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Measuring the Sustainability of Marine Ecotourism in Kiluan Marine Tourism Park, Lampung Province, Indonesia

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Abstract Ecotourism is a non-extractive economic exploitation activity that can minimize damage to natural resources and biodiversity loss so that it is often claimed to have great sustainability performance, marine ecotourism is no exception. However, this claim needs to be proven, including the terms of ecological, socio-cultural, economic, technological and institutional dimensions. This research was conducted in Teluk Kiluan, Tanggamus Regency, Lampung Province, Indonesia from September to December 2021. This study aims to measure the sustainability of marine ecotourism. The multi-dimensional scaling (MDS) method was applied to determine the five dimensions of sustainability using RAPFISH Software. On a scale of 0-100, it is concluded that the sustainability indexes for the five dimensions are 57.21, 51.08, 42.40, 42.18 and 34.98 respectively, which means that the first two index values are quite sustainable while the rest are less sustainable. To increase the aggregate sustainability of this ecotourism activity, the lowest average ordinated value should be the top priority by selecting 4 sensitive factors (attributes). The sequence of priority scales is thus: (a) institutional dimension; (b) infrastructure/technology dimension; (c) economic dimension; (d) social and cultural dimensions; and (e) ecological dimension.

Keywords Ecotourism, RAPFISH, MDS, Sustainability

1. Introduction

The development of ecotourism can be seen as an activity of economic exploitation that at the same time implements the preservation of natural resources, as do marine ecotourism activities, because it already contains aspects of sustainability. Preservation of natural resources and community culture will be a prerequisite for realizing the sustainability of each development process, which is practically based on economic development as a necessary condition. In its implementation, marine ecotourism relies a lot on the utilization of environmental services, which means it can minimize the exploitation of natural resources. Even in various aspects, marine ecotourism is a form of tourism that leads to metatourism, which means not selling the physical form of objects but selling philosophy and taste, so from this aspect, marine ecotourism will not recognize market saturation [1]. Marine tourism is a recreational activity carried out in seascapes and landscapes as long as it involves elements of travel by exploiting the natural potential of the sea as a tourist attraction (DWT) as well as a place for its activities [2]. That is, carrying out recreational activities in the marine environment on beaches and surrounding islands

can be regarded as marine tourism.

Marine ecotourism needs to be managed with the principle of prudence to maintain the authenticity and sustainability of coastal and marine resources. This principle is in line with the concept of conservation, so marine ecotourism can also be explained as a coastal and marine tourism activity developed with a marine conservation approach [3]. Thus, a marine conservation area must have excellence in the application of its management, namely the development of conservation-based marine tourism, which must maintain and develop ecological, economic, and aesthetic values. This process requires integration between research and education for the community, which is also a prerequisite for sustainability in the future [4] [5]. In this context, marine tourism management must be able to increase the eco-friendly economic activities of the community around tourist objects to support the sustainability of marine tourism itself. Pan et al. [6] state that sustainable tourism activities are only possible if they are based on a rational and comprehensive development plan that balances the needs of economic development with the limits of natural resource capacity, the level of technology adoption in social and cultural settings, and the flexibility of community institutions. In this way, it can be expected that environmental damage as a negative impact of tourism-based economic activities can be controlled, mitigated, remediated, and restored. Several studies that focus on measuring ecotourism sustainability include Walker et al. [7]; Boluk et al. [8]; Guo et al. [9]; Dalei et al. [10]; Wu et al. [11]; and Bausch et al. [12]. From several studies, no one has detailed sustainability into these five dimensions. Decomposing the sustainability performance of a tourism object into several dimensions can be used as a guide for efforts to improve its performance, especially for tourism objects burdened with the status of a marine conservation area such as the Teluk Kiluan Aquatic Tourism Park (TWP=Taman Wisata Perairan).

Administratively, it belongs to Kiluan Negeri Village, Kelumbayan District, and Tanggamus Regency. The wealth of the coastal and marine areas in Lampung Province, to be exact, in Tanggamus Regency has not been optimally cultivated so that it has not been able to provide welfare to the people who live in the region. In this regard, it is necessary to look for potential sector alternatives that can improve the welfare of the people living in the area on the one hand, and on the other hand, the utilization of resources as part of activities carried out to obtain economic benefits is not detrimental from an ecological and social perspective. One alternative that can be relied upon in the utilization of resources and in accordance with the principles of sustainable development is the development of marine ecotourism, and therefore, in the context of implementing effective and optimal sustainable development in coastal areas and small islands in Lampung Province, the role of ecotourism needs to be increased. Ecotourism is one of the most appropriate ways to reduce damage to natural resources and biodiversity.

Efforts to prevent the rate of damage to coastal and marine ecosystems with excessive utilization patterns, the most important thing in the concept of resource utilization for marine ecotourism requires a sustainability measurement model. The purpose of this research is to measure the sustainability of marine ecotourism. This research is important to do because ecotourism, besides providing benefits to local communities, also makes a direct contribution to conservation activities so that tourism development does not exploit environmental resources massively but can continue to be sustainable for the next generation. Integrated management is needed from the planning, implementation, monitoring, and evaluation stages to integrate all the interests of stakeholders. The ecotourism sustainability measurement model for each dimension uses multidimensional scaling (MDS) analysis. MDS aims to evaluate the sustainability of marine tourism management from five aspects, namely economic, socio-cultural, infrastructure/technology, institutional, and ecological aspects in Teluk Kiluan. Each dimension will provide attributes that are considered influential on the sustainability of management in each dimension, so that it is expected to produce a management direction with the concept of sustainable marine ecotourism. Sustainability in the context of tourism is generally considered to aim at achieving a balance between the economic, environmental, and social needs of all stakeholders when considering the impact of tourism [13-16]. Efforts to operationalize the concept of sustainable tourism have led to the development of a number of indicators in the hope of measuring sustainability [17-19].

2. Materials and Methods

2.1. Research Location

This research was conducted in Teluk Kiluan, Tanggamus Regency, Lampung Province, Indonesia (**Figure 1**), from September 2021 to December 2021. The data analysis method uses a sustainability analysis approach called multidimensional scaling (MDS) using Rapid Appraisal for Fisheries (RAPFISH) software. The research location was chosen based on data and information showing the development of marine ecotourism management at Teluk Kiluan Aquatic Tourism Park in Lampung Province in the regional waters conservation area for marine ecotourism areas, which is very rapid, so that it is feared that environmental degradation will result in a major impact on the sustainability of marine ecotourism management.

