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Sustainability of the Palm Oil Industry: An Empirical Study of the Development of Sustainable Oil Palm in Bengkalis Regency, Indonesia

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ABSTRACT

Bengkalis' economy has continued to contract since 2012. This is due to its very high dependence on oil and gas. It is necessary to develop other sectors that have high potential, such as oil palm plantations and the CPO processing industry which are in line with the Sustainable Development Goals (SDGs). Taking into account the complexities and problems that are quite complicated in the processing of the CPO industry, it is necessary to conduct research to determine the sustainability status of the CPO industry, identify factors that have high sensitivity/influence, and formulate the best scenario for its development. The analytical method used in this study is the Multi Dimensional Scaling (MDS) technique through the Rapid Appraisal Technique (RAP) approach with a multidimensional approach (economic, social, environmental, technological, and institutional). The research was conducted in Bengkalis Regency with respondents being managers of CPO processing industry companies with instruments in the form of questionnaires and structured through in-depth interviews. The data used is primary data. The results showed that the CPO processing industry was classified as sustainable with an index of 59.76. Dimensions included in the less sustainable category are environmental and technological dimensions. This shows that the CPO processing industry has not paid attention to environmental conditions and has not maximized technology to achieve its goals. With an optimistic scenario, the results show an increase in status to be very sustainable with an index of 78.78.

1. INTRODUCTION

Bengkalis is one of the rich regencies in Riau Province which is dominated by oil and gas mining. The economy's dependence on oil and gas has caused Bengkalis' economic growth continuously contracted since 2012. This was due to a natural declining process that led oil production to continue to decline from year to year [1]. Dependence on oil and gas must be reduced by developing other sectors that have high potential, such as *palm oil* plantation and *processing industry* with a contribution of 13 percent and 9 percent, respectively. The main commodity that dominates the two sectors is palm oil. This commodity is known as a leading commodity in Riau [2].

Palm oil commodities, both plantations, and industries have an impact on the surrounding community and job opportunities. These job opportunities include the appearance of a food and beverage business (restaurant), a transportation business, a home industry, the development of a village bank unit. On the other side, increasing purchasing power has led to the appearance of markets in residential and rural areas. Synergistically, the level of income and welfare of the community has also increased. In addition, consumption patterns and education of rural communities will increase. This can be seen from the increase in the welfare index of rural communities. From 2016 through 2018, the welfare index increased by 0.16. This means that the welfare of rural communities in the 2016-2018 period increased by 16% compared to the previous period. It turns out that oil palm farming contributes to the family economy in rural areas [3]. Plantation activities have opened up business opportunities in rural areas [4]. Economic growth in rural areas has expanded its business activities in the tertiary sector.

Market demand for CPO continues to increase, this shows that the future and potential of the palm oil industry will continue to grow. However, the huge and strategic potential of the CPO processing industry is not directly proportional to the quality of environmental management. The negative impacts of culture and exploitation of oil palm, such as river pollution and air pollution due to chemical pollution, have not been handled properly. The biggest challenge for the Indonesian palm oil industry now and in the years to come is in the form of negative campaigns on the impact of plantation expansion and the increasing perception of environmental degradation as a result of fertilizers and chemical use which have an impact on river water pollution, reduced groundwater quantity, soil erosion, and air pollution [5].

However, the CPO industry also has benefits such as economic, social value, and can be a friendly renewable energy source. The economic benefits of the CPO industry are being the main source of foreign exports, building the regional economy and increasing economic growth, increasing the income and welfare of farmers and industrial workers. Socially,

the CPO industry is useful in absorbing labor and reducing unemployment, as well as reducing poverty [3]. Besides, the CPO industry is also a provider of raw materials to produce two types of renewable energy, specifically first-generation biofuel in the form of biodiesel and second-generation fuel in the form of bioethanol (biomass-based) and biogas (POME-based). Meanwhile, the economic potential and environmental impacts of the palm oil industry have been widely discussed, especially regarding oil palm plantations. The results of research by Tan and Ndubisi, partner companies are very influential in the implementation of oil palm plantation development policies. On the other hand, the success of oil palm farmers is closely related to productivity and support for raw materials for the oil palm industry [6]. Palm oil waste in the form of stems and midribs can be reused and has economic value, especially in rural areas [7]. Plantation development (green economy) contributes to clean air for the surrounding community [8]. Adequate land tenure helps to address the underlying problem of poverty among small-scale indigenous peoples in Peninsular Malaysia [9].

The government has issued policies related to oil palm development that must be in line with sustainable development goals (SDGs) [3]. In its journey, the sustainability of the palm oil processing industry (CPO) has complexities and quite complicated problems. Environmental issues that are important issues regarding industrial sustainability and belief in the benefits resulting from economic, social, environmental, technological, and institutional aspects are justification and urgency why more comprehensive research is needed to dig deeper into the potential, urgency, and sustainability of the palm oil industry (CPO).

This study aims to determine the extent to which sustainability is multidimensional and for each dimension (economic, social, environmental, technological, and institutional), and to identify sensitive variables that affect the sustainability of the CPO industry in Bengkalis. By using questionnaires and structured questions through in-depth interviews with managers of CPO processing industry companies, primary data will be generated which will then be analyzed using Multi Dimensional Scaling (MDS) with the Rapid Appraisal Technique (RAP) approach and leverage analysis to determine factors that have high sensitivity/influence on sustainability. The benefits of this research study can be a reference for developing a sustainability system for the CPO industry to achieve the Sustainable Development Goals.

