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The Significance of Community Involvement in Enhancing Resilience to Environmental Risks in the Savu Sea National Marine Park, East Nusa Tenggara, Indonesia

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Abstract: The Savu Sea holds significant importance as a conservation area in Indonesia, providing sustenance and livelihoods for local communities. It is situated within the Coral Triangle, a critical hotspot for marine biodiversity worldwide. However, the Savu Sea is currently facing various threats, including overfishing, pollution, and the impacts of climate change. Effective management of this conservation area relies heavily on the active participation of local communities. Therefore, this study aims to address this issue by analyzing how factors within these communities, such as the socio-economic condition of coastal households, environmental awareness, the existence of community-based conservation areas, attitudes towards activities within the conservation area, and participation in multistakeholder institutions, contribute to a positive perception of the benefits provided by the Savu conservation area. To determine the complex causal conditions that influence the outcome of perception, the study employs the Qualitative Comparative Analysis (QCA) method, specifically using crisp set QCA (csQCA). A survey was conducted among 22 coastal villages surrounding the Savu Sea, resulting in the identification of 14 different combinations of pathways that contribute to varying levels of perception regarding conservation. Valuable lessons can be drawn from this study to enhance the design of policies aimed at effectively managing the Savu conservation area.

Keywords: savu sea; sustainable management of marine conservation area; Qualitative Comparative Analysis (QCA), causal condition combination

1. Introduction

The Savu Sea is an important ecosystem and livelihood resource for the people of Indonesia and in the eastern part provinces of Indonesia. It provides a home for a variety of marine life, including fish, coral reefs, and mangroves. These ecosystems support a wide range of economic activities, such as fishing, tourism, and coastal agriculture. The Savu Sea is also important for the environment. It helps to regulate the climate, protect coastal communities from storms, and provide a habitat for endangered species. However, the Savu Sea is facing a number of threats, including pollution, overfishing, and climate change. These threats could have a devastating impact on the livelihoods and environment of the region. To address this issue, Indonesian government established The Savu Sea National Marine Park in 2009 to protect the rich marine life and ecosystems of the Savu Sea. The park covers an area of 3.5 million hectares and includes a variety of habitats, such as coral reefs, mangroves, and seagrass beds.

The Savu Sea is an important ecosystem and livelihood resource. The effectiveness of the National Marine Park (NMP) in protecting this resource depends on stakeholder engagement. However, no study has yet been conducted on the impact of stakeholder engagement on the NMP's ability to mitigate risks to the community, prevent pollution, and protect ecosystems. As a result, the

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current management of the NMP may not be effective, and these risks may continue to pose a threat to the Savu Sea.

In the Savu Sea, the sustainability of shallow marine ecosystems, particularly mangroves and coral reefs, is being threatened by increasing pressure and destructive practices. Studies have shown that the average damage to these coastal ecosystems reaches 70% [1]. The complexity of coastal and marine activities contributes to the degradation and pollution of these areas. As a result, community participation in the management of coastal and marine areas, especially in the preservation of marine conservation areas, becomes crucial.

The success of conservation efforts often relies on local support, which is influenced by the perceptions of the impacts experienced by local communities, as well as opinions on management and governance [2]. Ecosystem services are derived from intricate interactions between physical, ecological, and human factors. Furthermore, human valuation of ecosystems is driven by various social, cultural, and economic factors that differ across different regions. The ocean not only serves as a transportation route for goods and people but also plays a vital role in ensuring the well-being of society. However, the utilization of marine resources can lead to environmental damage that directly impacts the utilization itself. Therefore, it is essential for resource users in Marine Protected Areas (MPAs) to understand the environmental risks associated with their activities. This is why MPAs are crucial in mitigating these risks.

The risks that arise in the absence of marine conservation measures include the degradation of natural resources, pollution, and the absence of spillover effects from MPAs. All of these risks can disrupt the livelihoods and welfare of coastal communities. To avoid these risks, it is necessary to increase community awareness about the importance of maintaining coastal ecosystems, including conservation areas. This research aims to explore how community perceptions can increase awareness of environmental damage resulting from the existence of marine protected areas as a means of risk mitigation.

The survey conducted in the coastal villages surrounding the Savu Sea in East Nusa Tenggara Province aimed to determine the factors that influence community perceptions regarding the significance of maintaining marine protected areas as a means of mitigating environmental and natural resource risks, as well as sustaining their livelihoods and the overall ecosystem's social and economic sustainability. The assessment of this perception is necessary because the mere presence of spillover effects and increased community ownership rights does not guarantee the effective management and long-term sustainability of marine protected areas. The potential benefits of spillover will not be realized without active community participation, which can be achieved through raising awareness about the environmental risks faced by the Savu Sea's marine protected area.

2. Brief Description of Savu Sea

2.1. When established? Location? Area?

Savu Sea NMP is a national marine protected area established in 2014 based on the Decree of the Minister of Marine Affairs and Fisheries Number 5 of 2014 with an area of 3,355,352.82 hectares. Savu NMP is located in East Nusa Tenggara Province, Indonesia, and the largest Marine Protected Area (MPA) in the World's Coral Triangle region. It covers only 2% of the world's marine area but contains around 76% of the world's coral reef species and 37% of the world's reef fish species. The Savu Sea is a migration site for 14 of the world's 27 cetacean species, including rare blue whales and sperm whales, and home to 4 species of sea turtles, 336 species of fish, and 500 species of coral. The Savu Sea has a wide range of coral reef cover with very high species biodiversity and deep-sea habitats that support cetacean diversity. Most of the beaches in this region have been identified as nesting sites for sea turtles, which are listed as endangered and threatened in the IUCN Red Data Book and CITES.

Savu Sea NMP is located in the Lesser Sunda Ecoregion, which includes the waters of the Sumba Strait and the eastern waters of Rote-Sabu-Batek. All of its waters are located in East Nusa Tenggara Province and surrounded by a series of islands namely Timor, Sabu, Sumba, and Flores Islands.