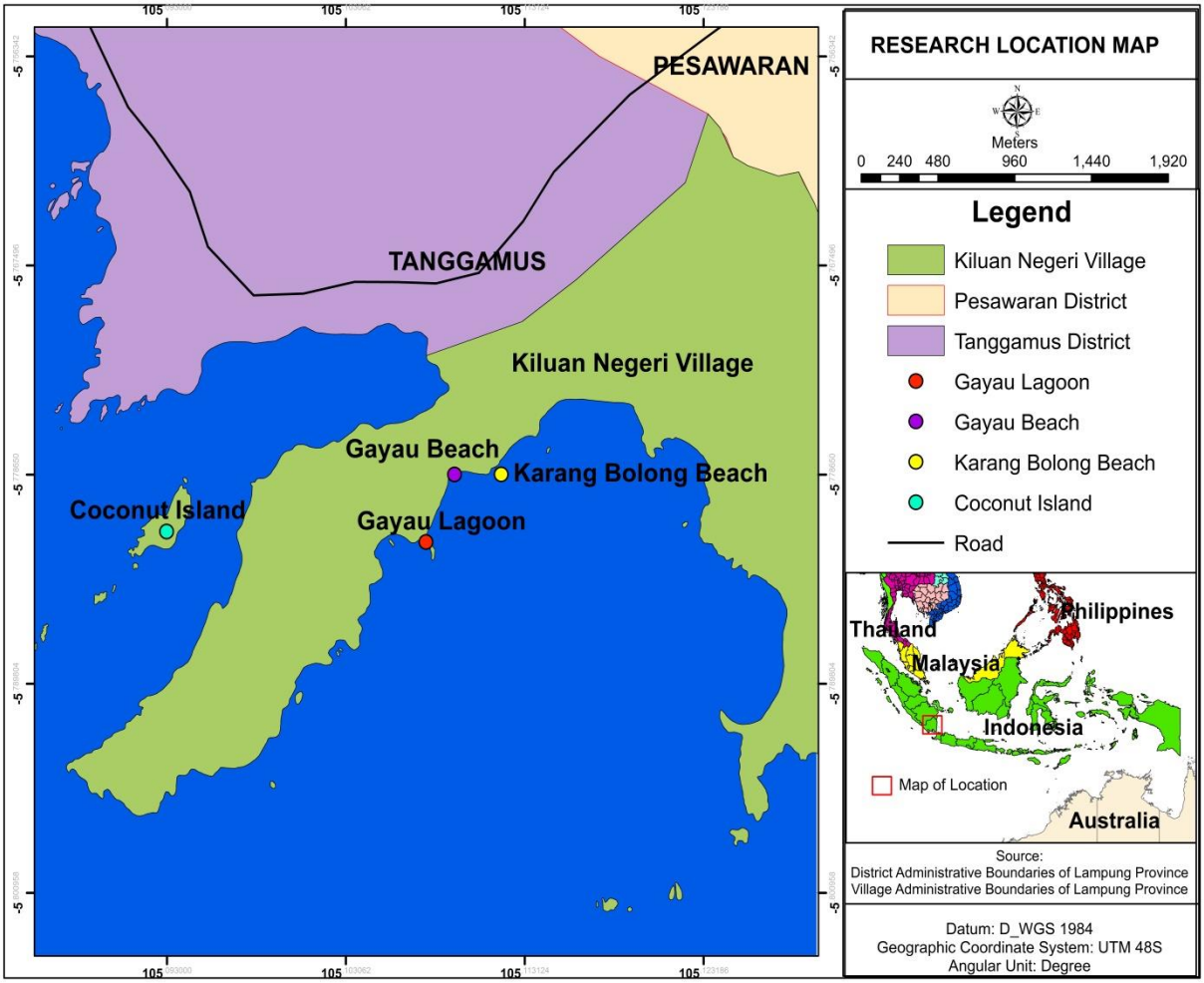

Figure 1. Research location

2.2. Data Collection

Data collection for measuring the sustainability of marine ecotourism management at Teluk Kiluan Aquatic Tourism Park in Lampung Province includes both primary and secondary data. The sustainable dimension data related to the management of marine ecotourism consists of five dimensions covering ecology, socio-culture, economy, infrastructure/technology, and institutions. Primary data collection was carried out by applying direct observation and measurement methods to the ecological dimension at the research location, while for the socio-cultural, economic, institutional, and infrastructure/technology aspects, the data was obtained through in-depth interviews and structured interviews, discussion, filling out the questionnaire, structured observation, and involved observation.

2.3. Data A nalysis

The method of data analysis is adapted to the research objectives, namely, to analyze the level of sustainability of marine ecotourism management in Teluk Kiluan Aquatic Tourism Park, Lampung Province. The data analysis method uses a sustainability analysis approach, namely the MDS method with the use of RAPFISH software. Determination of dimensions and attributes is based on research conditions and expert opinions. This study uses five dimensions: economic, socio-cultural, infrastructure/technology, institutional, and ecological. An assessment of each attribute is given a score that reflects the condition of the sustainability of the dimensions studied. The assessment refers to literature studies, scientific judgment, and the scientific judgment of researchers with bad and good scores on the ordinal scale. Provide an assessment of each attribute that has been compiled from each dimension using an ordinal scale of 0–2 on the assessment of attributes in each dimension as presented in **Table 1**. The scores used to determine the sustainability scale for each dimension in this study follow Pitcher and Preikshot. [20] as presented in **Table 2**.

