

The Development of Mitigation-Based Infrastructure of Coastal Settlement and Fishery-Economic Resilience

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Abstract Indonesia is a maritime country where most of the population depends on marine resources, including settlements in Lero. However, geographical conditions are often unsafe. Coastal communities must adapt to the climate, geographical conditions, and prosper with marine resources. So far, the reality is that fishermen's settlements are always identified as slums, undeveloped residents, and difficult to get out of poverty. This research aims to determine the coastal settlements characteristics in Lero, participation level in mitigation, mitigation-based infrastructure development strategies, and fisheries economic resilience. The method used is descriptive qualitative and quantitative. The analysis used includes: spatial, scoring, and IPA analyses. The research results show that the residents of Lero Village must be adaptive to disasters because of their geographical location. Community participation in disaster mitigation is strongly influenced by external factors. Meanwhile, internal factors have no effect. Regarding infrastructure development, there are four priority scale aspects that require handling, namely improving pier facilities, ship repairing facilities for fishermen, management of residential waste systems and waste management of Lero settlements. The development of Lero as a coastal tourism village must be supported by the development of local potential-based community skills to improve the socio-economic sustainability of the surrounding population.

Keywords Infrastructure, Coastal Settlement,

Mitigation, Fishers Economic Resilience

1. Introduction

Three-quarters of Indonesia's territory is water. Indonesia as an archipelago with 17,504 islands is the most islands in the world and has the second-longest coastline in the world after Canada [1]. This makes Indonesian seas rich in marine and coastal resources as well as biological diversity, according to the Food and Agriculture Organization of the United Nations (FAO) [2]. Indonesia has the second-highest capture fisheries in the world in marine waters. The abundance of fish resources should be able to support fishermen's income for their daily needs. However, economically, the fishermen's catch is insufficient to meet their primary necessities. Most of the Indonesian fishermen live in poverty and find it hard to escape the poverty chain. Moreover, Covid-19 has forced organizations in both the corporate and public sectors to suspend operations, and those that did not prepare for it are suffering as a result [3].

Activities in coastal areas are very diverse and specific, which of course becomes a forum for processing marine resources. The coastal area supports the economy by such as fishing, cultivating fish, seaweed, coral reefs, and salt farming. The wide and open space, the potential for big

sea waves, a very exotic sunset, even the fishermen's life are also unique as a potential for coastal tourism. It requires only a small amount of capital to develop [4]. However, disaster-prone such as coastal abrasion is currently a global issue. This indirectly affects the economic development of the local community.

Coastal abrasion reduces the coastal area starting from the areas closest to the sea. Furthermore, the abrasion can eat away at the coast so that seawater inundates, disrupts the fishing activity, or causes economic difficulties in coastal areas. Therefore, it is crucial to study and plan the infrastructure development for coastal settlements aiming at overcoming frequent disasters and enhancing the economy of the community. In this study, the case of Ujung Lero Village at Pinrang Regency was selected as the research object.

2. Literature Review

2.1. Disaster Proneness of Coastal Settlements

The types of disasters according to Law no. 24 of 2007 concerning Disaster Management [5], namely natural disasters, non-natural disasters, and social disasters, are as follows:

- a) Natural disasters include earthquakes, tsunamis, volcanic eruptions, floods, droughts, hurricanes, and landslides.
- b) Non-natural disasters in the form of failed technology, failed modernization, epidemics, and disease outbreaks.
- c) Social disasters include social conflicts between groups or between communities, and terror.

Table 1. Types and Characteristics of Disasters

Type Disaster	Reason	Predictability	Duration
Gelombang badai	Storm	Can	O'clock
Abrasi (erosi pantai)	Sea wave	Can	Year
Banjir rob	ups and down	Can	O'clock
Sedimentasi	Sediment load supply	Can	Year
Tsunami	Earthquakes, seabed landslides, volcanic eruptions	Can not	Minute

The prone factors of the coastal area include social, economic, and environmental proneness. [6] Meanwhile, according to [7], there are 8 indicators of regional resilience: geography, natural resources, demography, ideology, politics, economy, socio-culture, and security.