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Administratively, Savu Sea NMP is located in Kupang Regency, Rote Ndao Regency, South Central Timor Regency, Sabu Raijua Regency, Manggarai Regency, West Manggarai Regency, East Sumba Regency, Central Sumba Regency, West Sumba Regency, and Southwest Sumba Regency. Getting to Savu Sea NMP can be done by land, sea, and air. All of these routes are centered in Kupang the capital of East Nusa Tenggara Province and are directly connected to 10 regencies in the Savu Sea NMP area.

The establishment of the Savu Sea as a national marine protected area (Savu Sea NMP) was implemented with the aim of realizing the preservation of fish resources and ecosystems as part of the ecological region of the Lesser Sunda Marine Eco-Region, protecting and managing marine ecosystems Savu Sea and its surroundings, as a frame of reference for regional development in the field of fisheries, tourism, coastal communities, shipping, science and conservation, as well as improving the welfare of coastal communities through sustainable livelihoods.

2.2. Management Autorithies

Kupang National Marine Conservation Area Office (BKKPN), which is a technical implementation unit under the Directorate General of Marine Spatial Management. Technical implementation unit under the Directorate General of Marine Spatial Management, Ministry of Maritime Affairs and Fisheries (MMAF) has duties and functions in the management, utilization, and supervision of MPAs, one of which is the Savu Sea NMP. The conservation area management is carried out with a zoning system to regulate activities in the area of the national marine protected area to remain in accordance with the conservation methods. Zoning is divided into 3 main zones, which are the core zone, utilization zone, and sustainable fisheries zone.

2.3. The Role of NMP to Ecology, Economy and Society?

Ecology

The Savu Sea waters are very dynamic, it is a meeting of 2 large mass currents, water masses from the Indian Ocean and the Banda Sea. The phenomenon of upwelling or stirring of cold deep sea water masses and warm surface water makes this area an area with very high waters productivity so some species of whales reside in this sea. There are 22 species of marine mammals in the waters of Savu Sea NMP, consisting of 14 species of whales, 7 species of dolphins, and 1 species of dugong [3].

Oceanographically, the area has notoriously strong ocean currents. Water depths of up to 4,000 meters and steep cliffs are the dominant characteristics of the seascape in the Savu Sea. Wind patterns in the Western season period (December to February), are dominated by westerly winds that blow the strongest in December (>11 meters/second). The Savu Sea waters have a mixed tidal type leaning towards double daily, where in one day there are two high tides and two low tides.

Savu Sea NMP, which is part of the Lesser Sunda Eco-region, is recorded to have a total of 532 coral species and there are 11 endemic and sub-endemic species. Coral reefs in Savu Sea NMP are found scattered in coastal waters in all the regencies included in the Savu Sea NMP area with a total area of 63,339.32 hectares. The results of monitoring coral reef conditions in 2019 at 15 observation locations scattered throughout the conservation area show that in general the condition of the Savu Sea NMP coral reefs varies from very bad to moderate. The condition of coral reefs in the very bad category is 27%, the condition of coral reefs in the bad category is 46%, and the condition of coral reefs in the moderate category reaches 27%. The healthiest coral reef conditions are in the Rindi waters of East Sumba Regency and the worst coral reef conditions are in the Semau waters of Kupang Regency. According to [4], one of the causes of poor coral reef cover is caused by the presence of household waste, tourism activities, and environmentally unfriendly fishing patterns.

Monitoring data from 2015 to 2018 shows that the abundance of reef fish in Savu Sea NMP has a positive trend from year to year. The total number of reef fish individuals from the Chaetodontidae family found at the observation site in 2019 was 815 individuals consisting of 27 species. The most dominant reef fish species were Chaetodon klenii, *Chaetodon vagabundus* and *Chaetodon trifascialis*. The target fish group is a fish with high economic value and is the target of the fishing and fisheries business. The target fish species found are fish from the Acanthuridae, Serranidae, Lutjanidae, Lethrinidae, Nemipteridae, Mullidae, Kyphosidae, and Carangidae families.

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Sea urchins in Savu Sea NMP have a fairly wide distribution and are found in almost all areas with a presence percentage value of 93.3%. Based on data from benthos monitoring of Savu Sea NMP in 2019, 382 benthos individuals were found consisting of 8 species and included in 3 family groups, namely Echinodermata (*Acanthaster planci, Diadema sp, Linkia laevigata,* and *Cucumber*), Crustacea (Lobster), and Mollusca (Drupella, Tridacna, and Trochus). The number of occurrences of benthos individuals varied in each observation area with the highest percentage of individuals being Diadema sp. (Sea urchin) at 46%. The average abundance of benthos in Savu Sea NMP is 0.18 Ind/m^2.

Seagrass beds in the Savu Sea NMP area are most commonly found in the waters of East Sumba Regency, Sabu Raijua Regency, and Rote Ndao Regency, which are included in 10 species out of a total of 13 species in Indonesia. included in 10 species from a total of 13 species in Indonesia. The total area of Savu Sea NMP is 5320.62 hectares. The results of seagrass monitoring in the Savu Sea NMP from 2015-2019 showed a variety of seagrass cover values with the highest seagrass cover value in 2018 at 70%. The decrease in seagrass cover from 2018 to 2019 is thought to be due to the transitional effect of the western season to the eastern season, water characteristics, and community activities.

Mangrove forests in ENT Province consist of approximately 9 families divided into 15 species. Based on the results of satellite image analysis, the area of mangrove forests in the Savu Sea NMP area is 5019.53 hectares with the areas that have the largest mangrove area being in East Sumba Regency and in Rote Ndao Regency. Mangrove tree density varies between 900 - 2,367 ind/ha with a percentage of canopy cover in the tight category (>75%).

