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SUSTAINABILITY STUDY AND MANAGEMENT SCENARIOS OF RAMMANG-RAMMANG GEOPARK, MAROS REGENCY, SOUTH SULAWESI PROVINCE

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Abstract

Rammang-Rammang Geopark has become one of the growing tourist destinations. The need for research aims to understand the sustainability status and implement sustainable tourism management strategies and scenarios in the area. The method used in this research is a descriptive method with a quantitative approach. Rapfish and MICMAC were used as analysis tools. The results of Rapfish analysis show that the environmental sustainability and institutional status are relatively positive and well-maintained, but improvements need to be made in the social and economic dimensions of the community. MICMAC analysis showed that variables such as protection and rehabilitation of local flora, community participation, and integration of management programs significantly influenced the management system. Therefore, the combination of the two analytical tools formulates a management scenario to increase community participation, sustainable tourism education, coordination between management agencies and environmental management, and economic diversification through promotion, marketing, and digital campaigns on environmentally oriented tourism in a more serious geopark area to ensure the sustainability of ecotourism aspects.

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INTRODUCTION

In the 2030 Agenda, policies and promotion of sustainable tourism can create employment opportunities and promote local culture and products to boost the economy (Bauer & Ap, 2004; Regulation of Ministry of Tourism and Creative Economy No. 9 of 2021, 2021). In Indonesia, and even in the world, tourism has become one of the most developed sectors and is used to improve a country's economy (Parmawati & Hardyansah, 2020). It can even shift the manufacturing industry sector (Wahono et al., 2019). Therefore, the development of tourism destinations must be carried out in an integrated, sustainable, and responsible manner to provide long-term benefits (Gale & Hill, 2009) by measuring how social and economic systems develop toward sustainability and require humans to live within certain limits and ensure the sustainability of natural resources for the next generation (Graymore, 2005). The case in the Rammang-Rammang Geopark tourist area is a growing destination, with the growth of tourists that continues to increase. So, with all the beauty shown, tourism in the Rammang-Rammang area becomes a potential for welfare because the high number of tourist visits can increase regional income, as in Figure 1 (Asro, 2023).

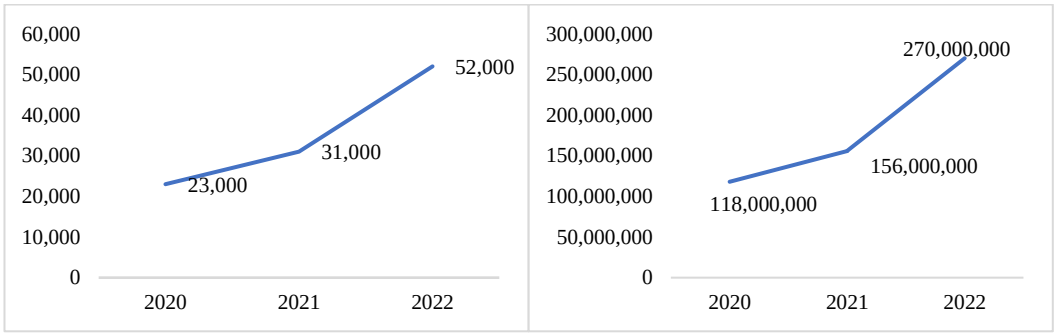

Figure 1. Visitor Data and Economic Income: (a) Visitor Data; (b) Tourism Turnover
Source: Kolom Desa, reprocessed from Asro, 2023

However, the increasing number of tourists will bring bad possibilities if not considered aspects of sustainability properly, such as the widespread number of buildings, loss of land cover, degradation, waste generation, and environmental pollution, which results in less aesthetics (Dwikorawati, 2012; Nunna & Banerjee, 2022). In addition, negative changes will occur if tourism development and management are solely economically oriented (Harahab et al., 2021). Therefore, it is essential to develop the Rammang-Rammang Geopark into sustainable tourism (Nurhayati et al., 2021) with a management system that considers environmental aspects because the ecosystem that is a natural tourist attraction has certain limitations. If these limits happen, it can damage and disrupt the ecosystem. According to residents and the researcher's observations, the development of tourists contributes to the increase of waste, the construction of villas around the riverbanks, the number of stalls that do not pay attention to environmental sustainability such as waste, and the potential for conflict between residents, stakeholders, and tourists.

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The urgency of this research lies in efforts to overcome the potential threats posed by tourism development, including environmental degradation and possible conflicts between interests, resulting in a decrease in the attractiveness and sustainability of geoparks as tourist destinations. Therefore, the research was to ensure the value of sustainability and long-term sustainability.

Thus, sustainable tourism becomes a significant part of planning and development because unplanned management results in big environmental problems (Raj Sharma & Bisht, 2019) so it needs to be done in an integrated, sustainable, responsible, and long-term oriented manner (Purwaningsih et al., 2021). There are two disadvantages if natural tourism is exploited without regard to sustainability aspects. First, tourist visits decrease due to the destruction of nature. Second is environmental degradation and reduced biodiversity (Adinugroho, 2021). Therefore, management scenarios are established to deal with the trade-off between economic progress and environmental damage (Wahono et al., 2019). Based on this background, the author formulated the purpose of this study to assess the sustainability status and formulate strategies and scenarios for sustainable tourism management in the Rammang-Rammang Geopark area.

METHODOLOGY

This research was a mixed method involving qualitative and quantitative approaches. Qualitative research explores existing facts using observation methods to inventory of environmental, social, economic, and institutional conditions (Creswell & Creswell, 2018). Quantitative analysis used the Rapfish Rap-Tourism method with Multidimensional Scaling (MDS) to assess the status and sustainability index of tourism management (Pitcher et al., 2013), and to determine sustainable tourism management scenarios with MICMAC analysis (Godet, 2006).

Location and Time of Research

Rammang-Rammang is in Salanrang village, Bontoa District, Maros Regency, South Sulawesi Province. It is approximately 32 km or 1 hour by land from Sultan Hasanuddin Airport, or a 5-minute drive from Makassar rail station. The research site map is in Figure 2. The study was conducted from August to November 2023.

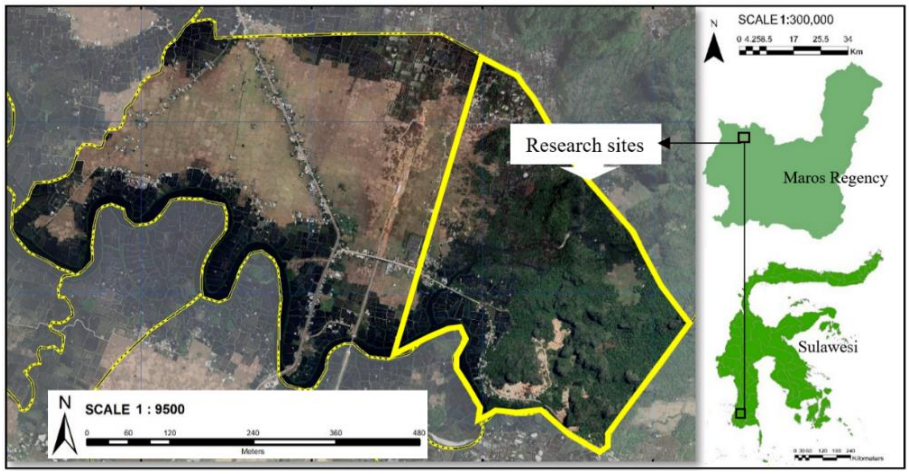

Figure 2. Research Location in Rammang-Rammang Geopark, Salenrang Village
Source: Author's primary data, 2023

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Data Collection Techniques

Data collection in this study used a combination of two methodologies, namely qualitative and quantitative. The first step was qualitative data collection using direct observation of environmental conditions, community involvement, and tourism administration in the Rammang-Rammang Geopark area. This observation was to get an authentic picture of the research location. In addition, secondary data was from previous research findings, reports, and information from relevant government agencies related to sustainable tourism management in Rammang-Rammang Geopark.

