

## SUSTAINABILITY ASSESSMENT FOR GEOTOURISM IN SAWAHLUNTO PROVINCE WITH ENVIRONMENT APPROACH

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**Abstract:** This research aims to identify factors and indicators for assessing geotourism using a sustainable environmental approach. The study incorporates a mixed method design, specifically the Explanatory Sequential Design. Data analysis employs the Confirmatory Factor Analysis (CFA) approach with the Partial Least Squares Structural Equation Modelling (PLS-SEM) method and the Gutman scale. The findings reveal that geotourism assessment includes three factors—environmental social, and economic—and a total of 100 indicators. The analysis indicates that the sustainability level is currently “not yet sustainable”, meeting the convergent validity criteria with factor loading values exceeding 0.5. The factor loading values range from 0.473 to 0.886, with social factors displaying the lowest loading value (0.517), signifying their dominance in the assessment, and indicating unsustainability. Comparatively, economic factors display a loading factor value of 0.743 and environmental factors register 0.888. The formulation of proposed policy strategies for assessing tourism through a sustainable environmental approach is informed by 49 dominant factors and indicators across the three environmental, social, and economic facets. These strategies will be enacted through Village Regulations and adapted Regional Regulations within villages and tourism areas.

Keywords: Geotourism, geopark, assessment, sustainable, environmental approach.

### Introduction

Integrated tourism and conservation activities are increasingly receiving attention in several countries, including Indonesia. Geotourism is a type of special interest tourism that utilises the potential of geological natural resources (Chen *et al.*, 2015; Putra *et al.*, 2023) as an attraction. Geotourism objects can be developed, including the shape of the landscape, the rocks that make it up, the geological structure, and history of the earth at the location of the tourist attraction as well as their relationship with culture, flora, and fauna (Halder & Sarda, 2021). The emphasis of geotourism visits is to understand and enrich tourists' insight into the process of forming physical phenomena on the earth (Reynard *et al.*, 2007; Reynard *et al.*, 2016). In recent years, awareness of nature protection, one of which is the development of geotourism with the protection of geological

heritage (geoheritage) has increased and become the main focus in sustainable development and land use planning (El Ansari, 2013; Alhadi *et al.*, 2023).

Geotourism is sustainable tourism with the main aim of recognising geological sites by fostering understanding, appreciation, and conservation of the environment and culture, as well as being beneficial for improving the economic welfare of local communities (Dowling, 2013; Umar & Arif, 2023). This activity is related to how to create geotourism products that maintain the protection of geological heritage, help improve the quality of community groups, communicate and publicise geological heritage, and collaborate with various stakeholders (Dowling & Newsome, 2006; Aimon & Zulvianti, 2023). The important thing in developing geotourism is understanding

the identity or character of a region or area. To achieve this, geotourism is seen to be based on the idea that the environment consists of abiotic, biotic, and cultural components. Experts are paying greater attention to environmentally innovative forms of tourism that foster environmental and social responsibility (Forsyth, 1997). Hasmira *et al.* (2023) add that local potential and wisdom for the development of geotourism in tourism development can be utilised as an economic aspect for developing and increasing regional opinion and increasing the welfare of local communities.

Based on an initial survey of the existing conditions of the National Geopark in West Sumatra which has been established since 2019, geotourism activities have developed (Ritonga & Prayoga, 2022; Górska-Zabielska, 2023; Kubalíková *et al.*, 2023) starting from socialisation and training activities related to geotourism to build visibility or support facilities for geotourism locations involving the Tourism Awareness Group (Pokdarwis). Other activists are in the National Geopark area in West Sumatra. Based on these conditions, it was found that the developments carried out were still not optimal, the activities carried out still did not meet geotourism standards such as (1) Minimal community involvement in the process of planning geotourism areas in national geopark areas; (2) The development carried out is not by geopark standards, namely utilising selected local natural materials and carried out independently of the community or labour intensive; (3) There is still a lack of supporting facilities and infrastructure for visibility; (4) Limited activities of the management body; (5) Limited budget availability; (6) Weak supporting regulations and problems with environmental management and preservation in the West Sumatra National Geopark area; and (7) The most worrying issue is concerning public appreciation (Ollier, 2012; Aimon *et al.*, 2021; Winarno *et al.*, 2023).

