TIERS Information Technology Journal
Vol.5, No.1, June 2024, pp. 52~64
ISSN: 2723-4533 / E-ISSN: 2723-4541
DOI: 10.38043/tiers.v5i1.5444

Consequences of Misclassification in Data Categorization for Tourism Attraction Recommendation DSS Using ARAS

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ABSTRACT

This research focuses on optimizing tourism attraction management in Bali using DSS and the ARAS method, emphasizing the importance of accurate data categorization. Bali's tourism industry, faced significant challenges during the COVID-19 pandemic, highlighting the need for effective management strategies. This study addresses these challenges by utilizing the ARAS method to analyze and rank tourist attractions. The research methodology follows the CRISP-DM model. The study demonstrates that improper use of conversion scales for quantitative data can lead to inaccurate rankings, as seen when comparing converted and non-converted data rankings. Alter01, Alter03, and Alter02 occupy the top three ranks in the non-converted data, while Alter09, Alter06, and Alter15 rank highest in the converted data. These findings highlight the need to use precise numerical values for criteria whenever possible and to reserve conversion scales for qualitative data, to ensure accurate and reliable recommendations. ARAS has a simple and easy-to-understand computational procedure. However, the results from ARAS heavily depend on the weights assigned to the criteria. Inaccurate determination of these weights can lead to outcomes that do not reflect actual preferences. The research concludes that implementing more refined data categorization techniques can enhance tourism management, promoting sustainable growth and more informed decision-making.

Keywords: Categorization, Tourism, DSS, ARAS

Article Info

Accepted : 18-06-2024
Revised : 03-03-2024
Published Online : 25-06-2024

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1. INTRODUCTION

Travel and accommodation at tourist destinations constitute the tourism industry [1]. It typically involves long-distance travel to attractive places that offer unique cultural, historical, or recreational experiences. Before the COVID-19 pandemic, Bali was one of Indonesia's most famous tourism destinations and a significant source of income for the country. Some tourist spots and accommodations in Bali were even forced to close temporarily due to a lack of visitors. The Balinese people, who rely on the tourism industry, experienced significant economic impacts from the decline in tourist numbers. Statistical data about tourism in Bali shows that before COVID-19, in 2019, Bali received around 6.3 million international tourists and approximately 10.5 million domestic tourists [2]. From this data, it is evident how impactful the COVID-19 pandemic was on the tourism industry in Bali. However, the government and tourism industry players continue to work on reviving the sector and attracting tourists back to Bali after the pandemic ends.

Various issues have emerged in Bali, such as COVID-19, land use, traffic congestion, security, rising living costs, social and cultural changes, and the optimization of tourism development and management, which are pressing problems that need to be addressed [3]. Decision Support Systems (DSS) can assist decision-makers in solving these diverse problems by utilizing the limited resources available to stakeholders [4]–[7]. DSS is advantageous in addressing complex and diverse problems, as it can process information more efficiently, provide in-depth data analysis, simplify complexity, avoid subjective bias, and deliver recommendation results [8]–[10].

This study will focus on providing recommendations to stakeholders using DSS with the multiple criteria decision-making (MCDM) technique. MCDM has various methods to help provide recommendation solutions. In this research, the Additive Ratio Assessment (ARAS) method will be used to determine the ranking of alternatives as recommended solutions [11]. Several studies in the field of DSS have been conducted previously, providing solutions to the problems encountered, such as the use of MCDM methods like CoCoSo, MOORA, WPM, SAW, WASPAS and TOPSIS [12]–[17]. Several studies have also implemented DSS in software that is practically used for solving a case study [18]–[21].

This research will also focus on the performance of ARAS methods, including their application to issues of tourism management optimization. This research also aims to provide insight into the development of DSS commonly occurring in Indonesia. There are four basic characteristics of DSS: multiple criteria, conflicting criteria, incomparable units, and design and selection processes [22], [23]. Some studies have not met these characteristics, especially concerning incomparable units, as some research uses only one unit of measure, thus not fulfilling the DSS characteristics.

The urgency of this research is that, by using DSS, tourism managers in Bali can optimize various resources more effectively and efficiently. This study also aids in selecting the best strategies to maintain and improve the quality of tourist attractions while preserving environmental balance and the sustainability of the tourism industry. If this research is not conducted promptly, the management of tourist attractions in Bali will remain suboptimal, potentially reducing tourist visits, decreasing income from the tourism industry, and causing unsustainable environmental damage. This could lead to long-term negative impacts on Bali's economy and environment. Therefore, it is crucial to conduct this research immediately to help improve the overall management of tourist attractions in Bali. Beyond the urgency concerning the research subject, there is also urgency in using the latest MCDM methods in DSS to refresh the commonly used DSS methods.

The ARAS method, valuable for multi-criteria decision-making, can be applied across various sectors. In tourism, it can help evaluate destinations and accommodations based on factors like accessibility, facilities, and safety. In agriculture, ARAS aids in choosing efficient farming methods and managing natural resources by considering productivity, environmental impact, and costs. For infrastructure and transportation, it assists in selecting projects and optimizing routes based on cost, benefits, and environmental effects. In healthcare and education, ARAS can evaluate facilities and institutions on service quality, cost, and performance. In energy and environmental sectors, it supports the selection of energy sources and environmental projects by assessing costs, impacts, and resource availability.

The benefits of this research are to provide projections of decision support system usage from various perspectives and practical solutions to the problems of optimizing tourism management in Bali. It is expected that the realization of this research will have a positive impact on knowledge about decision support systems and their application in finding solutions to various issues related to optimizing tourism management in Bali.

