

RESEARCH ARTICLE



Assessing the Sustainability Management of Djuanda Grand Forest Park in West Java, Indonesia

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ABSTRACT

Djuanda Grand Forest Park, established in 1985 by Presidential Decree No. 3, is Indonesia's first grand forest park and the largest in West Java Province, covering 528.393 hectares. The park's natural conditions support eco-tourism and environmental education. This study focuses on the sustainability of its management across four key dimensions: ecological, economic, sociocultural, and institutional. Using the Multi-Dimensional Scaling (MDS) method, data were collected from September to November 2023. The results of this research show that the ecological dimension value is 57.99% (entirely sustainable), the economic dimension value is 74.20% (entirely sustainable), the sociocultural dimension value is 32.48% (less sustainable), and the institutional dimension value is 52.80% (entirely sustainable). The overall value of the sustainability status of the Djuanda Grand Forest Park was 54.37% (entirely sustainable). The socio-cultural dimension exhibits the lowest value and is classified as less sustainable, whereas the economic dimension demonstrates the highest value and is classified as entirely sustainable.

Introduction

Djuanda Grand Forest Park, established in 1985 by Decree No. 3 of the President of the Republic of Indonesia, was the first grand forest park in Indonesia. The total area of Djuanda Grand Forest Park is 528.393 hectares (ha), which is the largest grand forest park in West Java Province [1]. In 2016, Ahmad Heryawan, as the Governor of West Java, signed the inscription of *Tebing Keraton* (in the Djuanda Grand Forest Park area) as a monitoring site for world migratory birds of prey (migration route from East Asia to South Asia). Environmental service revenues from tourism management have increased by 21.7% by 2021 compared with 2020 [2]. In general, the utilization of non-timber forest products has been demonstrated to have a less detrimental ecological impact than timber harvesting and wildlife hunting in conservation areas [3]. In addition to timber production, forests serve a multitude of other functions, including the provision of environmental services and promotion of nature tourism [4]. The insistence and expectations of eco-tourists can improve the quality of ecotourism's environmental preservation [5]. By the decree of the Minister of Forestry No. 107/kpts-II/2003, the management handed over to the West Java Provincial Government, thus becoming the Grand Forest Park Management Center Technical Implementation Unit of the West Java Provincial Forestry Service.

The management of the Djuanda Grand Forest Park is currently developing ecotourism activities. The effective carrying capacity of Djuanda Grand Forest Park is 384 tourists/day [6], however, the average number of tourists visiting the site between January and September 2023 is 1,228 tourists/day [7]. This has exceeded the effective carrying capacity, potentially damaging the area and not supporting sustainable ecotourism development. The objective of ecotourism is to transform existing behaviors into activities that are conducive to conservation goals and the economic well-being of local communities, which is intended to result in a reduction in the consumption of natural resources and an increase in support for conservation [8].

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Ecotourism has expanded to include the notion of accountability, environmentally responsible destination management, and sustainable growth of local human populations [9]. The number of visitors to ecotourism sites has an impact not only on economic income but also on the sustainability of the environment in these locations, and requires an effective management strategy. A high number of visitors has the potential to negatively impact natural resources at ecotourism sites [10].

Another threat is the damage caused by humans, including forest encroachment and people who still throw garbage or waste into the area. The issue of waste must be addressed urgently, as its continued accumulation could have a detrimental impact on the sustainability of the ecosystem and tourism sector [11]. In 2021, the total encroachment was 3 ha [2]. The current situation, whereby human exploitation and rapid urban development continue to pose a threat to biodiversity, demands immediate attention at the regional and global levels. Experts are seeking to identify concepts and approaches that will enable sustainable conservation of the Earth's remaining biodiversity [12]. Based on the opportunities and threats mentioned above, this study focuses on assessing the management of the Djuanda Grand Forest Park's sustainability status through an examination of its four pillars: ecological, economic, sociocultural, and institutional.

Materials and Methods

Study Area

This research was conducted in the Djuanda Grand Forest Park, West Java Province. It is geographically located at 107°30'01"–107°40'32" East Longitude and 06°49'28"–06°52'01" South Latitude (Figure 1). It is located in three administrative areas, covering 41.80% of Bandung Regency, 57.80% of West Bandung Regency, and 0.4% of Bandung City. Protection Block (308,614 ha), collection block (44,471 ha), and utilization block (175,308 ha). Djuanda Grand Forest Park is the largest grand forest park in West Java, and natural attractions are clustered into three areas: The *Bukit Dago*, at The *Pakar* and The *Maribaya*. This study was conducted from September to November 2023.