The conditions that occur in the development of the Sawahlunto National Geopark as a research location at this time are the lack of optimal protection of the physical environment

(abiotic), biological environment (biotic, flora, and fauna), and cultural environment (cultural) in various aspects, especially the arrangement of the National Geopark area. Then, weak regulations regarding stakeholders in the social and economic environmental sectors related to the National Geopark area have not yet fully implemented the concept of area management by an independent, professional management body as a third party to realise sustainable geotourism development in the Sawahlunto National Geopark area. The quality of geotourism interpretation is minimal because it still needs to involve experts and is still run by tourism guides, allowing geotourism to be weak in communicating data and facts related to geological sites and other important geotourism related aspects. Then, weaknesses in interpretation can hamper opportunities for research related to geotourism. For this reason, it is necessary to assess the sustainability of the Sawahlunto National Geopark geotourism using an environmental approach.

In general, this research aims to explore the importance of an environmental approach in realising sustainable tourism which is carried out through sustainability assessments. Furthermore, it also aims to systematically review the application of environmental indicators in geotourism development and ensure regional sustainability can be implemented optimally. Where novelty in this research is comprehensive, the geotourism sustainability assessment method refers to the 101 United Nations Educational, Scientific, and Cultural Organisation (UNESCO) checklist for geotourism sustainability, which is grouped based on three environmental sustainability indicators, namely environmental, social, and economic.

## Methods

This research uses a mixed method with a qualitative and quantitative approach. According to Mulisa (2022) and Matović and Ovesni (2023), a combined research method (mixed method) is a research method between

quantitative and qualitative method to be used together in a research activity so that more comprehensive, valid, reliable, and objective data is obtained. This research was carried out from June 2021 to July 2023. This research was carried out in the Sawahlunto National Geopark area. This research was carried out in several geological site locations which are part of the Sawahlunto National Geopark area which consists of 14 geosite locations in the village of Talago Gunung, Taratak Boncah, Lumindai, Silungkang Tigo, Kubang Tengah, Silungkang Oso, Muaro Kalaban, Rantih, Talawi Mudiak, Kolok Nan Tuo, Tumpuak Tengah, Tanah Lapang, Tanjung Sari, Siringan, and Silungkang.

**Data Analysis Technique**

- (1) Confirmatory Factor Analysis (CFA): CFA is a technique where a priori, theories, and concepts are known or determined in advance of the indicators used and which variables are included in these indicators. This research is a mixed method research using the Explanatory Sequential Design (Antony *et al.*, 2023; Chen *et al.*, 2023; Rupani & Vyas, 2023) with data analysis techniques using the CFA approach (Falah *et al.*, 2023; Mahfud *et al.*, 2023) using the Partial Least Squares Structural Equation Modelling (PLS-SEM) method (Widaningsih *et al.*, 2023; Yanti *et al.*, 2024).
- (2) Guttman scale: According to Dimitrov (2023) and Utama *et al.* (2023), the Guttman scale is a scale used to get firm answers from respondents. There are only two intervals such as “agree-disagree”; “yes-no”; “true-false”; “positive-negative”; “ever-never”; and others. This measurement scale can produce questions in the form of multiple

choices or checklists, with the highest score (agree) being one and the lowest (disagree) being zero. The scoring calculations for respondents on the Guttman scale can be seen in Table 1.

Scoring is carried out using a weight of 1 and 0 for answers to questions. Yes, an answer weight of (1) for positive questions and a weight of (0) for negative questions. For the answer No, the positive question score is (0) and the negative question score is (1).