2. RESEARCH METHOD

The research method used in this study follows the stages of the CRISP-DM model [24]–[26]. Issues related to data, such as data mining and decision support systems, can utilize the CRISP-DM method. This research model is expected to analyze business problems and current conditions, provide appropriate data transformation, and offer a model that can assess effectiveness and document the results obtained. CRISP-DM addresses these issues by defining a process model related to data mining and decision support systems, regardless of the sector or technology used.

2.1. Business Understanding

Business understanding is the stage used to determine business objectives, analyze the business situation, and establish the objectives of the decision support system. In this stage, a comprehensive understanding is based on analyses from observations, interviews, and documents supporting the research goals and results. The data used in this study will refer to data available on the internet from trusted sources, such as Central Bureau of Statistics (*Badan Pusat Statistik / BPS*) or manual data from the Tourism Office. Based on this data, various criteria and alternatives relevant to the problem of optimizing tourist attractions in Bali will be determined to find solutions. The issues addressed in this study may include selecting favorite tourist attractions, developing tourist villages, selecting favorite cultural tourism sites, and more.

The decision-making process involves stakeholders, including tourism experts, local government officials, and researchers, who provide input on the relevance and weighting of criteria. This collective input ensures that the evaluation is practical and reflects expert judgment. The ARAS method, used for ranking and recommending tourism attractions, integrates these weights and values into its evaluation model, providing a clear and straightforward decision-making process.

In the context of recommending tourism attractions, the ARAS method presents several advantages over other MCDM methods such as TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) and AHP (Analytic Hierarchy Process). ARAS evaluates alternatives based on the ratio of weighted normalized values, comparing each attraction to an optimal alternative. The main strengths of ARAS lie in its simplicity and ease of implementation. It allows for direct ranking of attractions without the need for complex hierarchical structures or extensive pairwise comparisons, as required by AHP. Additionally, ARAS can handle both quantitative and qualitative criteria simultaneously, and it does not impose restrictions on the number of criteria used. This makes ARAS highly suitable for practical applications where a clear and efficient decision-making process is needed.

On the other hand, TOPSIS requires the establishment of ideal and negative-ideal solutions, which can be challenging if these solutions are not realistic or achievable. TOPSIS can also be sensitive to the normalization method used, potentially affecting the final ranking. Meanwhile, AHP, although offering a detailed and structured approach with consistency checks, often becomes cumbersome when dealing with many criteria and alternatives due to the extensive pairwise comparison process.

Therefore, ARAS is chosen for tourism attraction recommendations due to its straightforward approach, flexibility in handling various types of criteria, and clarity in ranking alternatives. This method provides a direct and simple solution, making it well-suited for practical decision-making in recommending tourism attractions, while considering the strengths and limitations of other methods.

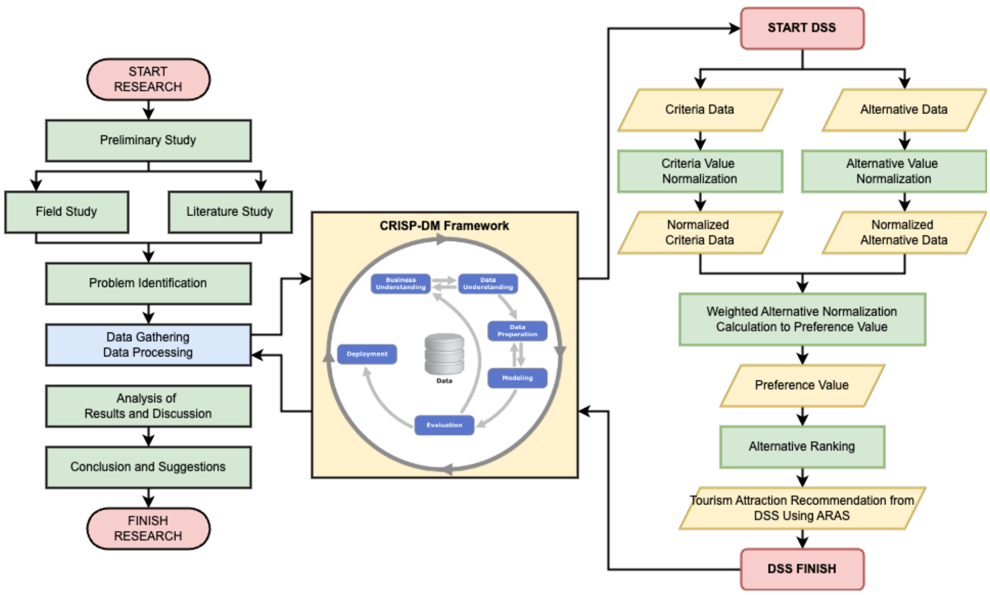

Figure 1. CRISP-DM Model Integrated with Research Methodology

2.2. Data Understanding

Data understanding stage involves data collection, data analysis, and evaluating the quality of the data used in the research. The research will focus on several case studies related to and potentially analyzing the optimization of tourist attraction management in Bali, such as selecting tourist destinations, hotels, restaurants, and travel packages. To provide recommendations to DSS users, it is necessary to obtain suitable data on criteria and alternatives. The criteria and alternatives are obtained from various credible sources, such as surveys, data from relevant agencies, and reputable journal articles. For the case study on selecting tourism destinations, the criteria used refer to the research conducted by Arida in 2017, including natural/biological conditions, physical environment, culture, amenities, institutions, human resources, community attitudes and lifestyle, and accessibility [27]. For the case study on selecting hotels and restaurants, based on Fazlan's research in 2020, the factors of price, facilities, location, service, process, reputation, religiosity, and knowledge are considered criteria [28]. In the case study on selecting tour packages, based on Naufal's research in 2020, factors of price, quality, facilities, accessibility, and promotion are considered criteria [29]. These criteria may change according to changes in input data obtained during the research.