Coastal settlement is one of the disaster-prone locations. According to [8], settlement, especially in the area where the land and water meet is the most crucial thing in

disaster mitigation activities because it is the people's gathering place. This area is the place of geological processes such as the interaction of wind, waves, and tides, and currents. According to Setyawan [9] there are 5 types of disasters in coastal settlements: Hurricane Wave, Abrasion, Rob Flood, Sedimentation, and Tsunami.

2.2. Mitigation

Mitigation can be done technically, naturally, or artificially. By the direction of the Ministry of Maritime Affairs and Fisheries [10] disaster management in coastal areas can be carried out with 3 strategies, namely protective, adaptive or backward patterns (doing nothing), among others, by integrating inter-sectoral programs in coastal areas development, securing residential coastal communities, use of space by the characteristics of the environment and the local community.

Disaster mitigation includes the recognition and adaptation to natural and man-made hazards, as well as sustainable activities to reduce or eliminate short, medium, and long term risks, both to human life and property. There are 4 things in disaster mitigation, namely: 1) providing information and maps of disaster-prone areas for each type of disaster; 2) socialize/increase public understanding and awareness in dealing with disasters, because they live in disaster-prone areas; 3) knowing what needs to be done and avoided, as well as knowing how to save oneself if a disaster occurs, and 4) regulating and managing disaster-prone areas to reduce the threat of disasters [11]

Disaster mitigation is disaster management by an effort to reduce disaster risk through physical development, awareness, and increasing the ability to face disaster [5] and is a necessary component of national development [12]. Based on the [11], disaster mitigation in coastal areas can be carried out structurally or non-structurally. Structural mitigation is a technical effort, both natural and artificial, which can prevent or minimize the possibility of disasters and their impacts. Meanwhile, non-structural mitigation is a non-technical effort related to adjustment and regulation of human activities to suit the structural mitigation and other efforts.

2.3. The Level of Community Socio-Economic Participation and Resilience in Disaster Management

Related to disaster management, resilience is to be prepared and strong in facing the possibility of a disaster. A disaster-resilient community has the strength and capability to minimize disaster risk by anticipation, overcoming, and recovery. Resilience to face disasters can be done by disaster mitigation. The main point of disaster mitigation is to reduce disaster risk, through physical development, awareness, and increasing the capability to face disaster [13].

Su'ud and Hakim [14] argues that resilience can be interpreted as the mental attitude of the community in facing potential disasters with organized strategic steps. To build community resilience in disaster management, it is a must to ensure that awareness and knowledge systems in the community have been built.

Arnstein [15] explains that community participation based on their strength determines an end product. Meanwhile, according to Wilcox [16], the forms of community participation are idea, energy, money, skills, and goods. In addition, Chakrabarti et al [17] state that the internal factors influencing community participation include age, gender, education, income, and home-ownership status. Furthermore, according to Holil [18], there are 4 external factors that can influence community participation: communication, social climate, the opportunity of participation, and initiative freedom. Because excessive reliance on a single sector or region creates vulnerability, governments must encourage economic diversification through regional integration, targeted education, and training initiatives to increase resilience [19].

In general, Wahyuni and Manaf [20] examined the level of participation and divided it into planning, implementation, and utilization stages. It was found that the influencing factors of participatory level in the planning stage are public knowledge, the role of government, the role of community leaders, the role of the private sector, and the role of community groups. while the stages of implementation and utilization of program results, factors that influence community participation are age, house status, number of residents, the role of government, the role of community leaders, the role of the private sector, and the role of community groups.

It is important to increase community participation in avoiding and reducing disaster risk by increasing their awareness and capacity [21]. Awareness is an essential process in realizing a disaster-resilient community. Awareness usually arises in people with direct experience of facing a serious disaster. This awareness can also arise from the education/learning process.