**Results**

Sawahlunto’s geological wealth, which has received National Geopark status has high prospects for development in protecting geological sites and improving the welfare of local and regional communities through sustainable geotourism activities. However, this geological site still requires many improvements and changes in management, different views and concepts of understanding geotourism, conservation and community involvement in its development, and preparing plans integrated with funding and regulations. Based on the results of studies conducted on sustainable geotourism, it was found that the geotourism of the Sawahlunto National Geopark still needs to be developed. The Sawahlunto National Geopark has geological diversity spread across several villages, as seen in Table 2 and Figure 1.

Based on Table 2 and Figure 2, geological sites as geological diversity are spread across 15 villages with their uniqueness and are related to the diversity of flora, fauna, and culture. This geopark is important in scientific and educational aspects and has great potential for tourism and sustainable development. The environmental, social, and economic factors of the Sawahlunto National Geopark are as follows:

Table 1: Guttman scale scoring

Alternative Answer	Score Alternative Answers	
	Positive	Negative
Yes	1	0
No	0	1

Table 2: Geological diversity of Sawahlunto National Geopark

No.	Geosite Group	Geosite Name	Village	Subdistrict
1	Batu Gamping Bukit Tangkoliang	Batu Gamping Bukit Tangkoliang	Talago Gunung	Barangin
2	Kompleks karst Silungkang	Ngalau Janjian	Talago Gunung	Barangin
		Bukit Inyiaik Suntiang	Taratak Boncah	Silungkang
		Hutan Batu	Lumindai	Barangin
		Andesit-basalt Silungkang	Silungkang Tigo	Silungkang
		Tabiang Tajam	Kubang Tengah	Lembah Segar
		Batu Runciang	Silungkang Oso	Silungkang
		Ngalau Lakuak	Muaro Kalaban	Silungkang
3	Sesar Minor Brani	Sesar Minor Brani	Talago Gunung	Barangin
4	Komplek Sawah Tambang	Stratigrafi Sawah Tambang	Muaro Kalaban	Silungkang
		Alam Rantih	Rantih	Talawi
		Air Terjun Landu	Rantih	Talawi
		Air Terjun Lurah Loba	Rantih	Talawi
		Air Terjun Tinongan	Rantih	Talawi
5	Interfingering Talawi Mudiak	Geosite Talawi Mudiak	Talawi Mudiak	Talawi
6	Komplek Sangkarewang	Sangkarewang	Kolok Nan Tuo	Barangin
		Fosil Gurame	Tumpuak Tengah	Talawi
7	Bukit Savana	Bukit Savana	Kolok Nan Tuo	Barangin
8	Lubang Tambang Mbah Soero	Lubang Tambang Mbah Soero	Tanah Lapang	Lembah Segar
		Puncak Polan	Tanjung Sari	Lembah Segar
		Puncak Cemara	Saringan	Lembah Segar
9	Fosil Trias	Muaro Kalaban	Silungkang	Silungkang

Source: Disparpora 2023 [Document for the Study of the Geological Heritage (Geoheritage) of Sawahlunto City]

Environmental factors: (1) Geological Diversity: Sawahlunto is known for its unique geological structure, including rock formations, fossils, and natural landscapes such as interesting hills and valleys. Protection of these sites is essential to maintain ecological and geological balance; (2) Biodiversity Conservation: This area is a habitat for many unique species of flora and fauna, some of which may be endemic. Conservation of biodiversity in Geoparks also helps maintain healthy ecosystem functions; and (3) Environmental Management and Care: Efforts to support the natural environment, control erosion, and manage waste

and pollution are important to maintain the quality and authenticity of the geopark.

