Rapseaweed analysis on the sustainability of seaweed cultivation activities in the waters of East Sumba Regency, East Nusa Tenggara Province, Indonesia

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Abstract. The sustainable use of seaweed resources is essentially a management goal that ensures the level of resource utilization does not cause damage or exceed its recovery capacity, thereby allowing it to meet the needs of both current and future generations. This study was conducted from July 2022 to January 2023 at several coastal locations engaged in seaweed farming in East Sumba Regency. The study measured five dimensions: economic, technological, social, institutional, and ethical. Each dimension consisted of several attributes analysed using Rapseaweed analysis. The results showed that one dimension needed improvement, namely the ethical dimension, with a sustainability index score of 39.8%. Meanwhile, the other four dimensions showed sustainability index values ranging from fairly sustainable to highly sustainable. The economic dimension had an index score of 70.26%, placing it in the fairly sustainable category. The technological dimension had a sustainability index score of 75.50%, categorized as highly sustainable. The social dimension had a sustainability index score of 84.15%, also categorized as highly sustainable. The institutional dimension achieved a sustainability index score of 94.18%, classified as highly sustainable, while the ethical dimension had a sustainability index score of 39.8%, categorized as unsustainable. Based on the results of the study, it can be concluded that seaweed farming activities in East Sumba Regency, East Nusa Tenggara Province, are in a highly sustainable condition. In order to improve the sustainability status, policymakers should consider the main attributes that have high leverage, which include by-products, conservation areas, conflict levels, community participation, security and waste disposal.
Keywords: East Sumba waters, *Kappaphycus alvarezii*, sustainability status.

Introduction. Regional development is an effort to build and develop an area based on a spatial approach by considering socio-cultural, economic, physical environment and institutional aspects in an integrated development planning and management framework (Alkadri 1999). Regional development must be an effort to grow the regional and local economy, so that the region can grow and develop independently by utilizing local resources. This strategy of regional development that relies on local resources is known as the concept of Local Economic Development. Spaces that have considerable potential in regional development are coastal and marine areas. Coastal areas have diverse natural resources, both renewable and non-renewable resources. In coastal areas, the fisheries sector is the main sector on which people depend (Nugoroho & Dahuri 2004). Based on the Ministry of Maritime Affairs and Fisheries in 2022 (Statistics and Information Center of the Ministry of Maritime Affairs and Fisheries 2022), the development of the fisheries sector in Indonesia, which is quite productive each year at 10.29%, has increased by 16.34% in the 2020-2021 period for aquaculture. Seaweed cultivation is also one of the

leading commodities as a generator of state revenue, based on FAO, Indonesia has become the largest seaweed exporting country in the world since 2007, and has increased every year (FAO 2018).

Seaweed is one of the leading commodities because this commodity has a high economic value and can absorb high labour (Ikhsan 2013). East Sumba Regency is one of the regencies in East Nusa Tenggara (ENT) that has a seaweed factory, namely PT Astil Sumba Timur, which has the potential to be developed. Based on the potential of coastal and marine resources in the province of ENT and East Sumba Regency in particular, efforts to optimize the utilization of these resources need to be explored and pursued as much as possible (Department of Maritime Affairs and Fisheries of East Nusa Tenggara Province 2020). Currently, most of the national seaweed production is still exported in the form of dried seaweed, amounting to 156.380 tons (65.8%), while only 81.394 tons (34.2%) are supplied to the industry (Central Bureau of Statistics 2020). Seeing the potential, there is still a great opportunity to increase added value through down streaming, especially in seaweed processing. For this reason, it is necessary to know the influential factors and regional typology of seaweed development, so that later it can provide an overview of how local economic development efforts can be carried out further based on the development cluster. Therefore, seaweed cultivation is expected to provide means to increase community income in coastal areas (Central Bureau of Statistics 2020).

Material and Method

Research time and location. The present research has been carried out for the waters of East Sumba Regency, from August 2022 to January 2023.

Material and tools. The method used in this research is Rapid Appraisal for Fisheries (Rapfish). Rapfish is a multi criteria analysis (MCA) method, which is operated with an ordination technique (placing in the order of measurable attributes) using multidimensional scaling (MDS) (Fauzi & Anna 2005; Muhsoni et al 2021) which is used to determine the sustainability status of efforts to utilize fisheries resources. The variables used to calculate the sustainability of seaweed development in East Sumba Regency are the economic dimension, social dimension, technological dimension, institutional dimension and ethical dimension. Rapseaweed analysis is a modification of the Rapfish program. This research was conducted through seven stages. The first stage is to determine the five dimensions to be analyzed. The five dimensions are economic (3 attributes), social (3 attributes), technological (3 attributes), institutional (3 attributes) and ethical (3 attributes). The second stage is the scoring of sustainable aspects in each dimension (on a scale of 1-3). Third is the presentation of scoring results on an ordinal scale with multidimensional scaling (MDS) analysis. The fourth is determining the position of management on the good and bad ordinal. Fifth is the analysis of attribute stability with Monte Carlo Analysis. Sixth is the identification of sensitive attributes with sensitivity analysis (leverage analysis). This identification is used to determine which attributes are sensitive to changing ordination. Seventh is the depiction of the sustainability index scale in a kite diagram (Pitcher & Preikshot 2001).

This research was conducted in East Sumba Regency from August 2022 to January 2023. Data collection was conducted by distributing questionnaires. The questionnaires were distributed using a three-level Likert scale that states the categories and ratings being measured. Answer options zero (0) means low, one (1) means medium, two (2) means high, and three (3) means very high (Table 1). The total number of respondents in this study was 170 respondents. Respondents who filled out the questionnaire were people who had carried out activities directly and were related to the object of this research, namely from East Sumba district. The determination of these respondents follows the guidelines which explain that the number of respondents for the test is recommended to be at least 30 respondents (Muhsoni et al 2021).