Public understanding builds a perception realized in

attitudes and actions to face disasters which is an adaptation strategy to environmental threats [22]. Community capacity and disaster preparedness are important factors in reducing the number of victims and the level of damage of a disaster. Related to community preparedness as a form of resilience, Su'ud and Hakim [14] argues that mutual cooperation is the social capital of the local community to face a disaster.

3. Methodology

3.1. Research Location

The research location is the coastal area of Lero village at Suppa sub-district, Pinrang Regency (Fig. 1). Specifically, the location includes Adolang hamlet, Butung hamlet and Ujung Lero hamlet.

3.2. Population and Respondent

The population of this research is all fishermen and merchants living in Lero Village, Suppa District, Pinrang Regency. The population is 1,318 people including 1,238 fishermen and 80 traders. By using the probability sampling technique, 66 heads of fisher/merchant family respondents including 9 people from Adolang hamlet, 51 people from Butung Hamlet, and 6 people from Ujung Lero Hamlet. The number of respondents was determined using the Slovin formula with an error of 12%.

The number of samples in this study was 66 samples, proportionally distributed as in Table 4.

Table 2. Proportional Distribution of Samples In Each Hamlet

Village	Number of Fisherman	Percentage (%)	Number of Sample
Adolang	170	13	9
Ujung Leor	1.024	78	51
Butung	124	9	6
Total	1.318	100	66