Social Factors: (1) Increased Awareness and Education: Geoparks provide opportunities for local people and visitors to learn about the natural and cultural history of the region. Educational and interpretive programs can increase public awareness of the importance of conservation; (2) Community Participation: Local communities are involved in Geopark activities through employment in the tourism sector, site management, and conservation activities. This helps in strengthening the sense of ownership and responsibility towards

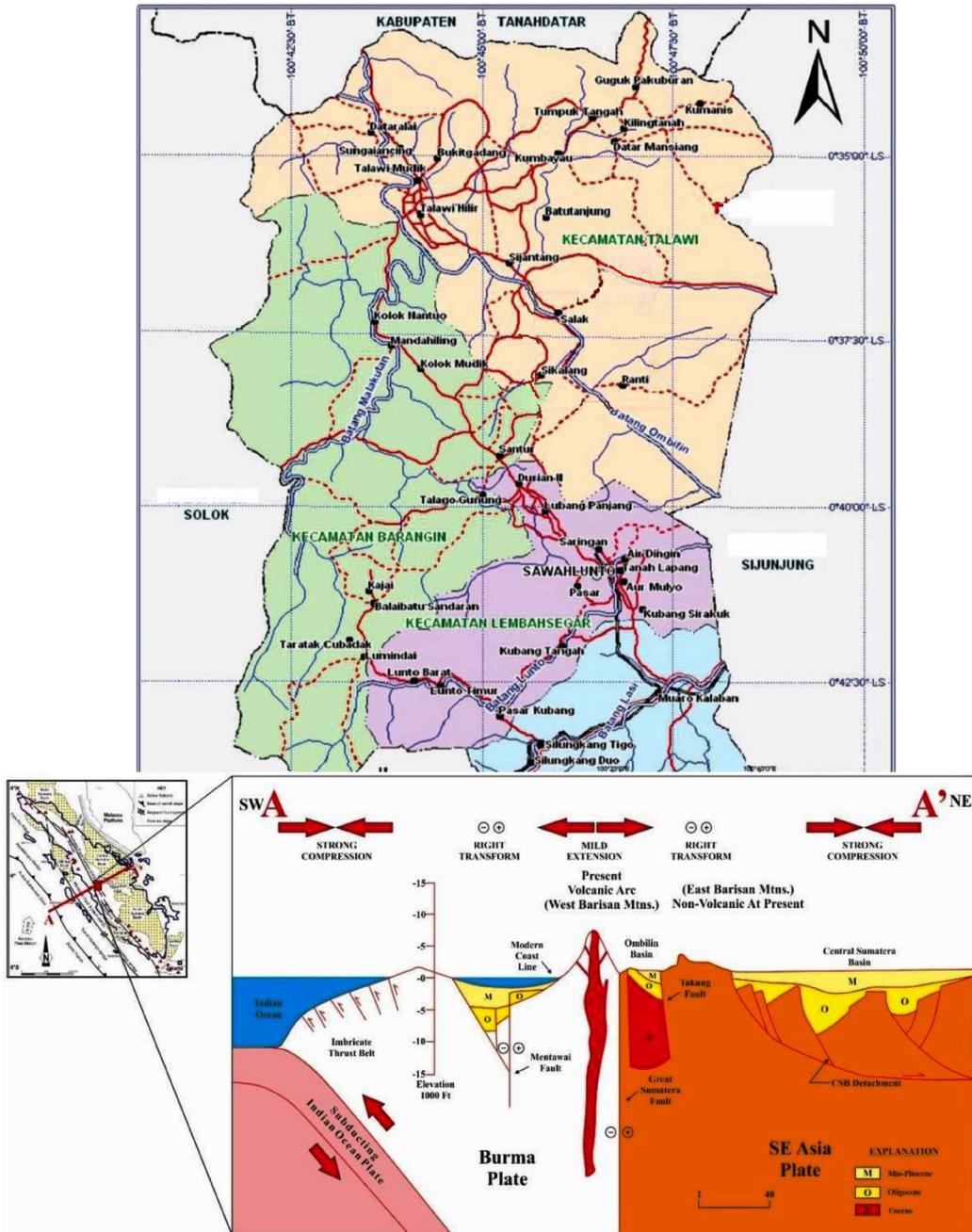


Figure 1: Map of the sampling site in relation to Pulau Batu Rusa (left) and Peninsular Malaysia (right)

the area; and (3) Cultural Identity: Geoparks also function as a medium for preserving and promoting local culture, including music, dances, crafts, and traditions, all of which add more value to the visitor experience.