Table 1. Sustainability indicators for each dimension in the management of marine tourism in Teluk Kiluan Marine Tourism Park

No.	Sustainability Dimension	Sustainability Indicator	
1.	Ecology	Snorkeling tourism suitability Suitability for diving tourism Beach tourism suitability Dolphin tour suitability Snorkeling tour carrying capacity Diving tourism carrying capacity Beach tourism carrying apacity	Dolphin tour carrying capacity Land use level Waste pollution Abrasion level of seashore Ecosystem preservation/conservation Water quality
2.	Social-cultur	Formal education level Community leisure and tourism Community attitudes and behavior Community knowledge about ecotourism	Potential social conflict Community quality of life Government role Private sector role
3.	Economy	Tourist visits number Marketing and promotion funding Optimum price products Diversification of ecotourism activities	Roomavailability/number of visitors Local minimum wage (ump=*upah minimum provinsi*) Labor absorption capacity Public social welfare Market potential expansion
4.	Infrastructure/ Technology	Infrastructure and land accessibility Infrastructure and sea transportation Tourism support facilities Electrical infrastructure Telecommunication	Clean water infrastructure and environmental sanitation Health care infrastructure Accommodation/homestays Availability of tourism signs Ecotechnology in marine tourism
5.	Institutional	Zoning and regulations for use Law enforcement Tourism management institute Government intervention	Availability of management rules Community compliance Supervision and promotion Society participation Stakeholder coordination

Table 2. Index value and sustainability category

Index value (%)	Sustainability category
0-25	Not sustainable
26-50	Less sustainable
51-75	Sufficiently sustainable
76-100	Sustainable

Source: Pitcher and Preikshot [20]

3. Result and Discussion

3.1. Index Value Analysis and Status of Multidimensional Sustainability TWP Teluk Kiluan

Figure 2 presents a kite diagram of the sustainability of TWP Teluk Kiluan. From Figure 2, the fate of marine tourism sustainability is especially critical in three dimensions, namely the institutional, technological, and economic dimensions, because it produces values between 26 and 50%. These three dimensions are categorized as critical or less sustainable considering that this location is actually a conservation area, which is not actually burdened with the function of supporting economic production but must function as a life support system to support economic activity in areas that are functional for extractives or cultivation areas that are located around it, both for the mainland area along the coast or in its waters, especially in the capture fisheries zone as well as for the marine tourism activity itself. However, there is still good hope for increasing the sustainability index for all dimensions because the ecological and socio-cultural dimensions produced in this MDS analysis are in the fairly sustainable category, namely, each is between 51 and 75%, especially if a management strategy is implemented for some of the most sensitive indicators used for each dimension.

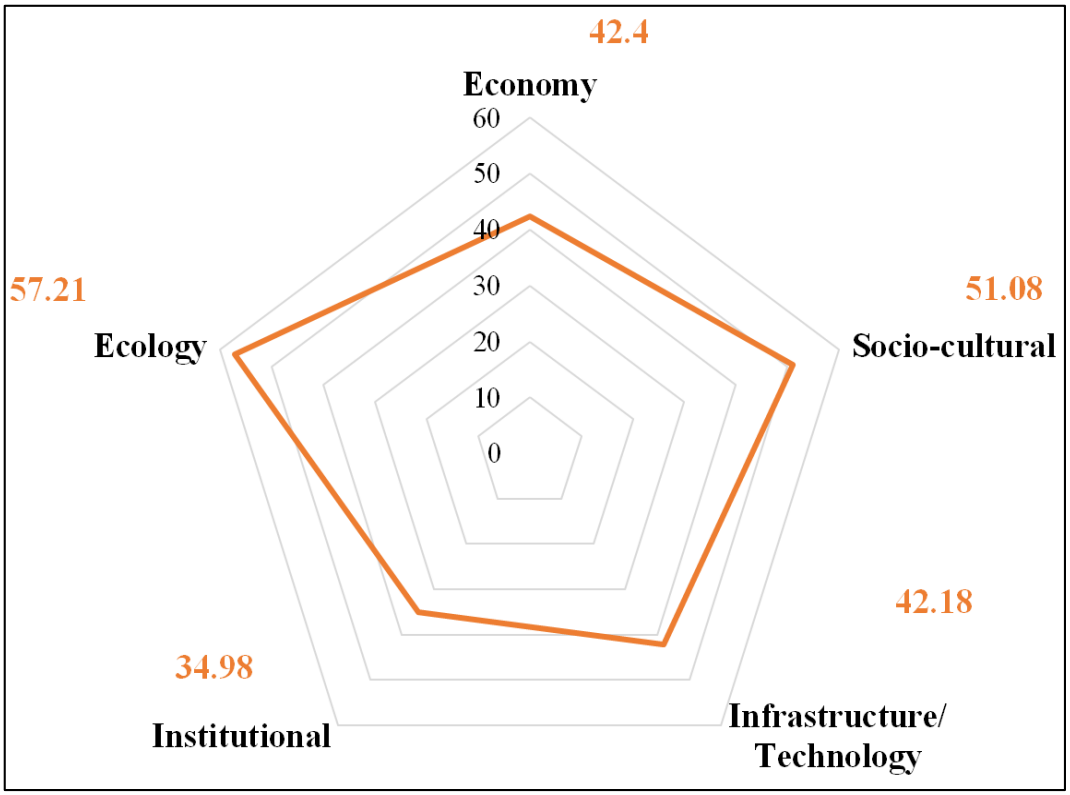

Figure 2. Kite diagram of the sustainability TWP Teluk Kiluan

Table 3. Ordination value of dimensions of sustainability of marine ecotourism in Teluk Kiluan Marine Tourism Park

Dimensions	Sustainability index		Difference	Stress	R^2	Sustainability category
	MDS	Monte carlo test				
Ecology	57.21	56.98	0.23	0.14	0.95	Sufficiently sustainable
Social-cultural	51.09	51.26	0.17	0.15	0.95	Sufficiently sustainable
Economic	42.40	43.07	0.67	0.14	0.95	Less sustainable
Infrastruktur/Teknologi	42.19	42.44	0.25	0.14	0.95	Less sustainable
Institutional	34.98	35.20	0.22	0.15	0.95	Less sustainable

It should be stated here that, before carrying out an analysis of the sensitivity, it is necessary to evaluate the robustness of the MDS results by examining the stress value or the gap between the results of the MDS analysis and the results of the Monte Carlo analysis that has been carried out, as well as the results of the goodness of fit analysis of the five indices. The sustainability dimension is applied as a tool for measuring the sustainability of marine tourism objects in research locations. The stress value and the multidimensional coefficient of determination, the accuracy of the configuration from a point that reflects the original data can be measured by looking at the stress value from the results of the Rap-TWPK ordinary analysis of the sustainability of TWP Teluk Kiluan marine ecotourism management for each dimension analyzed. The ability of each attribute to explain and contribute to the sustainability of the system is studied by looking at the value of the coefficient of determination (R^2) for each dimension analyzed. The stress value and the coefficient of determination for each dimension can be seen in **Table 3**.