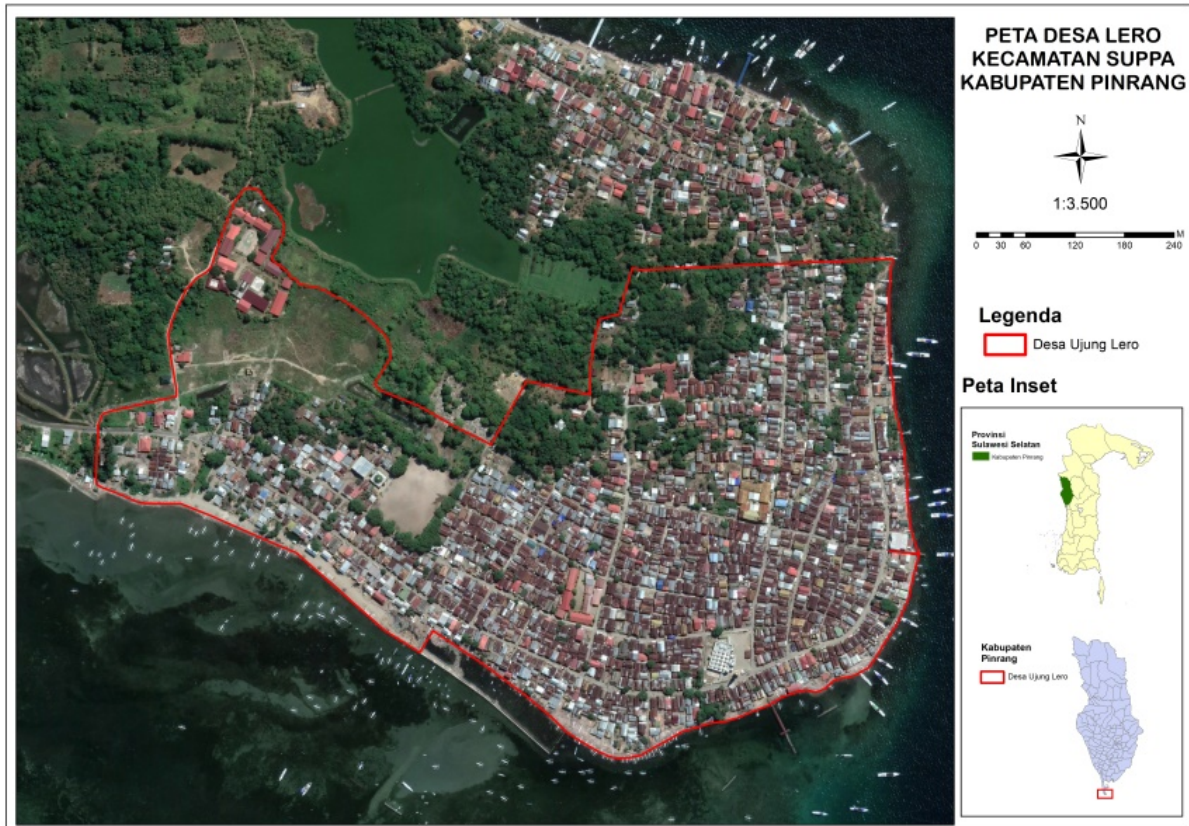


Figure 1. Map of Lero Village

3.3. Data Analysis Technique

The data is processed using qualitative and quantitative descriptive analysis, as well as spatial analysis on disaster threats to the quality and safety of coastal areas through past historical studies (geomorphology) and analysis of sea tides, wind, storm, and detailed coastlines. The socio-economic resilience of the local community was analyzed using FGD and questionnaire results followed by the infrastructure development strategy using an IPA (Importance-Performance Analysis). FGD (Focus Group Discussion) is a focus group is a small-group discussion that used to learn about opinions on a designated topic. Importance-Performance Analysis is a method of measuring the importance of certain attributes or indicators for respondents. In this technique, respondents are asked to rate the importance and performance of certain aspects. Then the average value of importance and performance is analyzed in the Importance-Performance Matrix, where the x-axis represents performance while the y-axis represents expectations.

4. Results and Discussion

Figure 1 shows that the geographic position of Lero Village is surrounded by beaches. Abrasion issue is closely related to coastal conditions and the geographic position of

an area. According to Bockstael [23], the physical condition of the environment greatly influences the settlement patterns. Furthermore, according to Hardie and Parks [24] and Knox and Marston [25], the settlement pattern is more determined by environmental physical factors than socio-economic factors. On the other hand, Paddiyatu and Pradoto [26] found that the social (76%) and the economy (80%) significantly influence the settlement pattern, although the biggest influence is the physical environment (88%). With the geographical position of Lero Village, abrasion and whirlwinds often happen in the settlements and beaches. For this reason, the people of Lero Village must be aware and prepared for disasters.

4.1. Correlation Analysis of Internal and External Factors on Community Participation in Mitigation Activities

The results of the Pearson correlations test for internal and external factors on community participation in disaster prevention and management were obtained using IBM SPSS Statistics. Based on the results of the questionnaire, internal factors (age, house ownership status, length of stay, latest education, and income) do not affect the participation of the Lero Village community.

However, external factors including communication, social climate, participational opportunities, and freedom

of creation have a strong one-way correlation which means that the higher the external factors, the higher the community participation will be and vice versa.

4.2. Analysis Community Socio-Economic Resilience

1. Side Job

Based on the table above, 88% of respondents do not have a side job which indicates that economic resilience is very poor.

2. Participation of Family Members in Assisting Main Job

The participation of family members in assisting the main work of the family head or other family members can encourage the socio-economic resilience of the community. For fishermen in Lero Village, the majority of

respondents get help from family members in doing their main work. Most of the family members helping with the main work are their wives or children. As shown in Figure 2, they help go to sea and process raw materials or catches. Figure 2 shows the activities of fishermen's families in processing their catch. The scoring results in the table above show that the socio-economic resilience of the fishermen in Lero Village in terms of the participation of family members helping the family head is very good.

3. Raw Material Processing

This activity is carried out directly by the community to obtain more benefits. 79% of the fishing community in Lero Village stated that they do not process raw materials directly, which indicates that the condition of socio-economic resilience is very poor because they do not maximize the benefits obtained.