Economic Factors: (1) Tourism Development: Sawahlunto National Geopark attracts domestic and international tourists, which helps improve the local economy. Geology and ecology-based tourism can often be more sustainable and

generate stable income for communities; (2) Job Creation: The tourism and conservation sector in the geoparks creates jobs for residents, ranging from tour guide services and lodging to the sale of local crafts and products; (3) Investment and Infrastructure: The development of infrastructure such as roads, public facilities, and services to support activities in geoparks also brings investment and improves the quality of life of local communities; and (4) Economic Diversification: Through the development of various economic activities related to geoparks such as agriculture, crafts, etc., the local economy will not only depend on one sector but will become more diverse and resilient.

Overall, the Sawahlunto National Geopark, with its integrated approach between nature conservation and socio-economic development, has the potential to become a model of sustainable development that can provide long-term benefits for the environment, community, and local economy.

The research results show the distribution of respondents' answers and observations in the field through direct surveys on environmental,

social, and economic factors. Several assessment indicators explain each factor. Environmental factors are the first factor with the indicators using 27 indicators, social factors with 42 indicators, and economic factors with 31 indicators. The CFA of latent variables for each indicator was carried out to confirm whether each indicator was valid in measuring the latent variable and determining the dominant indicators and factors related to the geotourism unsustainability assessment factors. In this study, there is one endogenous latent variable (unsustainable geotourism) and three exogenous latent variables (environmental, economic, and social factors). It can be described using the CFA scheme in Figure 2.

Based on the research scheme above, a CFA will then be carried out on the geotourism unsustainability variable with the results in Figure 3.

Based on the results of CFA in Figures 1 and 2 and Table 2, it was found that the indicators in the geotourism unsustainability assessment factors, namely environmental, economic, and social factors have met the convergent validity criteria (factor loading value greater than 0.5) in

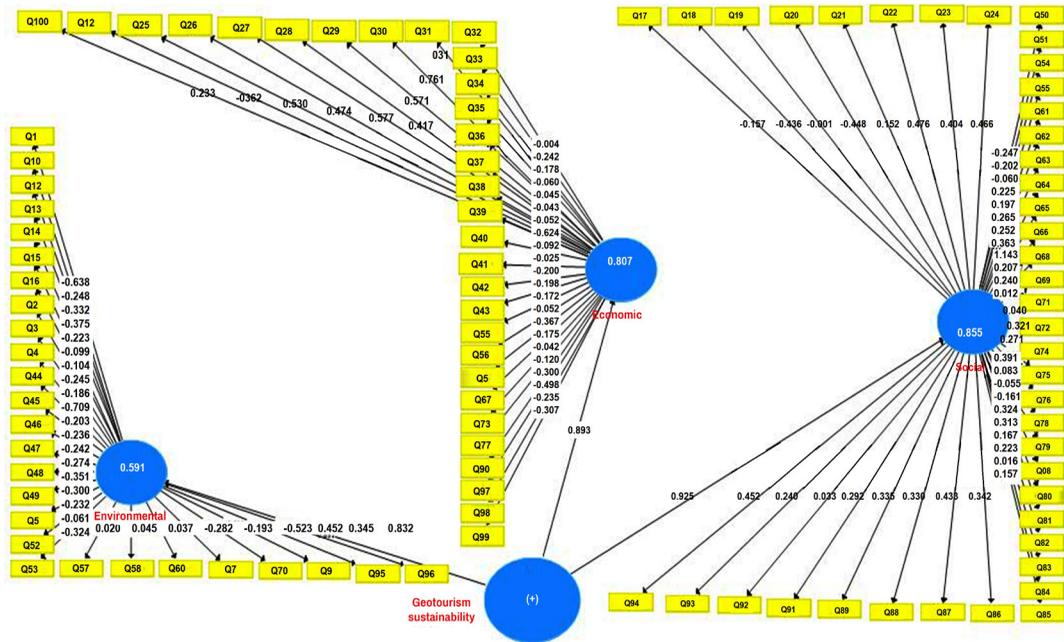


Figure 2: CFA measurement scheme (initial)