2.3. Data Preparation

Data preparation stage involves selecting data to be used and data to be excluded from the decision support system calculations. Data cleaning is performed to repair, remove, or ignore noise in the data. Stakeholders will weigh the criteria, and tourism data will be processed as alternatives and evaluated based on the predetermined criteria. Data preparation results will be explained later.

2.4. Modeling

In the business understanding stage, tools, techniques, or methods to be used in this study were selected. The method used is ARAS, which excels in providing solution recommendations. Before continuing the research, test design can be conducted with temporary data to prove that the method can be used.

ARAS method consists of the steps as below:

Step 1: The decision matrix is formed.

Step 2: The decision matrix is normalized ($r_{ij}{}^{*}$). Beneficial criteria are normalized with linear normalization procedure as follows:

$$r_{ij}{}^{*} = \frac{r_{ij}}{\sum_{1=0}^{m} r_{ij}} \quad (1)$$

Non-beneficial criteria are normalized with linear normalization procedure as follows:

$$r_{ij}{}^{*} = \frac{{}^{1}/_{r_{ij}}}{\sum_{1=0}^{m} r_{ij}} \quad (2)$$

Step 3: The normalized decision matrix ($\widehat{r_{ij}}$) is weighted as follows:

$$\widehat{r_{ij}} = r_{ij} \times w_j \quad (3)$$

Step 4: The optimality function (S_i) is determined for each alternative as follows:

$$S_i = \sum_{j=1}^{n} \widehat{r_{ij}} \quad (4)$$

Step 5: The degree of the utility (U_i) is determined for each alternative. It is calculated as follows:

$$U_i = \frac{S_i}{V_o} \quad (5)$$

2.5. Evaluation

Evaluation stage involves testing both the recommendations from the decision support system and the performance of the method used. It is necessary to check those manual calculations and the results obtained when implemented in the software match to ensure consistency. Consistency analysis is used to compare the performance between ARAS to measure which method is more consistent against changes in criteria weighting, making the more consistent method the better choice.

2.6. Deployment

Deployment stage involves planning deployment based on the evaluation conducted previously. If the test results are satisfactory, further deployment can be planned. In addition to planning deployment, monitoring and maintenance plans can be developed to produce a final report on the research results. This study will produce outputs in the form of scientific articles published in national journals with ISSN or national seminar proceedings.

3. RESULTS AND DISCUSSION

There are several documents on research related to the ARAS method found on Google Scholar from 2019 to 2023 with the keyword "ARAS Method." However, these studies have not met the characteristics of a Decision Support System (DSS), particularly regarding characteristics for incomparable units, as these studies still use only one type of unit. Additionally, some studies have criteria attributes that are not conflicting, for example, using only benefit-type criteria [30]. The results from the business understanding and data understanding phases have already been discussed. We will now focus on explaining the data preparation, modeling, and evaluation stages. Several citations will be provided to highlight the additional focus of this research and to compare and contrast the differences and findings presented in this study

3.1. Data Preparation Result

This research will provide an example if the data used in this study had non-conflicting criteria, only one unit type, or used categorical data for numerical values. The data used in this section is the Tourist Attraction Data in Klungkung Regency. The data will be processed using the ARAS method. The weighting used is based on direct input from decision maker. The following is the weighting of criteria that will be used in this research, as shown in Table 1.

Table 1. Weighting of Criteria

Criteria Code	C1	C2	C3	C4	C5
Criteria Attribute	+	+	+	-	-
Criteria Weighting	12,47	10,11	8,74	9,94	8,57
Normalized Criteria Weighting	25,03%	20,30%	17,53%	19,95%	17,20%

The first step in ARAS method is determining the optimum value and normalizing the alternatives. The optimum value for each criterion depends on the attribute of the criterion. If it has a benefit/maximum attribute, then the optimum value is the maximum value of the criterion in its column. If it has a cost/minimum attribute, then the optimum value is the minimum value of the criterion in its column. The alternative data and optimum values are shown in Table 2.

Table 2. Alternative Data & Optimum Value using ARAS

No	Alternative ID	Alternative	C1	C2	C3	C4	C5
0	AlterOpt	Optimum Alternative	100	68	57	0.25	295
1	Alter01	Kertha Gosa dan Taman Gili	100	68	56	0.25	2,269
2	Alter02	Museum Semarajaya	92	66	55	0.3	2,269
3	Alter03	Monumen Puputan Klungkung	93	67	55	0.25	2,269
4	Alter04	Lingkungan Taman Sari dan Penataran Agung	91	60	57	0.8	2,269
5	Alter05	Lingkungan Kentel Gumi	91	57	54	6.9	1,002
6	Alter06	Desa Tihingan	94	56	55	2.9	1,002
7	Alter07	Desa Kamasan	94	56	55	2.2	2,269
8	Alter08	Lingkungan Desa Gelgel	90	58	57	3.8	2,269
9	Alter09	Panti Timbrah	93	52	53	2	1,135
10	Alter10	Lingkungan Goa Lawah	94	58	53	9.1	1,135
11	Alter11	Pantai Kusamba	82	54	52	6.8	1,135
12	Alter12	Goa Peninggalan Jepang	95	63	50	4.3	1,002
13	Alter13	Pantai Lepang	82	54	50	6	1,002
14	Alter14	Batu Klotok	84	56	52	5.1	2,269
15	Alter15	Kawasan Tukad Unda	86	55	52	1.1	1,135
16	Alter16	Kawasan Tukad Melangit	87	57	50	7.3	1,002
17	Alter17	Kawasan Nusa Penida	95	60	55	99	295
18	Alter18	Goa Lawah	96	59	54	9.1	1,135

