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Mangrove Ecosystem Management Strategy to Support Sustainable Development Goal 14

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Sustainable mangrove management plays a pivotal role in advancing various sustainable development goals (SDGs). These encompass poverty and hunger eradication, fostering livelihoods and economic growth, countering the impacts of climate change, and protecting biodiversity. To investigate this matter, our study employed participatory rural appraisal (PRA) and focus group discussion (FGD) techniques. The study engaged with local government officials, fishermen, farmers, non-governmental organizations, women leaders, community leaders, and the general public actively involved in mangrove forest regions. The purposive sampling method ensured a representative sample. A comprehensive analysis was conducted, integrating SWOT analysis and the analytical hierarchy process (AHP). The findings revealed several key strategies: promoting the development of the potential of economically and sustainably valuable mangrove ecosystems through environmentally friendly planting and harvesting; empowering communities through farmers, fishermen, and women's groups to generate household-scale mangrove-based industries; providing all necessary facilities and infrastructure for mangrove ecotourism visitors; expanding the role of non-governmental organizations (NGOs) in improving community awareness and knowledge on the management of mangroves; and providing training to increase the diversification of mangrove economic products.

Keywords: mangrove management, SDG, silvofishery, strategy formulation, SWOT-AHP.

Introduction

Sustainable development goals (SDGs) are an integrated framework of human, social, and environmental development goals. SDGs are the global agreement that is then used as the main basis of national development planning for every country in the world. This is a common achievement that also answers the aspirations of mankind regarding a better life in the future, while still taking into account the various limitations of nature

or the surrounding environment. Specifically, SDG 14 aims at conserving and sustainably utilizing oceans, seas, and marine resources. SDG 14 creates a sustainable framework to regulate and protect marine and coastal ecosystems from land-based pollution, raise awareness of the impacts of ocean acidification, increase the economic benefits of sustainable use of marine resources, including through sustainable management of fisheries, aquaculture, and tourism, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and restore them for healthy and productive oceans.

Since sustainable development was popularized by the 1987 Our Common Future Report (WCED, 1987), it has denoted economic development without depleting natural resources and ecosystem services. This approach assumes that 'green' consumption and economic and technological development must be harmonized to offer a solution to the ecological dilemma faced by humanity (Ferreira et al., 2022; Magdoff and Foster, 2011). Sustainable natural resource management can support the achievement of economic development targets. As part of the effort to accelerate the attainment of SDG 14, the importance of sustainable mangrove forest management cannot be overstated. Wise mangrove management can serve various objectives, including the enhancement of aquatic animal life, the reduction of poverty and hunger, and the improvement of the quality of life for coastal communities. Sustainable mangrove management can expedite the realization of several SDGs, specifically (a) the elimination of poverty and hunger, (b) the generation of livelihoods and economic growth, (c) adaptation and mitigation of climate change impacts, and (d) the halt of biodiversity loss (Basyuni, 2023).

Mangroves are a vital natural resource of Indonesia's coastal regions. They possess some of the most productive ecological functions on Earth, creating unique habitats for a diverse range of aquatic and terrestrial life (Carugati et al., 2018). Additionally, mangroves offer a multitude of essential services that hold immense significance for human life, spanning biological, ecological, physical, and socio-economic dimensions (Abino et al., 2014; James et al., 2013; Romañach et al., 2018; Sandilyan and Kathiresan, 2015; Yanagisawa et al., 2010). These crucial services encompass improved water quality, carbon storage, and the provision of both timber and non-timber resources, as well as opportunities for ecotourism (Duke et al., 2007; Kathiresan and Bingham, 2001; Kusmana and Sukwika, 2018; Spalding, 2010).

Mangroves provide a wide diversity of ecosystem services estimated at around US$194 000 per year (Costanza et al., 2014). These services encompass the value of mangrove ecosystems as an ecotourism area, reaching IDR 95 354 976 per hectare per year, within a mangrove forest area of 173.39 hectares (Jabbar et al., 2021). Additionally, mangroves play a crucial role in ecological functions such as coastal protection (Barbier, 2016) and wastewater management (Bouchez et al., 2013). Moreover, mangroves are vital to humans for a diverse range of reasons, including their importance as fishery resources, support for farming, provision of forest products, as a source of building materials, protection against coastal erosion and hurricanes, pollution absorption, and their role in sustaining the fishing industry. Mangroves also serve as critical coastal, nursery, spawning, and breeding habitats for a variety of species, including fish, crustaceans, mammals, birds, insects, reptiles, and macrozoobenthos (Able, 2005; Albert and Schwarz, 2013; Arfan and Taufieq, 2017; Arfan et al., 2018; Manson et al., 2003; Walters et al., 2008).

