Effectiveness of Conservation Management of Olive Ridley Sea Turtles (*Lepidochelys olivacea*) at Abadi Turtle Conservation, Trisik Beach, Kulonprogo, Yogyakarta

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Abstract: Sea turtles are endangered species around the world; one of them is Olive Ridley Sea Turtle (*Lepidochelys olivacea*). Sea turtle extinction is caused by a decrease in the number of sea turtles laying eggs in their native habitat each year, hence sea turtle conservation is required in order to protect sea turtle populations. Sea turtle conservation in Indonesia is not yet deemed optimal; therefore, study on the effectiveness of sea turtle conservation, such as that of Olive Ridley Sea Turtles at the Abadi Turtle Conservation, Trisik Beach, Kulonprogo, Yogyakarta, is required. This research was conducted in December 2022. This study uses observation, a survey, a questionnaire, and SPSS Multidimensional Scaling (MDS) to handle the data. This study has numerous components, including social, economic, ecological, environmental, legal, and institutional, as well as infrastructure dimensions. These parameters are analyzed to determine stress and sustainability values. After MDS processing, the findings showed that the ecological dimension had the minimum stress value, which is very good, at 0.42%, and the sustainability value was 99.9%. So, from an ecological standpoint, conservation is very beneficial and can be implemented to ensure the effectiveness of Olive Ridley Sea Turtle conservation.

Keywords: effectiveness, conservation, kulonprogo, multidimension scaling, sea turtles

1. Introduction

Sea turtles are one of the aquatic biotas which are one of the largest reptiles that live in the sea. In Indonesia there are six species of sea turtles, namely Green Sea Turtle (*Chelonia mydas*), Hawksbill Sea

Turtle (*Eretmochelys imbricata*), Olive Ridley Sea Turtle (*Lepidochelys olivacea*), Leatherback Sea Turtle (Dermochelys coriacea), Loggerhead Sea Turtle (*Caretta-caretta*) and Flatback Sea Turtle (*Natator depressa*) (Ministry of Marine Affairs and Fisheries of the Republic of Indonesia, 2015).

All sea turtle species have been protected because they are categorized as endangered and are experiencing high population decline (Ministry of Marine Affairs and Fisheries of the Republic of Indonesia, 2015). All sea turtle species in Indonesia are regulated by written protection in Law no. 5 of 1990, Law no. 31 of 2004 and Government Regulation no. 7 and no. 8 of 1999, while internationally it has been included in Appendix 1 of CITES (Convention on International Trade in Endangereed Species), means that sea turtles are classified as endangered aquatic biotas and are prohibited from being traded in any form (Ministry of Marine Affairs and Fisheries of the Republic of Indonesia, 2015). One of the protected sea turtle species is Olive Ridley Sea Turtle (*Lepidochelys olivacea*) because according to Rohi (2020), it is said that the population of Olive Ridley Sea Turtles in Indonesia continues to decline due to several natural factors and the presence of predators that prey on them. Based on Rohi (2020), human activities are the biggest factor influencing sea turtle populations, such as water contamination and pollution, sand mining, development of coastal areas, selling meat and eggs for direct consumption, destruction of foraging areas, disruption of sea turtle migration routes and making accessories from sea turtle shells and there are other influencing factors, namely natural factors, including fluctuating nest temperatures, ebb and flow of waves, sea turtles being attacked by disease and the presence of predators (snakes, monitor lizards, crabs, etc.). Nesting sites or conservation efforts to preserve the population of Olive Ridley Sea Turtles in Indonesia always decrease every year, in 2008 there were approximately 15,000 nests, in 2011 it was 2,000 nests, and in 2013 it further decreased to 1,500 nests, this happened due to damage to nesting habitat or natural factors (Rohi, 2020).

Trisik Beach, Kulonprogo, is one of the beaches used by sea turtles to lay their eggs. Based on the results of a direct survey in 2022, Trisik Beach is experiencing several problems such as lots of rubbish and high waves resulting in abrasion. This results in reduced habitat for sea turtles to lay eggs naturally. Efforts to conserve sea turtles are supported by the Abadi Turtle Conservation group at Trisik Beach. Research related to the effectiveness of conservation management for Olive Ridley Sea Turtles at the Abadi Turtle Conservation has never been carried out, especially regarding information of the effectiveness of sea turtle conservation management. So, it is necessary to conduct research on the effectiveness of Olive Ridley Sea Turtle conservation management at the Abadi Turtle Conservation. The level of effectiveness of sea turtle conservation in carrying out Olive Ridley Sea Turtle conservation will influence the survival of the Olive Ridley Sea Turtle. The aim of this research is to determine the level of effectiveness of Olive Ridley Sea Turtle conservation management in the Abadi Turtle Conservation using the Multidimensional Scaling (MDS) approach.