The second step is quantitative data collection through surveys using questionnaires administered to 49 respondents who are local residents actively involved in tourism management. The selection of respondents used a simple random sampling technique. The purpose of the questionnaire was to collect quantitative data regarding community involvement, perceptions, and judgements towards sustainable tourism management (Mappasomba & Haidir, 2024). In addition, secondary data were from previous research findings, reports, and information from relevant government agencies related to sustainable tourism management in Rammang-Rammang Geopark. Subsequent data collection for the Rapfish and MICMAC matrices involved seven expert respondents selected by purposive sampling. These experts represent academics, tourism industry professionals, local government officials, and community leaders, aiming to gain comprehensive insights and viewpoints from experts regarding sustainable tourism supervision.

Data Analysis Techniques

Rapfish was a multi-disciplinary assessment technique used to evaluate sustainability (Pitcher & Preikshot, 2001), which evolved into rap-tourism and was employed to ensure the sustainability of natural resource management (Purwaningsih et al., 2020). The data analysis involved the Multidimensional Scaling (MDS) method, executed through two sequential stages (Santoso et al., 2023). Firstly, leverage analysis was employed to generate stress and the coefficient of determination (R2) values, providing insights into sensitive attributes or potential interventions that could enhance the sustainability status of the region. Secondly, Monte Carlo analysis estimates the impact of errors in the analysis process at a 95% confidence interval. The calculation method used in the MDS-RAPFISH analysis method was as follows (Hermawan et al., 2019; Yunus et al., 2023).

Standardize attribute scores to ensure consistent weighting and measurement scale alignment with the formula:

$$Xiksd = \frac{Xik - Xk}{Sk} \quad \text{...(1)}$$

Where:

Xiksd : the standard score value of the i-th region on each k-th attribute
Xik : the initial score value of the region to i on each k-th attribute
Xk : the mid-value of the score on each k-th attribute
Sk : the standard deviation of the score on each k-th attribute

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Compute the nearest distance based on the Euclidean distance using the given equation:

$$d12 = \sqrt{(x1 - x2)^2 + (y1 - y2)^2} \quad \text{...(2)}$$

Convert the Euclidean distance between two points (d12) into a two-dimensional Euclidean distance (D12) using the error value (e) in the equation:

$$d12 = a + bD12 + e \quad \text{...(3)}$$

Generate the minimal error value using Rapfish to derive the equation:

$$d12 = bD12 + e \quad \text{...(4)}$$

Compute stress values using the specified formula:

$$[Stress = \frac{1}{m}\sum_{k-1}^{m} \frac{\sum_i + \sum_j (D_{ijk} - d_{ijk})^2}{\sum_i \sum_j d_{ijk}^2}] \quad \text{...(5)}$$

Raptourism analyzed data to assess sustainability aspects across four dimensions: environmental, economic, socio-cultural, and institutional, conducted through several stages:

1. Determination of the sustainability dimension was based on field observations, library studies, and consultation with various stakeholders.
2. Each attribute within the dimensions was scaled based on scientific assessments by the researcher, ranging from 0 to 2, reflecting conditions from worst (0) to best (2).
3. The scores for each attribute were then analyzed multidimensionally using the Rapfish program to determine sustainability conditions, categorized as follows: Unsustainable (0.00-25.00), Less Sustainable (25.01-50.00), Sustainable (50.01-75.00), and Good or Very Sustainable (75.01-100.00) (Pitcher et al., 2013).

Variables and research data sources used for analyzing sustainability using the Raphtourism technique are in Table 1.

Table 1. Variables Data Raptourism

No.	Dimension	Attribute
1.	Environmental Dimension	Water safety and quality management.
		Prohibition of flora destruction.
		Protection and rehabilitation of local flora.
		Waste management program.
		Deterioration of surrounding ecosystem resources.
		Environmental management and protection.
2.	Economic Dimension	CSR fund support.
		Accessibility of tourist areas.
		Government budget for tourism management.
		The average income of the community.
		Community welfare level.
		Community involvement in local businesses.

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No.	Dimension	Attribute
3.	Social Dimension	Researcher's attention to the tourist area.
		Level of community education.
		Level of conflict between community members.
		Damage to tourism resources by the community.
		Community participation in tourism management.
		Community knowledge about sustainable tourism.
4.	Institutional Dimension	Integration of management programs.
		Level of community compliance.
		Availability of formal regulations.
		Involvement of community institutions.
		Local government commitment to conservation.
		Area legality.

Source: Authors' analysis, 2023

In the MICMAC analysis, the technical stages consisted of several significant steps. First, eleven key variables relevant to sustainable tourism management in the Rammang-Rammang Geopark were determined by identifying them in Table 2. Next, the level of influence and dependency between variables was assessed by assigning a score to each pair of variables based on the level of direct influence they had, using a rating scale from 0 to 4 (Ariyani et al., 2022; Wu et al., 2023).

The next step is to input the assessment data into the MICMAC software for further processing and analysis and a direct influence matrix analysis to determine the variables that fall into four quadrants. After that, a variable classification analysis is conducted based on the dependency and influence level to determine the most influential and dependent variables in the system (Fauzi, 2019). From the results of the analysis, the final step is to formulate appropriate management strategies and action scenarios to improve the sustainability of tourism management in the tourism area.

As indicated in Table 2, eleven variables are employed as leverage points for the sustainability analysis of the Rammang-Rammang Village Tourism area for the MICMAC analysis.

Table 2. Variables Data MICMAC

No.	Abbreviation	Variable
1.	PERLO	Protection of Local Flora Rehabilitation
2.	KSDE	Damage to Ecosystem Resources
3.	LPF	Prohibition of Destruction of Flora
4.	PM	Community Participation
5.	EDUMAS	Community Education Level
6.	TPMWB	Public Knowledge about Sustainable Tourism
7.	TKM	Community Compliance Rate
8.	TPM	People's Income Level
9.	APPK	Area Management Government Budget
10.	AKW	Tourist Area Accessibility
11.	LK	Area Legality

Source: Authors' analysis, 2023

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FINDINGS AND DISCUSSION

Characteristics of Respondent

Based on the analysis of questionnaires, interviews, and various supporting sources used in this study, we observed the respondents' gender as one of the relevant aspects. The data indicated that out of the total 49 respondents involved in this study, 78% were male, while female respondents accounted for 22%. This data served as the first step in understanding the characteristics of respondents and could be the basis for further exploration in the context of other research variables.