Based on Table 3, it shows stress value. The dimensional stress value is 0.14 and the average R^2 value is 0.95. In the Rap-TWPK, the stress value is said to be good if the value is 0.25 [21], meaning the goodness of fit value in MDS, which states that the attribute configuration can reflect the original data. While the R^2 value of 0.95 indicates that the attributes or factors assessed in each dimension are able to explain and contribute 95% to the sustainability of the system under study, according to Kavanagh [22], a good R^2 value is > 80% or close to 100%. Validation of the effect of random error using Monte Carlo analysis aims to determine, among other things: (a) the effect of error scoring attributes; (b) the effect of variations in scoring; (c) the stability of the MDS analysis process that is repeated; (d) input errors or missing data; and

(e) the stress value is acceptable if it is less than 20%.

The results of the Monte Carlo analysis show that the calculation value of the Monte Carlo analysis at the 95% confidence level for each dimension and a combination of the five dimensions compared to the MDS results has a relatively small difference. This shows that the results of the MDS calculation can reflect the actual value [23]. The results of the difference between Monte Carlo and MDS also show that the results of the MDS analysis on the sustainability of the Rap-TWPK marine ecotourism management of TWP Teluk Kiluan have relatively small procedural errors in determining attribute scoring due to lack of information, there is relatively low error from variations in score differences due to differences in opinions, there is a high level of MDS stability, errors in entering or missing data can be avoided, and high S stress values can be avoided.

Based on the ordinated value of the dimensions of sustainability of marine ecotourism in Teluk Kiluan Marine Tourism Park, from 5 dimensions, there are 3 dimensions with less sustainable categories. Barriers to sustainability are increasingly identified with the unfair distribution of resources, the privatization of common property, and the accumulated wealth of a small elite [24]. Sustainable tourism requires critical thinking, requiring a deeper exploration of the dynamics of power, privilege, hegemony, and hierarchical structures [25]. EPA, [26] describes sustainability as a guiding principle that creates and maintains conditions in which humans and nature can productively live in harmony without neglecting the needs of present and future generations. The challenge of sustainability is not limited by scientific disciplines but requires the integration of various types of knowledge held by various actors. Therefore, multi-stakeholder networks, including local communities, have emerged as an important tool for addressing sustainability challenges [27].

Collaboration among various actors is essential to creating social transformations that make sustainable development possible. This awareness shows that it is very important for all stakeholders to be involved in tourism planning and decision-making, including tourists, industry, government, communities, workers, and academies [28]. Neglecting adequate stakeholder engagement can lead to irreparable harm such as tourism conflicts and public opposition, ultimately risking an unsustainable future, according to Dewi and Lasso. [29]; Marwan and Isnaeni. [30]. The importance of natural resources as a key stakeholder in sustainability requires a voice [31] [32]. In summary, it can be said that in order to determine the sustainability of Teluk Kiluan TWP, it is necessary to measure the sustainability of marine tourism. In order to obtain an accurate sustainability value for each dimension, it is necessary to examine the results of the leverage factor analysis of each indicator used as an attribute of each of the five dimensions applied for the MDS analysis in this study area.

3.2. Sustainability Status Ecological Dimension

The most important use in any sustainability analysis of any resource exploitation motivated by economic growth or other capital accumulation is for the maintenance and care of the ecology so that it remains viable. There will be no economic activity when the ecology is not viable, especially if it collapses due to exploitation. The use of the results of the analysis on this level of sustainability is very urgent because the study location in the national spatial plan is allocated as a marine waters conservation area. By using eleven attributes or indicators, it shows the level of sustainability in the ecological dimension is sufficiently sustainable, namely 57.21% (**Figure 3**). **Figure 3** also presents the results of further analysis to examine the four attributes that have the greatest sensitivity.

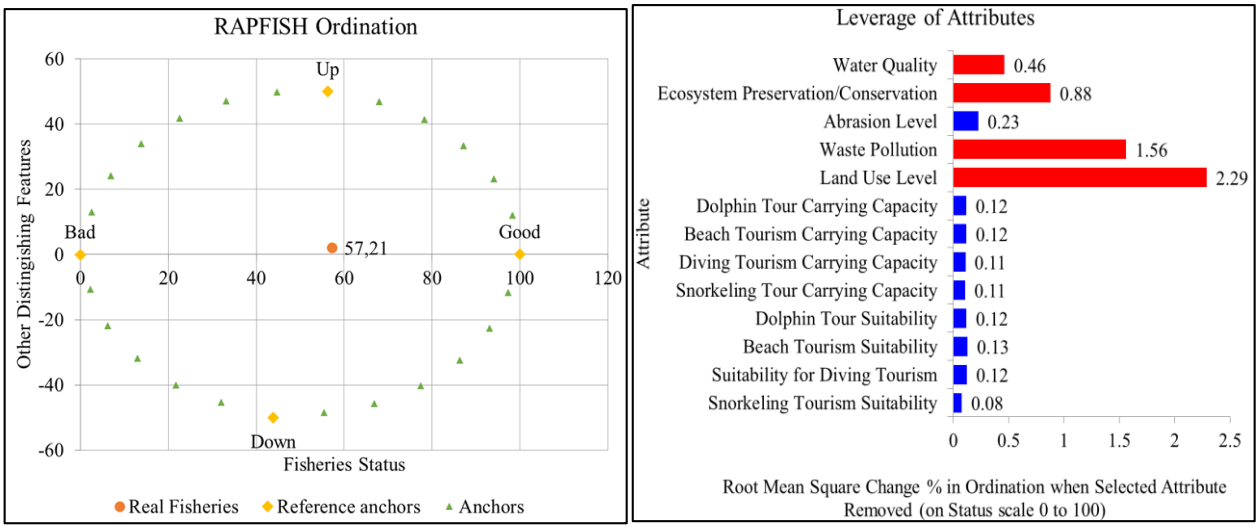

Figure 3. RAPFISH and leverage chart on ecology dimension

The allocation of present land use provides the greatest leverage, as reflected by the results of the Root Mean Square (RMS) analysis of 2.29. This attribute can provide the greatest expectations for maintaining and increasing the sustainability of the ecological dimension in this study area. It should be informed here that the research location is in a position adjacent to the Kota Agung container port. Even though road access is quite remote, access via sea waters is relatively close, which is less than 15 minutes using a speed boat. In this context, the allocation of present land use must continue to be managed, controlled, and maintained properly so that this indicator can contribute to increasing the sustainability of this ecological dimension while at the same time being able to suppress water pollution originating from Kota Agung port activities, support the preservation of ecosystems in the core zone of marine protected areas, and maintain water quality against the risk of seawater intrusion. In this way, the indicators of waste pollution, ecosystem protection, and water quality can also be continuously improved. In turn, the sustainability of the economic dimension can also be continuously improved based on ecological sustainability in an institutional setting that is flexible to technological changes, which, according to Usman et al. [33], will accelerate in the future.