2. Methods

The research was conducted in December 2022 at the Abadi Turtle Conservation, Trisik Beach, Kulonprogo, Bantul Regency, Yogyakarta. The research location is shown in Figure 1. This research used survey and questionnaire methods, and conducted interviews with 30 respondents. The data used in the research includes primary and secondary data. Primary data used included ecological data taken including field surveys to obtain vegetation data, semi-natural nest habitat conditions for Olive Ridley Sea Turtles, including temperature, depth, diameter, distance between nests for hatching eggs, as well as measurements of the length and width of the

hatchlings. Social data from interviews and questionnaires was taken from related agencies, coastal communities, the Abadi Turtle Conservation group, and so on. The data obtained covers several aspects from several dimensions, namely social, economic, ecological, environmental, infrastructure, legal and institutional, and multidimensional with predetermined parameters. Secondary data used includes historical data, organizational structure, data on the number of sea turtle eggs, hatchling release data and tourist data for 2019 – 2022.
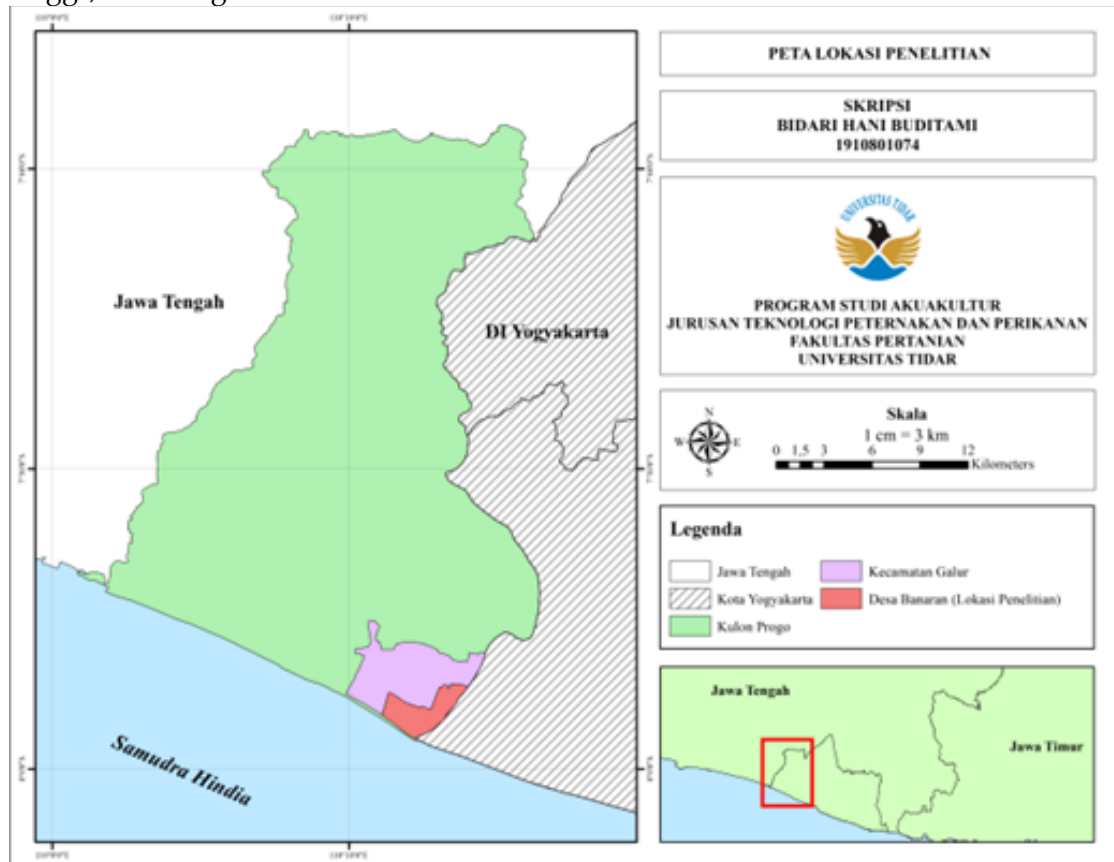
Figure 1. Research Location Map

Data analysis using the Multidimensional Scaling (MDS) approach using SPSS version 26. The assessment stage for each attribute on an ordinal scale is carried out based on the sustainability criteria for each dimension, ordination analysis based on the MDS method, index preparation, and the sustainability status of the development of the existing condition area being studied, good in general and in each dimension (Firliansyah and Eterna, 2017).

Social dimension data includes, 1) Education, 2) Community perception, 3) Local regulations regarding sea turtle conservation management, 4) Community participation, 5) Community support, 6) Community perception of tourists, 7) Sea Turtle Conservation Education, 8) Training, 9) Community attitudes (behavior) regarding sea turtle conservation management, 10) Community knowledge regarding turtle conservation management (Harmino, et al., 2021; Ismane, 2018).