Therefore, mangroves must be utilized with wise management to meet the needs and welfare of mankind, while harmonizing with other parts of the ecosystem where humans live (Kusmana, 2015). However, some individuals, in fulfilling their needs, contribute to the destruction of mangrove forests, as evidenced by the conversion of mangroves into fish and shrimp ponds, settlements, and industries. Hence, community involvement plays a crucial role in mangrove forest management decision-making. Nonetheless, there are challenges associated with community engagement in natural resource management, such as the limited time available for local communities to develop sustainable natural resource management (Dale et al., 2014; Pham et al., 2019; Song et al., 2021). In fact, the success of sustainable mangrove ecosystem management is contingent upon the engagement of the community residing in the vicinity of the mangrove area (Locatelli et al., 2014; Sachin et al., 2020; Uphoff, 1992). Coastal communities' reliance on mangrove forest ecosystems motivates them to restore, utilize, manage, and preserve these ecosystems using their local knowledge (Erftemeijer and Bualuang, 2002; Ha'apio, 2014; Ostrom et al., 1994; Widiastuti et al., 2018).

They represent the primary community stakeholders in mangrove rehabilitation, restoration, and sustainability initiatives, contributing to the preservation and rejuvenation of these vital resources (Abdullah et al., 2014; Firdaus et al., 2021; Setiawan, 2017).

The primary aim of this research is to develop sustainable strategies for managing mangrove ecosystems, with a focus on supporting the attainment of SDG 14. This research serves several key purposes: (1) ensuring the preservation of mangrove ecosystems and their resources; (2) a reference for local governments in formulating sustainable mangrove management policies; and (3) ensuring livelihoods and income sources for people living around the mangrove ecosystem area.

Methods

Data sources

The participatory rural appraisal (PRA) and focus group discussion (FGD) approaches were employed to conduct direct observations and in-depth interviews. The sampling technique employed was purposive sampling, which involves sampling based on specific considerations or selective criteria. Consequently, this research was carried out in the mangrove area of the west coast of South Sulawesi, given the diverse range of community activities taking place in this region. These activities encompass fishing, shrimp and crab harvesting, fish and shrimp cultivation in ponds, and cage-making, all of which have a significant impact on the mangrove ecosystem. To address the research objectives, in-depth interviews were conducted with members of the general public actively engaged in activities within the mangrove forest area. Additionally, FGDs were held in November 2022, involving various stakeholders such as local government representatives, leaders and members of fishermen and farmers groups, non-governmental organizations, women leaders, community leaders, and other individuals actively involved in the mangrove forest area. The FGDs and in-depth interviews focused on the following:

- mangrove resource potential;
- community activities in and around the mangrove area;
- management models and utilization of mangrove forest resources;
- local wisdom of the community;
- community traditions in managing and utilizing mangrove resources;
- equipment used by the community in utilizing the economic function of mangroves;
- local regulations on management and utilization;
- possible conflicts of interest;
- land tenure system;
- community economic activities.

SWOT analysis

SWOT analysis plays a crucial role in systematically identifying a wide range of factors for crafting effective strategies. Specifically, it places a strong focus on leveraging opportunities and strengths while diligently mitigating threats and weaknesses. Consequently, SWOT analysis serves as a valuable tool for assessing the overall situation and guiding the achievement of action plan goals (Jasiulewicz-Kaczmarek, 2016; Martínez-Hernández et al., 2021; Srdjevic et al., 2012; Sukri et al., 2022; Wang et al., 2014). In the context of this study, SWOT analysis involves the evaluation of both internal and external factors collected from observations, in-depth interviews, and FGDs. These factors are then assigned weightings and ratings to determine their significance. The primary objective of this analysis is to identify the strategy quadrant that demands immediate attention and holds a high priority for implementation. This is accomplished by establishing the X and Y axes: the X axis represents external factors, encompassing opportunities and threats, while the Y axis encompasses internal factors, including strengths and weaknesses.

Analytical hierarchy process (AHP)

The analytical hierarchy process (AHP) serves as the technique utilized in this study for prioritizing programs (Mafruhah et al., 2019). The AHP process consists of the following stages: first, describing the program in a comparison matrix; second, assigning assessment weights based on their level of importance; third, aggregating the consequences of the criteria to determine the priority of critical success factors; and lastly, calculating the consistency ratio of the eigenvalue (Bibin and Ardian, 2020; Kim et al., 2017; Singgalen and Manongga, 2022). In this research, AHP is implemented using Expert Choice 11.5 software.