Research variable. The parameters observed in the study were the economic dimension, technology dimension, social dimension, dimension of institutionality, and ethical dimension. The independent variables in this study are the seaweed while the dependent variables are economic dimension, technology dimension, social dimension, dimension of institutionality, and ethical dimension (Table 1).

Table 1

Dimensions and attributes

Dimensions	*Good*	*Bad*	*Attributes*
Economic dimension	3	0	- Economic value (regional min. wage) of ENT Province
	3	0	- Livelihood sourcing
	3	0	- Subsidy dependency
	3	0	- Contribution to original local government revenue (PAD)
	3	0	- Profit distribution > 50%
	3	0	- Seaweed fertilizing manpower
	3	0	- Business prospect
	3	0	- Income relative to regional minimum wage (RMW)
Technology dimension	3	0	- Type of cultivation technology
	3	0	- Seaweed cultivation area
	3	0	- Location of technology placement
	3	0	- Safety of technology for farmers
	3	0	- Technology threatens coral reefs, seagrass ecosystems
	3	0	- Boat landing site
	3	0	- Post-harvest
Social dimension	3	0	- Education level
	3	0	- Knowledge of seaweed farming
	3	0	- Level of conflict
	3	0	- Cultivators' concern for ecosystem sustainability
	3	0	- Participation of family members (nuclear family)
	3	0	- Ownership status
	3	0	- Cultivators' contribution to the development of the seaweed industry
Dimension of institutionality	3	0	- Cooperatives needed for seaweed business
	3	0	- Formal financial institutions for seaweed business
	3	0	- Non-formal institutions in seaweed business
	3	0	- Seaweed nursery unit
	3	0	- Central government's attention to seaweed business
	3	0	- Central regional attention to seaweed business
	3	0	- Attention to the seaweed effort
	3	0	- Seaweed products processing group
Ethical dimension	3	0	- Legal regulations
	3	0	- Violation of the law
	3	0	- Mitigation of ecosystem damage
	3	0	- Mitigation of habitat damage
	3	0	- Waste disposal
	3	0	- Local wisdom
	3	0	- The role of cultivators in policy

Data analysis. The data were analyzed descriptively. Table 1 is a description of the respondents who will be analysed using several predetermined indicators or attributes. Analysis of the sustainability of grass cultivation business development in East Sumba district was carried out with a Multi-Dimensional Scaling (MDS) approach called RAPFISH (Pitcher & Preikshot 2001), then strengthened with the Monte Carlo test then to find out the most influential attributes as levers, leverage analysis was carried out. Each attribute that has been compiled and filled with existing data conditions is then analyzed using MDS, then the sustainability index of each dimension is obtained (Table 2).

Table 2
Value of sustainability status index in seaweed cultivation business management in East Sumba Regency

No	*Index value*	*Categories sustainability*
1	0-25	Unsustainable
2	>25-50	Less sustainable
3	>50-75	Quite sustainable
4	>75-100	Highly Sustainable

Source: Purwaningsih & Santosa (2015)

Results. Seaweed is a very easy commodity to develop with relatively good value in the world market. Along with this, this activity will continue to exist and take place if high economic value is obtained. To determine the sustainability status of seaweed aquaculture from the economic dimension, 9 attributes are used as indicators to assess the status of economic sustainability. The attributes used as indicators in assessing the status of economic sustainability include (1) economic value (RMW) of ENT province; (2) marketing; (3) source of livelihood; (4) subsidy dependency; (5) contribution to original local government revenue (PAD*)*; (6) profit distribution; (7) seaweed cultivator labour; (8) business prospects; and (9) income relative to regional minimum wage (RMW).

Based on the results of the Rapseaweed analysis, which is a modification of the Rapfish program, the sustainability index value is 70.26% and is included in the moderately sustainable category (Figure 1).

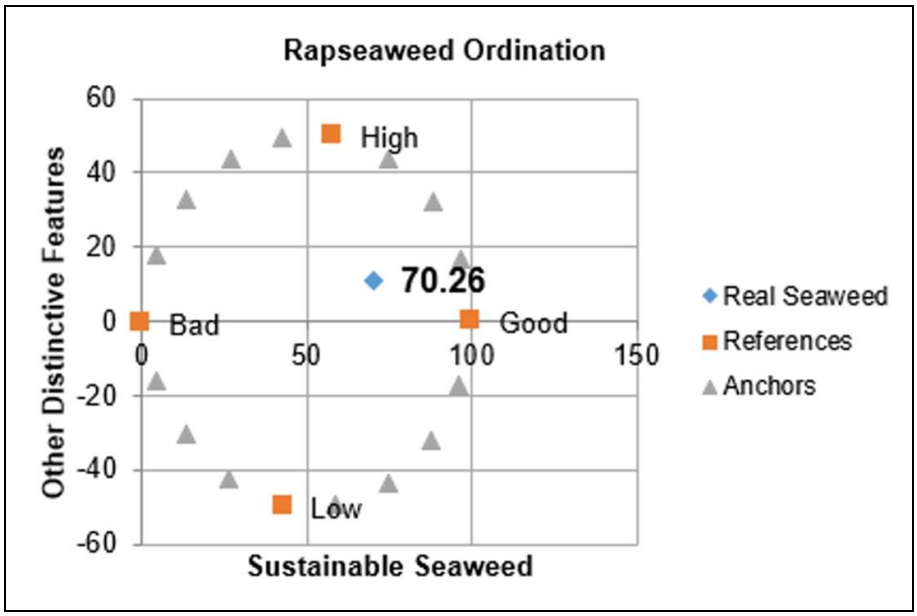

Figure 1. Sustainability index value of economic dimension.