Figure 3 also confirms that:

- (1) It is proven that geotourism unsustainability assessment factors can be formed by three factors, namely environmental, economic, and social factors.
- (2) The highest loading factor value is 0.880, social factors are the dominant assessment factor related to the unsustainability of geotourism in the Sawahlunto National Geopark area, West Sumatra. Compared with economic factors (0.846) and environmental factors (0.815).
- (3) The main dominant assessment factor is the social factors with a factor loading value of 0.880 and seven valid indicators, namely assessment indicators for questions 18, 20, 22, 23, 24, 87, and 94. The factor loading value of 0.424 represents the smallest positive value among the seven indicators and is deemed valid for social factors. As a result, the 87<sup>th</sup> indicator (S87) emerges as the preeminent indicator associated with the dominant social factors contributing to the unsustainability of geotourism in the Sawahlunto National Geopark area, West Sumatra. Specifically, S87 pertains to local knowledge and indigenous knowledge, practices, and systems for managing the identity of Intangible Cultural Heritage.

- (4) The second dominant assessment factor is the economic factors with the second highest factor loading value of 0.846 with five valid indicators, namely indicators for questions 25, 26, 27, 28, and 97. The factor loading value of 0.485 is the smallest value of the five valid indicators for the economic factors. So, indicator 28 (E28) is the dominant indicator of economic factors related to the unsustainability of geotourism in the Sawahlunto National Geopark area, West Sumatra. E28 indicates the completeness of visibility in sustainable economic development efforts.
- (5) The third dominant assessment factor is environmental factors with the lowest factor loading value, namely 0.665 with three valid indicators, namely indicators for questions 1, 4, and 9. The factor loading value of 0.722 is the smallest value of the three valid indicators for environmental factors. So, indicator 9 (L9) is the dominant indicator of environmental factors related to the unsustainability of geotourism in the Sawahlunto National Geopark area, West Sumatra. L9 is an indicator related to conservation efforts, having a database and the results of data collection on geological sites (geosites) in the geotourism area.

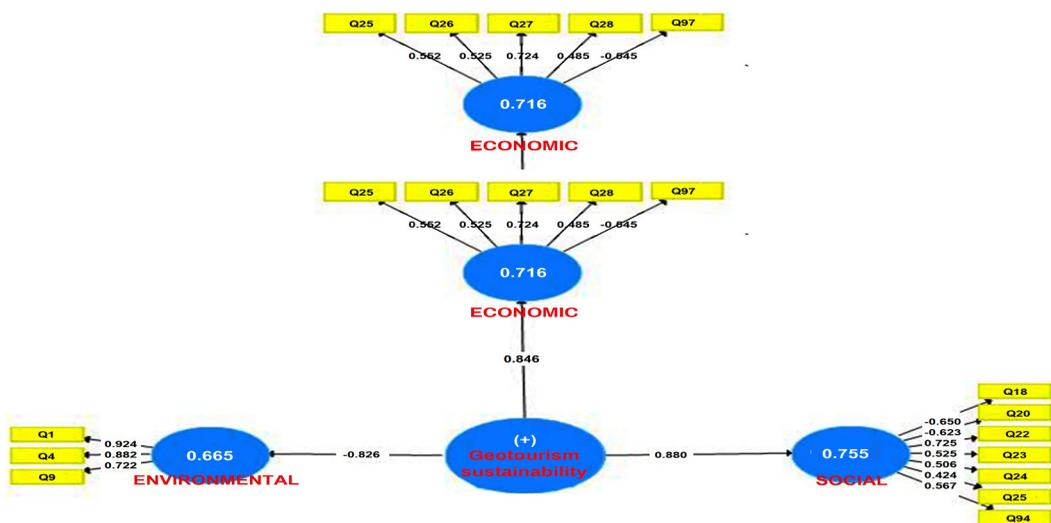


Figure 3: CFA measurement model (final)