Integrating of SWOT analysis and AHP

The data analysis technique used integrates SWOT and AHP analyses with the assistance of the *Expert Choice* application. The SWOT method is employed to establish clear objectives/criteria, identify SWOT factors, and formulate proposed strategic objectives. In contrast, AHP analysis employs quantitative methods to assess and compare criteria, factors, and proposed strategies. This comparative assessment helps prioritize alternatives that are considered more important. To conduct the AHP pairwise comparison, a questionnaire is used to gauge the priority levels among SWOT factors and proposed strategies. The integration process of SWOT and AHP is visually depicted in *Fig. 1*, illustrating the key stages involved.

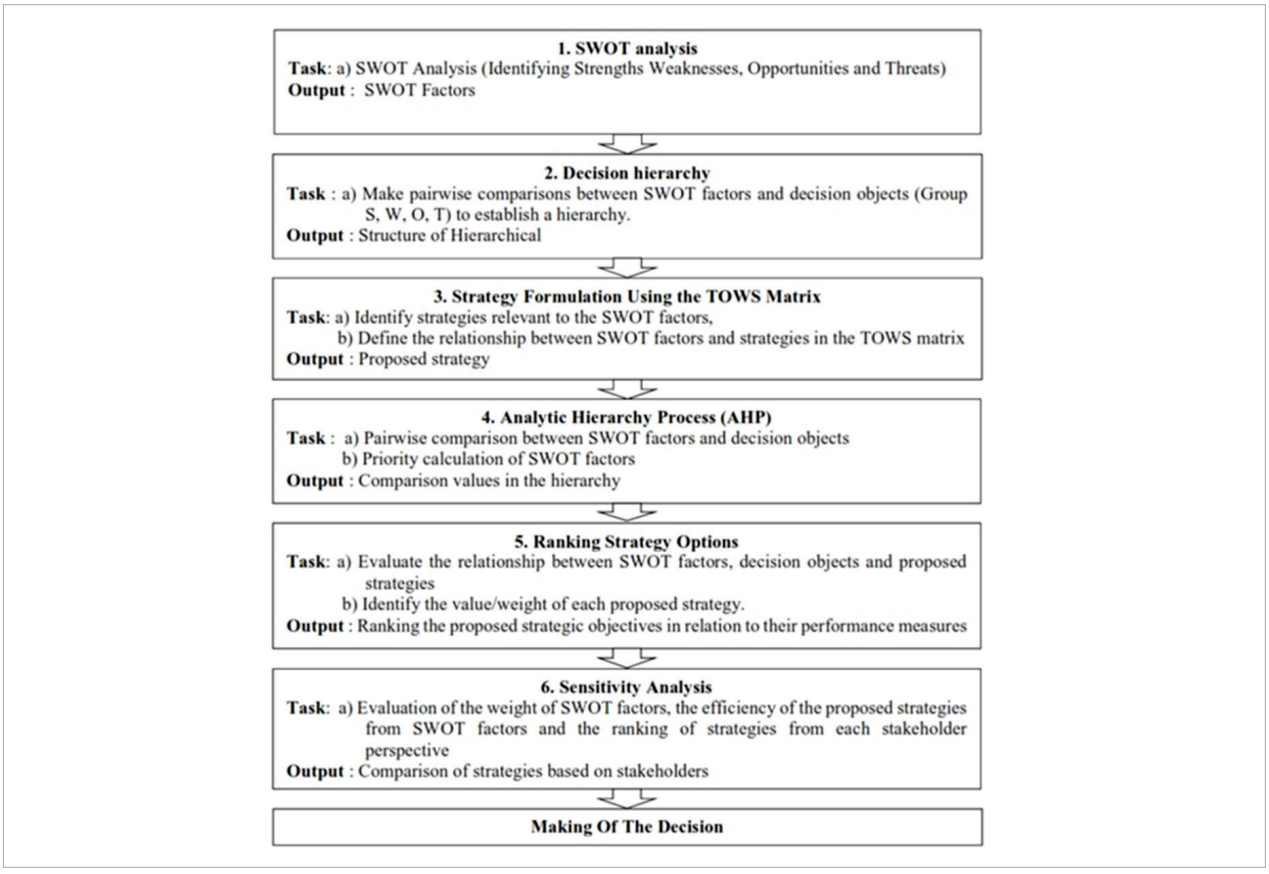
Assigning value to pairwise comparisons is determined by the relative importance or priority of one object compared to another. This process results in establishing a hierarchy of objects, ranging from those considered highly important to those deemed less significant.