The Savu Sea NMP are home to 6 species of sea turtles in Indonesia. They can be found throughout the Savu Sea NMP region. The 6 types of sea turtles include the Green Turtle (*Chelonia mydas*), Hawksbill Turtle (*Eretmochelys imbricata*), Olive Ridley Sea Turtle (*Lepidochelys olivacea*), Leatherback Sea Turtle (*Dermochelys coriacea*), Flatback Sea Turtle (*Natator depressus*), and loggerhead turtle (*Caretta caretta*).

Economy and Society

The archipelagic nature of ENT means that many people in this province live in coastal areas. The majority of their livelihoods are as fishermen and seaweed farmers. From the 2018 data, it was recorded that the number of Fishery Households (FHs) in the Savu Sea NMP area who worked as fishermen was 6343 FHs and those who worked as seaweed farmers were 3578 FHs. The area of seaweed farming is 3,555 hectares of the total potential for seaweed farming in Savu Sea NMP of 355,660.97 hectares with very diverse seaweed production values ranging from 0.5 - 4 tons/unit/year. Farmers' income from seaweed sales varies from one region to another, influenced by water conditions and the length of the planting period. The range of income is between IDR 9 million and IDR 34 million per person per year. In 2019, wet seaweed production was recorded at 2.4 million tons or worth 4.7 trillion IDR and dry seaweed production at 240 thousand tons or worth 5 trillion IDR.

Almost 90% of fishers in ENT province are small-scale fishers. The monthly income of fishers varies from region to region, ranging from IDR 1.9 million per month to IDR 4.3 million per month, which is highly influenced by the time of the fishing season as well as the type and size of the vessels used. Fishermen's fishing area is still less than 12 miles from the shoreline so the 12-mile area to the Exclusive Economic Zone (200 miles from the coast) is the only fishing area in the Savu Sea NMP. The Exclusive Economic Zone (200 miles from shore) in the Savu Sea MPA is not yet optimally utilized. There are 9 types of fishing gear that are widely used, namely bag trawls, purse seines, gill nets, lift nets, fishing rods, traps, collecting tools, catching tools, and others (stocking nets, forks, and spears).

The Savu Sea NMP is an important component and strategy for fisheries management and biodiversity conservation in the Savu Sea area of East Nusa Tenggara Province. The Savu NMP is managed through a system of zoning and management plans to protect biodiversity, the health of coral reef ecosystems, and populations of key commercial fish species.

The ocean supports the livelihoods of more than five million people in Nusa Tenggara Province, as well as regional economies. Humankind health and well-being depend upon the services provided by ecosystems and their components: water, nutrients, and organisms. Therefore, ecosystem services are the processes by which the environment produces resources utilized by humans such as clean air,

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water, food, and materials [5]. The Savu Sea can be an effective tool for protecting biodiversity and ensuring the sustainability of fisheries that can also have far-reaching social, economic, cultural and political impacts on local communities. Most communities are highly dependent on the Savu Sea. More than 65% of the province's potential fish resources are contributed by the Savu Sea [6].

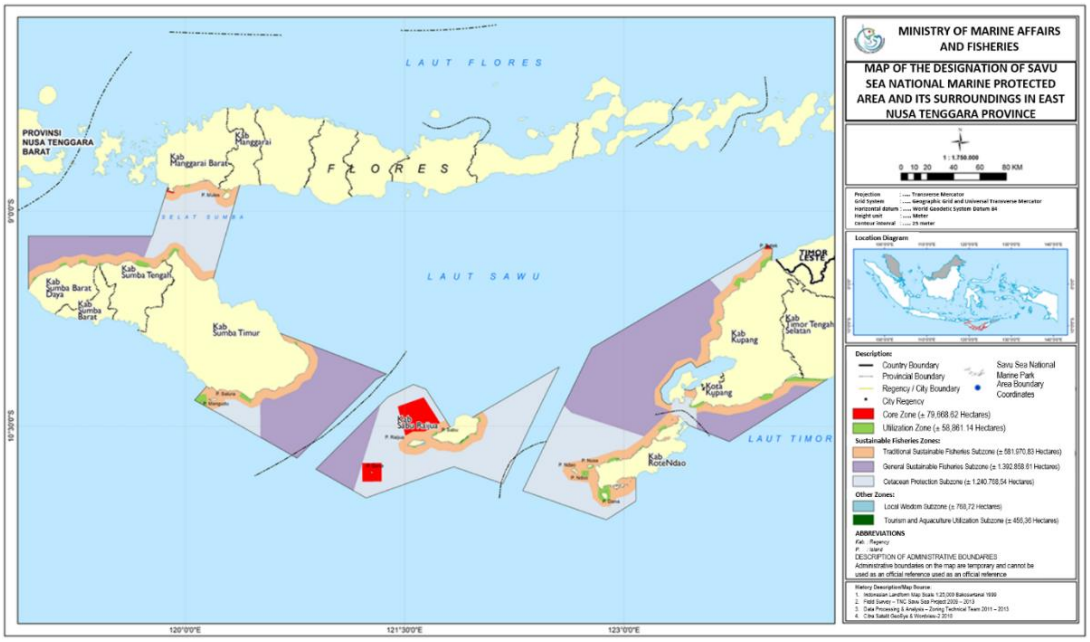

Figure 1. Map of Conservation Area and Zoning Division of Savu Sea NMP and its surroundings in East Nusa Tenggara Province, Indonesia [7].

3. Materials and Methods

This study utilizes Qualitative Comparative Analysis (QCA) as a method to assess the complex causality among villages in relation to their perception of the protected area in the Savu Sea. QCA was initially introduced by [8] as an alternative approach that lies between quantitative and qualitative analysis [9]. QCA is a case-oriented analysis that offers advantages in explaining complex causality, diversity, and the uniqueness of the cases under study [10,11].

