multiple benefit and cost criteria into a structured and objective evaluation framework. The results demonstrate that Bangsring Underwater consistently emerged as the most suitable destination, indicating its strong overall performance across facilities, safety, cleanliness, accessibility, and cost-related considerations. From a methodological perspective, MOORA proved to be more stable and consistent when applied across a heterogeneous group of decision makers, as reflected by its higher average accuracy value of 51.61%. In contrast, WASPAS exhibited higher responsiveness and superior performance in specific individual cases, achieving higher dominance frequencies and accuracy for certain respondents. These findings confirm that both methods are valid but serve different decision-making contexts: MOORA is more appropriate for generalized, policy-level tourism planning, while WASPAS is better suited for adaptive or personalized recommendation scenarios. The practical implications of this research include providing local authorities and tourism stakeholders with an empirical basis for adopting data-driven decision support tools in tourism planning. The methodological framework can be replicated in other regions with similar characteristics. Future research may extend this work by integrating additional criteria, increasing respondent diversity, or implementing the models in real-time digital platforms to enhance decision accuracy and usability in sustainable tourism management.

Reference

[1]   S. F. Persada *et al.*, "How Tourists Reacted to Ecotourism during COVID-19: Insights on Its Sustainability from a Multivariate Analysis Based on the Case of Banyuwangi," *Sustainability*, vol. 15, no. 2, p. 1440, Jan. 2023, doi: 10.3390/su15021440.
[2]   A. Purwaningtyas, "Implementasi Community Based Tourism Dalam Evaluasi Desa Wisata di Kabupaten Banyuwangi," *JAVANICA*, vol. 2, no. 1, pp. 40–50, Jun. 2023, doi: 10.57203/javanica.v2i1.2023.40-50.
[3]   K. D. A. Sutrisna, I. G. A. A. D. Indradewi, and G. S. Mahendra, "Implementasi Sistem Pendukung Keputusan dengan Metode SWARA-ARAS untuk Evaluasi Destinasi Wisata," *RIGGS*, vol. 4, no. 3, pp. 7912–7922, Oct. 2025, doi: 10.31004/riggs.v4i3.3205.
[4]   M. Iqbal, "Penerapan Metode SMART Dan Pembobotan ROC Pada Pemilihan Destinasi Wisata Teraman Di Indonesia," *JURNAL FASILKOM*, vol. 14, no. 2, Art. no. 2, Aug. 2024, doi: 10.37859/jf.v14i2.7256.
[5]   G. S. Mahendra, T. Santhi, K. D. A. Sutrisna, P. P. Cahayani, I. G. Hendrayana, and P. G. S. C. Nugraha, "Sistem Pendukung Keputusan untuk Merekomendasikan Wisata di Kabupaten Klungkung Menggunakan Metode MOORA," *RIGGS*, vol. 4, no. 1, pp. 567–575, Apr. 2025, doi: 10.31004/riggs.v4i1.780.
[6]   M. H. Rewo, I. G. M. Darmawiguna, and G. S. Mahendra, "Pengembangan Sistem Pendukung Keputusan Pemilihan Siswa Terbaik Di SMK Ti Global Singaraja Menggunakan Metode PIPRECIA-MARCOS," *CBIS*, vol. 13, no. 2, pp. 69–82, Sep. 2025, doi: 10.33884/cbis.v13i2.10683.
[7]   F. Al Zukhruf, T. Listyorini, and E. Supriyati, "Sistem Penentuan Kelayakan Destinasi Wisata UMKM Kuliner Kudus Dengan Metode Decision Tree," *JNKTI*, vol. 6, no. 1, pp. 103–108, Feb. 2023, doi: 10.32672/jnkti.v6i1.5751.
[8]   N. Onella, "Implementasi MAUT Dan ROC Untuk Menentukan Pemenang Wisata Rohani Tahunan Di BTPN Putri Hijau Medan," *Management of Information System Journal*, vol. 1, no. 2, Art. no. 2, Mar. 2023, doi: 10.47065/mis.v1i2.525.

[9]   F. Amsyari, K. H. Aryasta, I. G. N. A. Pernata, G. S. Mahendra, and I. G. Hendrayana, "Sistem Pendukung Keputusan dalam Menentukan Wisata Favorit di Kabupaten Buleleng Menggunakan Metode MOORA," *Komputa : Jurnal Ilmiah Komputer dan Informatika*, vol. 13, no. 2, pp. 51–59, Nov. 2024, doi: 10.34010/komputa.v13i2.11930.