Economic dimension data includes, 1) Average income of people in villages in sea turtle conservation areas, 2) The influence of area management on improving the community's economy, 3) Level of income of communities around the conservation area, 4) Community efforts to strengthen their ability to improve the economy, 5) Community livelihoods (Nordiansyah, 2016; Davidson and Maitland, 2022; Ismane, 2018)

Ecological dimension data includes, 1) Beach slope, 2) Vegetation cover, 3) Lighting, 4) Building distance from the coast, 5) Weather (Ismane, 2018). Environmental dimension data includes the

conservation environment at Trisik Beach. Protection, conservation or expansion of natural resources and the physical environment to ensure long-term and sustainable life of the ecosystem (Davidson and Maitland, 2022). The environmental dimension consists of: 1) Level of pollution in irrigation canals, 2) Availability of water or irrigation, 3) Fertility of the land, 4) Abundance of sea turtle populations (Ismane, 2018).

Data on the legal and institutional dimensions consist of 1) Availability of institutions that handle the management of sea turtle conservation areas, 2) Understanding of the rules/institutions/regulations of coastal conservation areas, 3) The role of government or Marine Affairs and Fisheries Service, 4) The role of the community, 5) The existence of sea turtle conservation management planning , 6) Extension centers, 7) Law enforcement or application of regulations regarding conservation, 8) Synchronization of central policies with the community, 9) Collaboration with surrounding areas (Ismane, 2018).

Infrastructure dimension data includes: 1) Road access and infrastructure to sea turtle conservation locations for tourists, 2) Availability of facilities for handling nesting and cultivating hatchlings and eggs, 3) Availability of worship facilities and toilets for tourists, 4) Availability of public transportation, 5) Availability of photo spots and egg hatching process, 6) Availability of photo spots and viewing of the hatchlings being released (Ismane, 2018). The sustainability status of Olive Ridley Sea Turtle conservation at Trisik Beach Abadi Turtle Conservation can be seen from the stress value and will get a Sustainability Index in percent RSQ. If using the MDS model, the higher the RSQ value, the better the MDS model (Ismane, 2018). If the stress value is lower, it shows that the Sustainability Index (SI) value is getting better (Ismane, 2018). The criteria for determining the stress value can be seen in Table 1. The sustainability status category in the form of a sustainability index value uses a scale developed by Columbia University, Canada, in Fauzi and Anna (2005) which is in Table 2.

Table 1. Stress level criteria

No	Stress (%)	Goodness of fit
1	≥20%	Poor
2	10%-20%	Fair
3	5%-10%	Good
4	2,5%-5%	Excellent
5	≤2,5%	Perfect

(Source: Columbia University, Canada, in Fauzi and Anna, 2005)

Table 2. Sustainability index level criteria

No	Index (%)	Sustainability status
1	0-25	Not sustainable
2	26-50	Poorly sustainable
3	50-75	Fairly sustainable
4	76-100	Sustainable

(Source: Columbia University, Canada, in Fauzi and Anna, 2005)

Goodness of Fit analysis from MDS for each dimension produces stress values and sustainability index values so that it can be concluded the level of condition for each condition dimension so that it can be used as a conservation management status as in Table 3.

Table 3. Measures of goodness of fit and sustainability

No	Dimensions	Stress Value	Sustainability Index	Conclusion
1	Social Dimension			
2	Economic Dimensions			
3	Ecological Dimensions			

| 4	Environmental Dimensions
5	Legal and Institutional Dimensions
6	Infrastructure Dimensions

(Source: Columbia University, Canada, in Fauzi and Anna, 2005)

3. Results and Discussion

3.1. Social Dimension

The results of the analysis from MDS will produce sub-dimensions that reflect the distribution of data on the effectiveness or sustainability of the Olive Ridley Sea Turtle Conservation management at the Abadi Turtle Conservation. After the data is analyzed, the Derived Stimulus Configuration or MDS Quadrant Results will be produced, as shown in Figure 2a and the Scatterplot of Linear Fit shown in Figure 2b. The Derived Stimulus Configuration graph is a grouping of respondent results that shows similarities in several criteria. The MDS graph is divided into 4 clusters or 4 quadrants where each cluster indicates similar indicators. Based on the social dimension analysis, cluster 1 shows that education and community participation are grouped into the same cluster, which means that the results of the respondents' answers are similar. In cluster 2, good knowledge of sea turtle conservation management, sea turtle conservation education, and sea turtle handling training resulted in similar answers from respondents. In cluster 3, community attitudes towards conservation and local regulations for conservation management get similar results. Meanwhile in cluster 4, grouping community support, community perception, community perception of tourists shows similarities in the respondents' results. In dimension 1 the lowest value is sea turtle handling training. Meanwhile, in dimension 2 the greatest value is in the education sector.