3.3. Sustainability Status Social and Cultural Dimension

When tourism becomes the hope and prima donna of almost all countries in the world, not only economic problems are expected to increase. However, it also impacts social and cultural dimensions. The socio-cultural dimension of sustainable tourism development means that it must respect the social culture of the local community. Increasing appreciation of local social and cultural values is also a strategy to increase sustainability in the dimension itself, as well as in the other four dimensions. For strengthening the ecological dimension, for example, local fishermen believe that there is a local belief, such as the appearance of dolphins around the fishing zone, which is a sign that there will be an abundance of catches [34]. Although now the research location is inhabited by 4 immigrant tribes beside the Lampung tribe, namely Sundanese, Javanese, Balinese and Bugis, this belief is still strong [35]. This fact is proof that the socio-cultural dimension has a fairly good level of sustainability (51.08 out of 100%). But it's a shame that social capital in the form of ethnic diversity and local wisdom that has offset the sustainability performance of this ecological dimension has not been able to become a driving force for improving the performance of the economic sustainability dimension. In the future, a strategy is needed to utilize the two ecological-economic dimensions to attract tourism through advertising, cultural performances, and the attractions of dolphin-friendly fishermen (**Figure 4**). With this increase in tourist attractiveness, it is possible to increase people's income as well as increase local government taxes, which can be reinvested for the development of road infrastructure, electric power, telecommunications facilities, and others. In turn, this can also be expected to have an impact on strengthening institutional dimensions through improved public services, supervision, guidance, and law enforcement for any violations in the Teluk Kiluan area.

(a) (b)

Figure 4. Dolphins Attraction in Teluk Kiluan [34] [36]

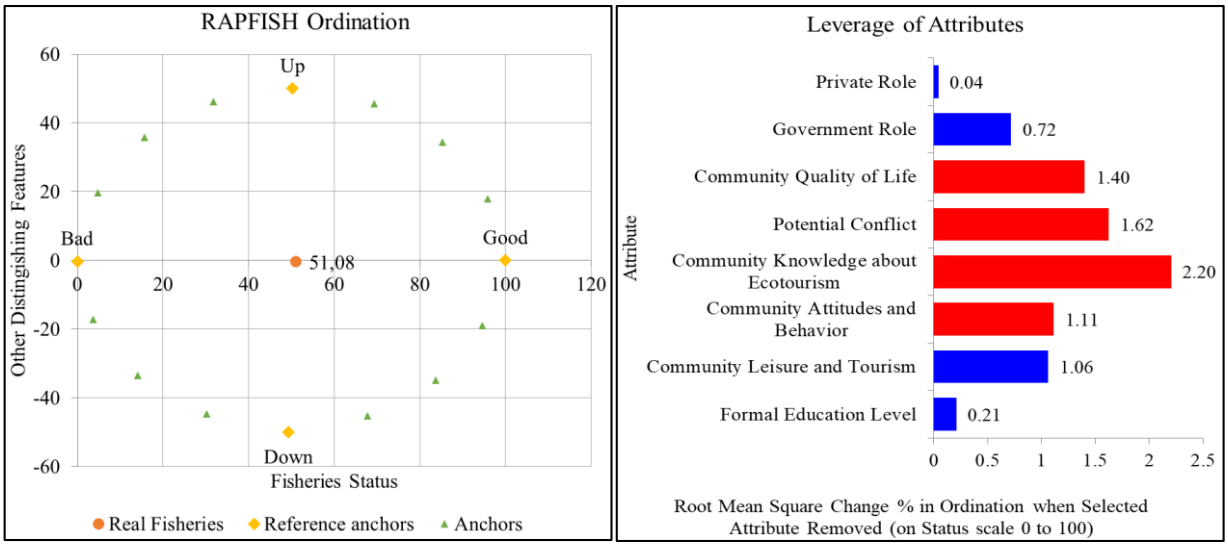

Figure 5. RAPFISH and leverage chart on social and cultural dimension

Basically, to achieve sustainable development, it is necessary to carry out further analysis of all the indicator variables that make up each dimension. In **Figure 5**, eight indicators for the socio-cultural dimension are presented, namely private role, government role, community quality of life, potential conflict, community knowledge about ecotourism, community attitudes and behavior, community leisure and tourism, and formal education level. **Figure 5** on the left side presents the social and cultural dimension of sustainability status performance, and on the right is the leverage factor of the eight indicators as output from the analysis using the MDS RAPFISH method.

Based on the results of the leverage analysis, the level of sustainability of the TWP Teluk Kiluan marine ecotourism on the socio-cultural dimension is explained in **Figure 5**. Of the 8 attributes analyzed, there are 4 attributes that are most sensitive in determining the value of the sustainability index for this socio-cultural dimension. As can be shown in **Figure 5** on the right, namely community knowledge about ecotourism (RMS value = 2.20%), potential conflicts with other uses (RMS = 1.62%), community quality of life (RMS = 1.40%), and community attitudes and behavior (RMS = 1.11%).

Based on the results of the leverage factor analysis, in order to increase the sustainability of the socio-cultural dimension more efficiently, these four indicators must become the preferred strategy for development. The first strategy needs to be prioritized based on the development of the largest RMS indicator: the level of public knowledge about ecotourism. Education, training, and outreach to the tourism service provider community are the domain of local public authorities to develop a tourism awareness attitude. Excellent service from service providers (including waitstaff, homestays, restaurants, fruit traders, fruit sellers, souvenirs, etc.) to every tourist can increase repeat visits by customers or tourists. Repeat visits are an important variable for the development of sustainable tourism activities because they will greatly reduce promotional costs to recruit new customers or tourists. More than that, it can increase the sustainability of the economic dimension. If so, according to Bakri et al. [37], it will also increase indicators of the sustainability of service providers' hospitality attitudes and improve the quality of life of the surrounding community, especially starting with people who are active or participating [38] as actors or providers of tourism services. A good quality of life in the end can also reduce the chance of conflict.