The main principle of QCA is complex causality, followed by diversity. QCA focuses on establishing links between outcomes and causal configurations, where these configurations are considered as explanatory conditions. Complex causality seeks to explain whether a factor X acts as a causal condition for a specific phenomenon or outcome (Y). In contrast to most regression analyses, which aim to determine the influence of a given causal factor on a variable while controlling for other causal factors, the primary focus of QCA is to explain how a particular outcome is produced [12].

QCA is a method that offers detailed within-case analysis and systematic cross-case comparison, making it particularly useful for research with small and medium-sized datasets. Its primary goal is to understand the causes of specific events or phenomena (causality) and identify the different variations within a given phenomenon. QCA combines traditional qualitative analysis with systematic comparisons across cases, providing a unique opportunity for analysis.

There are three commonly used variations of QCA techniques: crisp set QCA (csQCA), multivalue QCA (mcQCA), and fuzzy set QCA (fsQCA). In this study, crisp set QCA is employed due to the nature of the data, which includes information on the state of villages, responses to questions about environmental awareness, and factors influencing it. According to a bibliometric analysis by [13], crisp set QCA was the most popular method of QCA analysis as of 2017, followed by fsQCA. Crisp set QCA has been widely applied in various studies related to natural resource management, such as [14] research on fisheries management, [15] study on the success of payment for ecosystem services, and [16] examination of governing environmental conflict.

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To assess the factors or conditions related to the perception of protected areas as a means of mitigating environmental risk, this study proposes five conditions:

1. The socio-economic condition of coastal households around the Savu Sea (social),
2. Environmental awareness (awarenes),
3. The existence of a conservation area for the community (existence),
4. Attitudes towards activities (permitted or not permitted) in the conservation area (activity),
5. Participation in multistakeholder institutions (participation).

A total of 22 coastal villages were evaluated in terms of their perception of the nine conditions mentioned earlier and their perception of the protected area. The raw data for csQCA analysis can be found in Table 1, where Column 2 to Column 6 represent the nine conditions (X variables) described above, and the last column represents the outcome (Y variable) for csQCA.

Table 1. Dataset cs QCA environmental perception of Savu Sea protected area.

Vilage	Social	Awarenes	Existence	Activity	Participation	Perception
Benteng Dewa	1	1	1	1	1	1
Nanga Lili	1	1	1	1	1	1
Nanga Bere	1	1	1	0	1	1
Nuca Molas	1	0	0	0	1	1
Terong	0	1	0	1	0	0
Setar Ruwuk	0	0	0	1	0	0
Setar Lenda	0	1	0	1	1	0
Londa Lusi	1	1	1	0	1	1
Namodale	0	1	1	0	1	1
Tesabela	0	1	1	0	1	1
Nuse	1	1	0	1	0	1
Loborai	0	1	1	1	0	1
Mebba	0	1	1	1	1	1
Raemedia	0	1	1	1	1	1
Letekonda	1	0	0	1	1	1
Lokori	1	0	0	0	1	1
Lenang	1	1	1	0	1	1
Tablolong	1	1	1	1	1	1
Sulamu	1	0	1	1	0	1
South Netemnanu	0	1	1	1	0	1
North Netemnanu	0	0	1	1	0	1
Buraen	1	0	0	0	0	0

The raw data were analysed using Tosmana (Tool for Small N analysis) Software version 16. developed by [17].

4. Results and Discussion

Table 2 displays the results of the Truth Table generated using Tosmana Software. In total, there are 14 different pathways identified among the 22 coastal villages. Eight of these villages, namely Setar Ruwuk, Netemmanu Utara, Terong, Setar Lenda, Buraen, Letekonda, Sulamu, and Ndaonuse, have their own unique pathway. Each of these villages has a distinct combination of conditions that influences their perception of the conservation area.

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Among these pathways, Setar Ruwuk, Terong, Setar Lenda, and Buraen are coastal villages that have a perception outcome of zero, indicating a very low belief in the benefits of the conservation area for mitigating environmental risks. Out of the 14 pathways, ten of them show conditions that lead to a positive outcome (Perception = 1), indicating a stronger perception of the conservation area's benefits.

Table 2. Truth table of combination of conditions and outcome.

Truth-Table:

Vilage	Social	Awarenes	existence	activityyesno	participation	Perception
Setar Ruwuk	0	0	0	1	0	0
North Netemnanu	0	0	1	1	0	1
Terong	0	1	0	1	0	0
Setar Lenda	0	1	0	1	1	0
Namodale, Tesabela	0	1	1	0	1	1
Loborai, South Netemnanu	0	1	1	1	0	1
Mebba, Raemedia	0	1	1	1	1	1
Buraen	1	0	0	0	0	0
Nuca Molas, Lokori	1	0	0	0	1	1
Letekonda	1	0	0	1	1	1
Sulamu	1	0	1	1	0	1
Nuse	1	1	0	1	0	1
Nanga Bere, Londa Lusi, Lenang	1	1	1	0	1	1
Benteng Dewa, Nanga Lili, Tablolong	1	1	1	1	1	1

Created with Tosmana Version 1.61

The pathway demonstrating the presence of all conditions (Social = 1, Awarenes = 1, existence = 1, activity = 1, and participation = 1) and a positive outcome (perception = 1) is observed in three coastal villages: Benteng Dewa, Nanga Lili, and Tablolong. Similarly, Nanga Bere, Londa Lusi, and Lenang also exhibit a positive outcome, except for the absence of the activity condition (activity = 0). Loborai and Nemnanu Selatan show a positive perception of marine conservation, indicated by the presence of the awareness, existence, and activity conditions (awareness = 1, existence = 1, and activity = 1). Mebba and Raemedia demonstrate that the presence of awareness, existence, and activity is sufficient to generate a positive outcome in perception. On the other hand, Nuca Molas and Lokori require the presence of social economic status (social = 1) and participation in multi-stakeholder institutions to achieve a positive perception.

Each coastal village with a positive outcome has a unique pathway. For example, Ndaonuse requires the presence of social condition, awareness, and activity for a positive outcome, while Sulamu necessitates the presence of social status, existence, and activity for a positive perception.