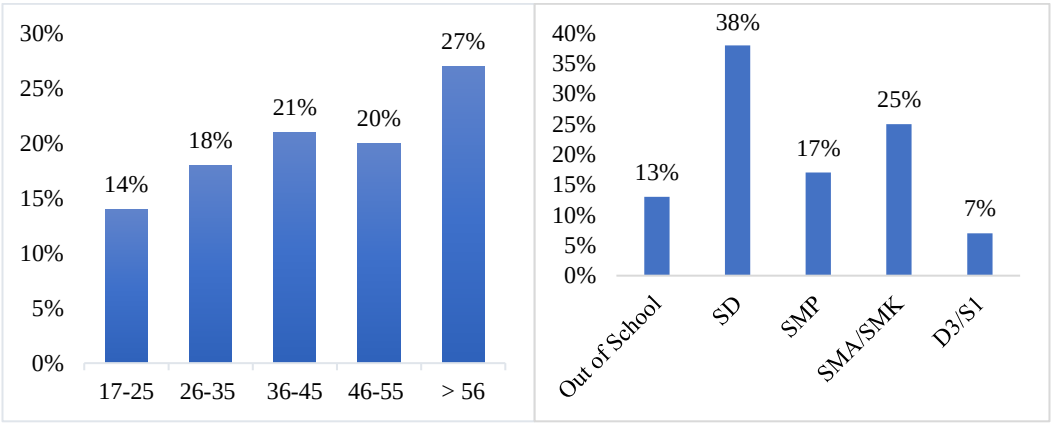

Figure 3. Characteristics of Respondents: (a) Characteristics of Respondents by Age; (b) Characteristics of Respondents based on Education
Source: Processed from primary data, 2023

Characteristics based on age groups involved in managing tourism activities showed that individuals aged 56 years and over had the highest level of engagement, comprising approximately 27% of the total sample (Figure 3). However, overall, respondents showed equal involvement on average. This analysis revealed diversity in age distribution within the study sample. It indicates that age variation was not dominated by a specific age group but involved productive ages. Regarding education, the dominance of lower levels of education among community members was noted, with some individuals having no formal education. It highlights a significant concern for developing the quality of community resources, particularly in education related to tourism management, environmental conservation, and the creative economy, as part of efforts to enhance living standards and welfare.

Rapfish Analysis for Environmental Dimensions

The data in Figure 4 showed that the attribute which had the most influence on the overall change in status in environmental management was the protection and rehabilitation of local flora, followed by general environmental management and protection and prevention of damage to neighboring ecosystems. Focusing on these attributes greatly supported the success of environmental management and conservation. Other attributes, such as water safety and quality and waste management, had less influence but were still important to manage effectively. The data showed that protection and restoration initiatives

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aimed at the local flora promote environmental sustainability within the Rammang-Rammang Geopark. Various native flora was a fundamental aspect of the karst environment and enhanced the attractiveness of ecotourism in the area. Furthermore, the importance of prohibiting damage inflicted on the flora underscored the need for strict regulations and law enforcement to mitigate the adverse effects of human activities on plant life.

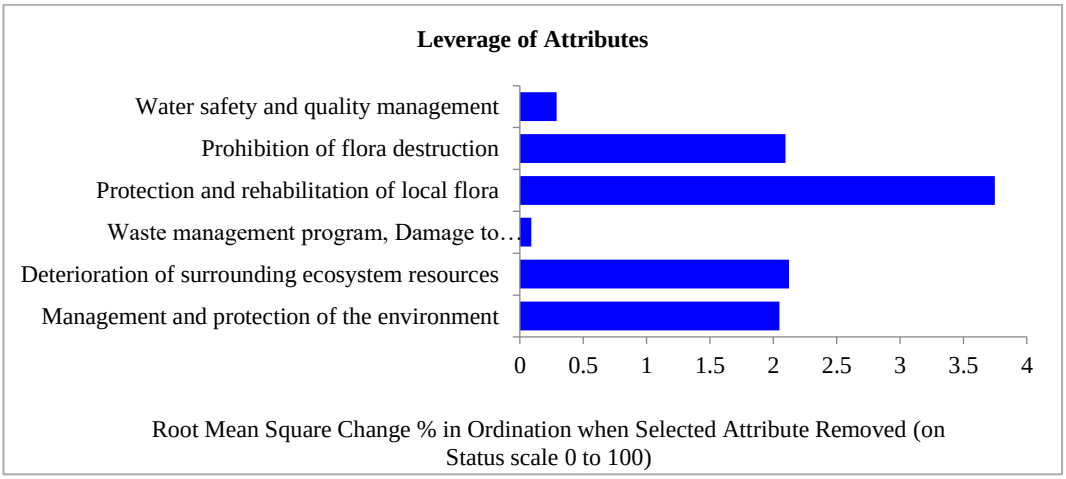

Figure 4. Environment Dimension State
Source: Processed from primary data, 2023

According to Iwan Dento, one of the environmental activists who campaigned for environmental sustainability in Rammang-Rammang began his social action, which includes efforts to preserve land, restore endangered ecosystems, or reduce air and water pollution. In addition, good waste management is also highly considered to maintain ecological balance by minimizing the generation of hazardous waste and encouraging waste recycling.

It was important to remember that environmental protection was a shared responsibility, and collaborating with external parties, such as environmental groups or local governments, was crucial to achieving environmental sustainability. Therefore, local communities were involved in environmental management, creating awareness about the importance of environmental protection.

Rapfish Analysis for Economic Dimensions

The data in Figure 5 showed that the most influential attribute on the overall status change in tourism management and community welfare was the average income followed by the government budget for tourism management. CSR fund support, accessibility of tourist areas, and the level of community welfare were also influential but on a smaller scale. Therefore, focusing on improving the economic welfare of the community and adequate government budget allocation supported the success of tourism management and the improvement of local community welfare.

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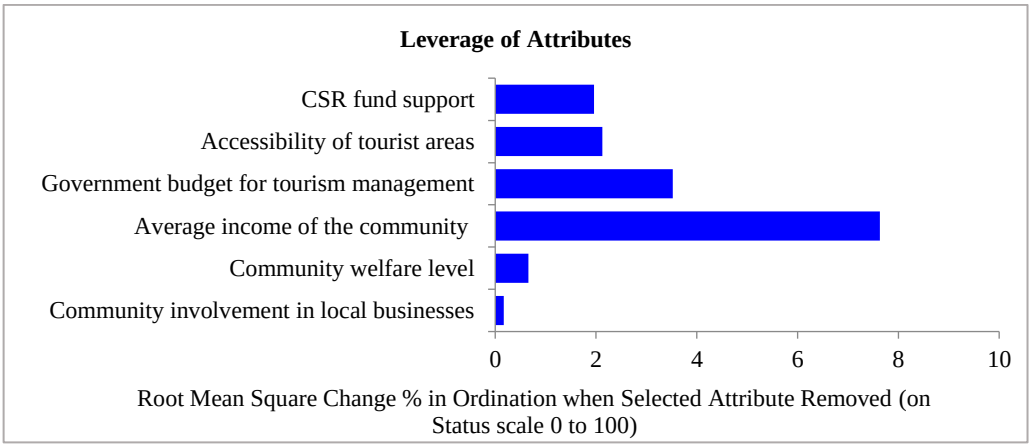

Figure 5. Status of the Economic Dimension
Source: Processed from primary data, 2023

These efforts are a step towards ensuring the long-term economic sustainability of local communities that depend on tourism activities. Therefore, the involvement of donor organizations, government agencies is needed to assist communities in various programs that foster their creativity, investment in business capital and marketing strategies.

Overall, this leverage analysis emphasized the importance of increasing community income, adequate government budget allocation, good accessibility to tourist areas, and support from CSR funds in maintaining the economic sustainability of tourism management. Therefore, long-term economic sustainability had to be prioritized by considering creative efforts to create marketable products and services offered to tourists. These efforts were a step towards ensuring the long-term economic sustainability of local communities that depended on tourism activities. Therefore, communities need donor organizations and government agencies to assist in various programs that foster their creativity, investment in business capital, and marketing strategies.

Rapfish Analysis for Social Dimension

The data in Figure 6 showed that the attributes that influence on the overall status change in tourism management and conservation were the level of community education and participation in tourism management. Local communities' knowledge of sustainable tourism also influences on sustainability. Factors such as the attention of researchers, the level of conflict within the community, and the damage to resources caused by tourism activities, as perceived by the community, had a small influence but were still important to consider. In addition, improving community education and participation supported the success of sustainable tourism management and conservation activities.