3.2. Modeling Result

The alternative normalization is performed using the following formula 1 and formula 2. The calculation for Alter01 is shown in the following formula, and the normalization results are displayed in Table 3.

$$r_{Alter01,K1}{}^{*} = \frac{100}{\sum(100,92,\cdots,95,96)} = \frac{100}{1639} = 0{,}0610$$
$$r_{Alter01,K2}{}^{*} = \frac{68}{\sum(68,66,\cdots,60,59)} = \frac{68}{1056} = 0{,}0644$$
$$r_{Alter01,K3}{}^{*} = \frac{56}{\sum(56,55,\cdots,55,54)} = \frac{56}{965} = 0{,}0580$$
$$r_{Alter01,K4}{}^{*} = \frac{1/_{0,25}}{\sum(1/_{0,25};1/_{0,3};\ldots 1/_{99};1/_{9,1})} = \frac{4}{16,31} = 0{,}2453$$
$$r_{Alter01,K5}{}^{*} = \frac{1/_{2269}}{\sum(1/_{2269};1/_{2269};\ldots 1/_{295};1/_{1135})} = \frac{0,00044}{0,01587} = 0{,}0278$$

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Table 3. Normalized Alternative Data using ARAS

No	Alternative ID	Alternative	C1	C2	C3	C4	C5
0	AlterOpt	Optimum Alternative	0,0610	0,0644	0,0591	0,2453	0,2136
1	Alter01	Kertha Gosa dan Taman Gili	0,0610	0,0644	0,0580	0,2453	0,0278
2	Alter02	Museum Semarajaya	0,0561	0,0625	0,0570	0,2044	0,0278
3	Alter03	Monumen Puputan Klungkung	0,0567	0,0634	0,0570	0,2453	0,0278
4	Alter04	Lingkungan Taman Sari dan Penataran Agung	0,0555	0,0568	0,0591	0,0766	0,0278
5	Alter05	Lingkungan Kentel Gumi	0,0555	0,0540	0,0560	0,0089	0,0629
6	Alter06	Desa Tihingan	0,0574	0,0530	0,0570	0,0211	0,0629
7	Alter07	Desa Kamasan	0,0574	0,0530	0,0570	0,0279	0,0278
8	Alter08	Lingkungan Desa Gelgel	0,0549	0,0549	0,0591	0,0161	0,0278
9	Alter09	Panti Timbrah	0,0567	0,0492	0,0549	0,0307	0,0555
10	Alter10	Lingkungan Goa Lawah	0,0574	0,0549	0,0549	0,0067	0,0555
11	Alter11	Pantai Kusamba	0,0500	0,0511	0,0539	0,0090	0,0555
12	Alter12	Goa Peninggalan Jepang	0,0580	0,0597	0,0518	0,0143	0,0629
13	Alter13	Pantai Lepang	0,0500	0,0511	0,0518	0,0102	0,0629
14	Alter14	Batu Klotok	0,0513	0,0530	0,0539	0,0120	0,0278
15	Alter15	Kawasan Tukad Unda	0,0525	0,0521	0,0539	0,0557	0,0555
16	Alter16	Kawasan Tukad Melangit	0,0531	0,0540	0,0518	0,0084	0,0629
17	Alter17	Kawasan Nusa Penida	0,0580	0,0568	0,0570	0,0006	0,2136
18	Alter18	Goa Lawah	0,0586	0,0559	0,0560	0,0067	0,0555

The next step in the ARAS method is calculating the weighted alternative normalization using the formula 3. Here is an example calculation for Alter01, and the weighted alternative normalization results are displayed in Table 4.

$$\hat{r}_{alter01,K1} = 0{,}0610 \times 25{,}03\% = 0{,}0153$$
$$\hat{r}_{alter01,K2} = 0{,}0644 \times 20{,}30\% = 0{,}0131$$
$$\hat{r}_{alter01,K3} = 0{,}0580 \times 17{,}53\% = 0{,}0102$$
$$\hat{r}_{alter01,K4} = 0{,}2453 \times 19{,}95\% = 0{,}0489$$
$$\hat{r}_{alter01,K5} = 0{,}0278 \times 17{,}20\% = 0{,}0048$$