2. METHODOLOGY

The data used in this study are primary data obtained from interviews with managers of the palm oil processing industry in 2020 because they are considered to know the overall performance or operations of the mill. Of the 10 industries in Bengkalis Regency, 6 industries responded and were willing to be interviewed. The data consists of several variables that contain the conditions of each industry. The research variables used in this study were 41 variables which were divided into 5 dimensions as presented in Table 1.

In the approach used to assess development sustainable development is not only seen from three dimensions (economic,ecological, and socio-cultural). The analysis of the sustainability of the palm oil processing industry is built using five dimensions, namely economic, social, environmental, technological, and institutional. Because it sees the very important role of the technological and institutional dimensions in the development of CPO processing. Each dimension consists of several measurement indicators. From the analysis results obtained sustainability status for each dimension.

Table 1. Research variable

Dimension	Number of Variables
Economic	9
Social	7
Environmental	10
Technological	9
Institutional	6
Total	**41**

The sustainability analysis of the palm oil processing industry in Bengkalis Regency was carried out using a Multi-Dimensional Scaling (MDS) technique through a Rapid Appraisal Technique (RAP) approach. MDS is a multivariate technique that can be used to determine the position of an object relative to other objects based on its similarity. This technique is used to determine sustainability [10, 11]. The RAP method was developed by the Fisheries Center. RAP is used to determine the sustainability status in the field of natural resources [12]. The advantage of this method is that RAP is a simple but comprehensive sustainability evaluation analysis and is identically used for a multi-disciplinary rapid assessment and evaluation of the sustainability of the palm oil industry [13].

However, this method also has a weakness, namely the uncertainty aspect caused by a). The impact of errors in scoring due to lack of information, b). The impact of diversity in scoring due to differences in assessment, errors in data entry, and c). The high stress value obtained from the ALSCAL algorithm. Therefore, it is necessary to carry out a Monte Carlo analysis technique which is a simulation method to evaluate the impact of random error on all dimensions [14].

The multidimensional RAP analysis process in this study was carried out through several stages as follows: 1) Determination of the dimension variables to evaluate the condition of the palm oil processing industry in Bengkalis Regency; 2) Assessment of variables on an ordinal scale based on dimensional sustainability criteria; 3) Data analysis using RAP-Multidimensional technique; 4) Assessing the index value and sustainability status of multidimensional as well as on each dimension; 5) Assessing sensitive variables that affect sustainability by using leverage analysis; and 6) Assessing the effect of errors in calculations using Monte Carlo analysis.

The MDS approach in RAP gives stable results compared to other multiple variable analysis methods (e.g. Factor Analysis) [12]. All data from the variables considered in this study are analyzed multidimensionally to determine points that reflect the position of sustainable development in each region. The reference point of the analysis is good and bad. The position of the points of sustainability of this development will visually be very difficult to imagine given the many dimensions. Therefore, to make it easier to visualize the position of a variable with other variables based on similarities or preferences, ordination analysis using the MDS method is used.

In the RAP-MDS analysis process which produces several error probabilities, it is necessary to evaluate the process error so that a Monte Carlo simulation is needed as a test of validity and accuracy. A Monte Carlo analysis was carried out to assess

the dimensions of uncertainty in the MDS. The results of the Monte Carlo analysis show that at the 95 confidence level for each dimension there is not much difference, the difference is relatively small. This situation shows that the simulation using Rap-MDS has a high level of confidence. If the results of the Monte Carlo simulation do not change significantly or have a very small difference in value, it can be said that the index results have been able to overcome random errors [12]. The simulation also serves to see the level of stability of the results.

In MDS, the same two objects are mapped in a point that is close to each other. On the other side, dissimilar objects are represented by points that are far apart. The score for each variable will form a matrix which is then standardized for the score for each variable. Thus, each variable has a uniform weight and differences between measurement scales can be eliminated. The standardization method used is as follows:

$$X_{ik}sd = \frac{X_{ik} - X_k}{S_k} \quad (1)$$

where, $X_{ik}sd$: The standard score value of the *i*-th region on the *k*-th variable; X_{ik}: The initial score value of the *i*-th region on the *k*-th variable; X_k: The median score on the *k*-th variable; S_k: The standard deviation on the *k*-th variable.

The distance between regions (including their reference points) is calculated using the Euclidean Distance Squared/Seuclid method. The Euclidean distance between object *i* and object *j* is defined as [15]:

$$d_{ij}^2 = \sum_{k=1}^{n} \left(X_{ik} - X_{jk}\right)^2 \quad (2)$$

where, X_{ik} is the observation value of the *i*-th object and the *k*-th variable, while X_{jk} is the observation value of the *j*-th object and the *k*-th variable.

This distance value is then sorted from the largest to the smallest. After that, create an ordinance for all dimensions based on the Multi-Dimensional Scaling analysis algorithm. Furthermore, the original dimensions of the number of variables are reduced to only two (2) dimensions which will be the *x*-axis and *y*-axis. The distance between objects is again calculated but now uses 2 dimensions. Then calculated the feasibility value of the Multi-Dimensional Scaling model can be seen from the stress value. The Kruskal Stress formula is usually used for the goodness of fit model which is defined as follows:

$$S - Stress = \left(\frac{\sum_{i=j}^{n}\left(d_{ij} - \hat{d}_{ij}\right)^2}{\sum_{i=j}^{n} d_{ij}^2}\right)^{1/2} \quad (3)$$

where, d_{ij}: distance between the *i*-th object and the *j*-th object; $\hat{d}_{ij}$: disparities (distance between pairs of objects into a new size) between the *i*-th object and the *j*-th object.