The results of the leverage analysis show that the attributes of contribution to PAD and seaweed farmer labour are the most sensitive to affect the sustainability of the economic dimension. Changes to these two sensitive attributes will easily affect the increase or decrease in the sustainability index value. The results of the leverage analysis are presented in Figure 2.

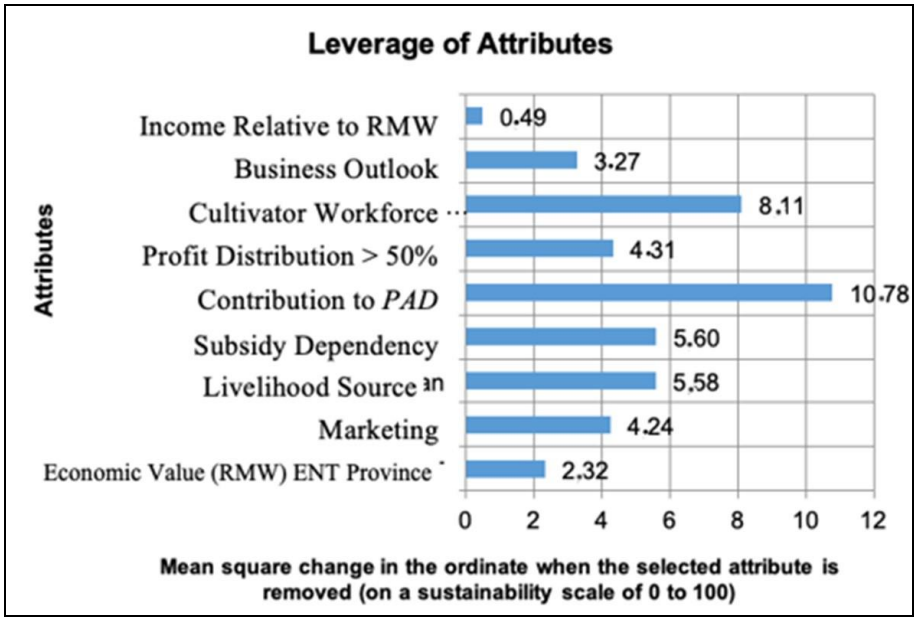

Figure 2. Economic dimension attribute values.

The contribution of seaweed farming activities to PAD is the most sensitive attribute. This means that seaweed cultivation activities in East Sumba have not been maximized. Less than optimal management of coastal and marine areas will have an impact on the contribution to PAD. The development of coastal and marine areas is not only done through seaweed cultivation activities but must be developed together with other sectors. This is done to increase the role of the fisheries sector to contribute more to increasing PAD in East Sumba. Government efforts in increasing PAD can be made by making policies that support the development of seaweed aquaculture activities, so that if this activity develops, the income of local communities and contributions to PAD will also increase because with the development of seaweed aquaculture businesses, it is expected that the trade and industry sectors will also develop.

Another sensitive attribute is the seaweed cultivator workforce. The availability of labour in a business is very important, and the role of the presence of a business or regional development must be able to have a positive impact on the surrounding community, through employment opportunities. The availability of sufficient workforce with good education will provide progress for the business being run, as well as regional progress. The process of developing opportunities, willingness/motivation, and the ability of the community to have more access to resources, thus increasing their capacity to determine their own future by participating in influencing and realizing the quality of life of themselves and their communities. The existence of a community involvement program to become a seaweed cultivation workforce properly and evenly in each village will be able to increase the ability of coastal communities to utilize the potential of existing natural resources, so as to improve their welfare, so that dependence on activities that can damage the environment can be reduced.

The application of technology in seaweed cultivation is highly dependent on water conditions. Appropriate technological information in its use will be able to increase the productivity of waters so that they can be utilized as well as possible and reduce negative impacts on environmental conditions and other coastal resources. In seaweed cultivation, there are several methods that can be used, namely long line, raft or bottom release. The use of the right method will provide good quality results and reduce the high cost of cultivation. The existence of the technology dimension reflects how far the use of technology can minimize the risk of failure of the sustainable use of natural resources and the environment (Susilo et al 2003).

The sustainability dimension of technology is organized based on 7 attributes, namely: (1) type of cultivation technology, (2) cultivation area, (3) location of technology placement, (4) technology that threatens coral reef ecosystems, (5) threats

to technology, (6) boat landing sites, and (7) post-harvest handling. The results of the Rapseaweed analysis of the technology dimension obtained a sustainability index value of 75.50% with a very sustainable status category as presented in Figure 3 below.

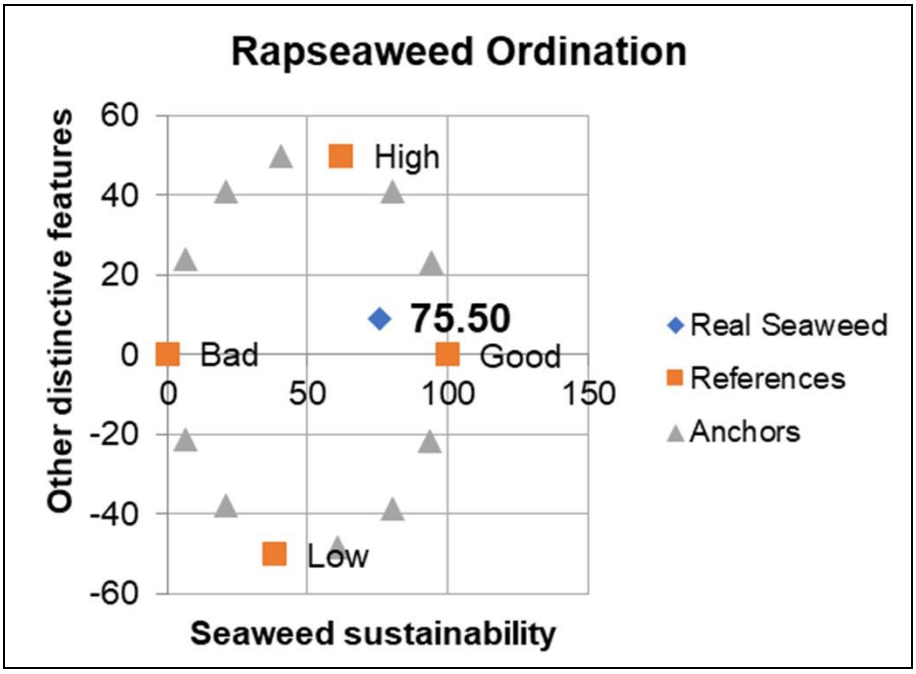

Figure 3. Sustainability index value of technology dimension.