Table 3. Analysis of Community Socio-Economic Resilience

No	Scoring Aspect		Scoring Criteria			
			Excellent	Good	Poor	Very Poor
1	Side Job	Total Respondent	3	5	0	58
		Percentage	4%	8%	0	88%
2	Participation of Family Members in Assisting Main Job	Total Respondent	26	14	7	19
		Percentage	39%	21%	11%	29%
3	Raw Material Processing	Total Respondent	11	0	3	52
		Percentage	17%	0	4%	79%
4	Ease of Borrowing Capital	Total Respondent	4	5	31	26
		Percentage	6%	8%	47%	39%
5	Marketing	Total Respondent	14	29	11	12
		Percentage	21%	44%	17%	18%
6	Community Groups	Total Respondent	30	1	6	29
		Percentage	45%	2%	9%	44%
7	Beneficiary Groups	Total Respondent	5	0	2	59
		Percentage	8%	0	3%	89%



Figure 2. The processing of fishes, fish eggs, and smoked fishes for sale

4. Ease of Borrowing Capital

Table 1 shows that the ease of the residents of Lero Village in borrowing capital is poor with a percentage of 47%. Most of the community feel that borrowing capital is difficult to do. However, some residents think that borrowing capital is quite easy to do, especially borrowing from their retainer.

5. Marketing

Economic activities in Lero Village are dominated by fish sales activities. Fishermen and local residents cooperate with each other in their managing catch, processing smoked fish and drying salted fish are shown in Figure 2. In terms of marketing, fishermen can get a higher profit if they market the products by themselves than if by collectors. In the Lero fishing community, most of the fishermen, or 44% of respondents selling their catch through customer collectors. This indicates good economic resilience because of the long-time relationship between fishermen and collectors, catches that are picked up directly, and higher selling prices applied by the collectors. Based on the scoring results, the socio-economic resilience of the Lero Village community in terms of the marketing system is good.

6. Community Groups

The community groups formed based on their livelihoods and interests can be useful in encouraging and increasing community economic resilience. These groups can enhance the creativity of the community in working, as well as become an assisting forum, guidance, and training provided by the government or the private sector. In Lero Village, 30 respondents or 45% respondents stated that there is a fishing community group, which shows good socio-economic resilience. With this group, it is hoped that the fishing community of Lero Village can improve the capacity of their human resources.

7. Beneficiary Groups

There are several community groups formed based on the profession. The results of the questionnaire show that the largest community group is fishermen. Based on the results of the questionnaire from 66 respondents, it is known that 85% of respondents stated that the community groups formed did not receive assistance from the government or the private sector in supporting fisheries, and only 15% of respondents stated that the community groups received assistance from the government.

The assessment scores of socio-economic resilience are as follows:

$$\begin{aligned}
 & \text{Total Score} \\
 & = ((nExE) + (nGxG) + (nPxP) + (nVPxVP)) \quad (1) \\
 & \text{Actual Score} \\
 & = \sum \text{Total Score} \\
 & = 909 \\
 & \text{Ideal Score} \\
 & = (\text{Total } n \times \text{Total Respondent} \times \text{Total Variable}) \\
 & = 4 \times 66 \times 7 \\
 & = 1848 \\
 & \text{Percentage} = \frac{\text{Actual Score}}{\text{Ideal Score}} \times 100\% \quad (2) \\
 & \text{Percentage} = \frac{909}{1848} \times 100\% \\
 & = 49,1\% \text{ (Poor)}
 \end{aligned}$$

The results of the scoring analysis on the several aspects above show the socio-economic resilience of the fishing community in Lero Village is 49,1% which indicates that the condition is poor. This condition is indicated by the 4 of 7 social resilience assessment variables that are poor and very poor. The variables with a bad score are side jobs, processing of raw materials, ease of borrowing capital, and beneficiary groups. Other variables that are in a good score include the participation of family members helping the main job, marketing, and the availability of community groups.