In general, the interpretation of these data suggested that the development and improvement of community education, encouraging the active involvement of communities in overseeing tourism activities, and efforts to reduce potential conflicts within communities were essential elements to uphold the social sustainability of tourism management.

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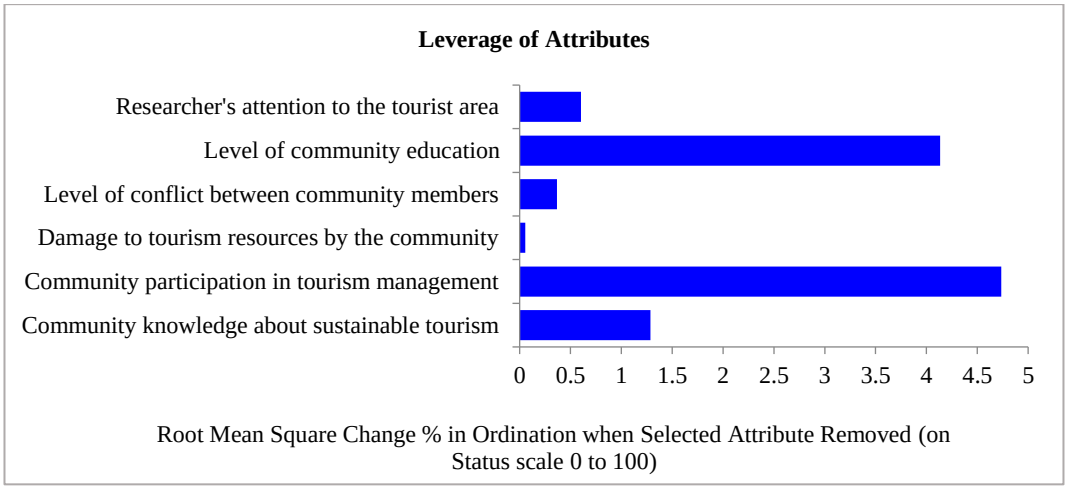

Figure 6. Social Dimension Status
Source: Processed from primary data, 2023

The empowerment process involves granting autonomy rights to communities or social organizations to participate actively in decision-making processes (Kumar et al., 2022). In addition, social sustainability relied on the issue of equality without discrimination and ensuring that every citizen had an equal opportunity to be involved in management (Gianfate et al., 2020). By placing a community empowerment orientation based on the principles of justice and social welfare, it was expected that local communities could contribute to tourism development.

Social sustainability depended on equality without discrimination and ensuring every citizen had an equal opportunity to be involved in tourism management. By placing the orientation of community empowerment based on the principles of justice and social welfare, it was hoped that local communities could contribute to more friendly-sustainable tourism development.

Rapfish Analysis for Institutional Dimensions

Overall, the data in Figure 7 emphasized the importance of area legality, community compliance, integration of management programs, and local government commitment in tourism and conservation management. Formal regulations and government commitment integrated with tourism activity programs ruled and impacted the overall status. It meant that legal certainty related to the tourism area greatly influenced the success of tourism management and conservation efforts, leading to positive impacts on environmental sustainability and local community empowerment, especially tourism businesses. The community's institutional system had functioned well, as indicated by the establishment of a management organization structure, direct involvement, and effective policies. This stability was supported by an institutional management system oriented towards tourism village management, based on the level of participation and awareness of the importance and benefits of tourism villages for employment, economic improvement, and welfare.

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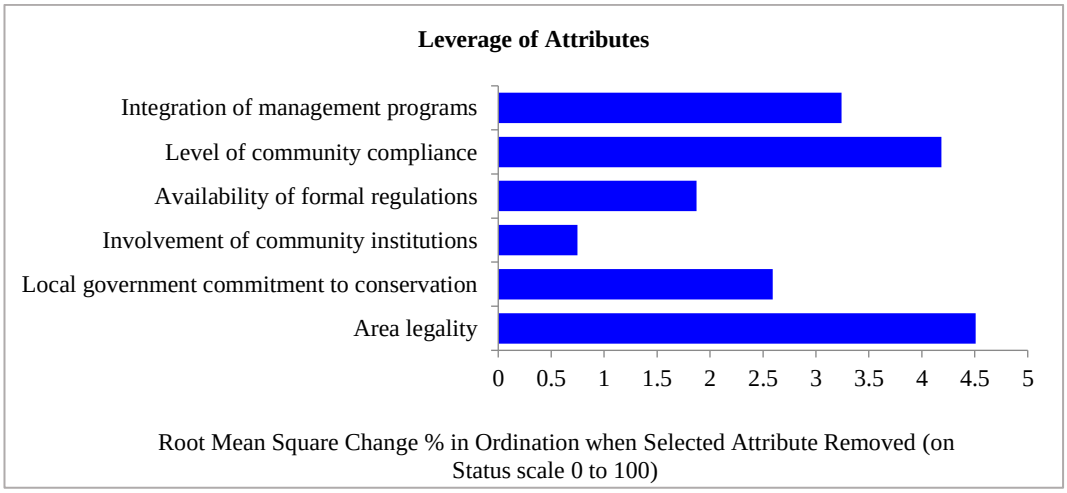

Figure 7. Status of Institutional Dimension
Source: Processed from primary data, 2023

By maintaining openness, accountability, and good governance, communities were better equipped to deal with potential changes and challenges that could impact community institutions. Therefore, it was critical to maintain the integrity of each individual and community group. Transparent management and community engagement were valuable components in maintaining the sustainability of tourism villages, ensuring that all parties with an interest in policy and resource management could access information transparently, thereby building trust and fostering cooperation between communities to identify potential solutions and problems (Rukmiyati et al., 2023).

Accountability was thus a key component of organizational/institutional sustainability. By maintaining openness, accountability, and good governance, communities could keep the sustainability index score on the institutional dimension high and be better prepared to deal with changes and challenges that could affect community institutions. Hence, it was necessary to maintain the integrity of each individual and community group. Overall, the raptourism data analysis indicates sustainable outcomes, consistent with the data analysis presented in Figure 8.

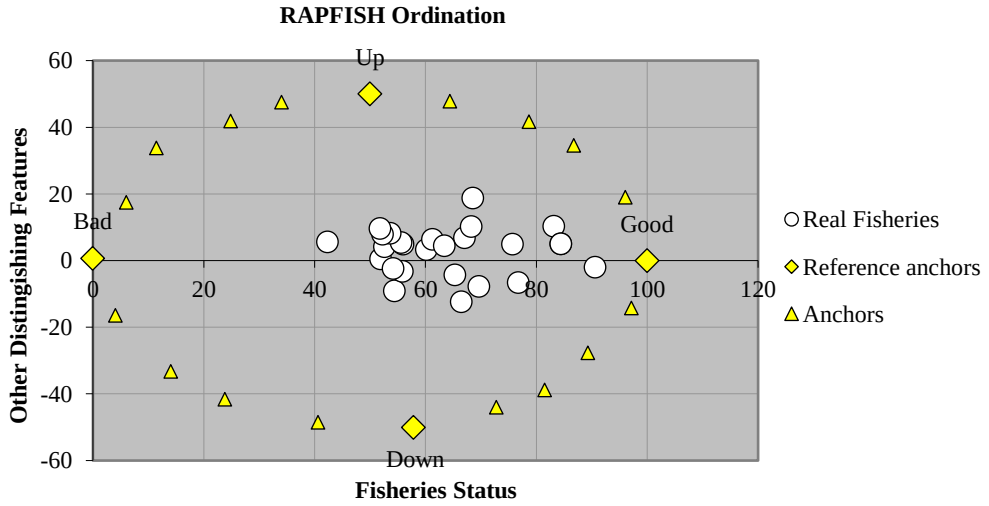

Figure 8. General Status of Sustainability
Source: Processed from primary data, 2023

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The Raptourism chart illustrated the integrated sustainability status across dimensions, where proximity to the zero point indicated a lower level of sustainability, and conversely, greater distance from the zero point signified a higher level of sustainability (Fauzi, 2019). Based on the chart analysis across all dimensions, it was evident that the social dimension had the lowest sustainability level among the four analyzed dimensions. Therefore, special attention was needed to manage the Rammang-Rammang Geopark tourism area, particularly in addressing the social dimension to enhance its sustainability, as presented in Table 3 and Figure 9.