Based on the Scatterplot of Linear Fit graph from MDS Social Dimensions, the results obtained are 43 points from which a straight line can be drawn following the trend of disparity distribution, which means that the trend shows the level of consistency of respondents' answers. Based on the Scatterplot of Linear Fit graph, if the points or scatterplot are close together, the more consistent the respondent will be in answering the questionnaire. If the scatter plot or disparity points are far from each other, it shows that respondents are inconsistent or inconsistent in answering the questionnaire. Based on the results of the social dimension scatterplot, it shows that the distance between data tends to be closer or closer. This shows that respondents' answers related to the social dimension of managing conservation areas have a high consistency value, with a coefficient of determination (R^2) of 0.92. Based on the results of stress value analysis and sustainable index value criteria (Ismane, 2018), a stress value of 15.9% is included in the Goodness of Fit Fair (fair) value. The stress value indicates the proportion of variance that is not explained by the model and the lower the stress value, the better the MDS model (Ismane, 2018). The stress value criterion of 15.9% is sufficient but has not reached good status. With a Sustainable Index (SI) of 92.5% indicating the sustainable category (Columbia University, Canada, in Fauzi and Anna, 2005). Abadi Turtle conservation management based on social dimensions shows sustainable results, which means that conservation can be developed further.
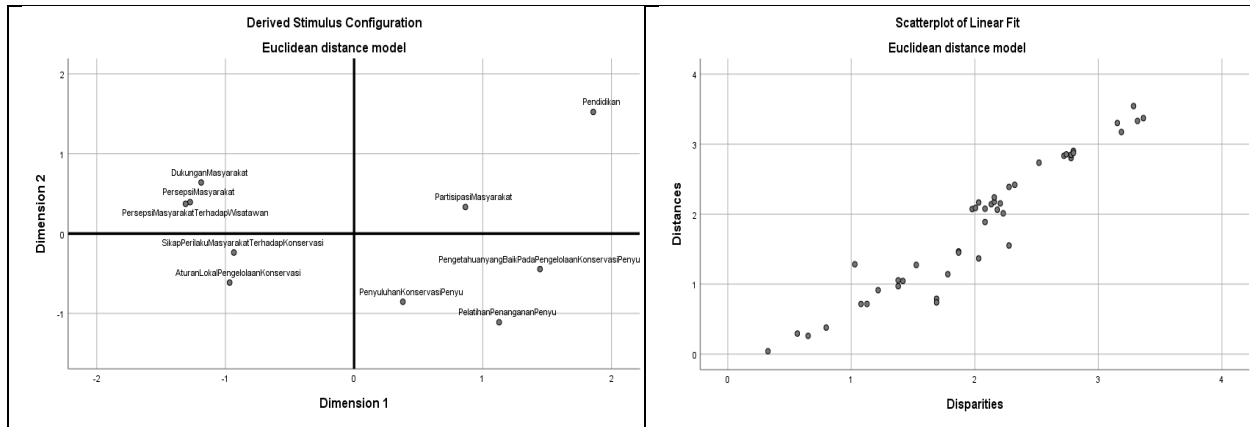
Figure 2. a). MDS Social Dimension Quadrant, b). Scatterplot of Linear Fit MDS Social Dimensions

3.2. Economic Dimension

Based on the results of the economic dimension questionnaire, by including economic aspects or indicators, it produces stress value criteria and conservation sustainability index value criteria. Results showing the similarity of each point will be seen in the Derived Stimulus Configuration quadrant shown in Figure 3a and the Scatterplot of Linear Fit as in Figure 3b. Based on the Derived Stimulus Configuration graph, which is a grouping of respondents' results, it shows similarities in several criteria. Based on the Multidimensional Scaling graph, each cluster indicates several indicators that are similar. Cluster 1 shows that the income level of the community around the conservation area and the average income are grouped in the same cluster, so there are similarities in the results of the respondents' answers in answering the questionnaire. Cluster 2 does not contain any indicators included in the cluster. In cluster 3 there are questionnaire indicators related to people's livelihoods, but they are not similar to other indicators. Meanwhile, in cluster 4, there is a grouping of indicators related to the influence of conservation area management on the community's economy and indicators of community efforts to strengthen the economy which have similar or similar results from respondents. Based on the results of the Derived Stimulus Configuration, results were obtained in dimension 1 with the smallest results obtained in community livelihoods. Dimension 2 obtained the greatest results on indicators of the influence of conservation management on the community economy.