Figure 3. Smoked fish processing for sale

Table 4. Analysis of Fishermen Settlement Infrastructure

No	Scoring Aspect		Scoring Criteria			
			Excellent	Good	Poor	Very Poor
1	Fish Drying	Respondent	0	0	23	43
		Percentage	0	0	35%	65%
2	Fish Auction Facilities	Respondent	0	0	22	44
		Percentage	0	0	33%	67%
3	Location of Ship Repair	Respondent	2	19	24	21
		Percentage	3%	29%	36%	32%
4	Fueling Location	Respondent	3	9	24	30
		Percentage	5%	14%	36%	45%
5	Ice-buying Location	Respondent	1	1	13	51
		Percentage	1,5%	1,5%	20%	77%
6	Road Network	Respondent	34	18	13	1
		Percentage	51,5%	27%	20%	1,5%

4.3. Analysis of Fishermen Settlement Infrastructure

1. Fish Drying Facility

The fish drying facility is one of the supporting facilities for fishing activities especially for processing the raw fish to increase the selling price. 65% of the research respondents do not have fish drying facilities, which indicates the inadequacy of basic fisheries infrastructure. For this reason, fish drying facilities are needed for fishermen to produce products with a higher selling price.

2. Fish Auction Facilities

The score of the fish auction facilities variable is “very poor” (67%). In Lero Village, there is no fish auction which is a product marketing tool. However, for the community of Lero Village, the need for fish auction is not high. This is because the marketing process is carried out individually through regular collectors, fish auction Pare-Pare, or through respective customers. The community thought that fish auction was not really needed because they felt that the marketing needs had been met. However, if the fish auction is revitalized, it will certainly be equipped with a workshop, a fuel container, and an ice factory. Therefore it can support fishing activities and in the future support tourism activities.

3. Ship Repair Location

The scoring analysis results show that the ship repair location variable is poor (36%). The ships are usually repaired in Pare-Pare City which is quite far from the settlement areas. Principally, a settlement the infrastructure and facilities that can support fishermen’s life.

4. Fueling Location

The lack of supporting facilities for refueling fishing boats makes most people need to go to the City of Pare-Pare and the capital city of Suppa District. Based on the questionnaire results, the fuel filling variable is very poor (45%). Therefore, in Lero Village, procurement of refueling facilities is needed.

5. Ice-buying Location

The ice-buying location variable is very poor (77%). Most of the community buy ice supplies at Suppa fish auction, which is far from the residential location. The lack of ice factory is one reason the community cannot store their fish when they fish too much. As a result, they cannot maintain market prices.

6. Road Network

Based on the results of the analysis, the condition of the road network in Lero Village is very good (51.5%). This greatly supports the transport that connects Lero Village to other villages. The connected accessibility will improve the distribution of marine products.

The score for supporting infrastructure for fishing settlements is as follows:

$$\text{Total Score} = ((nExE) + (nGxG) + (nPxP) + (nVPxVP)) \quad (1)$$

$$\begin{aligned} \text{Actual Score} \\ &= \sum \text{Total Score} \\ &= 729 \end{aligned}$$

$$\begin{aligned} \text{Ideal Score} \\ &= (\text{Total } n \times \text{Total Respondent} \times \text{Total Variable}) \\ &= 4 \times 66 \times 6 \\ &= 1.584 \end{aligned}$$

$$\text{Percentage} = \frac{\text{Actual Score}}{\text{Ideal Score}} \times 100\% \quad (2)$$

$$\begin{aligned} \text{Percentage} &= \frac{729}{1584} \times 100\% \\ &= 46\% \text{ (Poor)} \end{aligned}$$

Based on the results of the analysis, the resulting percentage value is 46% so that it is in the bad condition score range, namely $26\% \leq 50\%$. The score obtained is still at a low enough value so that it needs to be improved.