Table 3. MDS Validation and Accuracy

Dimensions	Sustainability Indeks Value %				
	Rapfish	Stress	RSQ	Montecarlo	Difference
Environment	66.20	0.16	0.94	67.09	0.89
Economic	55.78	0.15	0.94	56.21	0.43
Social	49.97	0.15	0.94	50.15	0.18
Institutional	81.40	0.14	0.95	80.00	1.40

Source: Processed from primary data, 2023

Figure 9. Radar Chart
Source: Processed from primary data, 2023

From this analysis, the environmental dimension scored 66.20%, the institutional dimension scored 81.40%, and the economic dimension scored 55.78%, indicating a fairly sustainable status. However, the social dimension scored 49.97%, signifying a less sustainable status. Considering this situation, effective management of sensitive attributes was needed to prevent or mitigate the decline in sustainability status and to promote an improvement in the sustainability status of other dimensions.

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MICMAC Analysis

The direct influence graph presented in Figure 10 showed the relationships and interrelationships between various variables that affected the sustainability of ecotourism management in Rammang-Rammang Geopark. This graph provided a clear visualization of variables that had a strong, moderate, or weak influence on others in the system. The figure showed that several variables had a strong influence (depicted by a red line) on other variables, such as:

1. PERLO (Protection and Rehabilitation of Local Flora) had a strong influence on the variables KSDE (Damage to Ecosystem Resources) and LPF (Prohibition of Flora Destruction).
2. KSDE (Damage to Ecosystem Resources) had a strong influence on the variables PERLO, LPF, PM (Community Participation), and TKM (Community Compliance Level).
3. TKM (Level of Community Compliance) had a strong influence on the variables KSDE, EDUMAS (Level of Community Education), and TPMWB (Community Knowledge of Sustainable Tourism).

It showed that efforts to protect and rehabilitate local flora, prevent damage to ecosystem resources, and maintain the level of compliance and community participation had a very strong influence in sustaining the management of ecotourism in Rammang-Rammang Geopark.

On the other hand, some variables had a weaker influence (depicted by blue or green lines) on others, such as TPM (Community Income Level), APPK (Government Budget for Area Management), AKW (Tourist Area Accessibility), and LK (Area Legality).

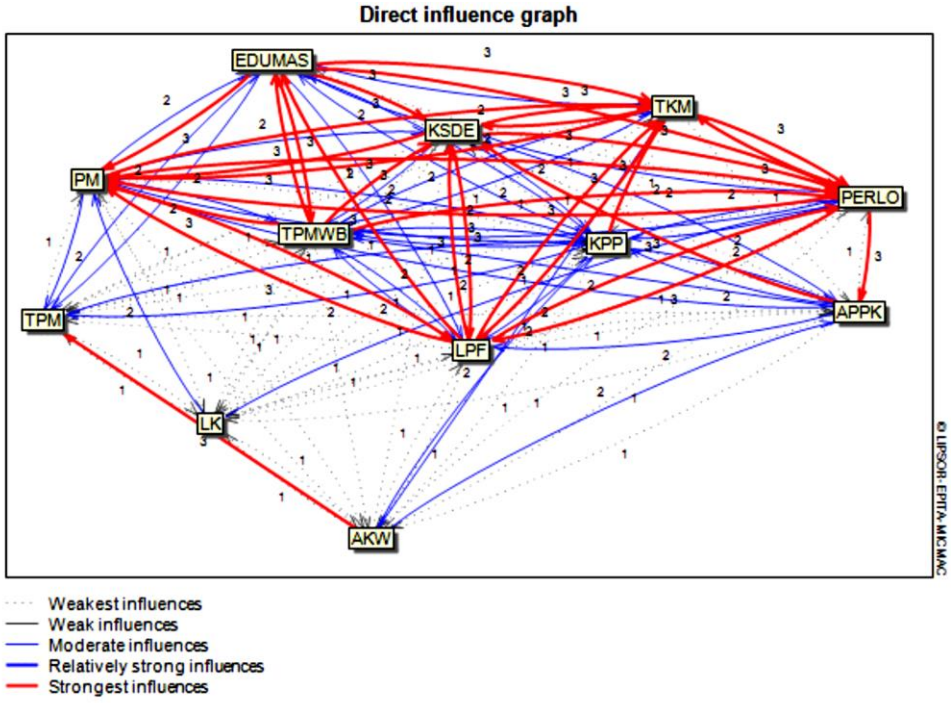

Figure 10. Direct Influence Graph
Source: Processed from primary data, 2023

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The interpretation of the graph showed that environmental factors such as protecting flora, preventing ecosystem damage, and encouraging community involvement and compliance strongly impact on the sustainability of tourism management. Therefore, the management strategy approach prioritized these variables. However, other factors such as community income levels, government assistance, ease of access, and the legal status of the area also played a noteworthy role in this framework. Although their influence was relatively weaker, these factors still required careful monitoring and addressing to uphold the overall sustainability of ecotourism management.

From the analysis results presented in Figure 11, the image showed a direct influence/dependence map, a visual representation of the relationships and dependencies between various factors in a given system or analysis. Here's an interpretation of the information presented in the image.

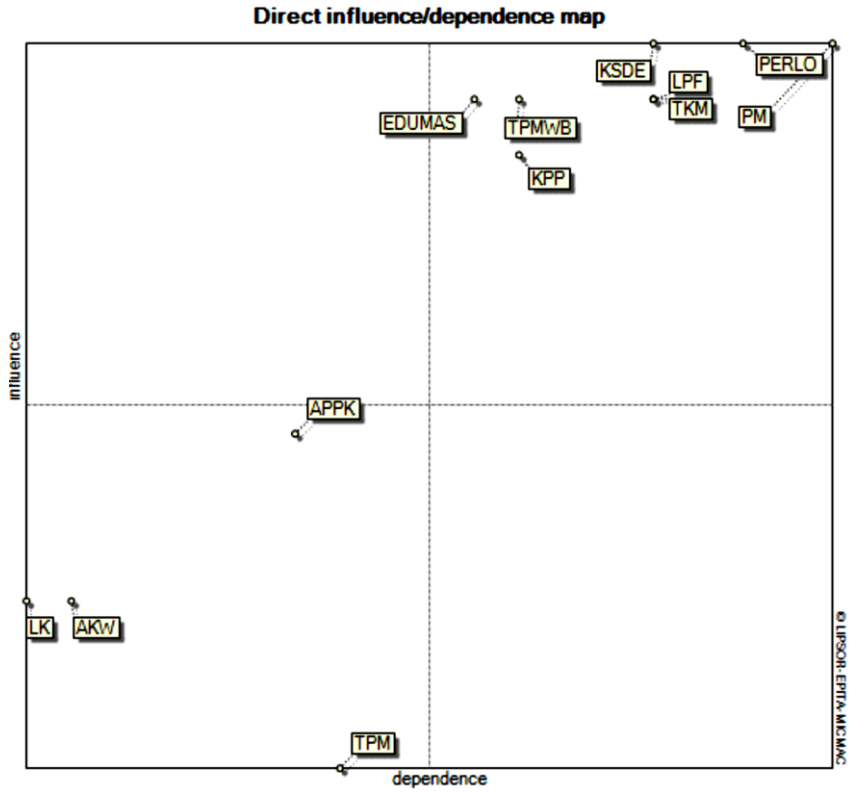

Figure 11. Direct Influence and Dependence Map
Source: Processed from primary data, 2023

The map has four quadrants, each representing a different category of factors based on their level of dependence and influence on other factors. Quadrant II (Relay Variables): This quadrant contained factors that had a high level of dependence on others while also significantly influencing on other factors. The factors in this quadrant were crucial and interconnected within the system. Some of the factors in this quadrant included:

1. PERLO (Protection and Rehabilitation of Local Flora): This factor had a high dependence on various other factors in the analysis, showing that the protection and rehabilitation of local flora was one of the essential factors in the Rammang-Rammang Geopark management.