3.4. Sustainability Status Economic Dimension

The economic dimension refers to tourism development that has economic sustainability. This means that the economic dimension has added value in the long term, providing economic benefits not only for local government revenues but also especially for the surrounding community. When people's income increases in a sustainable manner, it will simultaneously increase public spending and consumption, which means an increase in local government revenues through local taxes in every transaction. Coastal areas and tourism play an important role in the economy [39]. As in ecological systems, the economic system is essentially a relationship between producers and consumers, which also involves an intermediary or transportation system. Each individual is a consumer, while producers are individuals or groups that produce or provide goods and services to meet consumer demands. Consumer demands include basic needs as well as aspirational needs. Primary or basic needs generally do not vary for each individual, including the need to eat, drink, and meet biological needs. However, in contrast to aspirational needs, they are very diverse and cannot be limited. Producers of goods and services generally experience excess demand in meeting the amount demanded by consumers, which often exceeds the producer's ability to provide supply. The more advanced a region or country is, the more its primary needs are generally fulfilled. However,

it is different for aspirational needs, including the need for comfort and pleasure as provided by providers or tour service providers. This economic system will continue. The more advanced and developed a country is, the higher the welfare, which is characterized by the demand for aspirational goods, including tourism services.

The results of the MDS analysis show that the index value of the economic dimension of sustainability in the management of marine ecotourism at this study location is 42.40%. The sustainability performance of this dimension shows that the level of management of marine ecotourism is not sufficiently capable of providing sustainable economic benefits for the local community and automatically for the local government. This result should be the basis for the management of TWP Teluk Kiluan to increase sustainability in the economic dimension, which is an important pillar for the improvement of the other four dimensions. For this reason, it is necessary to review the results of the leverage analysis that has been obtained in this study. **Figure 6** below contains the results of the sustainability status of the economic dimension and leverage using the MDS RAPFISH method.

Based on the results of the TWP sustainability leverage analysis on the economic dimension, it is explained in **Figure 2** that, of the 9 attributes analyzed, it turns out that there are 4 attributes that are most sensitive to the magnitude of the sustainability index value for the economic dimension. These four attributes include local labor wages equal to the provincial minimum wage, which gives an RMS value of 3.99%, room availability-number of visitors (RMS = 3.64%), labor absorption (RMS = 3.05%), and marketing and promotion funding (RMS = 2.90). According to Heffiana et al. [40] the RMS value is a measure of the size of the role of each attribute in determining sustainability status. The most sensitive attribute for the economic dimension is labor wages (UMP), which means that the UMP attribute is very important to note in an effort to improve ecotourism sustainability performance. Thus, this attribute needs attention and is managed properly so that the sustainability index in the management of marine ecotourism is increased in the future, which will come. The economic dimension needs strengthening, such as by improving the economy and developing a sustainable funding system through training and employment development that supports ecotourism development. Thus, marine tourism activities in this region can create jobs for the local community, which at the same time increases the community's ability to consume or invest and increases local government tax revenues. Increasing the performance of the local economy stimulated by ecotourism is important, especially after the COVID-19 pandemic, as revealed by Bakri et al. [37], Marinello et al. [41], and Adedoyin et al. [42]. Tourism activities like this have been proven to encourage economic growth through investment opportunities and job opportunities [43].

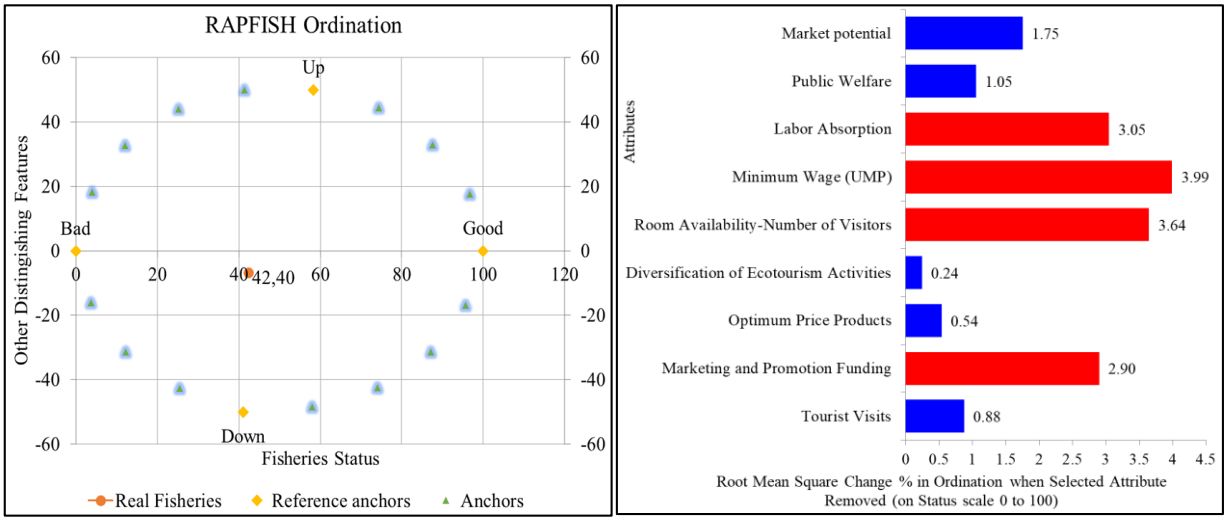

Figure 6. RAPFISH and leverage chart on economy dimension

3.5. Sustainability Status Infrastructure/Technology Dimension

The infrastructure/technology dimension is an important pillar indicator for the development of the sustainability of every tourism activity. Facilities and infrastructure have two sides of interest, namely as a tool to meet tourism needs and as a controller in order to maintain environmental balance [44]. General indicators that can determine the sustainability of this technological dimension include good physical accessibility of roads, availability of comfortable home stays, stable electric power supply, strong mobile signal, adequate means of transportation, availability of first aid in accident facilities, provision of clean water, sanitation facilities, and other supporting facilities. The results of the MDS analysis showed that the technology dimension sustainability index was 42.18%, classified as less sustainable, indicating that the provision and management were classified as unfavorable. The fact is that the management of marine ecotourism still does not meet the criteria of being sustainable, which can result not only in environmental damage but also in a reduction in the number of tourists. Because this dimension is essential for tourism development [45], in the future, infrastructure development must be carried out immediately on the basis of several indicators that have the greatest leverage. The results of the leverage factor analysis of ten indicators for the sustainability of this technological dimension are presented in **Figure 7**. From this figure, it appears that there are 4 indicators that have high RMS values: clean water and sanitation (3.89%), electrical infrastructure (2.87%), accommodation /homestays (2.04%), and ecotechnology in marine tourism(1.03%).