Figure 2 depicts a Venn diagram illustrating the combination of conditions and outcomes, as well as the coastal villages that align with the truth table analysis. In the diagram, each box is divided into two areas: zero and one. The horizontal axis represents the social condition, with zero (low social status) on the left side of the box and one (social = 1) on the right side. The vertical axis represents the awareness condition, with zero in the upper part and one in the lower part. The other four boxes can be interpreted in a similar manner, with each box displaying a combination of five digits representing the presence (1) or absence (0) of the five conditions.

The green-colored areas indicate an outcome of one (perception = 1). For instance, Letekonda exhibits a strong perception of Savu conservation supported by the presence of social status, activity, and participation, while the other two conditions are absent (indicated by the digit combination 10011). All other green areas represent combinations of causal conditions as outlined in the truth table analysis. The pink-colored areas indicate a zero outcome (low perception or perception = 0), while the white areas indicate a remainder (R), signifying the possibility of causal combinations among the five conditions, but these cases were not found in the study.

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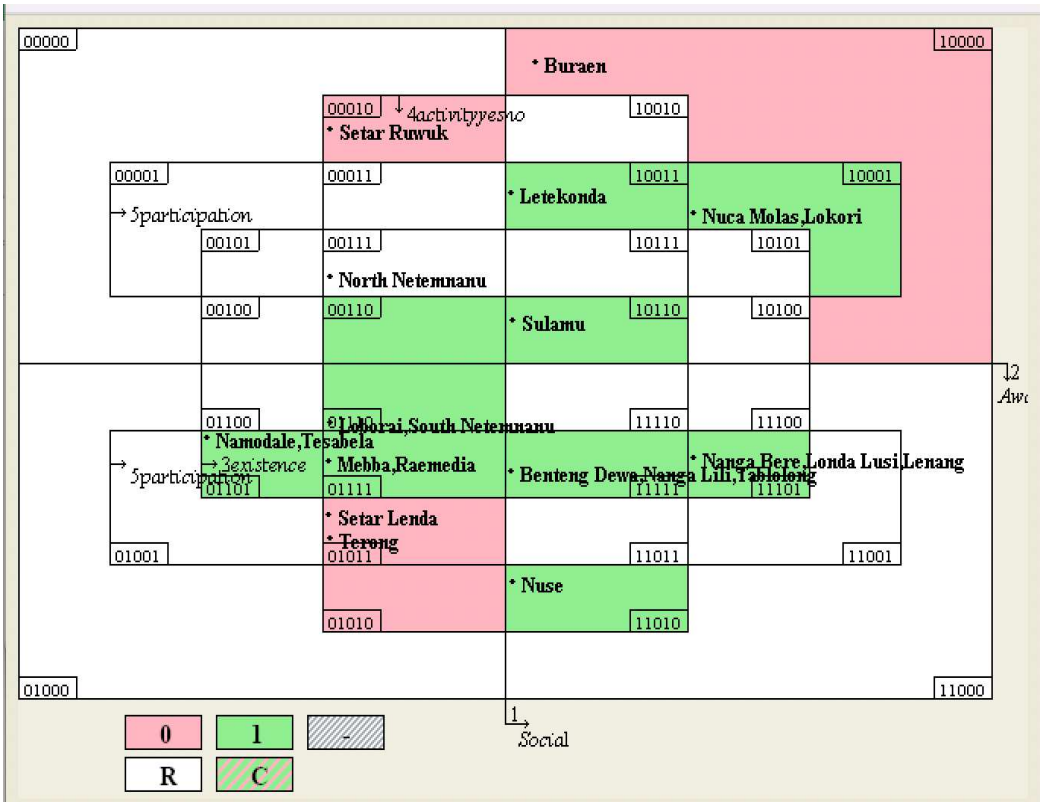

Figure 2. Venn diagram combinations of conditions and outcome.

Benteng Dewa, Nangalili, and Tablolong have excellent and similar pathways for positive outcomes. The social conditions of the community are primarily fishermen, farmers and traders who depend on coastal and marine resources for their livelihoods. In terms of educational background, most respondents have primary school education, followed by junior high school and then senior high school. In terms of information sources, the most widely used media are radio and television. Campaigns for sustainable management of coastal and marine resources through the media in the community play an important role as an awareness effort. Awareness efforts on the importance of coastal and marine resource management in the Savu Sea have been carried out by NGOs and local governments and can be accessed through several media (print and electronic) and verbally. Community awareness of coastal and marine environmental conservation regulations is very high, which can be assessed from several factors such as: the existence of the term and definition of marine protected areas in the community, community responses to the layout of villages in marine protected areas, community responses to the types of fishing gear allowed, community perceptions of activities allowed in coastal areas, and community attitudes towards receiving sanctions.

More than 70% of the community are aware of the term and definition of marine protected areas. Not only are they aware of the existence of conservation areas, but they have also applied the activities that are allowed/not allowed in conservation areas, such as being allowed to plant seaweed and not allowed to take corals or cut mangrove wood. The community also participates or takes on the role of a Supervisory Community Group, some are actively involved in the activities of local environmental organizations in their respective areas.

The level of dependence on the environment shapes the perception of conservation inherent in their daily lifestyle. The community's perception of knowledge and attitude towards the importance of local wisdom in conservation areas is very high. The community stated that the principle of living in harmony with nature is still practiced in daily life; the coast and sea in my village are maintained by customary rules; I will feel guilty if I do not take good care of nature; I believe conservation efforts will provide natural resource reserves for the future; I believe what I do will have an impact on the

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surrounding nature; I believe that practices/customs/customs related to nature management can be integrated with the management of existing marine protected areas.