Table 4. Weighted Normalized Alternative Data using ARAS

No	Alternative ID	Alternative	C1	C2	C3	C4	C5
0	AlterOpt	Optimum Alternative	0,0153	0,0131	0,0104	0,0489	0,0367
1	Alter01	Kertha Gosa dan Taman Gili	0,0153	0,0131	0,0102	0,0489	0,0048
2	Alter02	Museum Semarajaya	0,0140	0,0127	0,0100	0,0408	0,0048
3	Alter03	Monumen Puputan Klungkung	0,0142	0,0129	0,0100	0,0489	0,0048
4	Alter04	Lingkungan Taman Sari dan Penataran Agung	0,0139	0,0115	0,0104	0,0153	0,0048
5	Alter05	Lingkungan Kentel Gumi	0,0139	0,0110	0,0098	0,0018	0,0108
6	Alter06	Desa Tihingan	0,0144	0,0108	0,0100	0,0042	0,0108
7	Alter07	Desa Kamasan	0,0144	0,0108	0,0100	0,0056	0,0048
8	Alter08	Lingkungan Desa Gelgel	0,0137	0,0111	0,0104	0,0032	0,0048
9	Alter09	Panti Timbrah	0,0142	0,0100	0,0096	0,0061	0,0095
10	Alter10	Lingkungan Goa Lawah	0,0144	0,0111	0,0096	0,0013	0,0095
11	Alter11	Pantai Kusamba	0,0125	0,0104	0,0094	0,0018	0,0095
12	Alter12	Goa Peninggalan Jepang	0,0145	0,0121	0,0091	0,0028	0,0108
13	Alter13	Pantai Lepang	0,0125	0,0104	0,0091	0,0020	0,0108
14	Alter14	Batu Klotok	0,0128	0,0108	0,0094	0,0024	0,0048
15	Alter15	Kawasan Tukad Unda	0,0131	0,0106	0,0094	0,0111	0,0095
16	Alter16	Kawasan Tukad Melangit	0,0133	0,0110	0,0091	0,0017	0,0108
17	Alter17	Kawasan Nusa Penida	0,0145	0,0115	0,0100	0,0001	0,0367
18	Alter18	Goa Lawah	0,0147	0,0113	0,0098	0,0013	0,0095

Next, the optimization value in ARAS can be calculated using the formula 4. The utility value in ARAS is calculated using the following formula, where V_o is the optimization value of the optimal alternative, using formula 5. Here is an example calculation for Alter01, and the results of the optimization and utility values using the ARAS method on tourist attraction recommendations in Klungkung Regency are displayed in

Table 5. The Tourist Attraction Recommendations Graph in Klungkung Regency Using ARAS is shown in Figure 2.

$$V_0 = \sum(0{,}0153; 0{,}0131; 0{,}0104; 0{,}0489; 0{,}0367) = 0{,}1244$$
$$S_{Alter01} = \sum(0{,}0153; 0{,}0131; 0{,}0102; 0{,}0489; 0{,}0048) = 0{,}0922$$
$$k_{Alter01} = \frac{0{,}0922}{0{,}1244} = 0{,}7415$$

Table 5. Weighted Normalized Alternative Data using ARAS

No	Alternative ID	Alternative	Optimization Value	Utility Value	Rank
0	AlterOpt	Optimum Alternative	0,1244	1,0000	-
1	Alter01	Kertha Gosa dan Taman Gili	0,0922	0,7415	1
2	Alter02	Museum Semarajaya	0,0823	0,6616	3
3	Alter03	Monumen Puputan Klungkung	0,0908	0,7299	2
4	Alter04	Lingkungan Taman Sari dan Penataran Agung	0,0558	0,4491	5
5	Alter05	Lingkungan Kentel Gumi	0,0472	0,3800	10
6	Alter06	Desa Tihingan	0,0501	0,4032	7
7	Alter07	Desa Kamasan	0,0454	0,3654	14
8	Alter08	Lingkungan Desa Gelgel	0,0432	0,3477	17
9	Alter09	Panti Timbrah	0,0495	0,3980	8
10	Alter10	Lingkungan Goa Lawah	0,0460	0,3701	12
11	Alter11	Pantai Kusamba	0,0437	0,3514	16
12	Alter12	Goa Peninggalan Jepang	0,0494	0,3969	9
13	Alter13	Pantai Lepang	0,0448	0,3606	15
14	Alter14	Batu Klotok	0,0402	0,3234	18
15	Alter15	Kawasan Tukad Unda	0,0538	0,4328	6
16	Alter16	Kawasan Tukad Melangit	0,0458	0,3684	13
17	Alter17	Kawasan Nusa Penida	0,0729	0,5861	4
18	Alter18	Goa Lawah	0,0467	0,3755	11