The Scatterplot of Linear Fit graph from the MDS economic dimension produces 10 points that can be drawn straight lines following the trend of disparity distribution, which means that the trend shows that respondents' answers are relatively consistent. From the Scatterplot of Linear Fit graph, it shows that the disparity distance is not too close but a straight line can be drawn by following the disparity distribution trend, so it has a high answering consistency value with a coefficient of determination (R^2) of 0.98. The stress value obtained from the economic dimension was 14.1%, indicating a Goodness of Fit Fair (fair) result. The lower the stress value, the better the MDS results. The Sustainability Index for the economic dimension is 90.8%, indicating that the management of the Abadi Turtle Conservation can be carried out sustainably by reviewing the economic aspects of the communities that are impacted by the conservation.
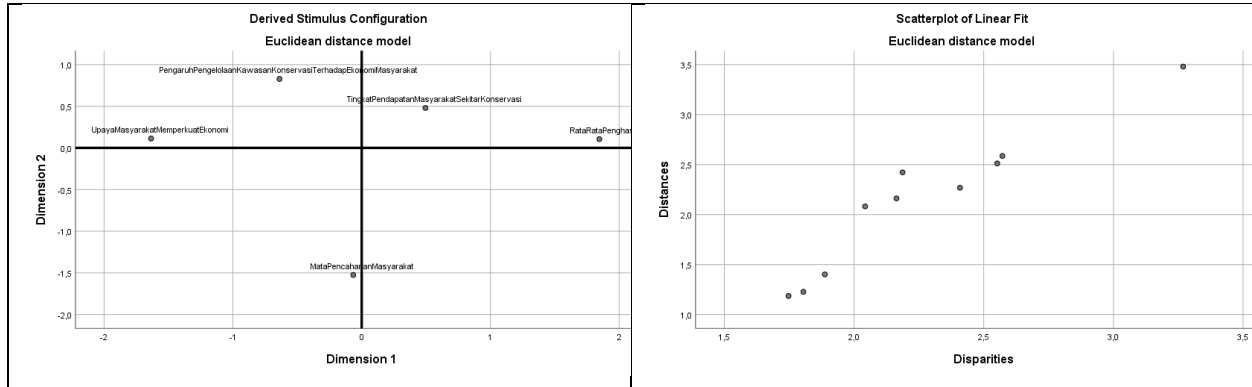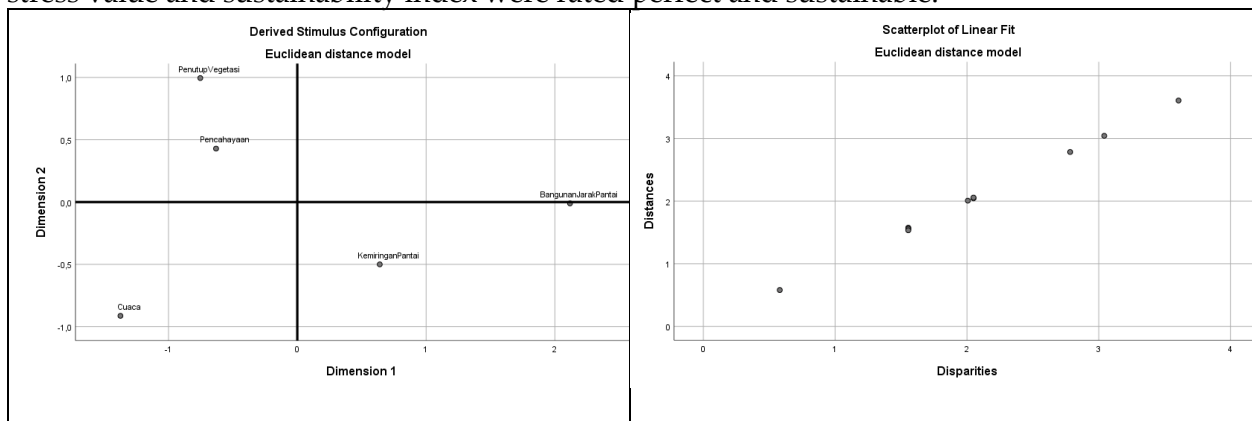
Figure 3. a). Economic Dimension MDS Quadrant Results, b). Scatterplot of Linear Fit MDS Economic Dimensions

3.3. Ecological Dimension

Ecological dimensions including beach slope, vegetation cover, lighting, distance to beaches and weather (Ismane, 2018) are analyzed to obtain Stress values and Sustainability Index. The results of the ecological dimension MDS quadrants are displayed in Figure 4a. Based on the Derived Stimulus Configuration graph, which is a grouping of results from respondents that show similar indicators. There are 4 clusters or 4 quadrants with each cluster indicating similar indicators. Cluster 1 does not contain indicators that show similarities or existing indicators. In cluster 2 there are indicators that are quite similar, namely related to the slope of the beach and the distance to the beach. Cluster 3 in the weather indicator shows that there is no similarity in results with other indicators. In cluster 4, there are similarities between lighting indicators and vegetation cover. Dimension 1 obtained the smallest value or result in the weather section, and in dimension 2 the highest result was obtained by vegetation cover. The results of the Scatterplot of Linear Fit are presented in Figure 4b.

Based on the Scatterplot of Linear Fit graph, it produces 8 points from which a straight line can be drawn following the trend of disparity distribution, which means the trend shows the level of consistency of respondents in answering. From the results of the scatterplot graphic of linear fit MDS, the distance between the data shows that a line can be drawn straight and there is a buildup of points which shows harmony in making the assessment. If the distance between data on the graph tends to be far apart, then there will be no similarities between the data, but a straight line can be drawn by following the trend with a coefficient value of 0.998. The stress value obtained from MDS processing was 0.42% and the Sustainability Index was 99.87%, which means that the stress value and sustainability index were rated perfect and sustainable.