The results of the leverage analysis show that the threat to technology attribute is the most sensitive attribute affecting the sustainability of the technology dimension. The results of the leverage analysis are presented in Figure 4 below.

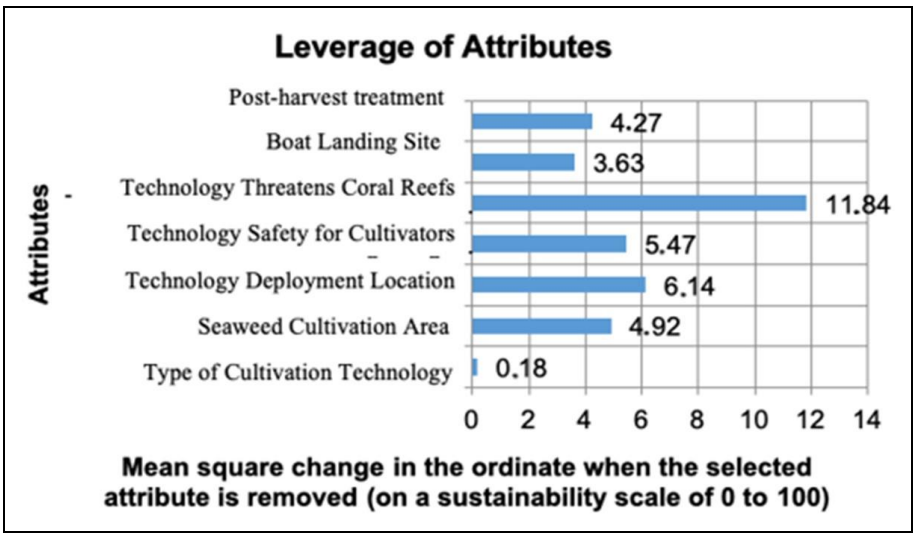

Figure 4. Technology dimension attribute values.

The presence of technology in seaweed farming can also pose a threat to the surrounding ecosystem, especially to the existence of coral reef ecosystems. Seaweed cultivation is located in the upper layer of the surface, so its presence can cause threats to the ecosystem below, such as coral reefs. Threats that can be caused by seaweed cultivation activities are in the form of obstruction of sunlight entering the water, thus disrupting the photosynthesis process. However, as an effort to prevent this, it can be done by structuring the cultivation construction and planting distance, so that it does not cause disturbance to other ecosystems.

The application of technology is very important in seaweed cultivation activities.

The accuracy of cultivation technology according to standards will provide increased production and quality of seaweed. In general, there are three methods of seaweed cultivation, namely the basic method, bottom-release and floating method (long line) (Afrianto & Liviawati 1993). The cultivation method developed at the research site is basic release, which is a seaweed cultivation system carried out on the bottom of the water with a maximum depth of 4 meters at high tide and 0.2 at the lowest ebb (SNI 2011). The standard set is 10x10 meters. The construction size can be more than the standard size set. This depends on the condition of the area, if the slope is relatively far, then the construction size can be increased with consideration, planting distance and seeds used according to the standard.

The social dimension of sustainability is organized based on 7 attributes, namely: (1) level of education, (2) knowledge of seaweed cultivation, (3) level of conflict, (4) cultivators' concern for ecosystem sustainability, (5) participation of family members (nuclear family), (6) ownership status, and (7) seaweed cultivators' contribution to the development of the seaweed industry in East Sumba Regency. The results of the Rapseaweed analysis of the social dimension obtained a sustainability index value of 84.15% with a very sustainable status category as presented in Figure 5.

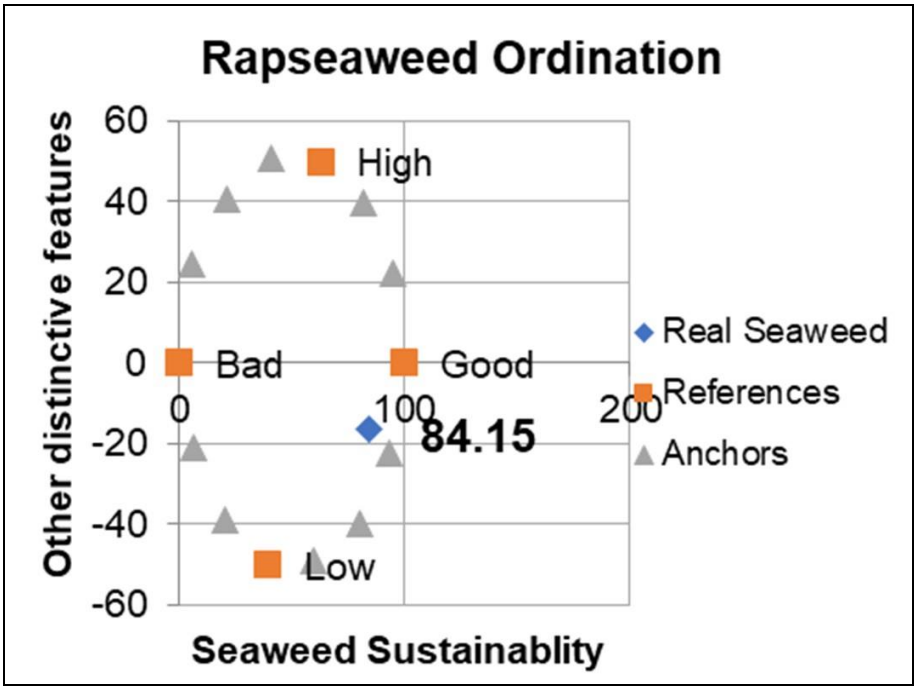

Figure 5. Sustainability index value of the social dimension.