Letekonda is a tourist village located in Loura Subdistrict, Southwest Sumba Regency. The Letekonda community has an educational background up to senior high school. Access to information sources mostly uses radio and television. The mastery of livelihood assets shows that the coastal area of the study village has natural assets that have the potential to be developed as a source of livelihood for the surrounding community. These natural assets are in the form of coastal ecosystems and marine biota, including mangrove ecosystems, coral reefs, seagrass beds, marine biota, and beautiful coastal panoramas. All of these natural assets have been utilized by local communities, both socially (food sources and social arenas), economically (sources of economic income), and culturally (cultural attractions/local traditions).

The main livelihood of the community is fishing, and side livelihoods are salt farmers, seaweed farmers, and seafood collectors. The fishing fleet used is equipped with outboard motor engines with an average engine power of 15-24 PK with an average boat size of less than 1GT. The main fishing gear used is purse seine, which is still considered an environmentally friendly fishing gear, while hand fishing rods, squid nets, fishing nets, fish arrows, fish spears, and pincers and gouges are used in small quantities with different concentrations of usage. In addition to fishing, some Letekonda communities also engage in seaweed cultivation and salt processing. Although still very limited, these activities have become alternative livelihoods for people who previously relied solely on agriculture and self-employment (trade). This condition also has implications for the ability of the fishing community to implement dual livelihood strategies.

The limitations of fisheries development are generally influenced by several factors, including the lack of knowledge and expertise of fishermen to catch fish, limited fishing gear, and limited infrastructure to support fisheries activities (capital, production facilities, institutions, etc.). In Southwest Sumba itself, these limitations can be seen as a positive value because the fisheries that take place are still traditional, not yet intensive and massive, and carried out on a small scale, so the fisheries pressure in this region is still relatively low.

Community leadership plays an important role in the structure of coastal communities. The community's perception of the existence of the Savu Sea NMP is important in maintaining coastal and marine natural assets, so the same for community participation in preserving the coastal and marine environment is very dependent on existing community leaders. High participation is shown by the community's desire to involve themselves in various activities related to coastal programs, such as empowerment activities and meetings with agencies/small businesses/universities regarding coastal and marine resource management.

In general, the community has a very good level of enthusiasm, participation and adaptation. Enthusiasm is shown by their curiosity and motivation for the coastal and marine development plan for both capture fisheries and beach/sun tourism. One example is the community's desire to know how FADs work by finding out information by asking related agencies or searching the internet and trying to practice. For example, fishermen's interest in learning fishing techniques with FADs. Fishermen learn by themselves through the internet, or ask other parties, then try to practice fishing with FADs, even though it is fairly unsuccessful, fishermen still try to find information as much as possible to be able to improve it.

Natural capital in the form of a very rich and beautiful coast supported by social capital with various distinctive traditions and has been recognized as a tourist attraction to foreign countries presents a very high opportunity for the development of fisheries as well as community-based tourism and local natural resources. This development will be able to become an alternative economy and multiple livelihood strategies for the sustainability of the lives of coastal communities. The presence of an alternative economy (dual livelihood strategy) will be able to help communities overcome existing vulnerability issues while reducing threats through reducing destructive activities that have been carried out due to household economic needs. Communities utilize coastal and marine areas as social arenas, food sources, household income, and cultural/traditional areas. Economic utilization of coastal and marine activities have been carried out in the form of fishing and other

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marine biota, seaweed cultivation, salt processing, and beach tourism. Although limited, the community still applies customary traditions in the utilization of coastal and marine resources, for example the tradition of "Pili Nyale" (catching sea worms) which is carried out only once a year in February-March, precisely the day before the implementation of the Pasola tradition. The utilization of marine resources by local communities in the coastal areas of the study villages is generally not optimal due to the limited production assets and technical skills possessed by the communities. This condition causes utilization activities to be concentrated in the coastal and coral reef areas.

Sulamu. The people of Sulamu Village make their main livelihoods as fishermen, farmers and traders. Most of the community relies heavily on coastal and marine resources as fishermen and seaweed farmers. Education levels in Sulamu are low, with the average graduating only from primary school and junior high school. However, access to information sources from households that control/own communication tools in Sulamu Village in 2020 was quite high and reached more than 61% of households in Sulamu Regency. Communication tools used as sources of information include radio/tape, television, satellite dishes and mobile phones. The existence of natural disaster anticipation/mitigation facilities/efforts such as an early warning system for natural disasters/specifically Tsunami, safety equipment, as well as signs and disaster evacuation routes already exist and function well compared to the other 6 villages that do not have these disaster mitigation facilities/efforts at all in Sulamu Regency.

The existence of the Savu Sea NMP is realized by the Sulamu Village community as a marine area that needs to be preserved to ensure the sustainability of coastal and marine resources. Protection efforts that have been carried out by the Sulamu Village community are conducting waste cleanup activities on the coast as well as community-based waste management discussions. Efforts to build public awareness in terms of waste disposal behavior to the willingness to manage waste together more responsibly and provide benefits are carried out with stakeholders who observe the coastal and marine environment.

This has a positive impact on the perception of the Sulamu Village community on the importance of the existence of the Savu Sea NMP. Community perceptions are built starting from campaigns and discussions of community-based coastal and marine management. With the presence of commitment as a positive outcome towards the perception and existence of the Savu Sea NMP, this village has proclaimed itself as “Kampung Bahari Nusantara” (or maritime village of the archipelago). The existence of this Kampung Bahari Nusantara, invites various parties to come and carry out various pro-coastal and marine environmental activities that can improve the standard of living of the people in this village.

Community activities in efforts to conserve coastal and marine resources in conservation areas are active participation through several programs such as: strengthening the mentoring of tolerance attitudes towards seaweed farming community groups through the existence of seaweed, and community empowerment based on fishermen partnerships with the district government. Other supporting activities that are routinely carried out by the Sulamu community such as beach cleaning, training to improve the quality of seafood products, and other activities in order to increase community capacity in sustainable coastal and marine resource management.