Figure 4. a). Ecological Dimension MDS Quadrant Results, b). Scatterplot of Linear Fit MDS Ecological Dimensions

3.4. Environmental Dimension

Based on MDS analysis of environmental dimensions, each quadrant that shows similarities or connections between points or Derived Stimulus Configuration is shown in Figure 5a. Derived Stimulus Configuration is a graph of grouping respondent results that shows the similarity of several criteria. Cluster 1 shows that there are no similarity indicators. However, in cluster 2 there are indicators related to the level of irrigation pollution that do not show similarities with other indicators. Cluster 3 shows that the abundance of sea turtle populations and conservation areas that are clean of rubbish show similarities in the results of the respondents' answers. In cluster 4, those related to land fertility and water availability or irrigation are grouped into the same quadrant, showing the similarity of the respondents' results. Dimension 1 obtained the smallest results on the indicator that conservation areas are clean from waste and dimension 2 obtained the largest results on water availability or irrigation. Scatterplot of Linear Fit of the Environmental dimension is shown in Figure 5b.

Based on the Scatterplot of Linear Fit graph, there are 10 points where a straight line cannot be drawn following the disparity distribution trend, which means that it does not show the level of consistency of respondents in answering the questionnaire. The Scatterplot of Linear Fit graph of the environmental dimension shows the results of disparity points that look sparse and cannot be drawn following the existing trend, indicating that respondents are inconsistent in answering the environmental dimension questionnaire, by obtaining a coefficient of determination (R^2) of 0.797. The results of the stress value in the economic dimension are 23.6%, if the stress value is ≥20% it means that the Goodness of Fit is poor (less). In the economic dimension, the stress value criteria are not good. In the sustainability index value criteria, it gets a fairly sustainable score because it gets a result of 79.7%.
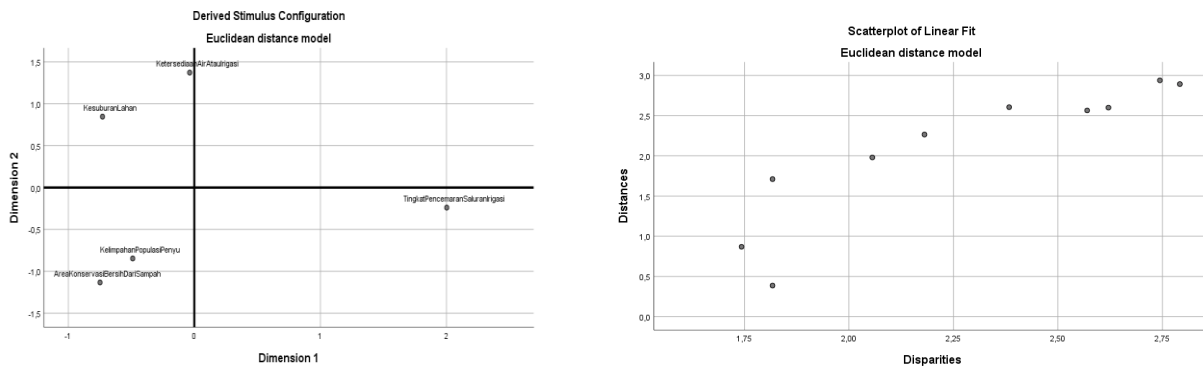
Figure 5. a). MDS Environmental Dimension quadrant results, b). Scatterplot of Linear Fit Environmental dimensions
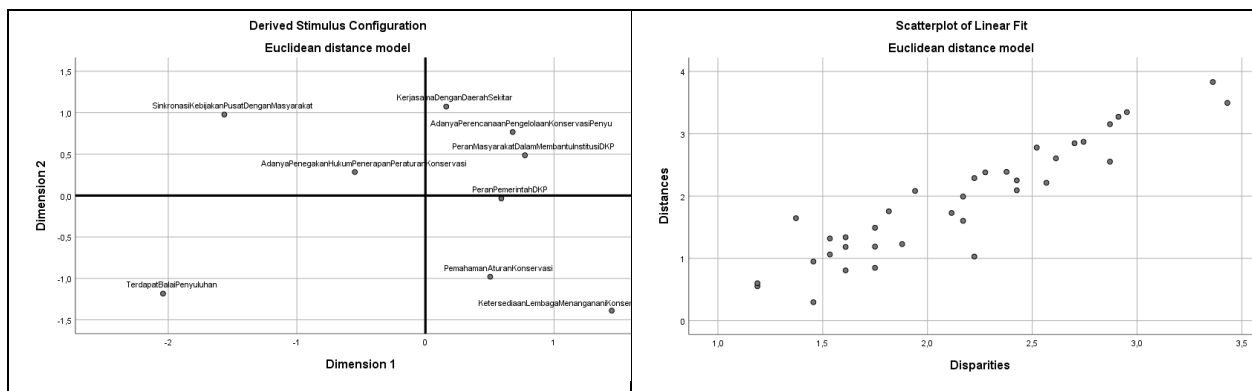
3.5. Legal and Institutional Dimension