Once the comparison is completed, the inconsistency value, often referred to as the consistency ratio (CR), is assessed. The desired outcome of the comparison process is an inconsistency value below 0.1 (10%). If the acquisition of this value is greater than a repetition is made to the *expert*.

Table 1. *AHP scale (Saaty, 2008)*

Value	Description
1	Both factors are absolutely vital.
3	One factor is marginally less significant compared to the other.
5	One factor takes precedence over the other.
7	One factor takes priority over another.
9	One factor is unquestionably more significant than the others.
2, 4, 6, 8	Intermediate values exist among two adjacent consideration values.

Fig. 1. *SWOT-AHP integration (Yavuz and Baycan, 2013)*



Results and Discussion

Sustainable mangrove forest management strategy using SWOT analysis

Sustainable mangrove ecosystem management strategies are formulated by grouping two strategic factors that arise from the situation and condition of the mangrove forest, namely, external factors encompassing opportunities and threats, and internal factors consisting of strengths and weaknesses. Based on the SWOT analysis, the derived strategy involves leveraging strengths to capitalize on opportunities, known as the strengths-opportunities strategy. This encompasses several key initiatives: firstly, the development of sustainable and economically valuable mangrove resources through environmentally friendly planting and harvesting (SO1); secondly, the provision of comprehensive facilities and infrastructure to cater to the needs of mangrove ecotourism tourists (SO2); thirdly, empowering communities, including fishermen, farmers, craftsmen, and women's groups, to establish mangrove-based industries and household-scale businesses (SO3); and fourthly, enhancing the role of non-governmental organizations (NGOs) in promoting public knowledge and awareness of effective mangrove management practices (SO4).

Additionally, the strategy also focuses on leveraging strengths to mitigate potential threats (strengths-threats strategy). This involves implementing strict regulations to curtail activities that could cause damage in and around mangrove areas (ST1), fostering community involvement based on environmental entrepreneurship and online natural resource management (ST2), and adopting integrated and sustainable mangrove management practices to ensure the ecosystem's long-term viability (ST3). This aligns with the findings of Chakraborty et al. (2019), which suggest that planned sustainable development practices can reduce the potential threat of biodiversity loss. On the other hand, efforts to conserve mangrove natural resources can be pursued while ensuring the maintenance of ecological and economic balance (Matani et al., 2021).

Moreover, the strategy aims to capitalize on existing opportunities to mitigate identified weaknesses through the weaknesses-opportunities strategy. Key initiatives encompass providing training to bolster the diversification of mangrove economic products (WO1), fostering engagement with stakeholders, companies, and community organizations in collaborative mangrove management and conservation endeavors (WO2), enhancing community involvement in the stewardship of adjacent mangrove resources (WO3), and conducting consistent training and coaching sessions on entrepreneurship and online marketing systems (WO4).

Finally, the strategy aims to address weaknesses and mitigate potential threats through the weaknesses-threats strategy. This entails enhancing government participation through outreach, mentoring, counseling, and training to safeguard the potential of mangrove development (WT1), engaging the community in the restoration of damaged mangrove areas (WT2), and providing training in the processing of various types of mangrove fruits into economically valuable products (WT3).

The coastal mangroves of Maros Regency exhibit significant potential for transformation into a thriving mangrove ecotourism destination. This potential is attributed to their easy accessibility and stunning natural beauty. Furthermore, the presence of abundant fish and crab resources, coupled with the community's adoption of eco-friendly fishing practices that safeguard the aquatic biota's habitat, serves to further bolster this potential. In certain regions, local inhabitants are actively involved in traditional cultivation, employing the silvofishery system. Notably, the engagement and commitment of various community groups in the vicinity of the mangrove area are noteworthy. These groups include members of fishing associations (UJUNG PAREPPA FISHERMEN GROUP), mangrove resource processing collectives (KUBE BINANGA SANGKARA I), and mangrove seedling provider associations (KUBE BINANGA SANGKARA II). Their active involvement underscores their dedication to the preservation and conservation of the mangrove ecosystem.

Nevertheless, despite these strengths, several weaknesses were identified. The absence of mentoring, training, and non-formal education programs has emerged as areas in need of improvement. Furthermore, the absence of garbage bins has led to littering in and around the mangrove area, posing a challenge to maintaining the mangroves sustainably. Additionally, communities currently lack the expertise required for the effective management of mangrove non-timber forest products to maximize their economic value. To tackle these issues, an assessment was conducted using participatory rural appraisal (PRA) and focus group discussion (FGD) methods. The outcomes of this assessment, detailing strengths and weaknesses in mangrove ecosystem management, are presented in *Tables 2* and *3*, providing weights and scores.

