

Priority strategy in the development of sustainable capture fisheries in the Marine Protected Area of Kiluan Bay, Lampung, Indonesia

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Abstract. Capture fisheries are important economic drivers in coastal communities. Ensuring the sustainable utilization of these resources must be a top priority to promote long-term environmental and economic stability. Kiluan Bay offers a high potential for capture fisheries. On the other hand, Kiluan Bay is designated as a marine protected area that consists of core zone, exploitation zone, and sustainable fisheries zone. This must be supported by long-term management to achieve the benefits. Therefore, study of sustainable capture fisheries strategy is required for continuous utilization in Kiluan Bay. Owing to these factors, the aim of this research was to deduce the development and management strategy of sustainable capture fisheries in Kiluan Bay. For this purpose, A'WOT analysis (AHP/SWOT), an analysis developed in combination with SWOT analysis (strengths, weaknesses, opportunities, threats) and the AHP (analytic hierarchy process) method, was used to determine priority factors and strategies. The results of the study indicate that sustainable fisheries in the Kiluan Bay area requires a strategy based on empowering of opportunity (0.329) and strength (0.361) factors. In addition, subfactor opportunity O3 and strength S2 become the priority subfactors with highest global weight 0.174 and 0.162 respectively. Hence, the proposed development strategy emphasizes the promotion of marine ecotourism to bolster the local economy of Kiluan Bay Village, concurrently fostering awareness through educational initiatives within marine ecotourism. Conversely, strategies centered on extensive exploitation of fisheries resources, such as enhancing facilities and infrastructure, are not identified as primary priorities.

Key Words: analytical hierarchy process, aquatic resources management, policy, sustainable development goals.

Introduction. Development of sustainable capture fisheries is carried out by optimization of productivity and efficiency efforts as well as maintenance of sustainability of its environment and resources (Putra et al 2021; Suharsono et al 2021). It is one of the mandates of Sustainable Development Goals (SDGs) to create balance between water conservation and resource utilization for people prosperity (Napitupulu et al 2022; Troell et al 2023; Yulianto et al 2023). The direction of this policy is proportional to the commitment of Ministry of Fisheries and Marine (KKP) of the Republic of Indonesia in the strategic plan of fisheries development for 2020–2024, to achieve prosperity of fishermen and create the maintenance of developed and sustainable fisheries (DJPT 2021; Supriani et al 2023).

In accordance to the Regulation of Marine and Fisheries Ministry number 14 year 2016 (KKP 2016), of Criteria and Category of Marine Protected Area for Water Ecotourism, marine protected areas are protected waters with zonation system to realize the sustainability of fish resources and its environment (MMAF/CTC 2020; Supriani et al 2023). The aim of this region is to observe the sustainability of marine-fisheries resources continuously, to maintain the environmental balance and its biodiversity, as well as managing the conservation area optimally–sustainably (Duadji & Tresiana 2020; Reza et al 2023). In accordance to the data of 2021, conservation areas represent 28.4 million hectares or 8.7 % of Indonesian total water area (DJPRL 2022).

One of the objects of sustainable capture fisheries development is Kiluan Bay, Lampung Province. Kiluan Bay was designated as marine conservation area by Decree of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia number 49 of 2019 (KKP 2019), and is split into three zones: core zone, utilization zone, and sustainable fishery zone (Figure 1). Thus this condition becomes a big asset for the development of sustainable capture fisheries. Furthermore, the long-standing integration of ecotourism within society contributes to enhancing the sustainability of capture fisheries (Reza et al 2023).