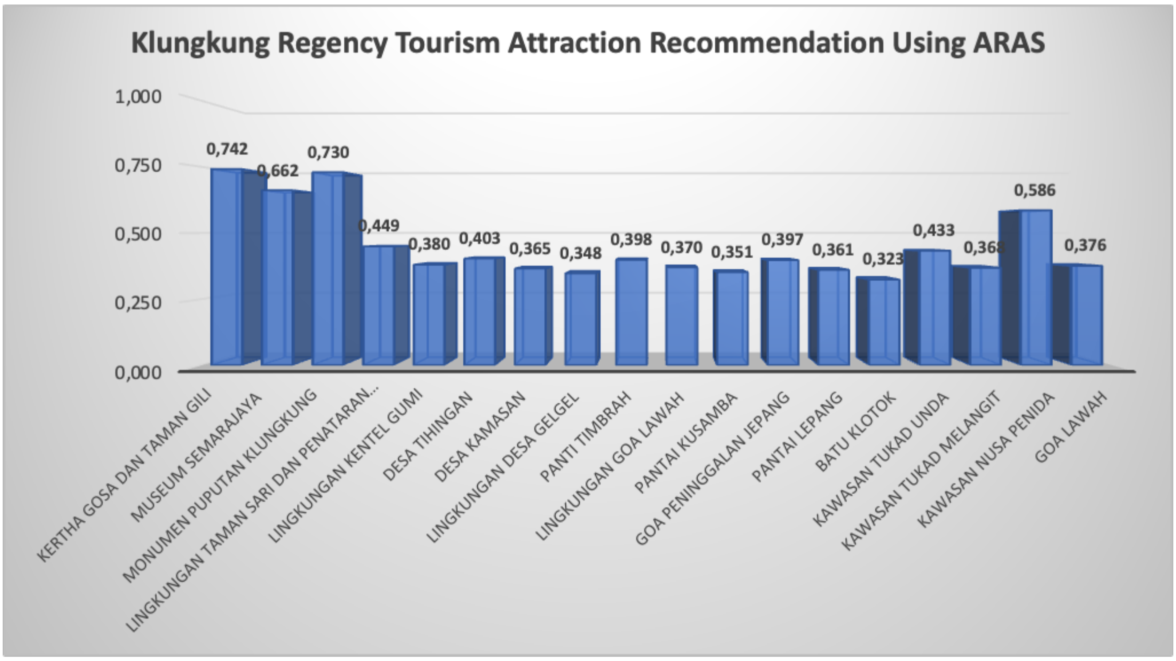

Figure 2. Klungkung Regency Tourism Attraction Recommendation using ARAS

3.3. Evaluation Result

All of these calculations are standard according to the rules and characteristics of DSS. The following will provide a difference in results where the previously given data will be calculated using categories that

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make all data on a Likert scale. Several studies also use techniques to transform data obtained, both numerical and qualitative, using the Likert scale [30]–[32].

Based on the case study using the ARAS method, five criteria are used: Nature & Culture (C1), Environment, Infrastructure & Accessibility (C2), Institutions, Human Resources & Community Life (C3), Distance from City Center (C4), and Population Density per km (C5). These five criteria can be simplified by categorizing the values into the following five Likert scales.

Table 6. Categorization and Likert Scale Values for Nature & Culture (C1)

Value	Category	Likert Value
≦50	Very Low	1
51 – 70	Low	2
71 – 90	Moderate	3
91 – 110	Good	4
> 110	Excellent	5

Table 7. Categorization and Likert Scale Values for Environment, Infrastructure & Accessibility (C2)

Value	Category	Likert Value
≦ 35	Very Low	1
36 - 45	Low	2
46 - 55	Moderate	3
56 - 65	Good	4
> 65	Excellent	5

Table 8. Categorization and Likert Scale Values for Institutions, Human Resources & Community Life (C3)

Value	Category	Likert Value
≦ 30	Very Low	1
31 - 40	Low	2
41 - 50	Moderate	3
51 - 60	Good	4
> 60	Excellent	5

Table 9. Categorization and Likert Scale Values for Distance from City Center (C4)

Value	Category	Likert Value
≦2	Very Close	5
2,1 - 4	Close	4
4,1 - 6	Moderate	3
6,1 - 8	Far	2
> 8	Very Far	1

Table 10. Categorization and Likert Scale Values for Population Density per-km (C5)

Value	Category	Likert Value
≦1000	Very Low Density	5
1001 - 1300	Low Density	4
1301 - 1600	Moderate Density	3
1601 - 1900	High Density	2
> 1900	Very High Density	1

Based on these categories, the tourist destination data shown in Table 11 and the alternative data converted using the previous category data are displayed in Table 12.

Table 2. Categorized Alternative Data using ARAS

No	Alternative ID	C1	C2	C3	C4	C5
1	Alter01	Good	Excellent	Excellent	Very Close	Very High Density
2	Alter02	Good	Excellent	Excellent	Very Close	Very High Density
3	Alter03	Good	Excellent	Excellent	Very Close	Very High Density
4	Alter04	Good	Good	Excellent	Very Close	Very High Density
5	Alter05	Good	Good	Excellent	Far	Low Density
6	Alter06	Good	Good	Excellent	Close	Low Density
7	Alter07	Good	Good	Excellent	Close	Very High Density
8	Alter08	Moderate	Good	Excellent	Close	Very High Density
9	Alter09	Good	Moderate	Excellent	Very Close	Low Density

No	Alternative ID	C1	C2	C3	C4	C5
10	Alter10	Good	Good	Excellent	Very Far	Low Density
11	Alter11	Moderate	Moderate	Excellent	Far	Low Density
12	Alter12	Good	Good	Good	Moderate	Low Density
13	Alter13	Moderate	Moderate	Good	Moderate	Low Density
14	Alter14	Moderate	Good	Excellent	Moderate	Very High Density
15	Alter15	Moderate	Moderate	Excellent	Very Close	Low Density
16	Alter16	Moderate	Good	Good	Far	Low Density
17	Alter17	Good	Good	Excellent	Very Far	Very Low Density
18	Alter18	Good	Good	Excellent	Very Far	Low Density

Table 12. Converted Categorized Alternative Data & Optimum Value using ARAS

No	Alternative ID	Alternative	C1	C2	C3	C4	C5
0	AlterOpt	Optimum Alternative	4	5	5	5	5
1	Alter01	Kertha Gosa dan Taman Gili	4	5	5	5	1
2	Alter02	Museum Semarajaya	4	5	5	5	1
3	Alter03	Monumen Puputan Klungkung	4	5	5	5	1
4	Alter04	Lingkungan Taman Sari dan Penataran Agung	4	4	5	5	1
5	Alter05	Lingkungan Kentel Gumi	4	4	5	2	4
6	Alter06	Desa Tihingan	4	4	5	4	4
7	Alter07	Desa Kamasan	4	4	5	4	1
8	Alter08	Lingkungan Desa Gelgel	3	4	5	4	1
9	Alter09	Panti Timbrah	4	3	5	5	4
10	Alter10	Lingkungan Goa Lawah	4	4	5	1	4
11	Alter11	Pantai Kusamba	3	3	5	2	4
12	Alter12	Goa Peninggalan Jepang	4	4	4	3	4
13	Alter13	Pantai Lepang	3	3	4	3	4
14	Alter14	Batu Klotok	3	4	5	3	1
15	Alter15	Kawasan Tukad Unda	3	3	5	5	4
16	Alter16	Kawasan Tukad Melangit	3	4	4	2	4
17	Alter17	Kawasan Nusa Penida	4	4	5	1	5
18	Alter18	Goa Lawah	4	4	5	1	4