Table 2. *Internal factor analysis*

No	Internal Factors	Weight	Rating	Score
	Strengths			
1	Mangrove areas can be managed into ecotourism areas.	0.11	5	0.53
2	Mangrove forests offer substantial economic opportunities.	0.09	5	0.43
3	The local community employs eco-friendly fishing gear, minimizing disruption to aquatic habitats.	0.04	4	0.17
4	Implementation of forest management systems, policies and strategies that support development in their respective regions.	0.06	3	0.19
5	Local fishing groups around the mangrove forest area play an active and participatory role.	0.11	4	0.43
6	Some individuals are involved in and comprehend the significance of silvofishery system cultivation.	0.11	3	0.32
	Sum			2.06
	Weaknesses			
1	Community involvement in mangrove forest resource management remains limited.	0.09	2	0.17
2	The community lacks expertise in transforming mangrove non-timber products into economically valuable goods.	0.11	2	0.21
3	Non-formal education and training opportunities in mangrove management are lacking.	0.06	2	0.13
4	The productivity of mother/woman groups is still underdeveloped, often relying on the income of the family's primary breadwinner, typically a fisherman.	0.06	1	0.06
5	Disposal of garbage and waste within the mangrove forest area is a prevalent behavior.	0.09	3	0.26
6	Lack of local community involvement in activities related to coastal area development.	0.09	2	0.17
	Sum	1.00		1
	Total			1.06

Table 3. *External factor analysis*

No	External Factors	Weight	Rating	Score
	Opportunities			
1	There is an increasing trend in visits to ecotourism areas in South Sulawesi as part of environmental conservation efforts.	0.12	5	0.58
2	Non-governmental organizations (NGOs), academics, researchers, and other community stakeholders show a growing interest in integrating knowledge and raising public awareness about the importance of managing and protecting mangrove areas.	0.09	3	0.28
3	Effective management systems, government policies, and regulations are in place to protect mangrove areas.	0.07	3	0.21
4	Potential management of culinary businesses and handicrafts and souvenirs typical of the area around the mangrove forest area.	0.09	3	0.28
5	The expansion of access, online advertising, sales, and product purchases enables them to be accessible to a wider audience.	0.09	4	0.37
6	Accessibility to the mangrove forest area is easy to reach.	0.12	3	0.35
	Sum			2.07
	Threats			
1	Mangrove forests are being converted into ponds by individuals and companies located outside of the mangrove areas.	0.09	3	0.28
2	Coastal erosion is a pressing issue along the coast of Maros-Pangkep Regency.	0.07	2	0.14
3	The mangrove areas are heavily polluted with plastic waste.	0.09	1	0.09
4	Mangrove forests are becoming increasingly limited and face critical conditions.	0.12	2	0.23
5	Growing competition with other mangrove areas.	0.05	3	0.14
	Sum	1.00		0.88
	Total			1.19

Some of the most significant opportunities and threats in mangrove management stem from the growing trend of mangrove ecotourism in South Sulawesi. This trend offers a valuable opportunity to preserve the role of mangrove areas as economic assets. Furthermore, the collaboration among NGOs, academics, researchers, and stakeholders facilitates the integration of knowledge and awareness regarding the importance of protecting mangrove forest areas, which is also a favorable opportunity. Moreover, the region's rich handicrafts and culinary offerings serve as special attractions for tourists, leveraging South Sulawesi's renowned reputation in these domains. The widespread accessibility, advertising, and online sales and purchases of products further expand this opportunity, making it accessible to a diverse audience.