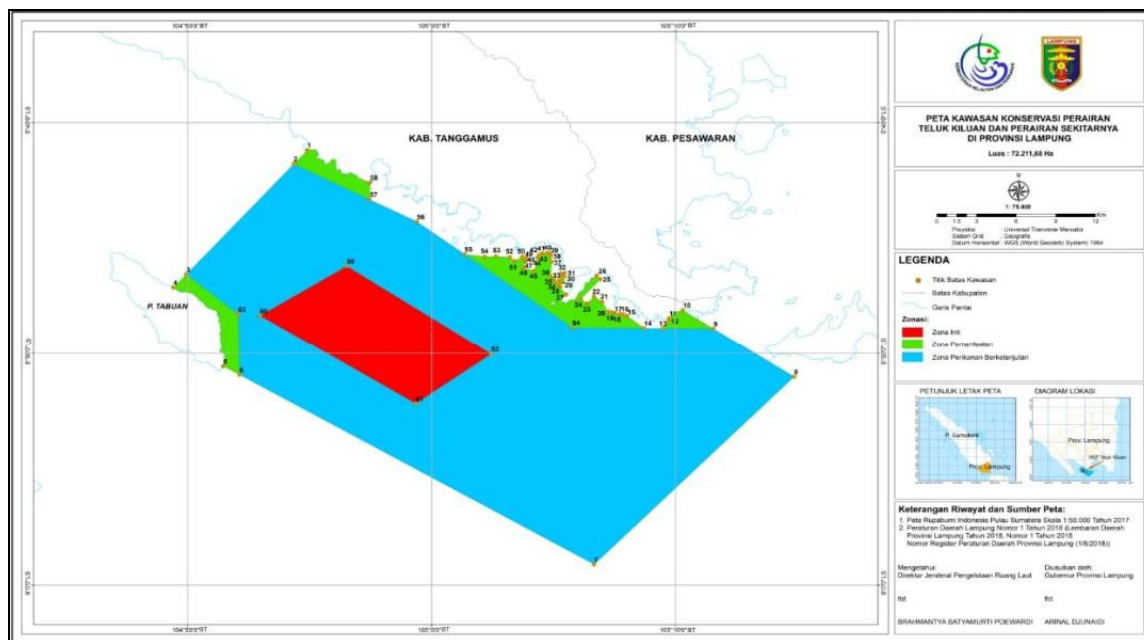


Figure 1. Map of Marine Protected Area of Kiluan Bay (KKP 2019).

Inappropriate management impacts negatively the utilization of fisheries resource, which consequently predicted depletion of development (Solihin et al 2016; Waileruny et al 2021). Hence, it is expected that government possess systematic, measured and oriented strategy as long term development guideline (Kurohman et al 2020). On the other hand, strategy policy study in Kiluan Bay inclined more toward tourism (Tresiana & Duadji 2018; Nurbaihaqi et al 2022; Bakri et al 2023). The lack of strategic study of capture fisheries in Kiluan Bay became a consideration to carry out this research.

In this study, one of the used Multi-Criteria Decision-Making methods is A'WOT (AHP/SWOT) that determinines the decision hierarchy with SWOT (Strengths Weaknesses Opportunites Threats) and AHP (Analytic Hierarchy Process) frameworks. SWOT analysis indicates limitation in quantitative measurement thus SWOT and AHP combination creates possibility of goal oriented strategy implementation (Kurttila et al 2000). A similar research which combines SWOT and AHP was carried out in Kubu Raya Regency coastal area (Imelda et al 2019) and Lingga Regency Regional Conservation Marine Area (Saudin et al 2019; Wijayanto et al 2021). The key distinction of our study lies in the SWOT analysis, which exclusively focuses on strategic variables. These variables are then assessed for their importance, allowing us to pinpoint the most crucial factors. It's worth noting that this approach yields more specific advantages, directly aligning with our goal of driving targeted sustainable development initiatives.

The aim of this study was to determine a strategy for the development and management of sustainable capture fisheries in Kiluan Bay. The benefit resulting from this study includes providing input to the government and other fisheries activity actors regarding strategies for developing sustainable fisheries in Kiluan Bay for short, medium and long term.

Material and Method

Study area and period. This study was conducted in Pekon Kiluan Negeri, Kelumbayan District, Tanggamus Regency, Lampung Province, Indonesia, in December 2022.

Data collection. Primary and secondary data was collected during this study. Primary data was collected by survey of targeted respondents which involved interview and questionnaire techniques assessing perception, behavior and preference of individuals or groups such as consumers and public opinion (Ponto 2015). Meanwhile secondary data was collected by literature study of village features such as: profile, monography, geographical condition, regional rules, articles, journal literature, reports, and publications.