Based on the conversion, the rules in the DSS characteristics are not met. According to this data, the criteria are non-conflicting because they all have maximum/benefit values, and all units are varied, with all units being Likert scales. The ARAS method is recalculated using the previously explained steps and compares the rankings between using the ARAS method without conversion and with conversion. The calculation results using the ARAS method and its rankings are displayed in Table 13.

Table 13. Weighted Normalized Alternative Data from Categorized Data using ARAS

No	Alternative ID	Alternative	Optimization Value	Utility Value	Rank
0	AlterOpt	Optimum Alternative	0,0727	1,0000	-
1	Alter01	Kertha Gosa dan Taman Gili	0,0595	0,818	4
2	Alter02	Museum Semarajaya	0,0595	0,818	4
3	Alter03	Monumen Puputan Klungkung	0,0595	0,818	4
4	Alter04	Lingkungan Taman Sari dan Penataran Agung	0,0566	0,779	8
5	Alter05	Lingkungan Kentel Gumi	0,0566	0,778	9
6	Alter06	Desa Tihingan	0,0632	0,869	2
7	Alter07	Desa Kamasan	0,0533	0,733	11
8	Alter08	Lingkungan Desa Gelgel	0,0495	0,681	17
9	Alter09	Panti Timbrah	0,0637	0,876	1
10	Alter10	Lingkungan Goa Lawah	0,0532	0,732	12
11	Alter11	Pantai Kusamba	0,0499	0,687	16
12	Alter12	Goa Peninggalan Jepang	0,0579	0,796	7
13	Alter13	Pantai Lepang	0,0512	0,705	14
14	Alter14	Batu Klotok	0,0462	0,635	18
15	Alter15	Kawasan Tukad Unda	0,0599	0,824	3
16	Alter16	Kawasan Tukad Melangit	0,0507	0,698	15

.

No	Alternative ID	Alternative	Optimization Value	Utility Value	Rank
17	Alter17	Kawasan Nusa Penida	0,0565	0,778	10
18	Alter18	Goa Lawah	0,0532	0,732	12

3.3. Discussion from Findings

There is a significant difference in calculation and ranking results between using the ARAS method without conversion and with conversion. The focus of the calculation is on the conditions of alternative codes Alter01, Alter02, Alter03, Alter06, Alter09, and Alter15. The ranking comparison between these alternatives is shown in Table 14.

Table 14. Ranking Comparison Between ARAS Without and With Data Categorization

No	Alternative ID	Alternative	Rank Without Data Categorization	Rank With Data Categorization
1	Alter01	Kertha Gosa dan Taman Gili	1	4
2	Alter02	Museum Semarajaya	3	4
3	Alter03	Monumen Puputan Klungkung	2	4
4	Alter06	Desa Tihingan	7	2
5	Alter09	Panti Timbrah	8	1
6	Alter15	Kawasan Tukad Unda	6	3

The rankings in the ARAS method without conversion show that the top 3 conditions are Alter01 as rank 1, Alter03 as rank 2, and Alter02 as rank 3. All rankings shown in the ARAS method without conversion have different rankings among alternatives from rank 1 to 18. The rankings in the ARAS method with conversion show that the top 3 conditions are Alter09 as rank 1, Alter06 as rank 2, and Alter15 as rank 3. Alter01, Alter02, Alter03 in calculations using the ARAS method with conversion show that all three are ranked 4, as they have the same value, as well as rank 12 occupied by Alter10 and Alter18. The emergence of the same rankings indicates a lack of accuracy in the calculations, resulting in the final values of the three alternatives being the same, thus sharing the same rank.

Next, consider Alter01, Alter02, and Alter03, which have the same rank. The alternative values of these three alternatives are displayed in more detail.

Table 15. Ranking Comparison Between ARAS Without and With Data Categorization

No	Alternative ID	Value Without Data Categorization					Value With Data Categorization				
		C1	C2	C3	C4	C5	C1	C2	C3	C4	C5
1	Alter01	100	68	56	0,25	2.269	4	5	5	5	1
2	Alter02	92	66	55	0,3	2.269	4	5	5	5	1
3	Alter03	93	67	55	0,25	2.269	4	5	5	5	1

It can be observed that in the section of alternative values without conversion between Alter01, Alter02, and Alter03, the values for C1, C2, C3, and C4 are relatively different from one another, resulting in differences in subsequent processes and thus yielding different outcomes up to the ranking level. In contrast, the converted alternative values have exactly the same values across the three criteria, which naturally results in the same final values when using the ARAS method, leading to the same rankings. This situation proves that performing conversions reduces the accuracy of the calculations made. Using converted calculations does not allow us to determine which alternative is more recommended between Alter01, Alter02, and Alter03, as they have the same values. There is also a difference in the top 3 rankings for converted and non-converted alternative values, which is confusing when providing recommendations.