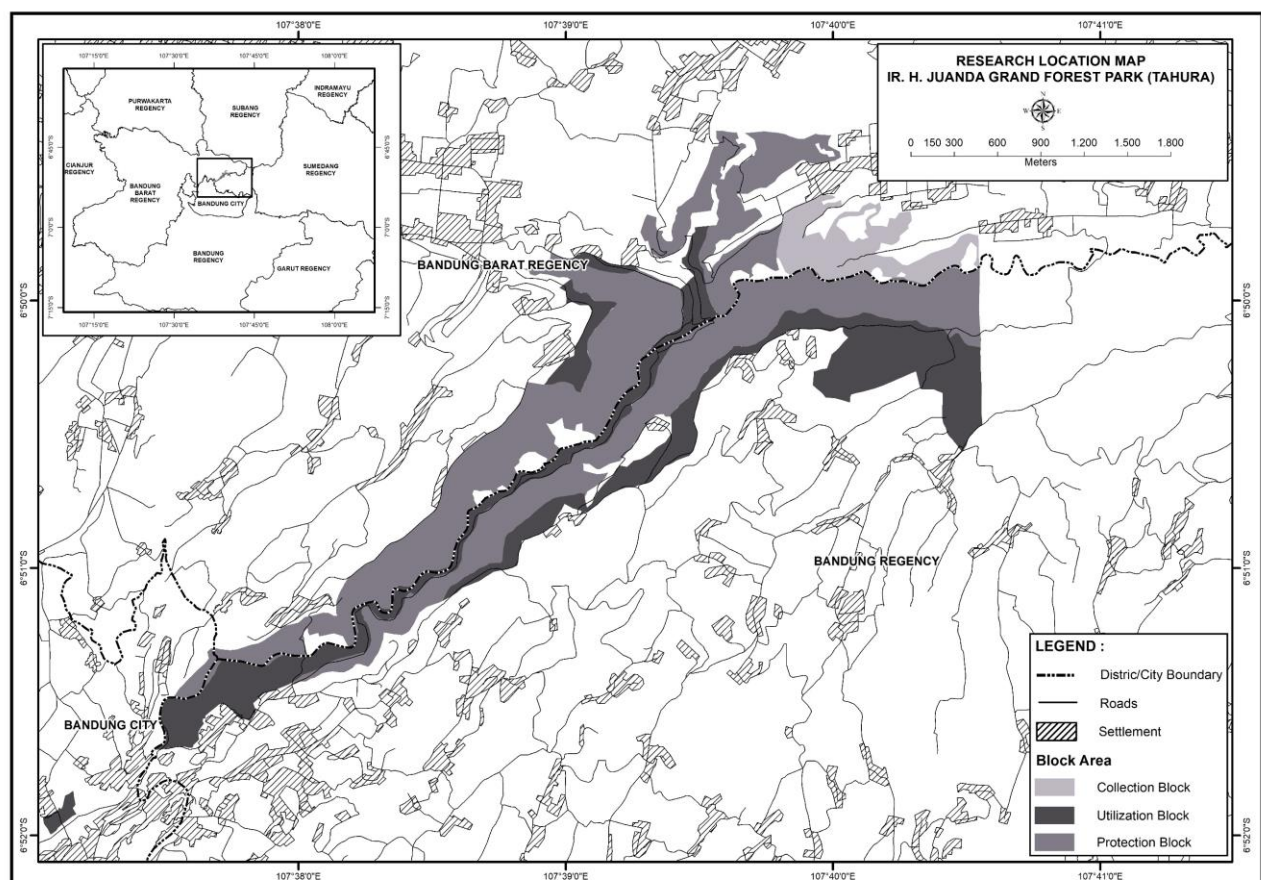


Figure 1. Map of research location.

Data Collection

Data sources include related literature and in-depth interviews with key informants. These informants were selected based on their relevance to the management and policy aspects of Djuanda Grand Forest Park. They include park managers and representatives from various government agencies involved in conservation, forestry, environment, and tourism. The key participants are outlined in Table 1.

Table 1. Key informants to analyze the sustainability status of Djuanda Grand Forest Park.

No	Institution	Total
1	West Java Natural Resources Conservation Center	1
2	West Java Provincial Environment Department	1
3	West Java Provincial Tourism and Culture Department	1
4	West Java Province Forestry Department	2
5	Djuanda Grand Forest Park Regional Technical Implementation Unit	5
Total key informants		10

Tools

The tools used in this research were cameras, voice recorders, Rap-Tourism software (rapid appraisal for tourism), and Microsoft Office. The sustainability of Djuanda Grand Forest Park was assessed using Multi-dimensional Scaling (MDS), adapted from the Rapfish Methodology. This is a multivariate technique used to analyze dimension positions based on indicator ratings (Figure 2) [13].