Clean water and sanitation can be a big leverage factor because marine tourism in Teluk Kiluan is located in a remote area, like an enclave, even though every tourist always needs fresh water to clean his wet limbs from the salty sea water so as to avoid irritation. Likewise, with clean environmental sanitation, it is very necessary for the comfort of every tourist from unpleasant odors or free from uncomfortable views in the form of being free from piles of garbage. Apart from that, sanitation which frees from various consumer goods waste brought by tourists also supports the sustainability of the ecological dimension, especially those originating from medicine waste or even Hazardous and Toxic Substances (B3=Bahan Berbahaya dan Beracun) waste such as styrofoam, plastic packaging etc.

The second indicator is that a stable electric power supply can be a lever for increasing the sustainability of the technological dimension. The location of marine tourism, which is in a remote area, also requires the provision of electrical power, making the infrastructure very expensive if it has to be provided by the private corporation holding the concession rights to this tourist park. Therefore, it is appropriate that investment by an electrical state-owned company (PLN=Perusahaan Listrik Negara) be carried out immediately so that this technology indicator can contribute to the sustainability of the technological dimension. More than that, this investment can also provide a multiplier effect for the growth and development of economic activity in the rural areas around Teluk Kiluan Tourism Park. The development of rural economic activity in turn can also stimulate an increase in the sustainability of the economic dimension through leveraging labor absorption indicators, market development, and increasing wages.

Leveraging the sustainability of the technological dimension can also be pursued by improving the quality of homestays. The sustainability of this indicator can also be improved because the main attraction of Teluk Kiluan Tourism Park is the appearance of dolphins. The sustainability of this indicator can also be improved because the main attraction of Teluk Kiluan Tourism Park is the appearance of dolphins. While the appearance of these very exotic mammals is before dawn, comfortable, clean, and quiet homestay facilities are a prerequisite for the development of this lodging infrastructure. Moreover, the distance from this taman wisata to down town takes no less than 6 hours by car. The necessity of staying at this tourist location cannot be avoided by every tourist who wants to witness the appearance of the dolphins at dawn. If this infrastructure/technology dimension can be improved through homestay performance indicators, then in turn it can be expected to contribute to increasing the sustainability of the economic dimension through the four indicators of these dimensions.

Leveraging the marine ecotechnology indicator is the fourth strategy for increasing the sustainability of the infrastructure/technology dimension. As with the performance of homestays, which are important facilities for tourists, almost all of whom want to observe dolphins, the provision of marine ecotechnology facilities is also a prerequisite. Provision of sea facilities such as snorkeling, diving, speed boats, cellphone signals, etc, is important for dolphin observation activities. The provision of these various facilities does not require a lot of public investment from the local government because there will be a lot of profit for private investors. Furthermore, increasing the sustainability of this indicator will eventually lead to an increase in the economic dimension through the four most sensitive indicators, as previously addressed.