The results of the leverage analysis show that the conflict level and education level attributes are the most sensitive attributes affecting the sustainability of the social dimension. The results of the leverage analysis are presented in Figure 6 below.

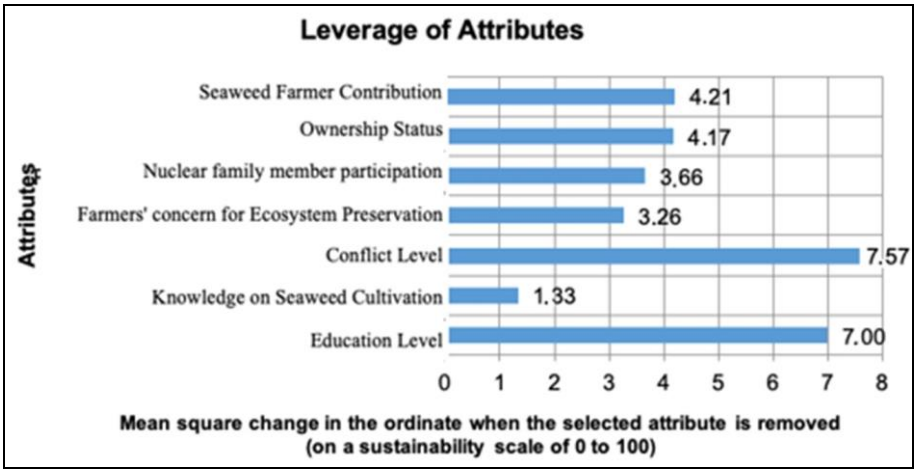

Figure 6. Social dimension attribute values.

Seaweed cultivation activities use sea surface space, so this can lead to conflicts in the community. Common conflicts are between seaweed farmers, fishermen and ecotourists (Fitriana & Stacey 2012). Cultivation activities that do not pay attention to the suitability of marine space and the carrying capacity of waters are one of the causes of conflict (Satria & Matsuda 2004). The suitability of marine space is important to consider in aquaculture activities, especially in the placement of aquaculture constructions (Soto et al 2008; GESAMP 2001). In planning coastal development, it is essential to consider the preservation of boat access lanes used by local fishers to maintain their livelihood activities and avoid unintended displacement (FAO 2018). As explained by Bavinck et al (2013) this needs to be considered so as not to obstruct access to boat routes from fishing activities in the surrounding area. Meanwhile, according to Neori et al (2004), the carrying capacity of waters is intended to consider the ability of waters to accommodate seaweed cultivation activities that are safe for the existence of other ecosystems. The role of the government is very important because it is the holder of the authority and needs to make efforts to guide and supervise all utilization activities that occur both at sea and on land (FAO 2018).

In addition to the attribute "Level of education" seaweed farmers are sensitive to the sustainability of seaweed management in the social dimension, because: (1) mastery of technology is influenced by the level of education of seaweed farmers, (2) the ability to gain access to the widest possible market, (3) the ability to obtain information disclosure of price fluctuations, (4) the ability to obtain easy access to capital, (5) the ability to prevent speculators who enter and extend the trade chain, (6) the freedom of collectors in manipulating prices and controlling the trade chain, as well as the difficulty of strengthening the institutional system at the farm level due to low levels of education.

The level of education of seaweed farmers, both formal and non-formal, will influence the way of thinking applied to their business, thus affecting the ability to adopt technology. The level of education, which is still dominated by elementary and junior high school graduates, affects the way of thinking in the application of seaweed cultivation techniques. In addition, it is difficult for the community to accept new information or technological innovations, to be able to apply the correct way of cultivating seaweed according to the Indonesian National Standard (SNI 2011) in increasing production. In this case, the government must be present in fostering and providing training to the cultivator community, in order to create quality human resources to improve the standard of living.

The institutional dimension of sustainability is organized based on 8 attributes, namely: (1) cooperatives, (2) formal financial institutions, (3) non-formal institutions, (4) seaweed nursery units, (5) central government attention to seaweed businesses in East Sumba district, (6) local government attention to seaweed businesses, (7) attention of extension workers to seaweed businesses, and (8) seaweed business processing groups. The results of the Rapseaweed analysis of the institutional dimension obtained a sustainability index value of 94.14% with a very sustainable status category (Figure 7).