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2. KSDE (Damage to Ecosystem Resources): This factor also had a high dependence on other factors and had a significant impact. It shows that efforts to reduce damage to ecosystem resources impact the sustainability of the region.
3. LPF (Prohibition of Flora Destruction): The prohibition of the destruction of flora impacts various other factors, but it also depends on certain factors. It emphasizes the importance of policies and rules related to the protection of flora within the Geopark area.
4. PM (Community Participation): Community participation was a key factor influencing many aspects of area management. This factor had a significant impact on various other factors in the analysis.
5. EDUMAS (Community Education Level): The education level of the community influences the system and has high dependencies on other factors. Community education plays an important role in the management of tourist areas.
6. TPMWB (Public Knowledge about Sustainable Tourism): Public knowledge about sustainable tourism in Quadrant II, with significant impact and dependence on other factors. It shows the importance of public knowledge related to sustainable tourism in the context of Geoparks.
7. TKM (Community Compliance Rate): Community compliance with rules and regulations influenced various other factors in the analysis. This factor had a significant impact and high dependence on others.

These factors were highly dependent on other factors in the system, but at the same time, they significantly impact other factors. They were considered key variables that needed to be carefully managed and addressed, as changes in these factors could have ripple effects throughout the system.

Quadrant IV (Autonomous Variables): This quadrant contains factors that have a low level of dependence on other factors but significantly influence others. These factors are relatively independent but still play an important role in the system. The factors are:

1. TPM (Community Income Level): Community income levels impact factors in the system, although they are less dependent on other factors. It shows the importance of the community economy in the context of tourism area management.
2. APPK (Government Budget for Area Management): The government budget for area management significantly impacts area management, although it does not depend heavily on other factors.
3. AKW (Tourist Area Accessibility): Tourist area accessibility affected various other factors in the system but does not have a high degree of dependence on other factors.
4. LK (Area Legality): Area legality is an important factor in tourism area management and significantly impacts other factors in the analysis.

While these factors are less dependent on other factors in the system, they can still substantially impact the overall dynamics. They might require focused attention and management, as they could influence other factors despite their relative independence.

The interpretation of this direct influence/dependence map highlighted the complex relationships and interdependencies among various factors within the system being analyzed. It helped identify the key variables that needed to be prioritized and managed

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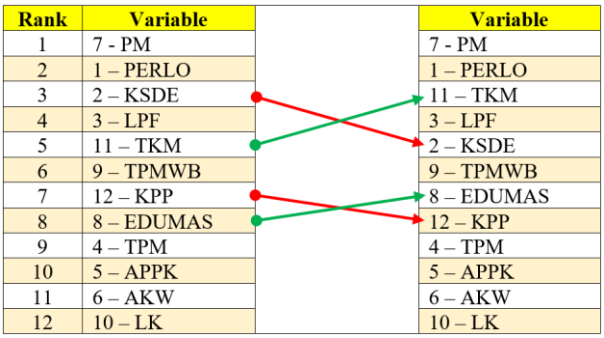
carefully and the relatively independent factors that could still have significantly impact the overall system.

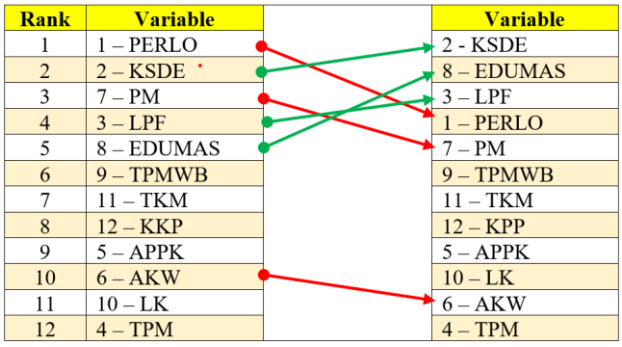
Classement par dépendance shown in Figure 12 is an analysis that classified variables based on dependence and influence in the system. In the results of this classification, variables were ranked based on the degree of dependence and their influence on other variables in the system.



Rank	Variable	Variable
1	7 - PM	7 - PM
2	1 – PERLO	1 – PERLO
3	2 – KSDE	11 – TKM
4	3 – LPF	3 – LPF
5	11 – TKM	2 – KSDE
6	9 – TPMWB	9 – TPMWB
7	12 – KPP	8 – EDUMAS
8	8 – EDUMAS	12 – KPP
9	4 – TPM	4 – TPM
10	5 – APPK	5 – APPK
11	6 – AKW	6 – AKW
12	10 – LK	10 – LK

Figure 12. Classification of Variables by Dependencies and Influences in the System
Source: Processed from primary data, 2023

Classifying variables according to their influence in this classification indicated that variables were classified based on their level of influence in the system (Figure 13). Variables that had more influence were ranked higher. The variables that were ranked higher on this list were those that had a greater impact in the system (Godet, 2006). The management of the Rammang-Rammang Geopark area had to pay close attention to the influencing variables, while the affected variables could be the focus of actions needed for better and more sustainable management efforts.



Rank	Variable	Variable
1	1 – PERLO	2 - KSDE
2	2 – KSDE	8 – EDUMAS
3	7 – PM	3 – LPF
4	3 – LPF	1 – PERLO
5	8 – EDUMAS	7 – PM
6	9 – TPMWB	9 – TPMWB
7	11 – TKM	11 – TKM
8	12 – KKP	12 – KPP
9	5 – APPK	5 – APPK
10	6 – AKW	10 – LK
11	10 – LK	6 – AKW
12	4 – TPM	4 – TPM

Figure 13. Classification by Degree of Influence in the System
Source: Processed from primary data, 2023

Based on the analysis using Direct Influence measurements, Classement par dépendance, and Classify Variables According to The Influence, a management strategy for the Rammang-Rammang Geopark area was formulated in Table 4.

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Table 4. Management Strategy

No.	Management Strategy	Empowered Variables (Influential Variables - Red)	Affected Variables (Dependent Variables - Green)
1.	Strengthen the Protection of Local Flora	(Damage to Ecosystem Resources)	-
2.	Overcoming Damage to Ecosystem Resources	(Protection of Rehabilitation of Local Flora), (Prohibition of Destruction of Flora)	-
3.	Increase Community Participation	(Protection of Rehabilitation of Local Flora), (Damage to Ecosystem Resources), (Prohibition of Destruction of Flora)	-
4.	Improving Education and Knowledge	(Protection of Rehabilitation of Local Flora), (Prohibition of Destruction of Flora)	-
5.	Drive Compliance	(Damage to Ecosystem Resources)	-
6.	Budget Management Funds	(Accessibility of Tourist Areas), (Area Legality)	-
7.	Improve Accessibility	-	(Protection of Rehabilitation of Local Flora), (Damage to Ecosystem Resources)
8.	Strengthening the Legal Framework	-	(Protection of Rehabilitation of Local Flora), (Prohibition of Destruction of Flora)
9.	Management Program Integration	-	-
10.	Monitoring and Evaluation	-	-

Source: Authors' analysis, 2023

The next step is to combine the analysis of Rapfish and Micmac, then formulate a scenario model of the management action of the Rammang-Rammang Geopark area in Table 5.