NuseVillage. Nuse Island is one of Indonesia's outermost small islands located in Ndao Nuse Subdistrict, Rote Ndao Regency. Nuse Island has coral reef and fish ecosystems and white sandy beaches that can be found in almost all parts of the island. More than 93% of villagers in Nuse Island, Ndao Nuse subdistrict make a living as fishermen and depend on the sea for their livelihood. Most of the Nuse people have only completed primary school.

The southern waters of Nuse Island, around 631.41 hectares, are included in the utilization zone of the Savu Sea National Park, supporting the activities of the fishing community. The small pelagic fisheries sector is the mainstay of the community. The fishery commodity comes from small pelagic fish with the leading commodity Squid (Loligo sp.). Simple fishing gear used by fishermen is environmentally friendly fishing gear, such as fishing rods and gill nets. The fishing fleet used by Nuse fishermen is dominated by Jukung (also known as cadik is a small wooden Indonesian outrigger canoe) and outboard motor boats.

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Perception is one of the factors that form an awareness in a person. The level of awareness of the Nuse community on the importance of conservation can be seen from how the Hoholok/Papadak wisdom is perceived towards the perceived object, in this case coastal and marine resources. If associated with the results of the study, the perception of conservation leads to a positive outcome.

The perception of conservation is very high because one of the local wisdoms that exists in Rote Ndao Regency and is still implemented until now is Hoholok/Papadak, which is a customary agreement/local wisdom that applies on land and at sea in an area that has natural resources that according to the owner/government can be useful for many people and steps, so it needs to be protected by customary events. The application of Hoholok/Papadak wisdom in coastal and marine areas in Rote Ndao Regency, which is first implemented on land and has an effect on resource sustainability, is deemed necessary to be adopted and applied in coastal and marine areas, especially to support the management and supervision of the Savu Sea NMP. To date, there are 3 nusak (customary areas) that are used as pilots for the application of Hoholok/Papadak in coastal and marine areas. However, the perception of the importance of protecting coastal and marine resources in the wisdom of Hoholok/Papadak and the existence of villages in the Savu Sea NMP conservation area is known to most Rote people so that the preservation of coastal and marine resources can be maintained in Nuse Village.

Nangabere, Londa Lusi, and Lenang. The communities in these three villages are mostly fishermen, farmers, and breeders. As a fishing community, they do not only earn income from catching fish, but also from obtaining fish, shellfish, shrimp, seaweed, at times when the sea is receding, or what is commonly known by the local term makameting. Community activities in utilizing coastal resources in addition to fishing, also a small portion of seaweed cultivation and salt-making business.

Public awareness of the importance of preserving the coastal and marine areas of the national marine park is shown in several coastal environmental conservation activities such as mangrove cultivation; protection of marine biota such as Olive Ridley turtles and the use of environmentally friendly fishing gear (passive, traditional fishing gear) such as Bubu often called traps and guiding barriers; these tools are often called fishing pots or fishing baskets. In order to prepare excellent fishermen as the backbone of the maritime economy, several fishermen capacity building trainings such as fishermen capacity building training in fisheries business management based on coastal ecosystem conservation have been conducted.

The existence of the Savu Sea NMP conservation area gives a special meaning to these three villages. With high awareness and always actively participating in efforts to conserve coastal and marine resources, several community-based environmental organizations such as the conservation youth association and the monitoring community group.

Participation in conservation efforts is very high in these three Villages, one example of community participation in turtle conservation activities such as the release of hatchlings released from five semi-natural nests and the Olive Ridley turtle species. People who are members of the Nanga Bere Village community group until 2021 to 2022 have released 1,800 sea turtles to the Savu Sea NMP. This activity aims to increase public awareness, especially the people of Nanga Bere Village, of the importance of preserving the environment, protecting protected biota and the function of conservation areas. Other participation took the form of mangrove plantation.

The perception of the community of Londa Lusi village in Rote Ndao Regency is influenced by the local wisdom of Hoholok/Papadak; while the perception of the community of Nangabere Village in West Manggarai Regency that conservation of coastal and marine resources is a must is expressed in a commitment that Nanga Bere Village becomes a pilot area for sea turtle conservation in mainland Flores and Indonesia; for the community of Lenang Village in Central Sumba Regency, coastal resources are a kind of economic support and at the same time to fulfill nutrition for people living in coastal areas.

Mebba dan Raemadia. The awareness of the people of Mebba Village and Raemadia Village in West Sabu Subdistrict, Sabu Raijua Regency has similarities in the perception of the existence of the Savu Sea NMP as a sustainable provider of coastal and marine resources. Making a living as

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fishermen, the community is very dependent on the availability of resources from coastal and marine ecosystems. In the coastal area, the community is aware of the importance of mangrove ecosystems as a habitat for existing marine biota and the importance of coastal environmental health in the pond area for salt production. In the marine area, the community realizes the importance of using environmentally friendly fishing gear.

The existence of conservation areas is an important part of local government policy as stipulated in the local regulation of Sabu Raijua Regency number 3 of 2011 concerning the regional spatial plan of Sabu Raijua Regency Year 2011-2031 which has well regulated nature conservation areas for the Savu Sea national waters conservation area; fisheries allotment areas for capture fisheries, aquaculture (including mariculture, seaweed, salt ponds) and industrial fish processing; local protection areas such as coastal border areas; as well as provisions for zoning regulations as well as the rights, obligations and roles of the community in spatial planning. The existence of this regional regulation assists sustainable coastal and marine resource management plans and supports all resource utilization activities.

The local government's focus on developing the area is also demonstrated by the government's commitment to propose the entire island of Sabu Raijua to become a national geopark area. Geoparks are the basis for geotourism development [18]. Geoparks can encourage this area not to have high-value geological heritage and geological diversity, but including biodiversity and culture that are integrated in it, and developed with three main pillars, namely conservation, education, and local economic development [19,20,21]. Thus, the development in these two villages has a clear pathway towards a conservation-based area.