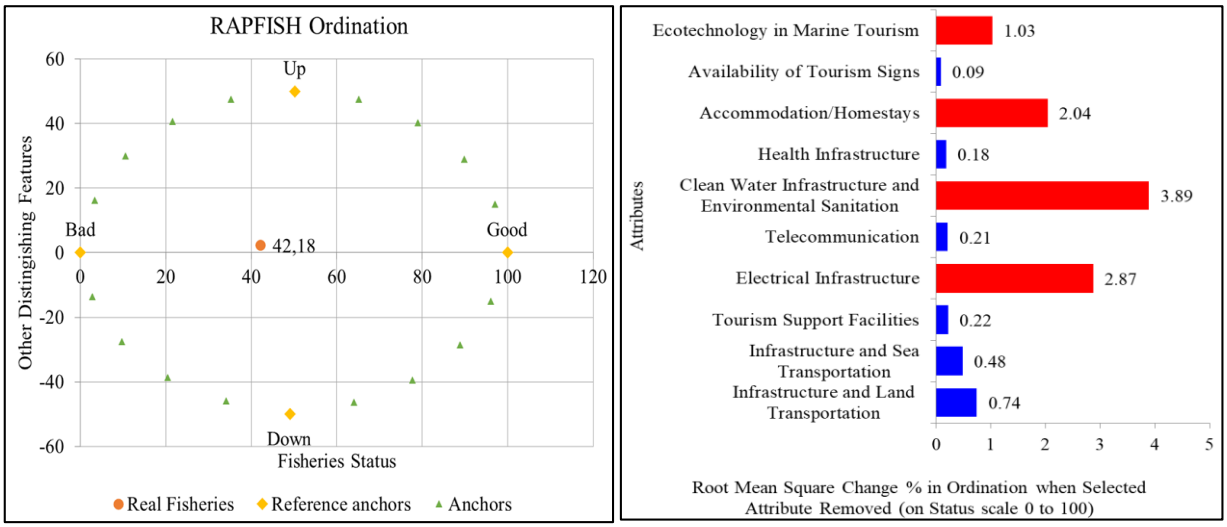

Figure 7. RAPFISH and leverage chart on infrastructure/technology dimension

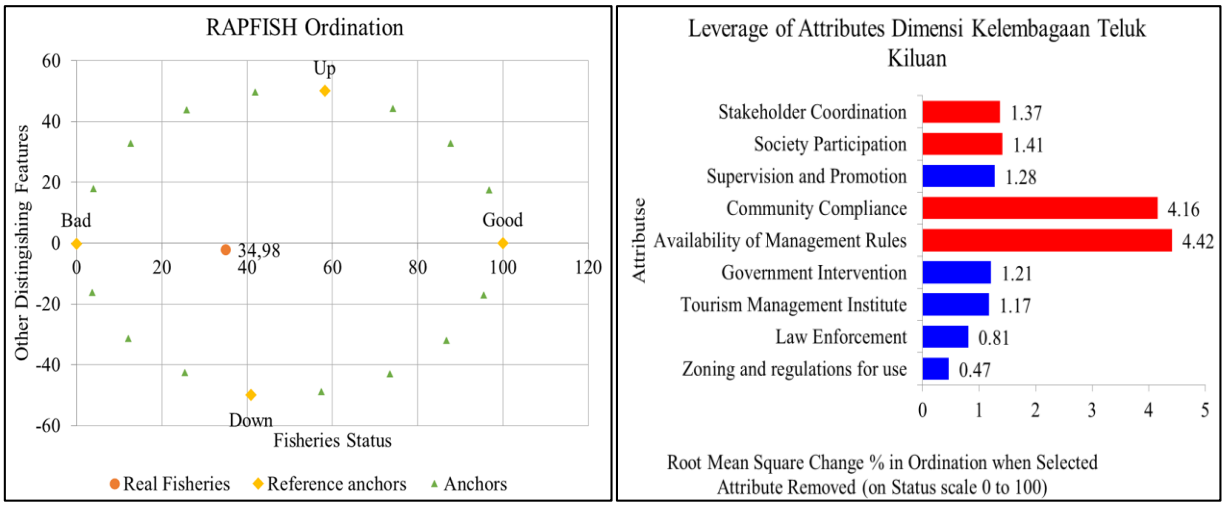

Figure 8. RAPFISH and leverage chart on the institutional dimension

3.6. Sustainability Status Institutional Dimension

Institutions are rules or rules of the game that are agreed upon and obeyed by two or more parties to regulate various relationships, which can be in the form of regulations, cultural recognition, or norms [46]. Because of this, institutions also play a role in managing resources and distributing benefits in an effort to increase tourism potential [47]. The institutional dimension is the skill to advance and implement internal and external policies in support of the sustainability of Teluk Kiluan marine ecotourism. The urgency of the existence of institutions in the field of tourism, among other things, is that institutions can act as a forum as well as a driving force in facilitating and developing community participation in the tourism sector. As shown in **Figure 8**, the results of the MDS analysis for the institutional dimension are 34.98%, classified as less sustainable. This means that this institutional dimension is not flexible enough to facilitate the dynamics of the relationship between stakeholders. In order to develop a strategy for the institutional dimension of sustainability, a leverage factor analysis has been carried out for this dimension. **Figure 8** presents the results of determining the sustainability status of the institutional dimension, along with the results of the leverage factor analysis of the nine indicators applied in this study.

Of the nine indicators or attributes applied, there are four attributes or indicators that are most sensitive to the magnitude of the dimension's sustainability index value. The most sensitive indicator is the availability management rule indicator with an RMS of (4.42%). This indicator is very crucial for controlling the daily core business as well as for planning the development of marine tourism at this research location. The development strategy that needs to be pursued is the preparation of standard operating procedures (SOP=Standar Operasional Prosedur) for management and training for SOP implementation. The second priority in efforts to develop sustainability

performance in the institutional dimensions of managing Teluk Kiluan marine ecotourism is empowering the surrounding community. These various empowerment programs must be carried out because increasing community compliance with relationships with other parties will have a large impact on increasing the sustainability of this institutional dimension. This claim is shown in the leverage analysis for the community compliance indicator, which produces an RMS of (4.16%). In this regard, empowerment can begin with community development programs, especially porter service providers, parking, children's playgrounds, boat rental services, culinary providers, fruit sellers, souvenir sellers, etc. These programs can simultaneously increase community participation in the management of this tourist park, which is the third largest leverage in influencing the increase in institutional sustainability as shown by the RSM value of (1.41%). Not only that, but further increasing community participation can also induce an increase in the sustainability of the economic dimension through leverage on the four indicators as previously addressed.

The fourth sensitive indicator in efforts to increase the sustainability of this institutional dimension is stakeholder coordination, which produces an RMS of (1.37%). There are two kinds of organizational relationships that form in each institution. The form of the relationship between one party that can give orders to other parties, aka structural relationships, such as the relationship of superiors to subordinates or those who control those who are controlled or also between those who are superior to those who are less or inferior. The second form is the equality relationship, in which neither party is superior to the other. Because neither party has the capacity to regulate the other, both parties have the capacity to organize jointly, or coordinate. It can be ascertained that structural relations are much faster at moving other parties to comply with a rule or with any agreement. But this relationship can only be effective if the structural relationship is still enduring. This means that structural relationships, which are often noncompliant in nature, can take place superficially based on compulsion and not awareness. On the other hand, coordinating relationships are often very difficult to build because they are based on equality, where neither party can force it on the other party. But on the contrary, if a relationship has occurred and is ongoing, then its nature can be more lasting. Therefore, in this study, the leveraging test on indicators or coordination attributes between stakeholders has a fairly sensitive RMS value if chosen as a strategy for increasing the sustainability of the institutional dimension.

3.7. Application of Each Dimension

Based on the results of the research, it is necessary to apply some strengthening for each dimension, namely: (1) strengthening the institutional/legal dimension, through increasing the value of leverage (availability of management regulations, level of community compliance, community participation, and coordination between stakeholders); (2) strengthening the infrastructure/technology dimension, through increasing leverage (clean water and environmental sanitation infrastructure, electricity infrastructure, accommodation/homestays, and ecotechnology in marine ecotourism); (3) strengthening the economic dimension, through increasing leverage (wages of local workers against the provincial minimum wage, availability of rooms with the number of visitors absorbing labor, and funding in marketing and promotion); (4) strengthening social and cultural dimensions, through increasing leverage (community knowledge about the environment (ecotourism) and local wisdom, potential conflicts with other uses, and changes in the quality of life of local communities); and (5) strengthening dimensions, through increasing leverage (level of land use for marine ecotourism facilities, waste pollution in Teluk Kiluan, ecosystem preservation/conservation in Kiluan Bay, and water quality).

4. Conclusions

The sustainability index for the ecological dimension is 57.21%; the status category is quite sustainable; the index value for the socio-cultural dimension is 51.08%; the sustainability index value for the economic dimension is 42.40%; the status category is less sustainable; the institutional dimension's sustainability index value was 34.98%; and the infrastructure/technology dimension's sustainability index value was 42.18% in the less sustainable category.

The scenario for the sustainability strategy for managing marine ecotourism at Teluk Kiluan Aquatic Tourism Park in Lampung Province is that a low average ordination value is a top priority and that it takes four indicators (attributes) that are sensitive in each dimension of sustainability. The order of the priority scales is: (a) the institutional dimension; (b) the infrastructure/technology dimension; (c) the economic dimension; (d) the social and cultural dimensions; and (e) the ecological dimensions.

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