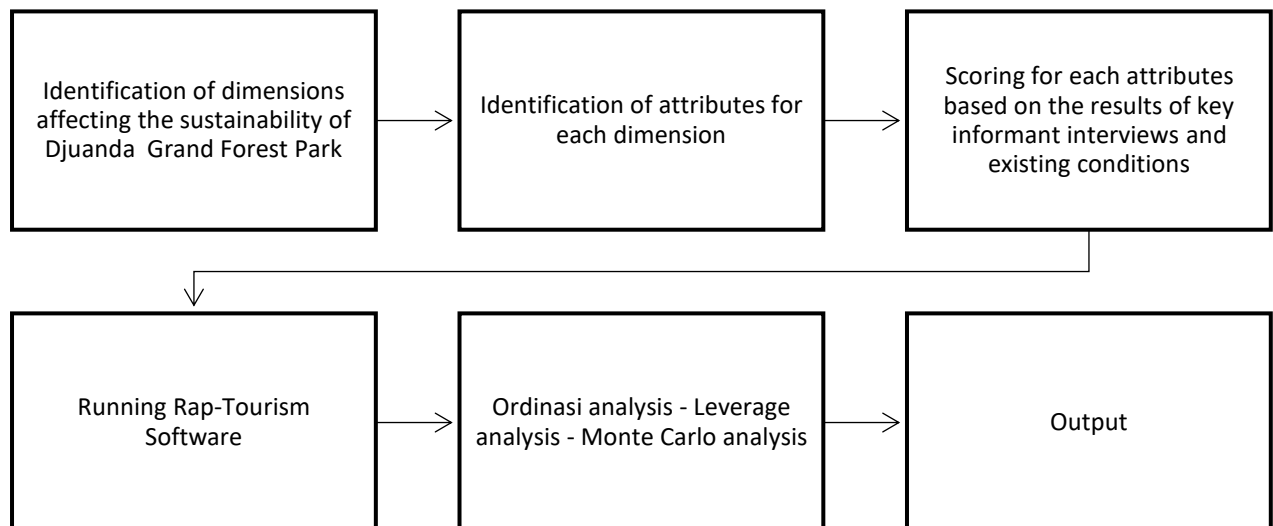


Figure 2. The stages of multidimensional scaling analysis.

MDS analysis is a multiple-variable technique that can be used to determine the position of dimensions based on the same indicator assessment [14]. The data analysis method uses the MDS ordination technique, as well as its derivatives, namely leverage analysis, to determine the significant level of influence of each dimensional attribute on sustainability [15], Monte Carlo analysis is used to determine the level of precision of the result [16]. This study analyzes the sustainability status of Djuanda Grand Forest Park using four dimensions: ecological dimension with eight attributes, economic dimension with six attributes, sociocultural dimension with five attributes, and institutional dimension with six attributes—data obtained from key informant assessments based on valid data owned by the manager. The details of the attributes used are listed in Table 2.

The rating of each dimension is divided into four category value intervals based on the rating standard [22]. Each dimension was assessed on a four-point scale, with a score range of 0.00 to 100.00. The categories are as follows: poor/not sustainable (0.00 to 25.00), less/less sustainable (25.01 to 50.00), fair/entirely sustainable (50.01 to 75.00, and good/highly sustainable (75.01 to 100.00). Leverage analysis can be employed to ascertain attributes that are sensitive or influential factors for sustainable management based on the root mean square value for each attribute. It can be posited that an elevated root mean square value signifies a heightened role for the attribute in enhancing the sustainability status.

Table 2. Shows the attributes for analysis of the sustainability of Djuanda Grand Forest Park.

Dimension	Attributes
Ecological dimension	Land stabilization [17]
	Land cover [18]
	Area boundaries maintained [19]
	Plant collection [20]
	Animal collection [20]
	Natural resource inventory results [19]
	Population collection development [20]
	Documentation of monitoring results and tracking of natural resource conditions [19]
Economic dimension	Financial management procedures [19]
	Financial reporting documents [19]
	Periodic financial audit every year [19]
	Cooperation document [19]
	Tourist guide services [21]
	Optimization of business permits [17]
Socio-cultural dimension	Document socio-economic data of surrounding communities [19]
	Preventing and overcoming human damage to botanical forest parks [17]
	Increase community understanding of conservation [20]
	Increase community knowledge and skills [20]
Institutional dimension	Community involvement [20]
	Long-term management plan for the botanical forest park [17]
	Human resources with appropriate skills and competencies [17]
	Human resource capacity building training [17]
	Information disclosure policy [17]
	Effective information system [17]
	Monitoring and evaluation documentation [17]

Results

Ecological Dimension

The results show index the ecological dimension is 57.99% (including the entirely sustainable category). The status of the ecological dimension indicates that the condition of environmental resources in Djuanda Grand Forest Park is maintained; however, further programmes and efforts are required to enhance the sustainability status. Figure 3 shows the detailed results analysis.