[10]   I. A. U. Dewi and G. S. Mahendra, "Implementasi Python untuk SPK Optimalisasi Pengelolaan Tempat Pengolahan Sampah Terpadu Menggunakan FUCOM-CoCoSo," *TEKNOMATIKA*, vol. 14, no. 02, pp. 1–14, Sep. 2024, doi: 10.61423/teknomatika.v14i02.628.

[11]   N. N. A. P. Siwa, I. M. Putrama, and G. S. Santyadiputra, "Development of Car Rental System Based on Geographic Information System and Decision Support System with AHP (Analytical Heirarchy Process) and SAW (Simple Additive Weighting) Method," *J. Phys.: Conf. Ser.*, vol. 1516, no. 1, p. 012013, Apr. 2020, doi: 10.1088/1742-6596/1516/1/012013.

[12]   G. S. Mahendra and I. G. Hendrayana, "Consequences of Misclassification in Data Categorization for Tourism Attraction Recommendation DSS Using ARAS," *TIERS*, vol. 5, no. 1, pp. 52–64, Jun. 2024, doi: 10.38043/tiers.v5i1.5416.

[13]   G. S. Mahendra and I. N. I. Wiradika, "Sistem Pendukung Keputusan Pemilihan Daya Tarik Wisata Favorit Menggunakan PIPRECIA-CoCoSo dengan Implementasi Python," *TEKNOMATIKA*, vol. 14, no. 01, pp. 1–12, Mar. 2024, doi: 10.61423/teknomatika.v14i01.630.

[14]   G. S. Mahendra, I. W. W. Karsana, and A. A. I. I. Paramitha, "DSS for Best E-Commerce Selection using AHP-WASPAS and AHP-MOORA Methods," *MATRIX*, vol. 11, no. 2, pp. 81–94, Jul. 2021, doi: 10.31940/matrix.v11i2.2306.

[15]   G. S. Mahendra, A. Lee, and G. D. S. Muni, "Sistem Pendukung Keputusan Menggunakan Metode FUCOM-MOORA untuk Penentuan Maskapai Favorit," *SISTEMASI*, vol. 10, no. 3, pp. 562–574, Oct. 2021, doi: 10.32520/stmsi.v10i3.1386.

[16]   I. G. Hendrayana and G. S. Mahendra, "Perancangan Metode AHP-MOORA Pada Sistem Pendukung Keputusan Pemilihan Paket Wisata," in *Prosiding Seminar Nasional Pendidikan Teknik Informatika (SENAPATI) Ke-10*, Singaraja, Sep. 2019, pp. 143–149.

[17]   G. S. Mahendra and I. G. B. Subawa, "Perancangan Metode AHP-WASPAS Pada Sistem Pendukung Keputusan Penempatan ATM," in *Prosiding Seminar Nasional Pendidikan Teknik Informatika (SENAPATI) Ke-10*, Singaraja, Sep. 2019, pp. 122–128.

[18]   N. K. T. Y. Pratiwi, P. A. E. D. Wasundhari, K. Nikova, and G. S. Mahendra, "Rekomendasi Hotel di Kawasan Lovina Menggunakan Sistem Pendukung Keputusan dengan Metode WASPAS," *JUNSIBI*, vol. 5, no. 1, pp. 30–40, Apr. 2024, doi: 10.55122/junsibi.v5i1.1146.

[19]   D. S. Pamucar, D. Božanic, and A. Randelovic, "Multi-criteria decision making: An example of sensitivity analysis," *Serbian Journal of Management*, vol. 12, no. 1, pp. 1–27, 2017, doi: 10.5937/sjm12-9464.

[20]   I. G. I. Sudipa and I. A. D. Puspitayani, "Analisis Sensitivitas AHP-SAW dan ROC-SAW dalam Pengambilan Keputusan Multikriteria," *International Journal of Natural Sciences and Engineering*, vol. 3, no. 2, pp. 87–95, 2019.

[21]   J. Więckowski, M. Hernes, and W. Sałabun, "Comparison of Multi-Criteria Decision Analysis Methods Under Comprehensive Sensitivity Analysis," *IEEE Access*, vol. 13, pp. 128122–128138, 2025, doi: 10.1109/ACCESS.2025.3588166.

[22]   E. Exenberger and J. Bucko, "Analysis of Online Consumer Behavior - Design of CRISP-DM Process Model," *AOL*, vol. 12, no. 3, pp. 13–22, Sep. 2020, doi: 10.7160/aol.2020.120302.

[23]   C. Schröer, F. Kruse, and J. M. Gómez, "A Systematic Literature Review on Applying CRISP-DM Process Model," *Procedia Computer Science*, vol. 181, pp. 526–534, 2021, doi: 10.1016/j.procs.2021.01.199.