Table 2. Sustainability status index value

Index Value	Status
0.00-25.00	Unsustainable
25.01-50.00	Less sustainable
50.01-75.00	Quite sustainable
75.01-100.00	Highly Sustainable

Goodness of fit in the MDS is reflected in the value of S-Stress and R^2. A good model is indicated by the S-Stress value which is smaller than 0.25 or S < 0.25 and R^2 which is close to 1. The sustainability index scale of the system under study has an interval of 0 percent to 100 percent. There are four categories of sustainability status as shown in Table 2 [16].

3. RESULT AND DISCUSSION

In this study, an analysis was conducted using the Multi-Dimensional Scaling (MDS) technique through the Rapid Appraisal Technique approach to determine the sustainability status of the palm oil processing industry in Bengkalis Regency.

3.1 Sustainability multidimensional analysis of the palm oil industry

The RAP-Multidimensional analysis produces a sustainability index value for the palm oil processing industry in Bengkalis Regency. From the results of the analysis, it is known that the sustainability status is as follows.

Table 3. Multidimensional sustainability index and status

Scope	Index	Status
Multidimensional	59.76	Quite Sustainable

Based on Table 3, it can be seen that the sustainability status of the condition of the palm oil industry in Bengkalis Regency is included in the fairly sustainable category. This is because the index value is in the range of 50.01 – 75.00. The index value was obtained based on the analysis of 41 variables included in five dimensions, there are economic (9 variables), social (7 variables), environmental (10 variables), technological (9 variables), and institutional (6 variables).

Figure 1 shows the value of the sustainability index for each dimension, where the lowest value is 34.48 for the technology dimension, followed by the environmental dimension index of 43.39. Thus, the technological and environmental dimensions are included in the less sustainable category. Meanwhile, the social dimension achieved the highest score, which was 78.95 and included in the very sustainable category. The economic and institutional dimensions are categorized as quite sustainable because the index value is in the range of 50.01 – 75.00. This is in line with the results of research by Syahza and Irianti, palm oil and its derivative products cause economic multiplier effects in rural areas, especially in the centers of oil palm plantations [17].

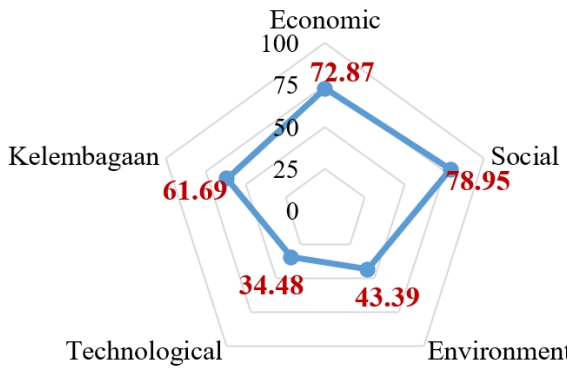


Figure 1. Multidimensional sustainability index diagram

3.2 The sustainability analysis of the palm oil industry for each dimension

In addition to analyzing the sustainability status of the multidimensional palm oil industry in Bengkalis Regency, the RAP analysis is also reviewed based on dimensions. Furthermore, a sensitivity analysis (leverage analysis) was carried out to determine the variables that affect the sustainability of the palm oil processing industry in Bengkalis Regency.

3.2.1 Economic dimension

Analysis of the sustainability index of the palm oil industry on the economic dimension shows an index value of 72.866. Visually, it can be seen that the index value is in the range of 50.01-75.00 so that the economic dimension is included in the fairly sustainable category (Figure 2).

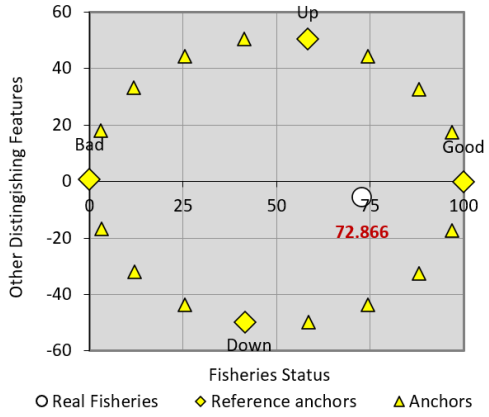


Figure 2. Sustainability status of economic dimension

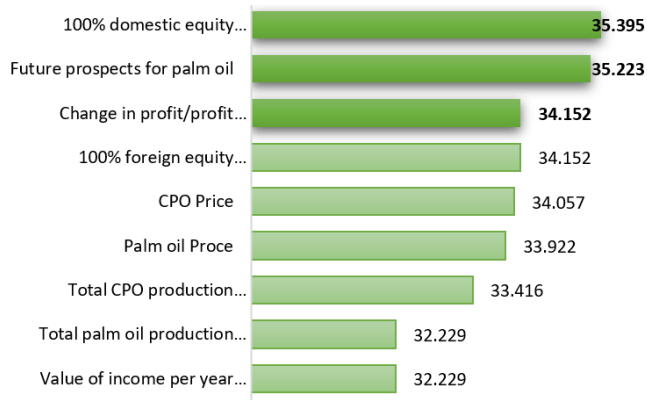


Figure 3. Leverage analysis of economic dimension

The value of the sustainability of the palm oil industry which is quite high in the economic dimension in Bengkalis Regency is influenced by several variables that get a fairly high score. Most of the industry's optimism in assessing the prospects for palm oil in the future is getting better. The proportion of domestic capital ownership which is higher than foreign ownership is one of the most sensitive variables. To find out in more detail which variables are sensitive to the economic dimensions of oil palm sustainability, see Figure 3.