Among the three factors and 100 indicators for each factor, the dominant factors and indicators were found in assessing the sustainability of geotourism in the Sawahlunto National Geopark area. The dominant factor with the highest number of indicators is the social factors, meaning that the social factors that most influences the sustainability of geotourism is related to the protection and improvement of the local economy. The lowest dominant assessment factor indicates that conservation efforts still need to be improved and there is no database and data collection results on geological sites (geosites) in the geotourism area. The significance of social factors and their numerous indicators, in contrast to minimal conservation efforts and the lack of a comprehensive database, impacts the sustainability of geotourism. These factors are important as they relate to protect the geological sites and enhance the local economy. The influence of these factors is substantial as they dictate the form of activities, encompassing both conservation and economic development. Identifying and addressing these key impacts is crucial for the long-term sustainability of geotourism.

### ***Positive Impact***

**Increased Community Involvement:** Awareness of the importance of social factors in geotourism sustainability emphasises the need to involve local communities more deeply. This can encourage local economic improvement through job creation and skills development.

**Environmental Education and Awareness:** The focus on social indicators allows the development of educational programs aimed at increasing public and visitor awareness of the importance of preserving the environment and geological heritage.

**Sustainable Economic Development:** Prioritising social factors in geotourism development represents an approach that focuses on long-term benefits for the local economy, not just short-term gains.

### ***Negative Impacts and Challenges***

**Lack of Conservation:** Indicators that show a lack of conservation efforts are a serious concern because they can threaten the sustainability of geological sites and the biodiversity of the area. Without adequate conservation, natural resources and natural beauty which are the main attractions can be degraded.

**Data Deficiencies:** Lack of databases and resulting data collection about geological sites creates obstacles in planning and implementing effective conservation strategies. This also limits the ability to assess the impact of human activities on these sites accurately.

### ***Implemented Strategy***

**Integrated Database Development:** Building and maintaining a comprehensive database of geological and biodiversity sites in the Sawahlunto National Geopark area is important for monitoring and managing resources in a sustainable manner.

**Increase Conservation Efforts:** Allocate more resources for conserving and maintaining geologically and biologically important sites. This program must involve local communities and related stakeholders to gain wider support.

**Integration of Economic and Conservation Activities:** Creating programs that integrate economic development with nature conservation such as ecotourism or educational tourism that provides economic benefits while preserving the environment.

This research highlights the importance of a holistic approach in managing and developing the Sawahlunto National Geopark, particularly emphasising community involvement and sustainable management of natural resources. Implementing recommendations from the results of this research can help maintain the sustainability of geotourism and long-term economic benefits for local communities.

## Conclusions

Based on the research results, it was concluded that Sawahlunto National Geopark was not sustainable in assessing the unsustainability of geotourism, namely environmental, economic, and social factors. Where: (1) The highest dominant assessment factors and indicators are social factors with the highest factor loading value, namely 0.880; (2) the lowest assessment factors and indicators are social factors with the lowest factor loading value, namely 0.424; and (3) the smallest indicator factor of 0.485 is the smallest value of the five valid indicators for economic factors and 0.721 for environmental factors with three dominant indicators, respectively. Suggestions given to the government are: (1) There is a need to increase institutional understanding of the importance of conducting geotourism sustainability assessments to realise sustainable geotourism development; (2) it is necessary to prepare an activity program that supports the implementation of sustainable geotourism which is in line with the preparation of the program implementation budget; and (3) it is necessary to formulate a policy that can serve as a reference in assessing the sustainability of geotourism so that it can easily be implemented independently by the relevant parties on an ongoing basis so that sustainable geotourism development can be realised optimally. In this case, it can be in the form of a Village Regulations.

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## Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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