Table 5. Action Scenarios

No.	Management Scenarios	Action
1.	Strengthening Local Flora Protection	Form a special team for the protection of local flora. Monitoring and replanting of local flora.
2.	Handling Damage to Ecosystem Resources	Identify areas with severe ecosystem damage. Implementation of a targeted and sustainable recovery program.
3.	Active Community Participation	Training and education programs for local communities. Encourage active participation in management and monitoring decisions.
4.	Education and Community Knowledge.	Continuing education programs in local schools. Workshops and training programs to increase knowledge about sustainable tourism.
5.	Monitoring and Enforcement	Increased enforcement of rules and regulations that protect the region. Patrol and routine monitoring.
6.	Adequate Budget Allocation	Ensure adequate budget allocation for area management. Use of budget for facility maintenance, environmental restoration, and awareness campaigns.

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No.	Management Scenarios	Action
7.	Improve Accessibility	Improve accessibility to the Geopark area with sustainability in mind. Improved road infrastructure and public transport accessibility.
8.	Strengthening the Legal Framework	Strengthen the legal framework that protects the region and regulates activities that damage the environment.
9.	Management Program Integration	Ensure that all management programs are well integrated and coordinate with stakeholders.
10.	Continuous Monitoring and Evaluation	Implement an ongoing monitoring and evaluation system to ensure that management scenarios are on track.

Source: Authors' analysis, 2023

Table 5 summarizes actions to be taken in each management scenario to maintain the sustainability of the Rammang-Rammang Geopark area. In its implementation, it was important to involve all relevant parties and continuously monitor the impact of these actions.

Ramang-Ramang Geopark Development Strategy

A comprehensive development strategy is needed to facilitate international recognition of the Ramang-Ramang Geopark by UNESCO to encompass conservation initiatives, advancement of public education and awareness programs, empowerment of local communities, sustainable infrastructure development, and the fortification of legal and institutional frameworks. All of which had to be implemented consistently and sustainably. This comprehensive approach was necessary for Ramang-Ramang to fulfil the global criteria set by UNESCO, thereby achieving recognition as a geopark of international status. The strategic steps required to secure UNESCO international recognition for Ramang-Rammang Geopark are in Table 6.

Table 6. Rammang-Rammang Geopark Sustainability Development Strategy based on UNESCO Standards

Strategy	Strategic Steps	Program Realization
Improved Environmental Conservation and Management	- Zoning of tourist areas	- Conservation Zoning was implemented in the form of restrictions on protected areas from tourist activities that had the potential to damage biodiversity and geology. - Tourism Zoning was established to restrict tourist travel activities in certain areas that were vulnerable to natural damage.
Enhanced Environmental Monitoring	- Drones and sensors were used to monitor environmental changes. - Communities engage in monitoring through training programs.	
Strengthening Education and Public Awareness	- Geopark Education Centre	- Facilities for geological education and conservation. - An integrated education program was created with a curriculum related to the protection and conservation of the geopark area in schools included in the Maros-Pangkep geopark zoning.

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Strategy	Strategic Steps	Program Realization
Awareness Raising through Educational Tourism Activities	- A tour community was created that offered geological and conservation knowledge. - Visitors were educated so that before the tour, they were educated for about 5 minutes about the tourist and protected zoning areas.	
Local Community Empowerment and Engagement	- Local Economic Empowerment	- Local wisdom-based micro-enterprises were developed businesses derived from handicrafts and guide services from the surrounding community. - Capacity building through training and mentoring on entrepreneurship and environmentally friendly technology.
Community Involvement in Geopark Management	- The community was involved in geopark management decision-making. - A conservation volunteer program was initiated to invite the community to participate in nature protection and conservation programs.	
Eco-friendly Infrastructure Development	- Environmentally Friendly Infrastructure Development	- Green Transport was developed, such as local vehicles like dokars or bicycles. - Hotels, bungalows, or lodges were built using natural materials.
Waste and Waste Management	- A 3R program (Reduce, Reuse, Recycle) was implemented for waste management. - Waste management facilities were built at certain points to treat solid and liquid waste and also served as educational tools.	
Strengthening Legal and Institutional Aspects	- Legal Recognition and Protection	- Protection Status: Immediate legal sanctions were implemented in the form of laws or regional regulations to protect geoparks from exploitation by collaborating to obtain regulatory support.

Source: Authors' analysis, 2023

The Importance of Promotion and Marketing to Support Tourism Sustainability

Promotion and advertising were considered very important in driving the progress of sustainable tourism, especially in relation to achieving the goals of the 2030 Agenda. They were highly beneficial in increasing the influx of tourists, resulting in beneficial effects on the local economy and employment opportunities, as they facilitated market diversification, thereby attracting diverse segments of tourists.

In addition, the support and strengthening of local culture and products through digital promotion make local products such as handicrafts, traditional cuisine, and cultural artworks more recognizable and attractive to visitors. It increased demand for local products and aided in the preservation of cultural heritage, thereby increasing appreciation

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from tourists and locals alike, which encouraged the preservation of the traditions and cultural practices that characterized Rammang-Rammang.

Furthermore, promotional initiatives that conveyed educational messages about environmental conservation and local culture motivated travelers to engage in more responsible tourism activities. The application of digital platforms, including social media, websites, and mobile apps, are an efficient strategy to disseminate information on sustainable practices adopted in tourist destinations, promoting increased public awareness and participation in sustainable tourism. They are listed in Table 7 below.

Table 7. Promotion Strategy

Strategy	Key Initiatives	Implementation
Identity Development and Branding	Developing a Distinctive Image (Branding)	- Identified the uniqueness of Ramang-Ramang Geopark, such as its distinctive karst formations. - Determined key messages such as 'Sustainable Nature Tourism Destination.' - Designed a logo and slogan that reflected sustainability values.
Use of Digital Technology for Promotion	Optimization of Promotion and Marketing on Social Media Interactive Website	- Created educational content about conservation and sustainability. - Encouraged influencers to promote the geopark.
	Interactive Website	- Created a website with detailed and complete information about the geopark area. - Facilitated online booking of tour packages and travel guides.
	Utilizing Mobile Applications as a Means of Digital Education	- Developed a mobile application as an interactive tourist guide. - Created a loyalty program for tourists with sustainability-related incentives.
Strategic Partnerships for Promotion	Cooperation with Travel Agent	- Collaborated with travel agencies to create tour packages that included visits to Ramang-Ramang Geopark and other tourist destinations. - Promoted tourist accommodation that was consistent with the principles of environmental sustainability.
	Cooperation with International Tourism Networks and International Medians that Focus on the Development of Geopark Natural Destinations	- Collaborated with international media and civil society organizations to promote conservation efforts in Ramang-Ramang. - Collaborated with geopark tourist destinations around the world for cross-promotion and experience sharing
Education and Community Engagement	Promotion Training for Local Communities	- Trained locals to become tour guides and promote conservation values. - Engaged local residents as agents to promote geopark tourism
	Educational Programs for Visitors	- Organized workshops on sustainable tourism. - Provided on-the-spot learning experiences for travelers.