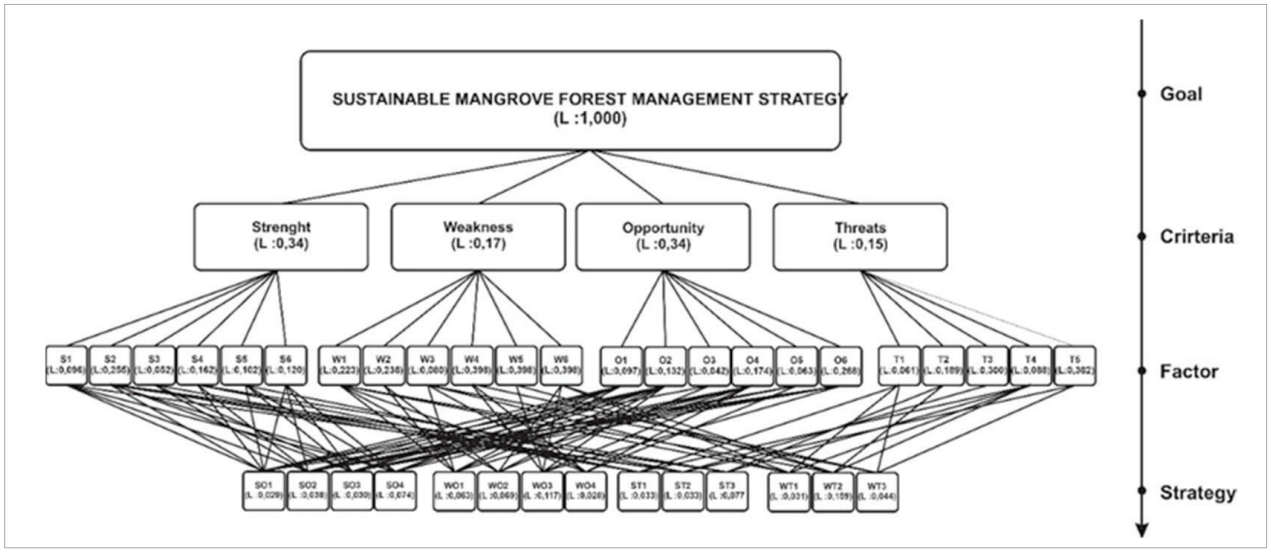
However, certain challenges persist. The conversion of mangrove forests into ponds by both individuals and companies threatens the integrity of the existing mangrove ecosystem. Coastal erosion remains a concern as it disrupts the natural propagation of mangroves. Another troubling issue is the pervasive presence of plastic waste in and around the mangrove area, posing a serious threat to the growth and reproduction of mangrove species and jeopardizing the overall health and balance of the ecosystem. These threats necessitate careful attention and prompt action to ensure the preservation and sustainable management of mangrove areas.

Sustainable mangrove forest management strategy using the integration of SWOT and AHP analysis

The factors identified through the SWOT analysis are subsequently subjected to further analysis using AHP, employing Expert Choice software to derive alternative strategies through pairwise comparisons. The hierarchical chart illustrating the integration of SWOT and AHP is presented in *Fig. 2*.

In *Fig. 2*, the initial step involves a broad comparison of group-level SWOT criteria, aiming to assess the relative importance of maximizing strengths, limiting weaknesses, capitalizing on opportunities, and mitigating threats. Aligned with the research objectives, which aim to develop a sustainable mangrove forest management strategy in support of SDGs 14, the highest priority is assigned a value of 1.000. To achieve this overarching strategy, specific criteria are derived from the elements of the SWOT analysis, namely strengths, weaknesses, opportunities, and threats. Within these criteria, strengths and opportunities are deemed of utmost significance, each assigned a value of 0.34. Each criterion further encompasses 6 factors for strengths, weaknesses, and opportunities, while threats consist of 5 factors, each with its unique value. To formulate effective strategies in alignment with the research objectives, these factors are subsequently combined with elements from other criteria to generate strategic ideas. Among the generated ideas, three strategies emerge

Fig. 2. *Hierarchy chart on SWOT and AHP integration*



with the highest values: SO1 (0.137), SO3 (0.132), and SO2 (0.127). Consequently, these three strategies are deemed as the primary focus for achieving sustainable mangrove forest management, which aligns with SDGs 14. The level of SWOT group criteria results obtained can be seen in *Fig. 3*.

Fig. 3 provides an overview of the prioritization of SWOT group criteria. The highest priority is attributed to the maximization of existing strengths and the utilization of external opportunities, achieving a score of 0.344. In contrast, the lowest priority is assigned to the avoidance of threats, with a value of 0.146. Following this, a prioritization process ensues among individual SWOT factors, involving a comparative analysis of factors within each category, encompassing strengths, weaknesses, opportunities, and threats. Detailed results of these comparisons are elaborated upon in *Figs. 4, 5, 6*, and *7*.

In *Fig. 4*, the most prominent strength factor is the potential to manage mangrove areas as ecotourism destinations, holding a value of 0.256. Conversely, the lowest-ranking strength factor pertains to the community's use of environmentally friendly fishing gear and their minimal disruption of the habitat of aquatic biota, with a value of 0.082.

In *Fig. 5*, the most significant weakness factor is the community's disposal of garbage and waste in and around the mangrove forest area, scoring a value of 0.260. On the other hand, the least impactful weakness factor pertains to the productivity of the mother/woman group, which is still notably low, and their reliance on the income of the family's primary breadwinner, who typically works as a fisherman, with a value of 0.060.