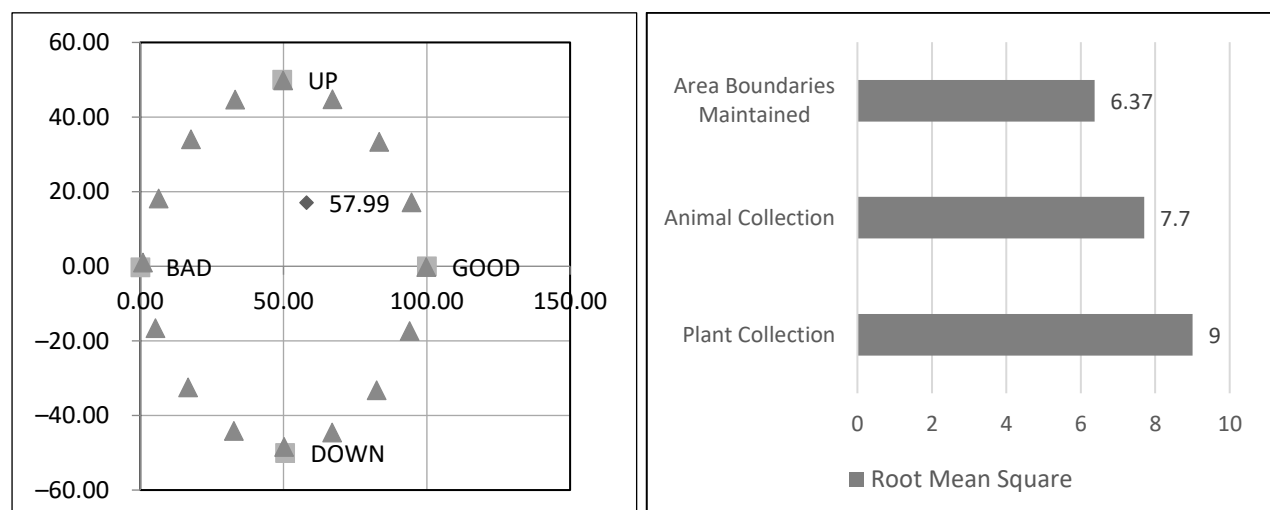


Figure 3. Ordination and leverage analysis of the ecological dimension.

Based on the assessment indicators, there are three attributes that affect the ecological condition of Djuanda Grand Forest Park: plant collections, animal collections, and area boundaries maintained. All three attributes influence each other. First, plant collection, this is a sensitive attribute that affects the sustainability because of the use of the grand forest park for biodiversity collection. Based on the highest density value at the tree

level, the pine species (with a density of 37.57 ind/ha) and the pole level are also dominated by pine species (with a density of 12.46 ind/ha) [23]. The management goals of the Djuanda Grand Forest Park are to preserve animal and plant collections and to explore the potential of the area [17]. It is crucial to provide a detailed description of the number of species, tree density, basal area, and stock (volume) per hectare in a forest stand to facilitate a comparison with the desired level for balanced forest health and growth [24]. Population development in the last 2 years has been carried out at the stage of efforts to maintain existing plants and not yet in the context of propagation of other types of plant collections. This condition occurs because of insufficient budget distribution for plant collection propagation activities. Plant collections are dominated by unnatural plants, with pine being the dominant plant.

Second, the animal collection is a sensitive attribute that affects sustainability because of the use of grand forest park for biodiversity collection. The management goals of the Djuanda Grand Forest Park are to preserve animal and plant collections and to explore the potential of the area [17]. Data on animal potential using the exploration method show that there are 68 species in the Djuanda Grand Forest Park and are dominated by long-tailed monkeys (*Macaca fascicularis*) [25]. Animal collections are conducted through the release of animals that are characteristic of and contribute to the region's biodiversity, with the objective of fostering a limited captive population through wildlife breeding activities, while maintaining genetic purity. Animal collections were primarily composed of native and natural species. A comprehensive understanding of the status and structure of biological resources is essential for their effective conservation and management [24].

Third, area boundaries, this attribute is critical due to its impact on the long-term viability of Djuanda Grand Forest Park, which is intricately linked to the management area of the grand forest park. Boundary disputes represent a significant challenge for modern societies, particularly when they give rise to localized conflicts that can present substantial obstacles for governments and local authorities in formulating effective policies for the conservation of natural resources [26]. The management of Djuanda Grand Forest Park has formed forestry police partner communities, whose duties include patrolling to monitor the boundaries and conditions of the area. Fifteen people were community partners of the forest police in the Djuanda Grand Forest Park. The community forest police partners are responsible for patrolling the area to ensure the boundaries are clearly delineated and the condition of the boundary pole is monitored. The findings of the monitoring are conveyed to the Djuanda manager to assess the condition of the boundary. The subsequent budget submission reflects the projected cost of the proposed renovation.

Economic Dimension

The results show index the economic dimension is 74.20% (including the entirely sustainable category). The results of the sustainability value in the economic dimension get the highest value compared to the other three dimensions. This shows that the implementation of the economic cycle in Djuanda Grand Forest Park is stable based on the evaluation attributes. Figure 4 shows the detailed results analysis.