Purposive sampling was carried out to determine the respondents by involving nonprobability sampling techniques which are most effective to study certain cultural burden with informant inside (Tongco 2007). Respondents were chosen by consideration of their knowledge and fishery experience in Kiluan Bay which consisted of 7 persons: two academicians, one village chief, two managers in ecotourism, and two fishermen in Pekon Kiluan Negeri, Kelumbayan District, Tanggamus Regency, Lampung.

Data analysis and determination of priority strategy. Data analysis was carried out by the combination of SWOT frames for goal formulation, criteria deduction, and sub criteria of SWOT variables as well as AHP analysis to elect the most reliable priority and alternative strategy during survey (Canto-Perello et al 2016; Saudin et al 2019; Annishia 2021). A number of studies has proved the combination of SWOT and AHP to determine priority strategy such as: Kurttila et al (2000), Kangas et al (2001), Pesonen et al (2001), Akbulak and Cengiz (2014), Canto-Perello et al (2016), and Lee et al (2021).

In accordance with Lee et al (2021), SWOT–AHP approach is described in these 6 steps:

1. Goal formulation by SWOT framework and construction of hierarchy model.
2. Pair ration of criteria and sub criteria of SWOT. This ratio is based on 9 point scale of Saaty (1989) for analytical efficiency.
3. Factor weight evaluation and local factor by AHP analysis. Local weight is calculated to determine SWOT sub factor weight. Weight calculation is assisted by Expert Choice version 11.
4. Reliability affirmation in the result of consistency index (CI) and consistency ratio (CR).
5. If the CR is less than 0.1, the result is reliable.
6. Global weight determination of each factor and ranking of strategy. Global weight is obtained by multiplication of SWOT criteria weight (level 2) and sub–factor (level 3).

AHP factor in sub criteria SWOT analysis is obtained by the interview result of informant and field observation result. Owing to these factors, each SWOT group is denoted by four factors which enables pair ration with AHP analysis (Table 1). Meanwhile hierarchy structure of AHP is displayed in Figure 2.

Table 1

AHP factors and descriptions in the SWOT matrix

<i>SWOT criteria (Factor)</i>	<i>SWOT sub-criteria (sub-factor)</i>	
Strengths (S)	S1	Sea water with abundant fish resources
	S2	Fishermen highly understand sustainable fishing
	S3	Strategic geographical location as water conservation area
	S4	The existence of fisherman group institution
Weaknesses (W)	W1	Absence of fishing harbor
	W2	Inefficient utilization of basic catching devices and technology despite resource abundance
	W3	Limited business development capital

	W4	Lack of variation in the handling and processing of fishery products
Opportunities (O)	O1	Job opportunities in the fisheries sector are still open
	O2	Increasing market demand for fishery products every year
	O3	Opportunity in capital improvement with marine ecotourism support
	O4	Massive government programs in growing micro, small and medium enterprises (MSMEs) in the fisheries sector
Treats (T)	T1	Increase of fish habitat damage as a result of climate change
	T2	The continuation of the fishing business is decreasing due to the large number of people migrating to the city
	T3	Lack of transportation facilities and infrastructure to support the fisheries sector
	T4	Limitation of communication networks

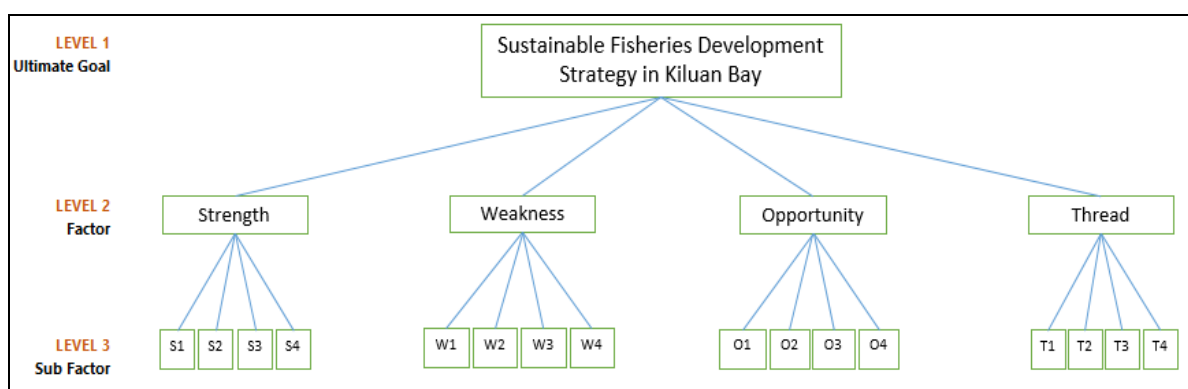


Figure 2. Hierarchical structure model for sustainable fisheries development strategy in Kiluan Bay.