Mangroves worldwide face significant anthropogenic pressures, including the discharge of sewage and plastic waste in and around mangrove ecosystems. These pollutants not only hinder mangrove growth but also lead to mangrove mortality. Research results have indicated that areas of the forest floor covered with 100% plastic exhibit a decrease in the area index and a substantial decline in survival (Bijsterveldt et al., 2021). A noteworthy point is that most mangroves, possessing a breathable root system, are exposed to the air, exemplified by species such as *Avicennia sp*

Fig. 3. *Comparison between criteria*

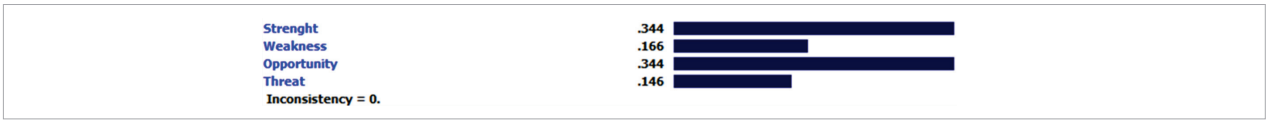


Fig. 4. *Comparison between factors on the element of strength*

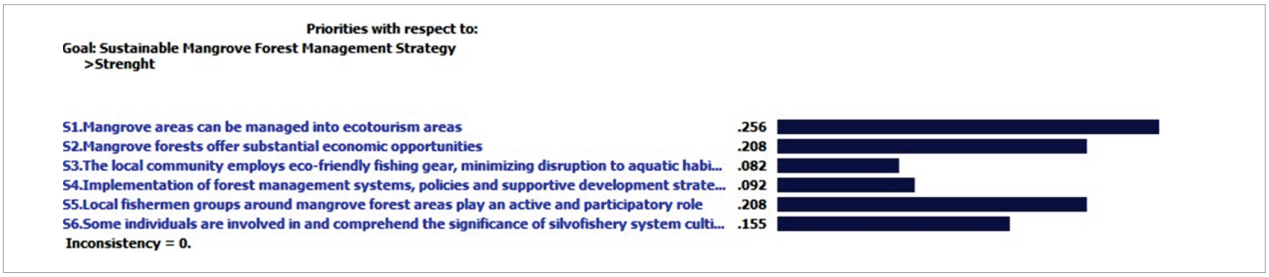


Fig. 5. *Comparison between factors on the element of weaknesses*

and *Sonneratia sp.* Consequently, they are particularly susceptible to suffocation due to the suffocating effect of plastic waste on pneumatophores and knee roots (Tomilson, 2016; Chen et al., 2018; Horstman et al., 2017; Martin et al., 2019). Hence, there is a pressing need to empower women's groups, especially, through training aimed at recycling plastic waste into economically valuable handicrafts.

In *Fig. 6*, the most significant opportunity factor is the increasing trend of visits to ecotourism areas in South Sulawesi, within the context of environmental conservation efforts, with a value of 0.280. Conversely, the least impactful opportunity factor pertains to the management systems, policies, and strategies that support and the government regulations aimed at protecting mangrove areas, scoring a value of 0.101.

Fig. 7 indicates that the most significant threat factor, with a value of 0.318, is the conversion of mangrove forests into ponds conducted by individuals or companies located outside the mangrove forest area. On the other hand, the least impactful threat factor, with a value of 0.102, pertains to the amount of plastic waste in the mangrove forest area. Moreover, the comparison between alternative strategies formed from a combination of factors within the SWOT analysis is illustrated in *Fig. 8*.

The development of sustainable mangrove ecosystem management strategies focuses on opportunities, strengths, weaknesses, and threats that are expected to accelerate the achievement of SDGs 14, which include:

- Sustainable development goal 14 (SDG 14) emphasizes the necessity of conserving and utilizing oceans and marine resources sustainably to promote overall sustainable development.
- SDG 14.1 focuses on mitigating and significantly reducing marine pollution, especially that originating from land-based activities such as marine litter and nutrient pollution.
- SDG 14.3 aims to decrease and mitigate the impacts of ocean acidification and encourages increased scientific collaboration at all levels to address this issue.
- SDG 14.7 seeks to enhance the economic benefits of sustainable marine resource utilization, particularly for small island developing states and least developed countries. This encompasses the sustainable management of fisheries, aquaculture, and tourism.
- SDG 14.A aims to advance scientific knowledge, foster research capacity, and facilitate the transfer of marine technology, all while adhering to the Intergovernmental Oceanographic Commission's Criteria and Guidelines for Marine Technology Transfer. The ultimate goal is to improve ocean health and increase the contribution of marine biodiversity to the development of emerging countries, especially small island developing states and least developed nations.