Based on the results of the leverage analysis as shown in Figure 3, of the 9 variables analyzed 3 sensitive variables affect the value of the sustainability index of the economic dimension, namely (1) 100% domestic capital ownership, (2) future prospects palm oil, (3) change in profit compared to year. Therefore, in order for economic sustainability to be achieved or to be further improved, these three variables need to be prioritized. This is in line with the results of research by Syahza and Asmit, plantation activities have not only shifted the focus of community livelihood from the primary sector, but also expanded the scope of their business to the tertiary sector [2].

3.2.2 Social dimension

The results of the RAP calculation show that the index of the palm oil industry in the Bengkalis Regency is 78,952 (presented in Figures 4 and 5). This figure is the highest index value when compared to other dimensions. This makes Bengkalis Regency into the highly sustainable category because it has an index value of more than 75 percent.

The existence of the palm oil industry in the Bengkalis Regency has had an impact on the social aspects of the community around the company. One of the sustainable palm oil industries is to have a social responsibility towards workers and the surrounding community. The efforts of the palm oil industry in the Bengkalis Regency are carried out to provide a more positive social impact to the surrounding community. This is evidenced by the high value of the social dimension index.

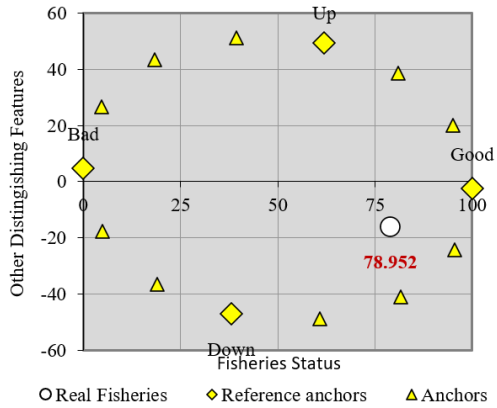


Figure 4. Sustainability status of social dimension

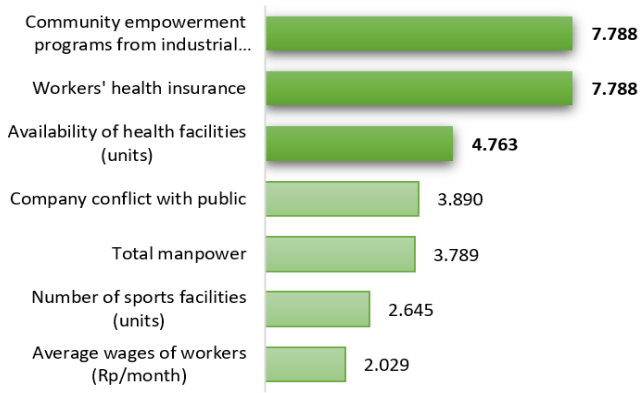


Figure 5. Leverage analysis of social dimensions

Based on the results of the analysis of leverage on the social dimension, three variables that have high leverage are (1) community empowerment programs, (2) workers' health insurance, and (3) availability of health facilities (Figure 5). This means that to improve the sustainability status of the social dimension, these three attributes need to get attention and consideration. On the other hand, Ayob revealed that

entrepreneurs have the ability to address social and economic problems that cannot be necessarily be handled by both the government and companies. Collaborations established by entrepreneurs have greater potential for solving social and economic problems in the community, especially in developing countries [18].

3.2.3 Environmental dimension

Environmental issues are still one of the main challenges in the development of the palm oil industry. Starting from deforestation due to the clearing of new land for oil palm plantations as the main raw material for the CPO industry to waste generated from the CPO industry, both liquid, solid, and gas waste. Although it is undeniable that in a production activity there will be waste generated if the waste is managed and processed properly then the negative impact that can be caused can be minimized.