4.4. Analysis of the Infrastructural Development of The Coastal Settlements of Tanjung Ujung Lero on Mitigation as the Control of Fishery Economy

Importance-Performance Analysis is carried out quantitatively by calculating the level of respondents' satisfaction with infrastructure condition in Lero where this calculation analysis used SPSS software. The results of the analysis showed the conditions and strategies that need to be carried out based on the infrastructure indicators location in the quadrant. Overall, the

respondents' satisfaction level scores on each indicator or attribute are shown in table 5.

Table 5 shows that there are 12 indicators that are used as attributes or indicators in the IPA assessment. The column marked in red indicates the respondent's dissatisfaction with the condition of the infrastructure. It is indicated by the presence of a minus value in the gap score for each attribute. The attribute gap score is obtained from the Importance value minus the Performance value. It shows that the attributes with negative values have not met the expectations of the local community. From these data, further analysis is needed to determine the existing priority scale.

The next step is a mapping of the value of performance or importance (x) and the value of expectation or performance (y) which produces a matrix consisting of four quadrants where each quadrant shows a priority scale in policy making in the form of improving performance or maintaining performance.

Table 5. Respondent Satisfaction Level with Infrastructure Condition

No.	Indicator	Importance	Performance	Gap Score
1	Lero's Pier Facility	4,606	1,55	-3,056
2	Fish Drying Facility	3,969	1,94	-2,029
3	Fish Auction Facility	2,393	1,95	-0,443
4	Fisherman's Ship Repairing Facility	4,636	2,02	-2,616
5	Fisherman's Ship Fueling Facility	4,393	2,26	-2,133
6	Fisherman's Ice-Supplying Facility	3,969	1,97	-1,999
7	Lero's Road Network	4,818	2,86	-1,958
8	Lero Community's Water Source	5	3	-2,000
9	Lero Community's Garbage Management System	5	1,05	-3,950
10	Lero Community's Waste Management System	4,969	1,05	-3,919
11	Lero's Electric Network	5	5	0,000
12	Lero's Internet Network	5	5	0,000