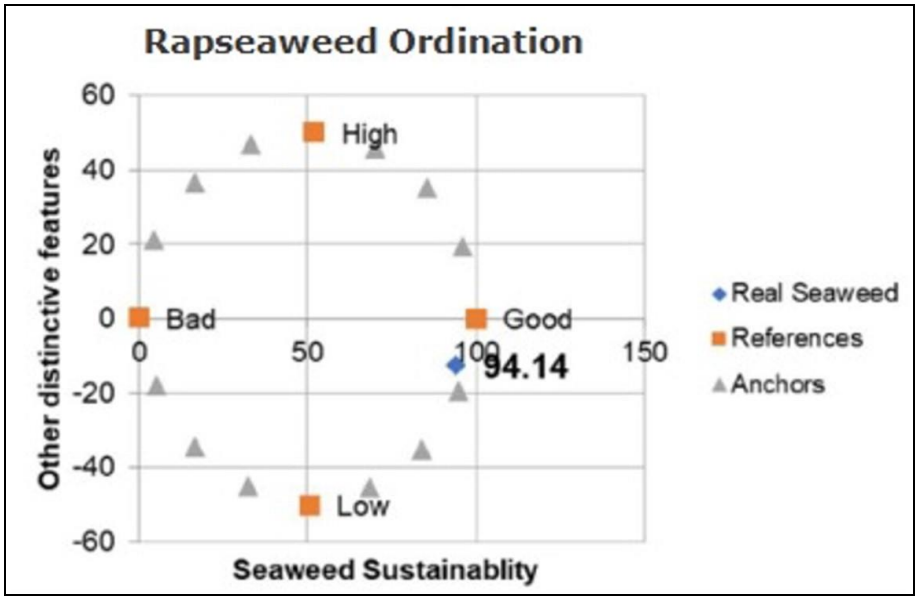

Figure 7. The value of the sustainability index of the institutional dimension.

The results of the leverage analysis show that the cooperative institution attribute is the most sensitive attribute affecting the sustainability of the institutional dimension (Figure 8).

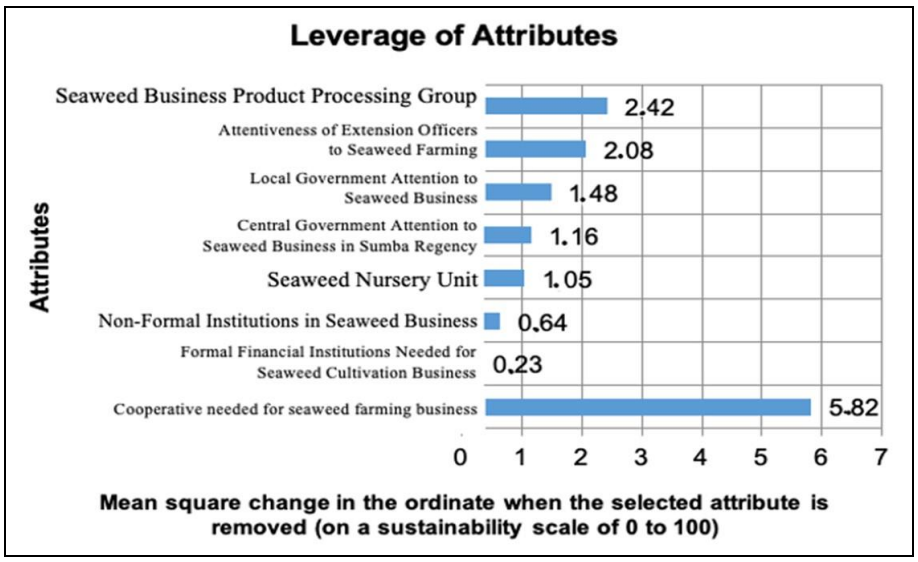

Figure 8. Institutional dimension attribute values.

Although farmers prefer to borrow capital from small collectors rather than cooperatives (large collectors), the presence of cooperatives in seaweed cultivation businesses run by the community provides certainty in terms of capital. This is because capital is the core of every business. Without capital, the business will not be able to grow and become bigger. The presence of cooperative institutions is expected not only to provide capital assistance for cultivators who do not have or lack capital, but these cooperative institutions must be able to play a greater role in regulating the marketing system, especially the appropriate purchase price and minimizing marketing margins by shortening the marketing chain. In addition, this institution must also be able to control the quality of seaweed, in terms of post-harvest handling to maintain the quality of seaweed.

The presence of cooperative institutions for the fisheries sector, both capture and aquaculture, aims to prevent people from borrowing money from middlemen, because this can be detrimental to the cultivators themselves. It is common that when middlemen

provide capital loans, the return of the loan capital is often much higher, making it burdensome for the farmers. In addition, middlemen also act as collectors, who can play the buying price, thus affecting the income of seaweed farmers. For this reason, the role of the government is needed in the establishment of cooperative and non-cooperative institutions to ensure the availability of capital for farmers to be able to run and develop seaweed farming businesses to remain sustainable. In addition, the role of cooperatives is expected to be able to regulate the post-harvest process to ensure quality, and more importantly the presence of cooperatives must be able to regulate the marketing chain to provide better prices for seaweed farmers in East Sumba Regency.

The sustainability of the ethical dimension is structured based on 7 attributes, namely: (1) laws and regulations, (2) violations of laws/regulations, (3) mitigation of ecosystem damage, (4) mitigation of habitat damage, (5) waste disposal, (6) local wisdom, and (7) the role of cultivators in making policies. The results of the Rapseaweed analysis of the ethical dimension obtained a sustainability index value of 39.88% with the category of unsustainable status as depicted in Figure 9.

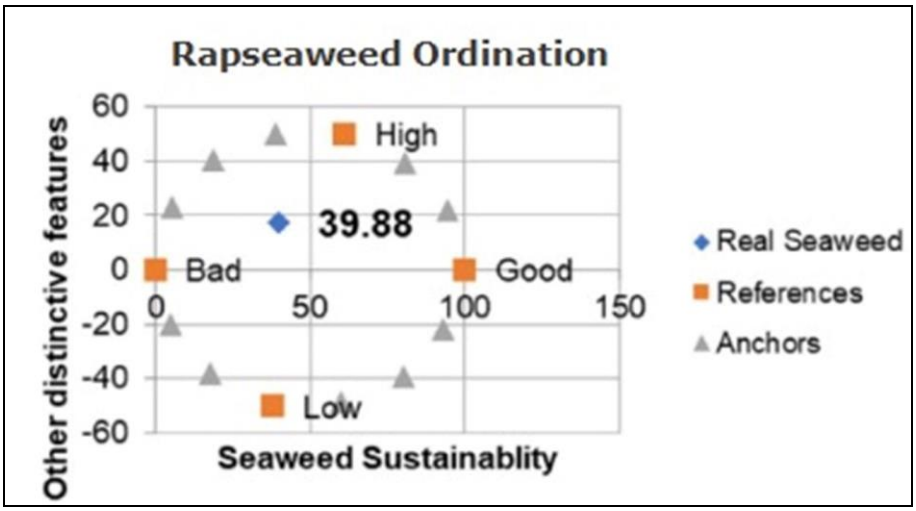

Figure 9. Ethical dimension sustainability index value.