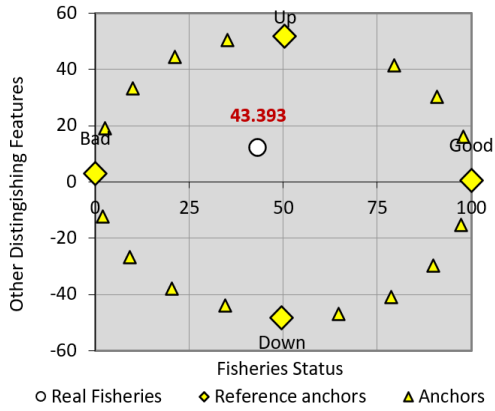


Figure 6. Sustainability status of environmental dimension

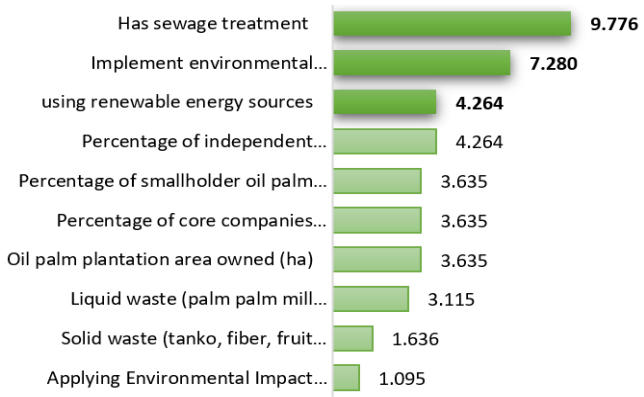


Figure 7. Leverage analysis of environmental dimensions

From the analysis of the sustainability index of the palm oil industry (CPO), the environmental dimension shows a value of 43.39 with a less sustainable status. The results of the analysis are presented in Figures 6 and 7. The low value of sustainability in this dimension is due to several things, including the high demand for palm oil raw materials, both from independent smallholders, plasma plantations. This shows that the need for land for oil palm plantations is very large, if there is no increase in oil palm productivity, it is possible that new land clearing will continue to meet the increasing demand for CPO production. Very few companies apply sustainable principles so that Indonesian Sustainable Palm Oil (ISPO) is required for industry standards [19]. Most oil palm plantation companies do not care about sustainable development, this is evidenced by the low implementation of the Roundtable on Sustainable Palm Oil (RSPO) and ISPO in the field, both from the company side and from the farmer side [20]. As oil palm plantations develop, the potential environmental impacts must be comprehensively controlled [21]. Another thing that causes the sustainability index value for the environmental dimension is the high amount of waste produced by the CPO industry, both solid (empty fruit bunches, fiber, fruit shells, and burning ash) and liquid (palm oil mills effluent/POME). The waste generated is directly proportional to the amount of production value produced by the CPO industry. If it is not managed properly it will damage the environment and it is also possible to cause disputes with the community around the CPO mill.

From the results of the environmental sustainability leverage analysis, as shown in Figure 7, it is known that from the 10 variables analyzed there are 3 sensitive variables affecting the sustainability of the palm oil processing industry, namely (1) have sewage treatment, (2) implement environmental management and (3) using renewable energy resources.

The third factor or variable, namely the use of new and renewable energy is not an easy path for the industrial world because it requires a large investment cost to make it happen. Currently, the government is aggressively encouraging industrial companies to be able to use new and renewable energy (EBT) by providing incentives in the hope that in the future they can produce industrial products that are supported by clean energy.

3.2.4 Technological dimension

The increasing global demand for palm oil as a raw material for various types of daily products, as well as an effort to meet the needs of the domestic and world markets in the use of biofuels, requires science and technology to increase productivity of palm oil in a sustainably.

From the analysis of the sustainability index of the palm oil industry (CPO), the technological dimension is 34.48. This value is classified as very low and is categorized as less sustainable. This is because there are still few CPO industrial companies that develop CPO derivative products, not even a single company that does refining or processing CPO into finished goods. Likewise with biodiesel production, in Bengkalis there is no single CPO industry that also produces biodiesel, even though domestic demand for biofuels is very high. The results of the technology sustainability analysis are presented in Figures 8 and 9.

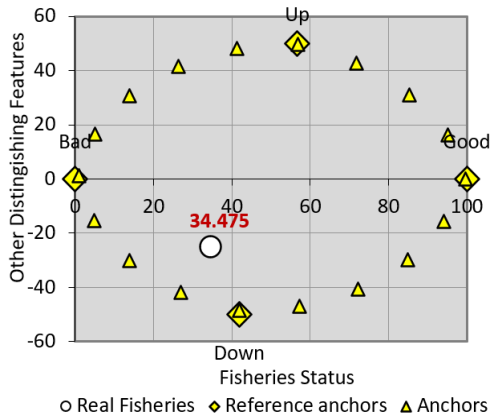


Figure 8. Sustainability status of technological dimension

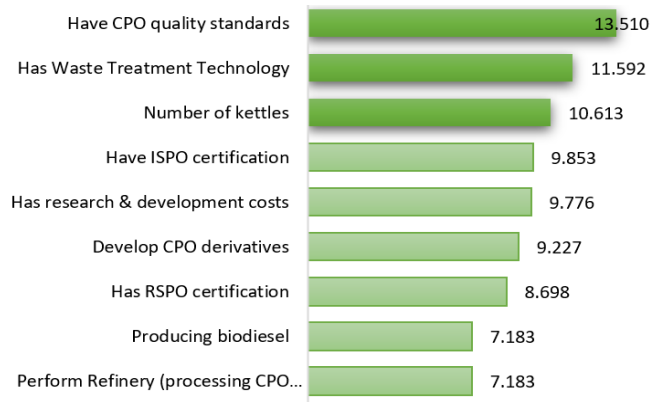


Figure 9. Leverage analysis of technological dimensions

Another factor that causes the low value of sustainability in the technology dimension is the low number of CPO industrial companies that already have RSPO and ISPO certifications [19-22]. RSPO and ISPO have a goal to ensure the continuity of the palm oil industry that is sustainable and environmentally friendly. Or in other words, it is hoped that the oil palm industry can continue to develop without ignoring the problems of forest destruction, preservation of flora and fauna, and the welfare of communities around oil palm plantations. Another sustainable manufacturing, there is a difference where the current achievement of this practice in Malaysian mills is seen to be slightly lower than the priority given to them [23].

Based on the results of the leverage analysis as shown in Figure 9, 3 variables are most sensitive to affect the value of the sustainability index value of the technology dimension of the palm oil processing industry (CPO), namely (1) have CPO quality standards, (2) has waste treatment technology, and (3) the number of kettles/boilers. Thus, so that this sustainability can be maintained and even improved in the future, the existence of these variables needs serious attention. It is intended that the use of innovation and technology can increase the productivity of the CPO industry in a sustainable manner.