The legal and institutional dimensions are based on the government bureaucratic system that oversees or assists conservation management, namely related to the Maritime Affairs and Fisheries Service, the Natural Resources Conservation Agency, and other related government institutions. MDS analysis results obtained similarity results between points (Derived Stimulus Configuration Euclidean Distance Model) are shown in Figure 6a. The Derived Stimulus Configuration graph is a grouping of respondent results that can be identified by the similarity of several indicator criteria. Cluster 1 shows that regarding cooperation with surrounding areas, sea turtle conservation management planning, the government's role in assisting Maritime Affairs

and Fisheries Service institutions have similar results from respondents' answers. In cluster 2 related to the role of the government's Maritime Affairs and Fisheries Service, understanding of conservation regulations, availability of institutions dealing with conservation, there are similarities in the results of respondents' answers. In cluster 3, the indicators related to counseling centers have no similarities, meaning that the respondents' answers are not similar to other indicators. In cluster 4 related to the synchronization of central policies with the community with indicators of law enforcement in the implementation of conservation regulations, the results of respondents' answers are similar. In dimension 1, the smallest results were obtained, namely the availability of institutions that handle conservation. Meanwhile, in dimension 2, the greatest value results were obtained from collaboration with surrounding areas. Scatterplot of Linear Fit is shown in Figure 6b.

Based on the Scatterplot of Linear Fit graph, the results obtained are 35 points from which a straight line can be drawn following the trend of disparity distribution, which means it shows the level of harmony or consistency of respondents in answering the questionnaire. The distance between the disparity points or scatterplot is quite close together and there are points that overlap each other, which means that the respondents' answers are harmonious and consistent, with a coefficient of determination (R^2) of 0.862. The results of the MDS analysis show that the legal and institutional dimensions have a stress value of 22.1%, which indicates a poor stress value because the percentage is too high. This is different from the sustainability index value which shows a result of 86.2% which is sustainable in the conservation management of Olive Ridley Sea Turtles at the Abadi Turtle Conservation. These results refer to Columbia University, Canada, in Fauzi and Anna, 2005, regarding the criteria for sustainable index values.
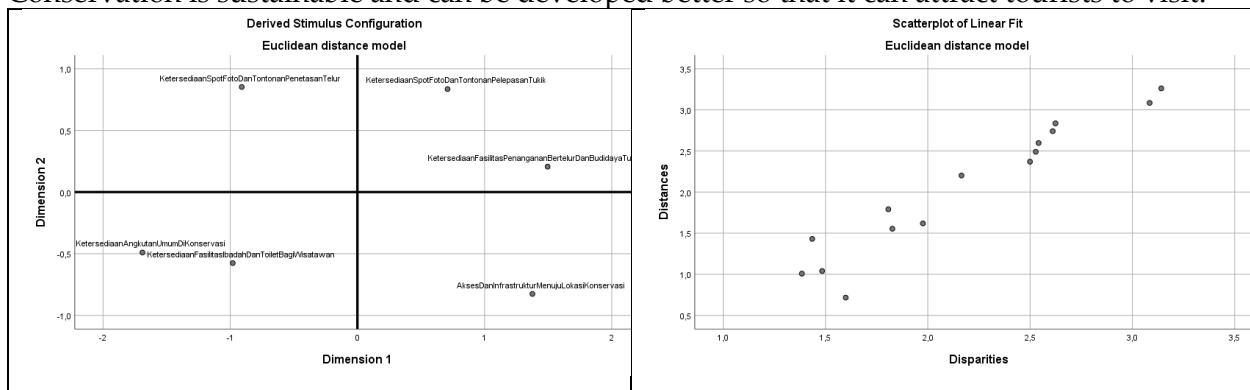

Figure 6. a). MDS Quadrant Results Legal and Institutional Dimensions, b). Scatterplot of Linear Fit Legal and Institutional Dimensions

3.6. Infrastructure Dimension

The infrastructure dimension includes the facilities available at the Abadi Turtle conservation, supporting tourists to come and travel. The data was analyzed using the Multidimensional Scaling (MDS) method to obtain stress values and sustainable values that indicate the effectiveness of sea turtle conservation management. The analysis results show that the quadrants that show similarities between points (Derived Stimulus Configuration) are shown in Figure 7a. The results of the Derived Stimulus Configuration graph show the grouping of similarities in questionnaire respondents' answers from several indicators. Cluster 1, shows the indicators for the availability of photo spots and the moment of hatchling release with the indicators for the availability of egg handling facilities and hatchling cultivation which are similar to the respondents' results. Cluster 2 related to access and infrastructure to conservation locations does not have similar results to other indicators. In cluster 3 related to the availability of conservation public transportation and the availability of worship facilities and toilets for tourists, there are similar results from the answers of questionnaire respondents. Meanwhile, in cluster or quadrant