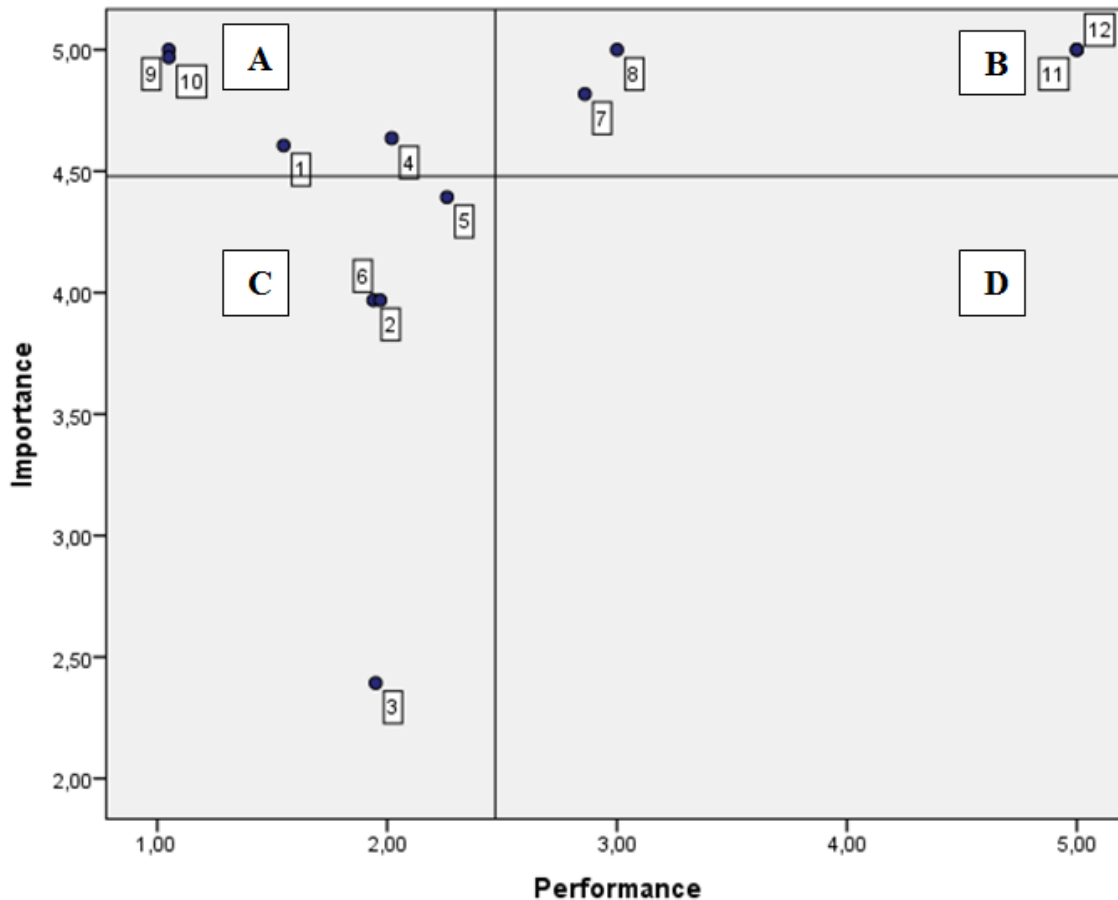


Figure 4. IPA Analysis Quadrant

From Figure 4, it can be interpreted as follows:

1. Quadrant A

Quadrant A shows the attributes or indicators that are considered important by the local community but do not perform well. The variables included in quadrant A include:

- (1) Lero's Pier Facility
- (4) Fisherman's Ship Repairing Facility
- (9) Lero Community's Garbage Management System
- (10) Lero Community's Waste Management System

Thus, the above items can be ignored/have a priority scale for improvement for the local government.

2. Quadrant B

Quadrant B shows attributes or indicators that are considered important by the community and have been implemented properly so as to obtain satisfaction for the community. The variables included in this quadrant are:

- (7) Lero's Road Network
- (8) Lero Community's Water Source
- (11) Lero's Electric Network
- (12) Lero's Internet Network

Thus, the performance of these items needs to be maintained by the local government.

3. Quadrant C

Quadrant C shows factors with a low level of expectation or importance according to society and do not have good performance. The variables in quadrant C are as follows:

- (2) Fish Drying Facility
- (3) Fish Auction Facility
- (5) Fisherman's Ship Fueling Facility
- (6) Fisherman's Ice-Supplying Facility

Thus, the above items can be ignored or have a priority scale for improvement for the local government

4. Quadrant D

Quadrant D shows indicators or attributes that are considered less important for the community but are carried out excessively. In terms of infrastructure, Lero does not find any attributes or indicators that fall into the D quadrant category.

5. Conclusions

- 1) Due to the physical and geographical conditions, residents of the Lero Village must be prepared and resilient to disasters and should be managed into groups.

- 2) The level of participation of the Lero Village community in mitigation efforts is not influenced by internal factors (age, education, income, home status, and length of stay) but is strongly influenced by external factors (communication, social climate, opportunities to participate, and freedom of creation).
- 3) The socio-economic resilience of the Lero Village community and the housing infrastructure is poor. The condition of socio-economic resilience is still at 49.1% and settlement infrastructure is at 46%. This suggests an improvement in socio-economic resilience and settlement infrastructure to improve the welfare of the community in Lero Village. For this reason, the improvement is focused on the infrastructures that support marketing. Besides it also needs easy access to capital, training and empowerment to increase product diversification.
- 4) Aspects of the coastal settlement infrastructure of Ujung Lero which is a priority scale in improvement by the government due to high expectations or interests for the community but has poor performance consisting of 4 indicators, including:
 - (a) Lero's Pier Facility
 - (b) Fisherman's Ship Repairing Facility
 - (c) Lero Community's Garbage Management System
 - (d) Lero Community's Waste Management System

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