3.2.5 Institutional dimension

Institutional is a human relationship that is formed through a group structure in society that is formed to regulate an organization with the same goal and is limited by norms and codes of ethics for the success of the initial formation of the institution. In the system, both plantations and the oil palm industry, there are many institutions that play a role related to input access, financial access, market access, institutional access, land access, and access to information technology. Based on the sustainability analysis of the palm oil processing industry, the score is 61.69 (Figure 10). The index value on this dimension indicates the moderately sustainable status.

From the results of the leverage analysis (Figure 11), it can be seen that the variables or factors that are sensitive to the sustainability of rice availability, on the institutional dimension there are 3 variables, namely (1) join labor unions, (2) have partnership with companies others, and (3) have a assisted farmer groups.

Trade unions as a forum for workers play a role as a tool to fight for, protect, defend the interests and welfare of workers and their families. The existence of trade unions can be a link between workers and companies to minimize conflicts that may occur between workers and companies. Therefore, the existence of trade unions is very important in the CPO industry.

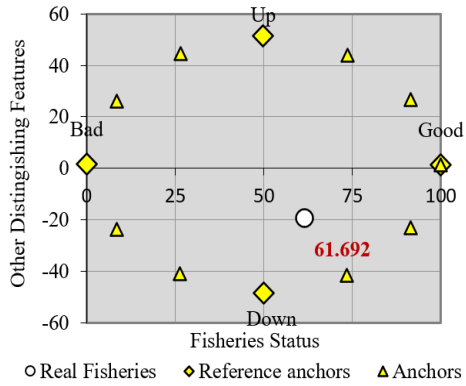


Figure 10. Sustainability status of institutional dimension

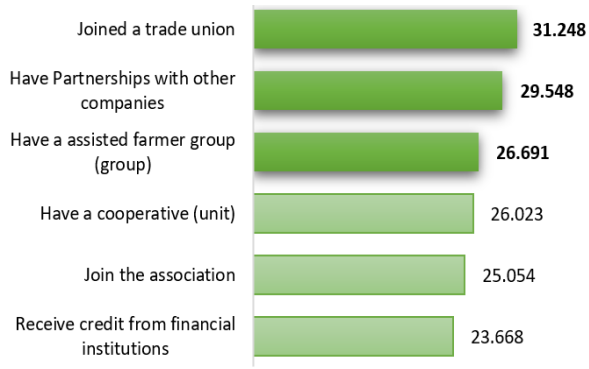


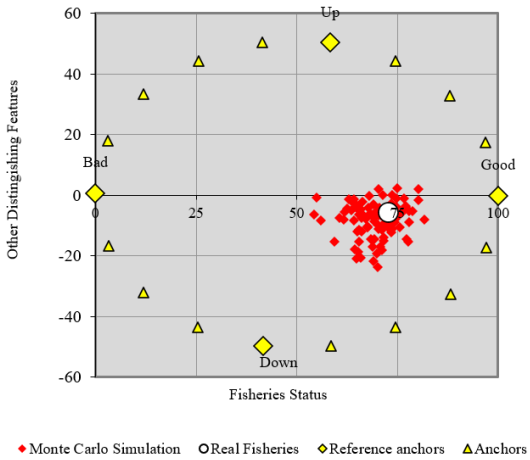
Figure 11. Leverage analysis of institutional dimensions

Another important factor in the institutional dimension is the existence of partnerships with other companies and the community. In the production process of the CPO industry, from input to marketing, the involvement of other companies and the community is very much needed. One form of partnership with other companies and the community, including in terms of supplying raw materials, requires Fresh Fruit Bunches (FFB) from independent oil palm and plasma farmers. In some CPO industrial companies, in terms of transportation, partnerships with other companies are also needed to bring CPO to large holding companies. The development of oil palm plantations has created entrepreneurial capabilities for farmers who are able to capture business opportunities in the agricultural sector, especially the plantation sub-sector [24].

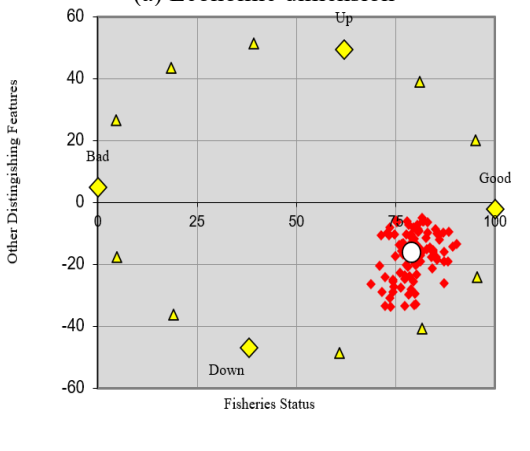
3.3 Monte Carlo analysis

The results of the Monte Carlo analysis show that the value of the sustainability index of the palm oil industry in the Bengkalis Regency shows results that are not much different from the results of the RAP analysis. The Monte Carlo analysis in this study was repeated 100 times, the repeated data analysis process was quite stable and errors in data input and data loss could be avoided.

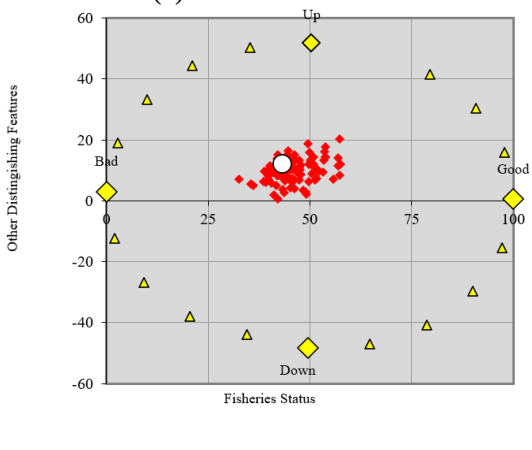
The results of the Monte Carlo analysis can be seen in Figure 12 as the output of the RAP analysis. In the figure, it can be seen that the plot points collect or clump together at one point. That is, the results of this analysis are convergent in determining the sustainability status of the palm oil processing industry in Bengkalis Regency. Thus, it can be stated well and prove that the effect of error can be avoided. This is in line with the results of previous studies which also used Monte Carlo Simulation [25-27].