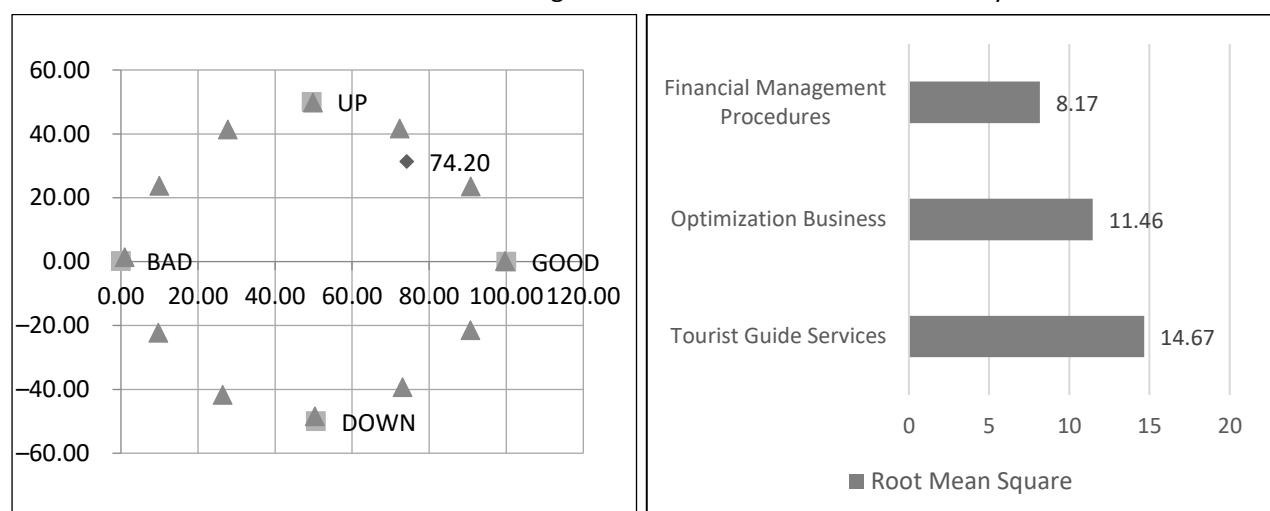


Figure 4. Ordination and leverage analysis of the economic dimension.

Based on the assessment indicators, there are three attributes that affect the economic condition of Djuanda Grand Forest Park: tourist guide services, optimization of business permits, and financial management procedures. Managers need to pay attention to three main attributes: First, tourist guide services, because of the profession's impact on environmental education and enhancement of tourist satisfaction. Certificate of the Minister of Manpower No. 234 of 2023 concerning determining the Indonesian national work competency standard [27], in connection with the roles and responsibilities of tour guides, a professional tour guide has been issued by the National Professional Certification Agency. In Djuanda Grand Forest Park, there are no tour guide services or ecotourism guides. Managers need to provide tour guides or ecotourism guides because this role is important for increasing tourist visits and satisfaction, and plays an essential role in environmental education efforts to raise awareness and appreciation of nature. Government regulation 108 of 2015 [28] states that one of the benefits of grand forest parks is that they are used for educational activities and increase conservation awareness.

Second, optimization of business permits (specifically, this study categorizes business permits as stalls in the area), because there are conditions for stalls that have obtained permits, but their functions are not optimized. Based on the data from the inventory of stalls in the zone of Djuanda Grand Forest Park in 2023, out of a total of 86 stalls, there are 22 stalls with severely damaged conditions and 13 stalls with mildly damaged conditions. Stalls in the severely damaged category are no longer operational and abandoned, and stalls in the mildly damaged category operate only on holidays with inappropriate stall conditions. Documents related to the inventory of stands in the area have not been regularly scheduled. Third, financial management, because it will provide appropriate standard guidelines based on applicable regulations so that the same standardization will facilitate the preparation of reports and the financial audit process. Based on West Java Governor Decree No. 539 of 2020, Djuanda Forest Park [29]. The system was established as a regional public service agency. A regional public service agency is a system that is applied by the implementing unit to provide services to the community. It offers flexibility in financial management patterns, which is an exception to the general provisions of regional management. The financial management of Djuanda Grand Forest Park follows applicable regulations and is authorized by local officials.

Sociocultural Dimension

The results show index the socio-cultural dimension is 32.48% (including the less sustainable category). The results of the sustainability value in the socio-cultural dimension get the lowest value compared to the other three dimensions. This shows that the implementation of the socio-cultural programme in Djuanda Grand Forest Park has not been running according to the assessment indicators. Figure 5 shows the detailed results analysis.