Further observations can be made for Alter01, Alter02, Alter03, Alter06, Alter09, and Alter15, which rank in the top 3 in both the converted and non-converted calculations. The detailed alternative and normalized alternative values for these six alternatives in non-converted calculations are shown in Table 16, and in converted calculations in Table 17.

Table 16. Normalized Alternative Value for Data Without Categorization

Alternative ID	Alternative Value Without Data Categorization					Normalized Alternative Value				
	C1	C2	C3	C4	C5	C1	C2	C3	C4	C5
AlterOpt	100	68	57	0,25	295	0,061	0,064	0,059	0,245	0,214
Alter01	100	68	56	0,25	2.269	0,061	0,064	0,058	0,245	0,028
Alter02	92	66	55	0,3	2.269	0,056	0,063	0,057	0,204	0,028
Alter03	93	67	55	0,25	2.269	0,057	0,063	0,057	0,245	0,028
Alter06	94	56	55	2,9	1.002	0,057	0,053	0,057	0,021	0,063
Alter09	93	52	53	2	1.135	0,057	0,049	0,055	0,031	0,056
Alter15	86	55	52	1,1	1.135	0,052	0,052	0,054	0,056	0,056

Table 17. Normalized Alternative Value for Data With Categorization

Alternative ID	Alternative Value Without Data Categorization					Normalized Alternative Value				
	C1	C2	C3	C4	C5	C1	C2	C3	C4	C5
AlterOpt	4	5	5	5	5	0,061	0,070	0,057	0,083	0,096
Alter01	4	5	5	5	1	0,061	0,070	0,057	0,083	0,019
Alter02	4	5	5	5	1	0,061	0,070	0,057	0,083	0,019
Alter03	4	5	5	5	1	0,061	0,070	0,057	0,083	0,019
Alter06	4	4	5	4	4	0,061	0,056	0,057	0,067	0,077
Alter09	4	3	5	5	4	0,061	0,042	0,057	0,083	0,077
Alter15	3	3	5	5	4	0,045	0,042	0,057	0,083	0,077

Based on the data, it can be seen that the weighting of the criteria affects the calculations, where criterion C1 has the largest weighting compared to other criteria, although the others are not significantly different in their weightings. In the non-converted alternative values condition, the range of values produced is very diverse; however, Alter01 tends to have higher values compared to other alternatives. The calculation of the weighted normalized alternative values will favor Alter01 because it generally has superior values, except for criterion C5. However, C5 has the smallest weight of 17.20%, so when the alternative is still generally superior in the other criteria, it yields a better ranking. Compared to Alter06, Alter09, and Alter15, Alter01, Alter02, and Alter03 rank in the top 3.

In contrast, with converted alternative values, the data shows more uniformity. It can be noted in criterion C1 that all alternatives except Alter15 have the top values where their normalized values match the optimal alternative values. The same condition is found in criterion C3, where all alternatives have optimal values. In criterion C4, all alternatives also have optimal values except for Alter06, which still has a fairly high normalized value.

Based on the findings from the ranking and gap comparisons, it can be seen that the characteristics of the decision support system (DSS) previously explained are not met. It is hoped that in determining alternative values, if numerical values with definite values have been obtained, those values can be used without needing to convert them into a conversion scale. Only criteria with qualitative values need to be transformed using a conversion scale.

4. CONCLUSION

The research underscores the critical importance of accurately categorizing data in Decision Support Systems (DSS) for tourism attraction recommendations using the Additive Ratio Assessment (ARAS) method. Misclassification or improper categorization, such as the inappropriate use of conversion scales for data that can be quantitatively measured, can lead to significant discrepancies in recommendation rankings. For instance, when comparing converted and non-converted data, the rankings differ substantially, with Alter01, Alter03, and Alter02 occupying the top three ranks in the non-converted ARAS method, while Alter09, Alter06, and Alter15 rank highest in the converted data. This can obscure true value differences between alternatives, resulting in multiple alternatives being assigned the same rank, despite having distinct characteristics, as seen with Alter01, Alter02, and Alter03 all sharing the same rank of 4 in the converted data due to identical values. Such inaccuracies can lead to poor decision-making, affecting the optimization of tourism management, particularly in regions like Bali, where tourism is a crucial economic driver. The study emphasizes using precise numerical values for criteria whenever possible and only resorting to conversion scales for qualitative data. This approach ensures the integrity of the DSS process, providing reliable and differentiated recommendations that accurately reflect the data's characteristics.

To address these limitations, future research should focus on refining data categorization practices to reduce the impact of conversion scales. Investigating alternative methods that preserve quantitative data integrity could enhance the ARAS method's accuracy. Furthermore, developing more objective approaches for criteria weighting, such as data-driven methods or sensitivity analysis, could better reflect the true importance of each criterion. Comparing ARAS with other multi-criteria decision-making methods would also be

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beneficial to assess its relative performance and suitability for specific contexts. Finally, incorporating advanced data analysis techniques, such as machine learning or statistical modeling, may provide deeper insights and reveal patterns that traditional ARAS methods might miss. By addressing these areas, future research can improve the effectiveness and reliability of the ARAS method, leading to more accurate decision support systems in tourism and beyond.

ACKNOWLEDGEMENT

Thanks are extended to Universitas Pendidikan Ganesha for funding this research through the Beginner Lecturer Research Grant scheme in 2023, with Contract Number 913/UN48.16/LT/2023 dated April 26, 2023.

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