The results of the leverage analysis show that the attributes of violation of laws/regulations and the existence of local wisdom (customary rules) are the most sensitive attributes affecting the sustainability of the ethical dimension (Figure 10).

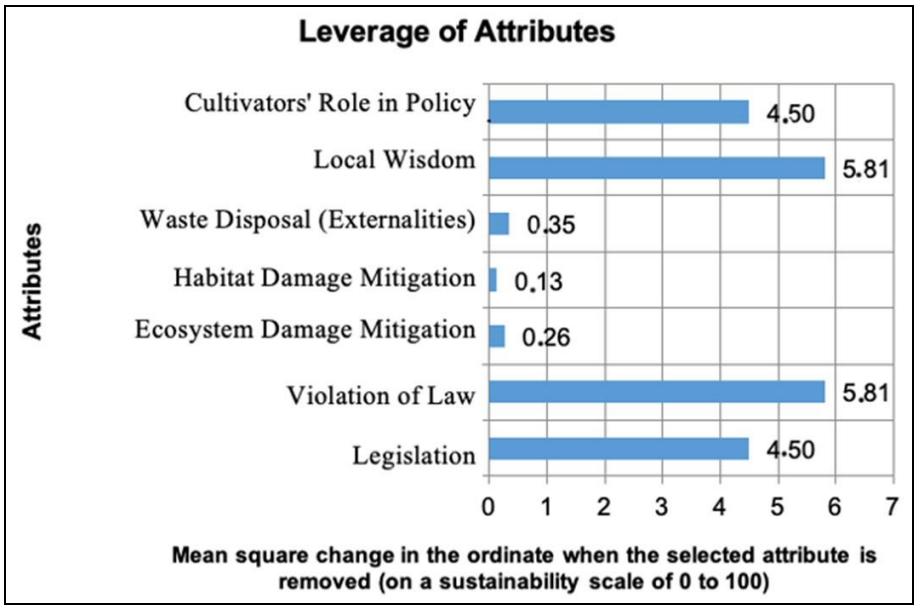

Figure 10. Ethical dimension attribute values.

The lack of customary rules (local wisdom) in seaweed farming locations in East Sumba Regency causes frequent violations committed by farmers. For the sustainability of the ethical dimension, it is necessary to provide local/customary rules that regulate seaweed cultivation activities. In addition, there also needs to be local/customary sanctions for perpetrators of rule violations so that they can reduce rule violations such as land grabbing and theft. Therefore, there is a need for socialization, counselling and community involvement in making local rules.

Discussion. The sustainability index in the economic dimension produces a value of 70.26%, meaning that the economic dimension is included in the moderately sustainable category because it is in the range of index values > 50 - 75. As explained by Purwaningsih and Santosa (2015), the status of sustainable management index value is > 50 -75.

This means that the development of seaweed aquaculture in the economic aspect is quite sustainable. The results of the leverage of attributes analysis of sustainability in the economic dimension show the most influential attributes, namely economic improvement with a leverage value of 4.50 as well as it is depicted in other studies (Githa et al 2020; Oedjoe et al 2026). This shows that seaweed farming can improve the economy of the surrounding community. This means that the activity shows a fairly high economic performance because it is able to provide great benefits to business actors/cultivators (Marzuki et al 2017; Oedjoe et al 2026). In addition, seaweed farming activities provide an opportunity to be used as a source of new economic growth and a driver of economic improvement in coastal areas, especially in the coastal areas of East Sumba. However, in order for sustainability to occur in the future, attributes that have a negative impact must be immediately corrected, while those that have a positive impact must be maintained and improved, so that seaweed farming activities in East Sumba remain sustainable (Radulovich et al 2015; Oedjoe et al 2026). Regarding overall sustainability, the seaweed farming industry in East Sumba is generally sustainable, with sustainability index values ranging from 70 to 94.18%. Institutional dimension (94.18 - fairly sustainable): The highest sustainability value is found in the institutional dimension, which indicates that the support from local governance, policies, and institutional structures is strong. Institutions play a crucial role in enabling the long-term viability of the seaweed farming sector. As explained by Persoon et al 2003, regarding the principle of sustainable management with a multidimensional approach (economic, social, environmental, institutional).

The institutional dimension, which recorded the highest sustainability index (94.18%), reflects the strong influence of local policies and effective institutional structures, consistent with Ostrom's (1990) findings regarding the importance of institutions in managing shared resources. In the context of seaweed farming, local government support, local regulations, and institutional roles have been shown to be key factors in maintaining the sustainability of this industry (Waldron et al 2023).

Technology dimension (leverage of attributes - threat to coral reefs): The analysis highlights that one of the technological factors, namely technology that threatens coral reefs, is a significant challenge. This suggests that the farming practices or the tools used may have negative environmental impacts, especially on marine ecosystems. According to Gomez et al (1994), fishing using destructive technologies such as explosives and cyanide is one of the biggest threats to coral reefs in Southeast Asia. As explained by Burke et al (2011), threats to coral reefs from human activities include coastal farming, aquaculture, and the use of environmentally unfriendly technologies. As stated by Hughes et al (2003), the combined impact of technology and human pressure on coral reefs such as destructive fishing gear technology or waste from intensive farming is called a degradation factor. Wilkinson (2008) also explained that large-scale fishing, coastal reclamation, and motorboat-based tourism can threaten the sustainability of coral reefs. Spalding and Brown (2015) present offshore drilling technology and uncontrolled coastal development as major threats to coral reef ecosystems.