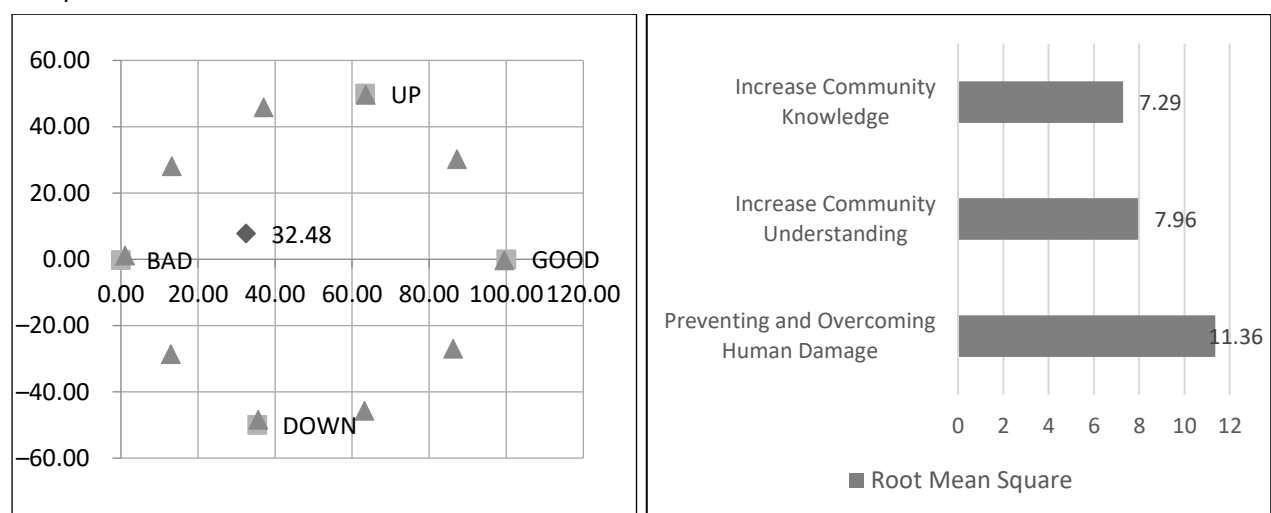


Figure 5. Ordination and leverage analysis of the sociocultural dimension.

Based on the assessment indicators, there are three attributes that affect the social-cultural condition of Djuanda Grand Forest Park: preventing and overcoming human damage to grand forest parks, increasing community understanding of conservation, and increasing community knowledge and skills. Management needs to increase special attention to the socio-cultural dimension, as this will affect sustainability in general because this dimension can be a challenge as well as a threat in the future.

Managers need to pay attention to three main attributes as follows: first, preventing and overcoming human damage to forest parks, because damage affects the balance of the ecosystem and must be addressed by the management of the Grand Forest Park. It is imperative that the disrupted harmony of the natural environment be re-established to fulfill its vital role in sustaining life and conferring benefits for the collective well-being of society and for the cause of intergenerational justice [30]. Damage caused by humans in the Djuanda Grand Forest Park area included forest encroachment and littering. The manager of the Djuanda Grand Forest Park, together with the community group of partners of the forest police, has been conducting regular joint patrols to prevent damage to the area caused by the community, but the agreement is still in the process of being finalized. The five locations with the highest concentrations of waste piles were Cibodas Village, Wangunharja Village, Mekarwangi Village, Ciburial Village, and Cibodas Village. To solve this waste problem, the Djuanda Grand Forest Park Manager has coordinated with the West Java Provincial Environment Office, and the results of the problem are still being resolved. The resolution of human-induced environmental degradation can be achieved through the advancement of legal development and enforcement [30].

Second, increase community understanding of conservation, because public or community conservation knowledge influences behavior. It is imperative that an inclusive and equitable approach to tourism development be adopted to guarantee that all stakeholders benefit and that environmental management is aligned with community prosperity [31]. There is no regular agenda for the Djuanda Grand Forest Park management to increase community understanding of conservation, and managers must create the program. The benefits derived from grand forest park are employed for the advancement of educational and conservation initiatives, as well as the promotion of awareness regarding these matters. The programs that can be developed in Djuanda Grand Forest Park include optimizing environmental education through various interpretive media that attract public interest.

Third, increase community knowledge and skills, because efforts to increase knowledge and skills improve the community's well-being. The contribution of natural ecosystems to local economic development is both direct and indirect [32]. Community participation can be defined as the active role of the community in contributing to the achievement of objectives set out in the management plan for a natural conservation area. It is essential to understand the motivations and decision-making processes of individuals who choose to participate in developing strategies that prioritize the park's ecological integrity and ensure that the economic benefits of tourism are felt across the community [31]. It is incumbent upon the government to empower communities situated in proximity to nature conservation areas with the objective of enhancing their quality of life. The Djuanda Grand Forest Park administration does not establish a recurring agenda for community skill and knowledge development; instead, it is the responsibility of the administration to develop such a program. Among the programs that can be implemented is the reestablishment of the honeybee breeding program that was discontinued in the Djuanda Grand Forest Park.

Institutional Dimension

The results show that the institutional dimension is 52.80% (including the entirely sustainable category). The status of the institutional dimension shows that management in Djuanda Grand Forest Park has been running according to the work plan, especially for public information disclosure and effective information systems. However, attention is needed to efforts to increase the capacity of human resources. Figure 6 shows the detail results analysis. Based on the assessment indicators, there are three attributes that affect the institutional condition of Djuanda Grand Forest Park: an effective information system, human resource capacity-building training, and human resources with appropriate skills and competencies. Managers need to pay attention to three main attributes as follows: first, an effective information system, because an effective information system for promotion and communication to the public can provide accurate information to visitors and is an effort to increase the number of visits. Djuanda Grand Forest Park already has social media, and Instagram is the most used, but it needs to be optimized for Facebook, YouTube, Twitter (x), and other websites. For direct information services, there is an information center office for visitors.