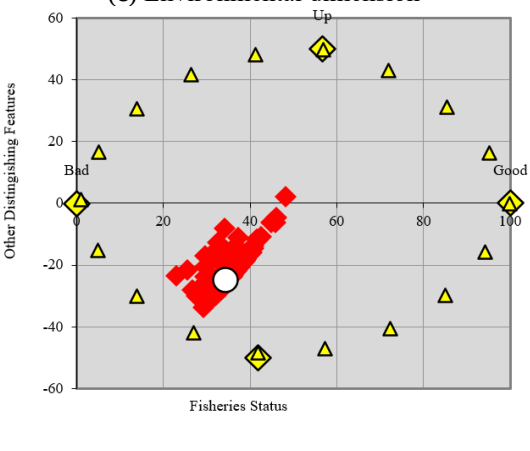
(a) Economic dimension



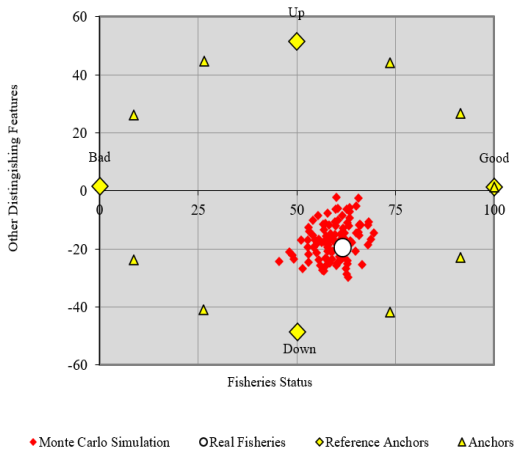
(b) Social dimension



(c) Environmental dimension



(d) Technological dimension



(e) Institutional dimension

Figure 12. Monte Carlo analysis

3.4 Goodness of fit

To describe the RAP statistically, the measurement of the R-Square value (square of correlation) of each dimension is used. The requirement for the S-Stress (Standard Residual Sum of Square) value must be less than 25 percent or 0.25. Meanwhile, the R-square is close to 100 percent or 1. In Table 4, the values of S-Stress and R-Square are presented.

Table 4. S-stress and R-square per dimension

Dimension	*S-stress*	*R-square*
Economic	0.00267	0.99926
Social	0.00089	0.99953
Environmental	0.00045	0.99976
Technological	0.00000	0.99990
Institutional	0.00087	0.99943

The five dimensions have an S-Stress value less than 0.25 and the R-Square value obtained shows a value close to 1 or 100%. Thus the results of the analysis of the level of sustainability of the palm oil processing industry in Bengkalis Regency have met the goodness of fit criteria so that it is feasible to. The same results were also obtained from previous studies that used S-Stress and R-Square in calculating goodness of fit [14].

3.5 Sustainability status improvement strategy

The results of the analysis of RAP_multidimensional and Montecarlo both show that the index value of the sustainability index of the palm oil processing industry in the Bengkalis Regency is in a fairly sustainable status. For this index value to continue to increase until it reaches a very sustainable status in the future, it is necessary to make improvements to the sensitive variables that influence and become key variables on the index value of the economic, social, technological, and institutional dimensions. The same study also uses an optimistic strategy to improve the status of sustainability villages in the Meranti Islands Regency [28]. Table 5 contains the variables that become the key variables according to the level of influence on each dimension.

Various policies can be developed from key variables according to their level of influence on each dimension. Table 6 presents an overview of policy recommendations that can be applied to improve the status of sustainability.

Table 5. Dimension and key variables

No	Dimension	Key variables	Score
1	Economic	100% domestic equity ownership	35,39
		Future prospects for palm oil	35,22
		Change in profit/profit compared to years	24,15
2	Social	Community empowerment programs from industrial companies	7,79
		Workers' health insurance	7,79
		Availability of health facilities (units)	4,76
3	Environmental	Has sewage treatment	9,78
		Implement environmental management	4,26
		Using renewable energy sources	4,26
4	Technological	Have CPO quality standards	13,51
		Has Waste Treatment Technology	11,59
		Number of kettles	10,61
5	Institutional Dimension	Joined a trade union	31,24
		Have Partnerships with other companies	29,54
		Have Partnerships with other companies	26,69