In addition to the commitment of the local government, the community is also taking part in efforts to conserve and protect resources. This can be seen from the utilization activities of coastal areas such as salt ponds in Mebba Village producing quality salt according to Indonesian national standards; while resource utilization in marine areas is the activity of catching small pelagic fisheries, demersal fish and reef fish using fishing gear that is very environmentally friendly based on the Code of Conduct Responsible for Fisheries (CCRF) [22]. These two resource utilization activities determine the high rate of community perception and participation in protecting coastal and marine resources [23].

Community perception in the use of environmentally friendly fishing gear is very well shown by the use of gill net, troll line, casting net, purse seine, and long line. The highest scores for CCRF criteria assessment [24] are high selectivity of fishing gear, not damaging habitats and breeding grounds for fish or other organisms, and not damaging marine biodiversity.

Community participation in both villages in maintaining the health of marine ecosystems can be seen from the high participation rate of fishermen, almost all of whom use very environmentally friendly fishing gear. In addition, the community actively participates in several conservation activities of the Savu Sea such as routine monitoring and review of management plans and zoning of the Savu Sea NMP, community capacity building activities, and active in carrying out marine monitoring functions as a community supervisory group.

Loborai and South Netemnanu. Loborai Village in Sabu Raijua Regency and South Netemnanu Village in Kupang Regency have the same perception or perspective on the existence of the Savu Sea NMP as a coastal and marine area that can provide a future for the community. The uniqueness of the resources and the existence of the two areas which are the core zone and utilization zone of the Savu Sea NMP, make these two locations have the same pathways and produce positive cluster outcomes.

The importance of the existence of the Savu Sea NMP conservation area is a shared responsibility and requires cooperation from all parties. Conservation activities such as mangrove plantation are carried out with the concept of pentahelix [25,26] or multi-stakeholders involving elements of government, academics, agencies or businesses, communities or communities and the media [27]. In the case of Loborai Village, the existence of coastal and marine areas and resources cannot be separated from the attention of the local government. In the seaweed farming sector, there is a seaweed factory in this area; the tourism sector, such as the existence of Raemea Beach, which is one

of the unique and amazing tourist attractions with white sand and giant golden-red cliffs; and the existence of Biu Port (the longest port dock in ENT Province) for sea transportation services between regions in ENT Province. The presence of coastal and marine resources as well as port facilities has fostered a very high public awareness of the importance of protecting and preserving the environment [28]. This is evident from several community activities in efforts to protect coastal marine areas and resources such as participating in various opportunities such as the mangrove planting movement in Loborai Village, as well as community participation in several existing conservation programs.

Regarding South Netemnanu Village, the existence of Batek Island covering an area of 946.02 hectares as a core zone in the Savu Sea NMP area plays an important role in maintaining the boundaries between countries. Batek Island is Indonesia's frontier island bordering the Democratic Republic of Timor Leste, the beach is a green turtle nesting site, there are coral reefs, migration corridors for cetaceans, whales and dolphins. In this core zone, there is an Indonesian National Army guard post on the island. With the existence of this core zone, community awareness has increased in terms of national defense and security, and community activities are limited in this area with the core zone.

Namodale and Tesabela. Public awareness of the abundance of marine life and the good condition of coral reefs with a percentage of live coral cover of up to 80% greatly supports underwater tourism activities. This healthy water condition supports tourism activities in Tesabela Village and Namodale Village. Having beach tourism and marine tourism capital makes these two villages in the same pathway cluster with positive outcomes.

The existence of the Savu Sea NMP is of particular concern to the people of Namodale Village and Tesabela Village. There is concern from the provincial government such as launching Namodale Village as Kampung Tangguh Nusantara in 2021 as an effort to increase public awareness to maintain health protocols in the context of national economic recovery from the impact of covid-19 and various other efforts such as revitalizing inclusive tourism villages and increasing the capacity of multi-parties to support tourism.

Community participation in these two regions is very high, especially in active participation in several environmental programs in coastal and marine areas such as mangrove tree planting activities as a concern for the environment, especially in efforts to prevent coastal abrasion, as well as several monitoring activities for the use of marine resources of the Savu Sea MNP which are routine activities of the BKKPN. The perception of the community in Namodale Village and Tesabela Village on marine conservation is very high because one of the local wisdoms [29-31] in Rote Ndao Regency that is still implemented today is Hoholok/Papadak.

5. Conclusions

Stakeholder engagement plays a crucial role in achieving successful and sustainable management of marine conservation areas, particularly in the case of the Savu Sea marine conservation area. The active participation of stakeholders and their strong perception regarding the significance of marine conservation as a means to mitigate environmental risks are essential for ensuring the sustainable livelihoods of the coastal communities surrounding the Savu Sea. This study identifies the complex causal conditions that contribute to strong participation in the sustainable management of the marine conservation program in the Savu Sea. It highlights that awareness of environmental issues and participation in multistakeholder institutions form a robust combination of conditions that lead to a positive perception. Additionally, social status partially supports the strong perception of the conservation area.

The findings of this study offer valuable insights for policymakers, emphasizing the importance of fostering strong positive perceptions to harness the benefits of the marine conservation area. Encouraging community involvement in the protection, utilization, and enforcement of sustainable marine conservation in the Savu Sea is crucial. Such efforts would enhance resilience to environmental risks stemming from the unsustainable use of marine resources. Moreover, a strong perception among coastal communities would foster a sense of ownership and belonging to the

conservation area, challenging the common perception that conservation areas are solely top-down management schemes designed by the government for conservation purposes.

At its current stage, this study relies on primary data in the form of crisp set data (binary). Further research could be developed, such as using fuzzy set QCA to incorporate more complex causal conditions. Additionally, combining secondary data on the ecosystem services provided by the conservation area would provide a more comprehensive understanding of the role of the conservation area for coastal communities. Furthermore, exploring the resilience aspect by combining social resilience and ecosystem resilience to mitigate risks driven by socio-economic and environmental factors could be another avenue for future studies.

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