Results and Discussion

General overview of the location. Administratively, Kiluan Bay is located in the Kiluan Negeri Village, Kelumbayan District, Tanggamus Regency, Lampung Province. Pekon Kiluan Negeri is located around 75 km southwest of Bandar Lampung or 2–3 hours' land journey. Pekon Kiluan is 21.48 km² with a total population of 1525 (BPS 2022). Most of the population in Kiluan Negeri works as traditional fishermen. Meanwhile other professions are farmer, laborer, trader, or tourism management (Hasbullah et al 2016; Tresiana & Duadji 2018; Yulianto et al 2023).

Pekon Kiluan Negeri is a well-known tourism location in Lampung Province as a result of society based ecotourism (Hasbullah et al 2016; Reza et al 2023; Yulianto et al 2023). Consequently, it has major potential for population of Kiluan Negeri to stimulate the regional economy (Duadji & Tresiana 2020; Yulianto et al 2023). Apart from natural landscapes such as coral reef, seagrass and mangrove habitats, this region functions as a conservation area of protected species such as hawksbill turtles (*Eretmochelys imbricata*), leatherback turtles (*Dermochelys coriacea*), bottlenose dolphin (*Tursiops truncatus*) and long-beaked dolphin (*Stenella longirostris*) (Hibatullah et al 2021). Hence, a number of tourism activities for tourists are offered in Kilian Negeri for example: beach activities, snorkelling, diving, and educational conservation tourism (Akbar et al 2019; Hibatullah et al 2021).

Capture fishery in Kiluan Bay is noted as not massively exploited (Reza et al 2023). The most utilized catching method is still longline fishing, with an average ship size of 2–5 GT (Figure 3). The fishing operations are primarily concentrated within the bay itself and cannot extend offshore. Meanwhile assisting devices are only flashlights or small lamps, with main fishing targets being demersal and small pelagic aquatic organisms such as: octopus (*Octopus* spp.), red snapper (*Lutjanus* spp.), coral grouper (*Epinephelus* spp.), dolphinfish (*Coryphaena hippurus*), mackerel tuna (*Euthynnus*

affinis), largehead hairtail (*Trichiurus lepturus*) etc. (Figure 3). In addition, the absence of a fishing landing harbor means that fishermen can only sell their catches directly to collectors and middlemen (Reza et al 2023). The general condition of capture fisheries in Kiluan Bay obtained from the survey can be seen in Table 2.

Table 2

General fishery data in Kiluan Bay

No.	Indicator	Annotation
1	Average trips number in 1 month	26 times
2	Estimated duration of trip	7-9 hours
3	Approximate average distance for fishing	5-10 km from the shore
4	Estimated cost of trip (fuel, ice, and bait)	IDR 100.000 – IDR 200.000
5	Type of fishing gear	Longline
6	Average gear size	300-500 m
7	Fishing aids	Flashlight, lamp
8	Boat size	2-5 GT
9	Main target	Octopus, red snapper, coral grouper, dolphinfish, mackerel tuna, largehead hairtail
10	Size of fishing crew	One person



Figure 3. Small scale fishing boats in Kiluan Bay and catches.

Kiluan Bay has been declared a marine protected area since 2019 (KKP 2019; Reza et al 2023). Although it is included in a marine conservation area, fishery resources in Kiluan Bay are still utilizable as it contains sustainable fisheries and utilization zones (Annishia 2021; Reza et al 2023). Sustainable fishery zones consist of two subzones: general sustainable fisheries and cetacean protection. Both subzones are designed to facilitate eco-friendly fishing practices with minimal risk to habitats. This utilization aims to support small scale or traditional fishery to accommodate the interest of local fishers (Reza et al 2023). The purpose of these sustainable fishery and utilization zones is to protect and preserve both fish stocks and their habitats. Hence, it is prohibited to operate environmentally dangerous catching devices such as drift gillnets (DKP 2014; Supriani et al 2023; Reza et al 2023).