Source: Authors' analysis, 2023

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This study provides an understanding of the characteristics of the community involved in tourism management. Demographic data indicates that most respondents are male, with a dominance in the age group of 56 years and above. It reflects gender inequality in tourism management, despite the positive impact of women's involvement in tourism management, offering diverse perspectives and creating broader social impacts (Alarcón & Cole, 2019). Therefore, increasing women's participation in management activities is essential to achieve holistic sustainability in the context of the Rammang-Rammang Geopark.

The development of this tourist area requires a systematic methodology to gain international recognition, especially from UNESCO. An important component is the coupling of conservation initiatives with tourism management, which requires the protection of the biodiversity and geological features of the area. Strict enforcement of zoning regulations and rehabilitation of disturbed ecosystems are fundamental early actions. In addition, increased environmental education and awareness initiatives are essential to increase the knowledge and involvement of local communities and tourists in conservation efforts.

Rapfish Analysis observes comprehensive attention to environmental issues in tourism management in Rammang-Rammang Geopark. It is in line with the global emphasis on environmental sustainability in the tourism industry, emphasizing the importance of sustainable ecotourism management to protect natural heritage and biodiversity (Boley & Green, 2016). Forest protection efforts, waste management, and campaigns by environmental activists in Rammang-Rammang reflect positive steps. Nonetheless, cooperation with external parties, such as environmental groups or local governments, was identified as an important factor in achieving optimal environmental sustainability. In the economic dimension, Rapfish's results show increased income through tourism management. However, the study provides a warning that reliance on tourism as a source of income can be a long-term risk. Increased economic value through diversification of tourism products and services must be realized to reduce the risk of over-reliance (Solarin et al., 2023). Empirical studies and creative approaches are needed to create memorable travel experiences and compelling products, so that destinations remain attractive to tourists (Lončarić et al., 2021).

Rapfish's analysis shows that, despite the considerable focus on environmental issues in tourism management, collaboration with external entities, including environmental organizations and local governments, requires optimization to realise maximum environmental sustainability. In addition, increased community engagement and institutional optimizations are essential to ensure that geopark management is implemented in a transparent and inclusive manner. Diversification of the tourism economy should also be considered to mitigate the risks associated with long-term dependence on a single source of revenue focused solely on the tourism sector.

The social dimension shows that community participation is still suboptimal. Community empowerment and improvement of skills and resources are needed to increase participation in tourism management. The concept of equality without discrimination being essential to achieve sustainability was identified as a key element in achieving tourism sustainability (Okazaki, 2008). Community empowerment through improving skills and resources can help create a sense of belonging and responsibility towards tourism management (Patadjenu et al., 2023). Better accountability through increased participation

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and transparency can improve institutional effectiveness (Widhianthini, 2017). Therefore, suggestions to strengthen the structure and increase the involvement of all parties can contribute positively to institutional sustainability in the Rammang-Rammang Geopark.

The Montecarlo Analysis states that the sustainability index is classified as sustainable overall. However, environmental, economic, and social dimensions need further attention. The analysis results reveal an evaluation of four main dimensions to explore effectiveness and sustainability with management scenario analysis that focuses on 12 main interrelated aspects (Godet, 2006). The MICMAC analysis provides the foundation for more targeted management strategies, including strengthening the protection of local flora, addressing damage to ecosystem resources, and increasing community participation. The integration of Rapfish and MICMAC results in action scenarios that include strengthening local flora protection, addressing damage to ecosystem resources, increasing community participation, and increasing community education and knowledge. This scenario provides a concrete foundation to improve the sustainability of the Rammang-Rammang Geopark. Although the overall sustainability index is categorized as sustainable, the social and institutional dimensions require high attention. The level of community participation in tourism management remains suboptimal, indicating an urgent need to enhance community empowerment initiatives and improve available skills and resources.

In addition, the MICMAC analysis maps out a strategic basis for more targeted management, which includes measures to enhance protection of local flora, address degradation of ecosystem resources, and strengthen community participation. These initiatives will foster a sense of ownership and accountability towards tourism management that ultimately contributes to sustainability in all aspects. In effect, strong institutional governance and active involvement of all stakeholders can enhance institutional privilege in the sustainable management of this geopark.

Based on the research findings, strengthened policy implications include increasing women's participation in tourism management to achieve comprehensive sustainability. Additionally, optimizing external collaboration with environmental groups or local governments needs enhancement to attain optimal environmental sustainability. Encouraging tourism economic diversification is essential to reduce long-term dependency risks while enhancing community empowerment and skills is necessary for their increased involvement in tourism management. Furthermore, the improvement of institutional structures and engagement of all stakeholders is needed to enhance institutional sustainability.

In-depth impact and dependency analyses on environmental, economic, and social dimensions need to be conducted for a more comprehensive understanding. Further studies on the influence of community empowerment on participation in tourism management can also be a focus of future research, while the development of more specific management scenarios is required to support the sustainability of the Geopark Rammang-Rammang tourism area.

Then, proceed with promotion and marketing through the implementation of digital promotion strategies so that geopark tourism attraction can increase domestic and international tourists. The goal is not just an increase in tourist numbers but includes branding that resonates with sustainability principles, such as prioritizing environmental management and sustainability. In this context, promotion and marketing are not only a

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mechanism to attract tourist numbers but also an instrument to enlighten visitors on the importance of environmental protection and local cultural heritage. In addition, promotional efforts should support the diversification of tourism advantages, including the utilization of local handicrafts, promotion of traditional cooking, and cultural art performances, all of which can strengthen the local economy and protect cultural heritage.

CONCLUSION

The development of tourism villages in Rammang-Rammang Geopark has great potential in supporting environmental conservation and improve the welfare of local communities. This study shows that village tourism can be an effective instrument for conserving natural and cultural resources through active involvement of local communities and sustainable management.

In this analysis, the rate of the environmental and institutional dimensions is strong, while the Social and Economic dimensions need to be improved. In addition, sustainability and protection of local flora needs to be addressed proactively to ensure its sustainability due to their close relationship with ecological aspects. Important variables such as the protection and rehabilitation of local flora, community participation, and integration of management programs strongly influence on the tourism management system based on the MICMAC analysis. Therefore, to achieve sustainability in tourism management, management scenarios that focus on increasing community participation, sustainable tourism education, coordination between management agencies, and environmental management need to be strengthened because the sustainability of tourism management is not only seen from one aspect but includes various interconnected dimensions.

Because the sustainability of tourism management is not only seen from one aspect but includes various interconnected dimensions. Therefore, by identifying the four dimensions, this research demonstrates a holistic approach to evaluating the sustainability of tourism management in the area. The development of the management plan includes the identification of vulnerable areas as well as zoning mapping that separates open areas from others that need to be protected. Eco-friendly infrastructure planning, such as pedestrian paths and local transport, such as dokar and supporting facilities, is the key to minimizing negative impacts on the environment. In addition, awareness-raising and education through environmental campaigns and training for local communities on tourism management are strengthened, as local communities are the most potential tour guides.

Thus, a multidimensional approach to evaluating sustainability using four key dimensions serves as an important basic analytical framework for formulating appropriate management recommendations. The gist of this study is that a multidimensional approach to evaluating and achieving sustainability in tourism management is needed to enrich perspectives. In this study, important variables such as the protection and rehabilitation of local flora, community participation, and integration of management programs are very influential on tourism management. In addition, the promotion and marketing aspects are very influential on increasing the number of tourist visits which ultimately have an impact on community welfare provided that local communities are assisted in the manufacture of local products, providing support to small and medium enterprises related to ecotourism, such as homestays, handicrafts, and traditional cuisine. Thus, the proposed management scenario should focus on increasing community participation, ecotourism education,

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coordination between management agencies and environmental management, and collaboration between Geopark managers throughout Indonesia and local and international entrepreneurs to ensure that the economic benefits of tourism can ensure the sustainability of tourism in the area.

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