Second, human resource capacity-building training, because efforts to increase the capacity of human resources are essential for improving the skills of managers. Human resource training programs for managers are conducted only by external parties and have not become a routine annual agenda. In 2023, a training program was implemented in July and September. Basic forest and land fire prevention management training in July and September and introduction to geoparks. Managers should participate in programs designed to enhance their capacity. Internal parties should conduct this program to ensure that the training themes align with the specific skills required for effective management.

Third, human resources with appropriate skills and competencies, because, with qualification standards and competencies according to the position, the work tasks performed will effectively and efficiently achieve the objectives of the Djuanda Grand Forest Park management. The Djuanda Grand Forest Park manager has conducted job analysis only for permanent staff (civil servants); thus, job analysis for professional services has not been conducted. Managers should have a job analysis document for professional services, because these services are also crucial in supporting the achievement of common goals.

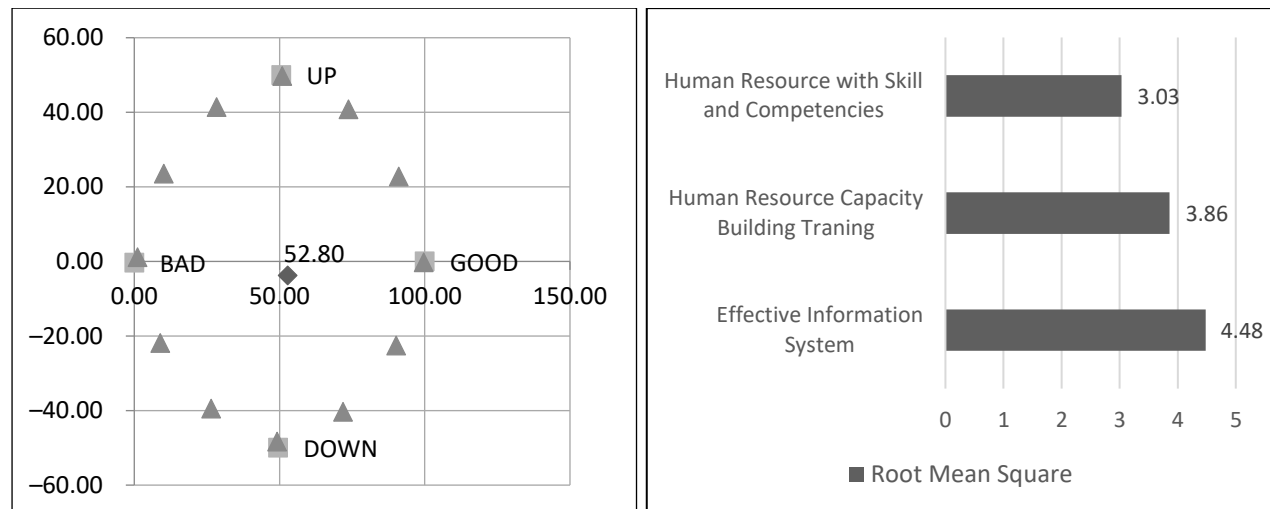


Figure 6. Ordination and leverage analysis of the institutional dimension.

Discussion

The assessment is based on a four-dimensional model with 25 attributes. Monte Carlo parameters can be considered good if the difference between the Monte Carlo value and the value of the sustainability ordination is maximum or $< 5\%$ [33]. The S-stress value can indicate the size of the error; if it is less than 0.25, the data are suitable for use [34]. If the R^2 value is close to 1, it indicates that the resulting model can explain the data well or that the existing data are increasingly well represented [33]. The rating of each dimension is divided into four category value intervals based on the rating standard [22]. Each dimension was assessed on a four-point scale, with a score range of 0.00 to 100.00. Scoring for each attribute based on the results of key informant interviews and existing conditions.

Table 3. Sustainability status of Djuanda Grand Forest Park.

No	Dimension	Ordination value (%)	S-Stress	R^2	Monte Carlo (%)	Between Monte Carlo value and ordination value (%)	Category
1	Ecological	57.99	0.14	0.94	56.81	1.18	entirely sustainable
2	Economic	74.20	0.14	0.94	71.51	2.69	entirely sustainable
3	Sociocultural	32.48	0.16	0.94	32.97	0.49	less sustainable
4	Institutional	52.80	0.16	0.94	52.13	0.67	entirely sustainable
	multidimensional	54.37	-	-	-	-	entirely sustainable

Each dimension can influence the other. Good ecological conditions can improve the economy by increasing interest in tourist visits; from a socio-cultural perspective, it will increase opportunities for the community to cooperate in efforts to use environmental services. If economic conditions are strong, it can encourage environmental conservation programmes, it can encourage community empowerment programmes, and it can have an impact on institutions because it can improve management soft skills. If socio-cultural conditions are strong, it can encourage environmental sustainability and support income generation. If institutional conditions are strong, it can ensure that any environmental, economic and socio-cultural programme can be implemented according to work objectives.