Priority level of SWOT factors. The level 2 factors, which comprise the SWOT analysis groups - strengths (S), weaknesses (W), opportunities (O), and threats (T) - delineate strategic elements. Strengths and opportunities are leveraged to their fullest extent, while weaknesses and threats are addressed and mitigated (Canto-Perello et al 2016; Lee et al 2021; Annishia 2021). The weights and priorities of the factors that have been analyzed are listed in Table 3.

Table 3

SWOT factor weights and priorities for sustainable fisheries development strategy in Kiluan Bay

No.	SWOT component	Weight	Priority level
1	Strengths	0.361	1
2	Weakness	0.055	4
3	Opportunities	0.329	2
4	Threats	0.255	3
Inconsistency ratio = 0.00213			

Owing to the results, it appears clearly that strength factors need to be prioritized and improved before opportunity factor in threat factor mitigation. Meanwhile weakness factor is not prioritized in carrying out sustainable fishery development in Kiluan Bay. It is similar to the research of Imelda et al (2019) which mentioned that strength and opportunity factors were considered more important to prioritize both in optimization and affirmation for management of sustainable fisheries in Kubu Raya coastal area.

Lee et al (2021) highlighted that prioritizing opportunities and strengths over weaknesses and threats is essential, as it indirectly addresses the latter. In relation to this study, a number of participating experts in a survey view that strength and opportunity factors were considered firstly for fishery development in Kiluan Bay. In other words, utilization of strength and opportunity in Kiluan Negeri society is the most important. Hence a number of attempts and support from a lot of sides are needed to develop the sustainable capture fisheries in Kiluan Bay (Tresiana & Duadji 2018; Duadji & Tresiana 2020).

Priority strategy of sustainable fishery development. After obtaining the priority factor of SWOT, local weight is determined in each subfactor. Table 4 shows analysis results of subfactor priority in SWOT factors: fishermen understand that sustainable fishing (0.448) is the most crucial subfactor in strength category, followed by the existence of fisherman group institution (0.350). In weakness category, "inefficient utilization of basic catching devices and technology despite resource abundance" (0.429) is the problem that needs solving, following by subfactor "absence of fishing harbor" (0.263). Owing to opportunity related to sustainable capture fisheries development, "opportunity in capital improvement with marine ecotourism support" (0.529) indicates highest priority followed by "massive governmental program to grow microeconomy in fishery sector". Meanwhile for threat category, subfactor which treats the development of sustainable capture fisheries development is "increase of fish habitat damage as a result of climate change" (0.143) and "limitation of communication network" (0.044).

The last stage is the determination of obtained global weight by multiplication of SWOT factors (priority group level 2) with local weight (level 3). Comprehensive analysis indicated that subfactor opportunity O3 ("opportunity in modal improvement with marine ecotourism support" (0.174) has highest priority and is followed by subfactor strength S2 (fishermen highly understand sustainable fishing, 0.162) and subfactor threat T1 (increase of fish habitat damage as a result of climate change, 0.143). Comprehensive relative priority from each strength factors and opportunities has higher rank than other groups, while priority level of weakness group is the lowest.

Table 4

AHP factors and descriptions in the SWOT-matrix for sustainable fisheries development strategy in Kiluan Bay

SWOT criteria (factor)	Criteria weight	Local		Global		
		Weight	Priority	Weight	Priority	
Strengths (S)	0.361	S1	0.059	4	0.021	13
		S2	0.448	1	0.162	2
		S3	0.143	3	0.052	6
		S4	0.350	2	0.126	4
Weaknesses (W)	0.055	W1	0.263	2	0.014	14
		W2	0.429	1	0.024	12
		W3	0.205	3	0.011	15
		W4	0.103	4	0.006	16
Opportunities (O)	0.329	O1	0.077	4	0.025	11
		O2	0.146	3	0.048	7
		O3	0.529	1	0.174	1
		O4	0.248	2	0.082	5
Threats (T)	0.255	T1	0.698	1	0.143	3
		T2	0.084	4	0.031	10
		T3	0.100	3	0.037	9
		T4	0.119	2	0.044	8