Economic dimension (leverage of attributes - economic improvement): The economic dimension shows that seaweed farming is positively contributing to the local

economy, particularly through the improvement of the livelihoods of surrounding communities. However, further economic benefits can likely be realized through better market access, training, and scaling of operations. Food and Agriculture Organization of the United Nations (2018) reports the economic impact of seaweed cultivation, including its contribution to increasing the income of coastal communities, as well as the importance of market access and training to increase economic value. Hurtado et al (2019) presents the impact of seaweed cultivation on improving the welfare of people in Southeast Asia, including Indonesia, as well as the importance of business scale and training. Likewise, Fitriana and Stacey (2012) explain the economic impact of seaweed cultivation on local communities in Eastern Indonesia and mention the need for training and market access to increase economic benefits. World Bank (2023) presents the importance of seaweed cultivation in improving the local economy and suggests increased market access and training.

Ethics dimension (39.8 - less sustainable): The ethics dimension, with a score of 39.8, is the lowest, indicating that ethical concerns, such as violations of regulations, lack of coordination between local authorities and customary institutions, and issues like land grabbing and theft, are significant obstacles to sustainability. Challenges in the ethics dimension: The lack of coordination between government and customary institutions is identified as a key issue leading to frequent violations of rules, undermining the long-term sustainability of seaweed farming. The need for local/customary regulations and sanctions is emphasized to curb unethical practices. Bennett et al (2019) explains how the exploitation of coastal resources without ethics and oversight can damage the social and ecological order, including practices such as land grabbing. Whereas Cinner et al (2012) explains that failure in coordination between government and local institutions in managing marine resources can lead to weak compliance and reduced sustainability. Adrianto et al (2005) explains that a dimensional approach (including ethics) is necessary to assess sustainability and emphasizes the importance of local regulations and sanctions in preventing unethical actions.

Just like in the Rapfish analysis, the sustainability status is visualized using a kite diagram to better understand the multi-dimensional aspects of sustainability (Pitcher & Preikshot 2001). This shows that current cultivation practices are on a positive path, but need improvement so that they can be sustainable.

The value of the sustainability status of the results from the Rapseaweed analysis, from each dimension, is then positioned in the form of a kite diagram with the intention of easily understanding the picture of sustainability status, as presented in Figure 11.

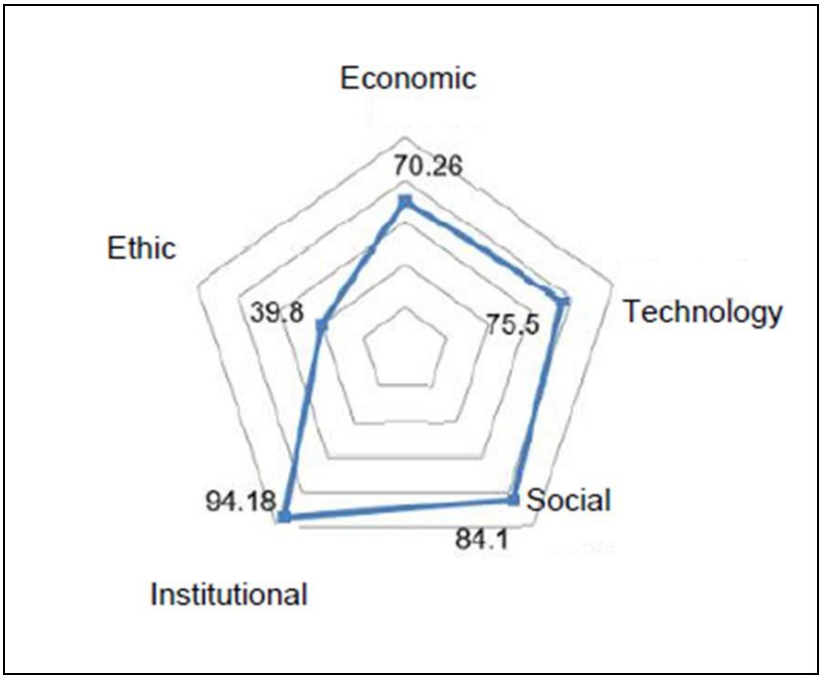

Figure 11. Kite diagram - sustainability index values of seaweed farming along five dimensions.

The results of the *Rapfish* multidimensional analysis show that there are 4 dimensions that support the sustainability of seaweed development, while the ethical dimension that discusses the involvement of cultivators in making rules does not support the sustainability of seaweed development in East Sumba Regency, so it needs to be evaluated. With this sustainability status, seaweed development planning for the next five years needs to maintain the social, economic, technological and institutional dimensions, but the ethical dimension needs to be improved.

Conclusions. The results of the analysis of the sustainability of seaweed farming in East Sumba Regency are quite sustainable with an index value of 70.26 – 94.18. Among the five dimensions, namely the economic, social, technological and institutional dimensions, the highest sustainability index value is shown by the institutional dimension of 94.18 with a fairly sustainable category. This shows that the institutional dimension is the most influential dimension on seaweed farming in East Sumba Regency regarding sustainability. The results of the leverage of attributes analysis in the technology dimension show that there is one attribute that influences the sustainable development process, namely technology that threatens coral reefs. Meanwhile, the lowest sustainability value is shown by the ethics dimension of 39.8, which falls in the less sustainable category. This shows that the ethics dimension needs to be improved in seaweed farming. The results of the leverage of attributes analysis in the economic dimension show that there are attributes that are influential in the sustainable development process, namely improving the economy of the surrounding community.

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Conflict of Interest. The authors declare that there is no conflict of interest.

Data Availability. The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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