4, the indicators related to the availability of photo spots and the egg hatching process do not have similar results to the other indicators. In dimension 1, the smallest results are obtained in terms of access and infrastructure to conservation locations. In dimension 2, the largest results were obtained in the availability of photo spots and the egg hatching process. Scatterplot of Linear Fit Infrastructure Dimensions is shown in Figure 7b. Based on the Scatterplot of Linear Fit graph, the results show that there are 15 points, including which a straight line can be drawn following the trend of disparity distribution, which means that the trend shows the level of consistency of respondents in answering, showing that there is harmony in the answers. If the points on the scatterplot are close to each other, the respondent's consistency will be better in filling out the questionnaire. If the points of disparity appear to be far apart, then respondents do not answer consistently and are not in harmony when filling out the questionnaire. Based on the results of the scatterplot of linear fit of the infrastructure dimension, it can be seen that there are several points that are far apart and there are several points that are close together, indicating that there are some respondents who appear to be incongruent in filling out the questionnaire and some who are in harmony in filling out the questionnaire. By obtaining a coefficient of determination or R^2 value of 0.925.

Processing infrastructure data using MDS shows that the stress value is 13.8% which is included in the Fair "Goodness of Fit" category. Meanwhile, the sustainability index value criteria obtained 92.5%, which means that the infrastructure management at the Abadi Turtle Conservation is sustainable and can be developed better so that it can attract tourists to visit.

Figure 7. a). Results of the Infrastructure Dimension MDS quadrant, b). Scatterplot of Linear Fit Infrastructure Dimensions

3.7. Goodness of Fit Analysis

Based on MDS analysis which aims to cluster and level of alignment of perceptions of each dimension, in order to obtain final conclusions about conservation area management. The Goodness of Fit results are shown in Table 4. Based on the Goodness of Fit and sustainable values, the social dimension, economic dimension and infrastructure dimension obtained fair and sustainable results. The environmental dimension and legal and institutional dimensions obtain poor and sustainable results. Meanwhile, the ecological dimension gets perfect and sustainable scores. By averaging the overall 6 dimensions, the stress value and sustainability index are obtained which fall into the fair and sustainable categories. Based on the 6 dimensions which contain a stress value and a sustainability index for each dimension, the ecological dimension obtained the highest sustainability value, namely 99.9%, and the best stress value was obtained by the ecological dimension, namely 0.42%, which is shown in Figure 8.

Table 4. Measures of goodness of fit and sustainability

No	Dimensions	Stress Level (%)	Sustainability Index (%)	Conclusion
1	Social Dimension	15,9	92,5	Fair and Sustainable
2	Economic Dimensions	14,1	90,8	Fair and Sustainable
3	Ecological Dimensions	0,42	99,9	Perfect and Sustainable
4	Environmental Dimensions	23,6	79,7	Poor and Sustainable
5	Legal and Institutional Dimensions	22,1	86,2	Poor and Sustainable
6	Infrastructure Dimensions	13,8	92,5	Fair and Sustainable
	Average	14,9	90,2	Fair and Sustainable

Source: Analysis of questionnaire data, 2023
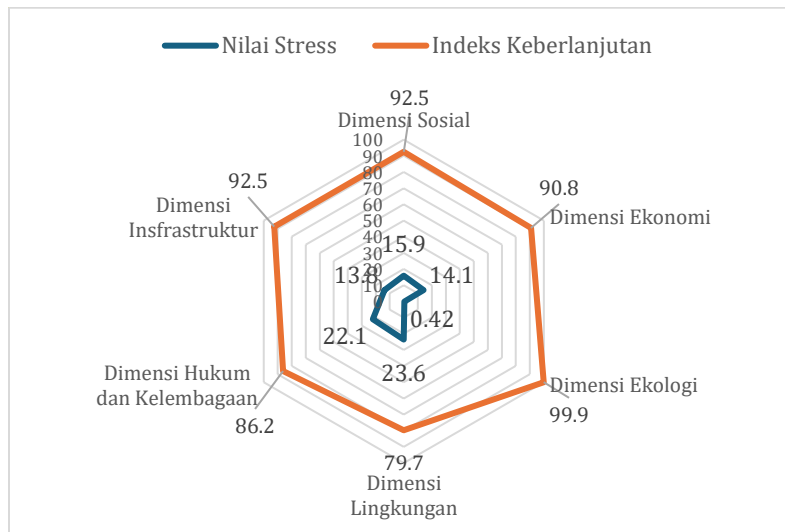
Figure 8. Conclusion of 6 Related Dimensions

4. Conclusion

Research on the Effectiveness of Olive Ridley Sea Turtle Conservation Management at Trisik Beach can be concluded that the social dimension, economic dimension and infrastructure dimension for the stress value index and sustainability index are fair and sustainable. Meanwhile, in the environmental dimension as well as the legal and institutional dimensions, the stress value is considered poor and the sustainability index value is considered to be sustainable. The best results were obtained from the ecological dimension with perfect stress values and a sustainable sustainability index. Based on the 6 dimensions which contain the stress value and sustainability index for each dimension, the ecological dimension obtained the highest sustainability value, namely 99.9%, and the best stress value was obtained from the ecological dimension, namely 0.42%.

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