This study is capable to give practical solutions as the result is applicable to deduce the effective policy or strategy to develop a sustainable fishery in Kiluan Bay. Owing to the analysis result, O3 factor and S2 factor are clearly indicating current sustainable fishery development. By the empowerment of marine ecotourism in fishermen villages, population prosperity is rising (Hasbullah et al 2016; Bakri et al 2023; Yulianto et al 2023), and consequently fishermen do not need to exploit the resources enormously with negative effects (Hasbullah et al 2016; Putra et al 2021). Promotion and government assistance programs are carried out to increase the number of tourists (Harianto et al 2020; Duadji & Treasiana 2020; Annishia 2021). Apart from this, increased numbers of tourist result in ecological damage if unregulated. Hence the strategy to raise the environmental awareness of tourists need to be improved (Nurbaihaqi et al 2022; Supriani et al 2023). Additionally, higher awareness of village population of sustainable fisheries becomes a large capital for development. It is clear that promoting marine ecotourism can effectively engage the local communities as environmental ambassadors for tourists (Nurbaihaqi et al 2022).

After assessment of subfactor O3 and S2 as well as threat T1 factor, it is clearly seen that those factors are crucial for sustainable fishery development. Specifically, the rising fish habitat damage due to climate change (0.143) becomes a serious threat for the development efforts of sustainable fisheries. The importance of habitat and environmental conditions in sustainable fisheries cannot be overstated. Beyond simply ensuring the sustainability of resources, they play a crucial role in supporting both the livelihoods of local populations and the long-term economic viability of the fishery industry in Kiluan Bay.

The strategy of affirming marine ecotourism aligns with governmental initiatives to designate Kiluan Bay and its surroundings as a conservation area comprising three zones: core, sustainable fisheries, and utilization zone. The enhancement of environment conservation aspect is needed to give alternative strategy (Annishia 2021), that elevates fishermen prosperity by ecotourism which prevents exploitation in core zone and maintaining the fishery ecosystem in sustainable and utilization fishery zones (Supriani et al 2023).

Weakness factor is currently in the unprioritized category in both weight factor and global weight subfactor. Hence, fisheries resource exploitation related strategy has not been main priority to carry out. In other words, weakness solving strategy is

implementable as mid and long term strategy which is supplemented by other studies particularly fishing bioeconomy.

This research holds significant value as it presents a detailed strategy for sustainable fishery development, building upon previous studies by conducting a thorough SWOT analysis (Imelda et al 2019; Saudin et al 2019; Wijayanto et al 2021). In contrast to other studies that hastily formulate strategies without prior mapping of key priority factors, thereby constraining the selection process, our research offers a comprehensive approach by meticulously identifying priority factors aligned with global priority sequences. This ensures a more robust and informed strategy development process. Hence, this research gives more comprehensive proposal for priority factors in accordance to global priority sequence. Therefore, a whole subfactor is selectable for continuous improvement either as short, medium, or long term strategy. In other words, this research is distinguished by the existing ones through obtained detail and realistic strategy by systematic factors. Lee et al (2021) explained that A'WOT analysis assists systematically and scientifically various attributes to promote effective policy.

Conclusions. After assessing the important factors in sustainable capture fisheries through A'WOT analysis, it was found that strengths (0.361) and opportunities (0.329) were relatively more important in the development of sustainable fisheries in the Marine Protected Area of Kiluan Bay. In addition, the O3 and S2 subfactors are priority subfactors with the highest global weight, namely 0.174 and 0.162 respectively. Thus, it can be concluded that sustainable fishing in the Marine Protected Area of Kiluan Bay requires a strategy based on strengthening the opportunities and strengths factors, which is increasing marine ecotourism to drive the economy of the Kiluan Bay community as capital for carrying out sustainable capture fisheries activities accompanied by increasing tourist awareness about sustainable capture fisheries through marine ecotourism education. The exploitation of fishery resources on a massive scale, such as increasing fishery support facilities and infrastructure, is not a top priority to support sustainable fishery development in Kiluan Bay.

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