The results of multidimensional scaling can map dimensions based on visual similarity in a geometric map called a perceptual map (Figure 7), so it can describe the position between dimensions and determine the interdependence or interrelationship between data variables [35]. The economic dimension received the highest score because, based on interviews and assessments of existing conditions, the average attribute is 4, which means it is maintained in good condition. Conversely, the sociocultural dimension received an average score of 1 to 2, indicating that its attributes necessitate greater attention. The data collected through key informant interviews can lead to subjective judgements.

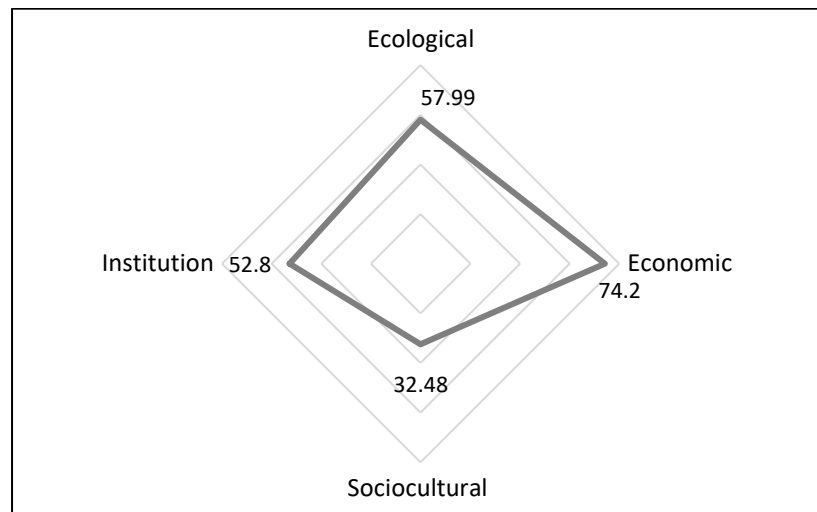


Figure 7. Diagram of sustainability status Djuanda Grand Forest Park.

Programme strategies for the ecological dimension are (1) initiatives to increase tree collections to form a tree adoption programme with direct involvement of tourists, as the planting programme has not been carried out for almost 2 years due to budget constraints; (2) provision of a budget to carry out physical renovations of the area boundaries, which need to be carried out regularly to ensure that the area boundaries remain appropriate; (3) provision of food trees for wildlife, this is important as it can increase biodiversity in the area which is currently dominated by long-tailed monkey species. The programme strategies for the economic dimension are (1) managers need certified tour guides to provide safety and environmental education to tourists. Currently, there are no legal tour guides. This can be a potential management conflict with the community and can reduce tourist comfort. (2) The responsibility of the management team is to conduct regular stall inventory checks, which can ensure that all business licence holders maintain their respective areas to an acceptable standard. Currently, many stall areas are in poor condition.

Programme strategies for the socio-cultural dimension are (1) Managers need to use technology to prevent forest encroachment, as humans still cause environmental damage in Djuanda Grand Forest Park. (2) Develop a programme to increase the empowerment and knowledge of the community around the area, as there is currently no such programme. This is necessary to raise the environmental and economic awareness of both the area managers and the community. The programme strategies for the institutional dimension are (1) to optimise social media and websites and to provide information service posts in the regions, as information has not been disseminated in the area (2) provide training to improve soft skills of employees, this is necessary to further improve the ability of managers following the development of science and technology (3) conduct periodic evaluations related to employee performance, this is important as there is no periodic performance evaluation.

Conclusion

Sustainability analysis of Djuanda Grand Forest Park was conducted using multidimensional scaling with multidimensional considerations, which yielded a value of 54.37% (entirely sustainable). The values of these dimensions affect the sustainability level. A lower value for each dimension indicates greater vulnerability to sustainability issues. To maintain sustainability in each dimension, the sustainability value of the Djuanda Grand Forest Park must be increased. The sociocultural dimension had the lowest value, indicating the highest vulnerability. The application of this concept to sustainable tourism engagement has not been

sufficiently documented, particularly regarding its potential impact on individuals' willingness to engage in further conservation or tourism management activities. To enhance sustainability, it is essential to implement strategies that empower communities, enhance their knowledge and skills, and foster engagement in sustainable practices. This could include initiatives such as waste recycling coaching programs, utilizing organic materials for product development, and promoting forest honeybee cultivation. Enhancing the sociocultural dimension can positively impact the Djuanda Grand Forest Park's overall sustainability status. This research provides an overview of the sustainability conditions of Djuanda Grand Forest Park using a four-dimensional approach, and if the weak dimensions are not improved, they may threaten the existence of Djuanda Grand Forest Park in the future. Each dimension describes the current conditions and problems that need to be considered by the manager.

Author Contributions

KWW: Conceptualization, Investigation, Formal Analysis, Data Collection, Writing – original draft; **RS:** Conceptualization, Methodology, Formal Analysis and Critical revision of the manuscript focus on protected area; **HSA:** Conceptualization, Methodology, Formal Analysis and Critical revision of the manuscript focus on cultural and nature tourism.

Conflicts of Interest

There are no conflicts to declare.

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