Fig. 6. *Comparison between factors on the element of opportunity*

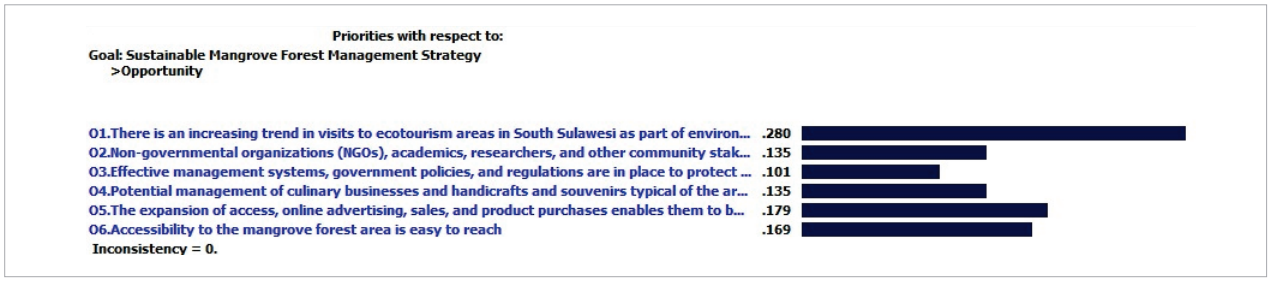


Fig. 7. *Comparison between factors on the threat element*

Based on the integrated analysis of SWOT and AHP, five priority strategies have been identified within the Sustainable Mangrove Forest Management Strategy to expedite the achievement of SDGs 14, as depicted in *Fig. 8*, as follows:

1 Promoting the development of economically and environmentally sustainable mangrove ecosystems through practices like silvofishery (SO1). Silvofishery, which involves environmentally friendly planting and harvesting, has demonstrated its potential to increase farmers' incomes and positively impact mangrove conservation (Susilo et al., 2018). It serves as a complementary solution for mangrove ecosystem conservation and supports SDG 14 by emphasizing the need to conserve and sustainably use oceans and marine resources for overall sustainable development. It also aligns with SDG 14.2 by promoting the sustainable management and protection of marine and coastal ecosystems.

2 Empowering communities, including farmers, fishermen, and women's groups, to establish small-scale mangrove-based industries (SO3). The formation of fishermen groups aims to enhance members' self-sufficiency in business activities, thus improving household economies (Adi et al., 2018; Amal Arfan et al., 2023). This strategy aligns with SDG 14.b, which aims to provide access to marine resources and markets for small-scale fishing workers, and SDG 14.7, which seeks to increase economic benefits and sustainable use of marine resources, including fisheries, aquaculture, and tourism.

3 Providing essential facilities and infrastructure for mangrove ecotourism visitors (SO2). This strategy supports SDG 14.b by ensuring access to marine resources and markets for small-scale fishing laborers.

4 Expanding the role of non-governmental organizations (NGOs) in enhancing community awareness and knowledge about mangrove management (SO4). NGOs serve as vital intermediaries that bridge government interests with the needs of local communities (Kurniawati et al., 2021). This strategy aligns with SDG 14.a, focusing on increasing scientific knowledge to enhance ocean health and maximize the contribution of marine biodiversity to the development of developing countries.

5 Offering training to diversify mangrove economic products (WO1). This strategy supports SDG 14.b by facilitating access to marine resources and markets for small-scale fishing labor and SDG 14.a by promoting scientific knowledge to improve ocean health and bolster the contribution of marine biodiversity to developing countries' development.

Fig. 8. *Comparison of strategies*

Conclusions

The integration of SWOT-AHP proves to be an effective approach for formulating strategies in Mangrove Ecosystem Management that align with Sustainable Development Goals. Among the various approaches considered, the strengths-opportunities (SO) strategy is chosen, emphasizing the utilization of strengths to leverage existing opportunities. These strategies are designed to contribute to the attainment of SDGs 14 and encompass a range of initiatives, including the development of sustainable and economically valuable

mangrove resources through environmentally friendly practices, the establishment of comprehensive facilities and infrastructure to promote mangrove ecotourism, the empowerment of local communities to create mangrove-based industries and small-scale businesses, and the involvement of NGOs to enhance public awareness and comprehension of mangrove management. These measures are vital for the conservation and protection of mangrove ecosystems while aligning with the broader objectives of sustainable development.

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