Table 6. Policy recommendations for improving the status of sustainability

No	Dimension	Policy Recommendations
1	Economic	Ensuring efforts to provide incentives in the form of tax and levy relief; and convenience for domestic investors in the form of providing data and information, facilities and infrastructure, land or location, technical assistance, simplification of licensing, and certification, especially in leading sectors
		Ensuring that long-term CPO exports remain good and the government's efforts to prioritize the development and use of renewable energy, one of which is the use of Biodiesel
		Ensuring an increase in profits or profits for the CPO Industry through efforts to expand or develop the industry in fields that are still related to the main product (CPO)
2	Social	Adding criminal sanctions in the legislation if community empowerment is not carried out, or making community empowerment an obligation for the company to be carried out.
		Ensure that BPJS (Social Security Administering Bureu) is a government-owned public legal entity that organizes health insurance programs for the entire community, including taking action to pick up the ball directly to the company so that all employees have worker health insurance.
		Ensuring that every CPO industrial company is required to implement an occupational health program (Depnakertrans regulations), there is at least 1 first aid worker at each work location that affects the provision of first aid for employees with health problems that must be treated immediately.
3	Environmental	Ensuring that the industry has an WWTP (Wastewater Treatment Plant) infrastructure and a waste treatment plant in accordance with Law no. 32 of 2009 concerning the Protection and Management of the environment.
		Ensuring that the CPO industry must increase the value of the Corporate Performance Rating Assessment Program (PROPER) to blue, green, and gold in environmental management within a certain period of time, if it cannot increase the proper value, the CPO industrial company will be given strict sanctions.
		Provide incentives to companies/industry that use new and renewable energy to trigger a clean energy mix and produce industrial products that are supported by clean energy
4	Technological	Ensuring the industry implements quality control as an effort to improve quality, starting from the initial input in the form of providing raw materials, production processes, to the output process of finished goods.
		Ensuring the industry carries out waste treatment to minimize the waste generated. For this type of waste can be reused as fuel, fertilizer, animal feed, and can also be sold to generate additional income). As for liquid waste, membrane technology and electrocoagulation can be used.
		Ensure that boilers as a source of gas pollution in the CPO industry do not use incinerators used to burn empty bunches.
5	Institutional	Ensure that the company/industry does not hinder the establishment of trade unions and is obliged to provide opportunities for workers to carry out trade union activities. If it is proven that it hinders and does not provide opportunities, then the company must be given criminal sanctions.
		The government provides physical facilities as well as facilities for obtaining capital from banks in order to stimulate the industry to develop business through partnership relationships.
		Ensuring the industry to finance farmer groups through several efforts: encouraging and guiding farmers to be able to cooperate in the economic field in groups, fostering and facilitating farmer groups, as well as providing assistance and training to farmers in order to increase farmer capacity. farmer human resources.

Table 7. Result of RAP analysis-multidimensional pessimistic scenario and optimistic scenario

No	Dimension	Pessimistic Scenario		Optimistic Scenario	
		Index	Indicator	Index	Indicator
1	Economic	72,87	Highly Sustainable	76.02	Highly Sustainable
2	Social	78,95	Highly Sustainable	78.95	Highly Sustainable
3	Environmental	43,39	Less sustainable	76.71	Highly Sustainable
4	Technological	34,48	Less sustainable	77.05	Highly Sustainable
5	Institutional	61,69	Quite sustainable	76.53	Highly Sustainable
Multidimentional		**59,76**	**Quite Sustainable**	**78,78**	**Highly Sustainable**

The implementation of policy recommendations must be carried out to improve the sustainable status which previously had moderately sustainable status to become highly sustainable in the CPO processing industry in Bengkalis Regency. This is done by changing the value of the key variables in each dimension from the initial value (pessimistic scenario) to the maximum value (optimistic scenario) as contained in Appendix.

Changes in the sustainability status of the results of the RAP-Multidimensional analysis compared between pessimistic and optimistic scenarios can be seen in the Table 7. A kite diagram for each scenario with values for each dimension is shown in the Figure 13.

The results show an increase in the index value in each dimension as well as in multidimensionality, all of which are in a very sustainable status.

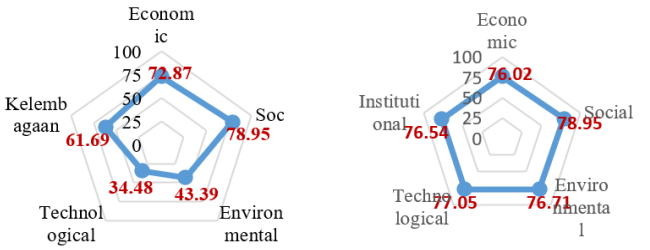


Figure 13. Multidimensional sustainability index diagram pesiimistic scenario and optimistic scenario

The implementation of policy recommendations is a long stage and must be passed properly, not only for the smooth implementation of development and achieving optimal results for the CPO industry, but also for achieving the sustainability status of the CPO industry in Bengkalis Regency.

4. CONCLUSIONS

This study resulted in a palm oil processing industry (CPO) sustainability index value of 59.76 and was categorized as quite sustainable. When viewed from each dimension, it can be seen that only one dimension indicates a very sustainable status, namely the social dimension with an index value of 78.95. The economic and institutional dimensions are categorized as quite sustainable with index values of 72.87 and 61.69, respectively.

The high value of the economic dimension index further emphasizes that the CPO processing industry actually provides economic benefits for and deserves to be continuously developed in Bengkalis district. Likewise, the high index value on the institutional dimension, explains that the CPO processing industry in its operational activities really needs good bonds between companies, communities, and other institutions.

Two dimensions that are categorized as less sustainable are environmental and technological dimensions with index values of 43.39 and 34.48, respectively. This shows that the CPO processing industry has not fully paid attention to environmental conditions and has not maximized technology to achieve its goals.

To be able to improve the sustainability status of the palm oil processing industry, an optimistic scenario can be used, by providing more specific treatment and management of the variables that have high sensitivity or influence on each dimension, especially the variables contained in the dimensions with less status sustainable (environment and technology).

By using an optimistic scenario, the results show an increase in the index value in each dimension and multidimensionality, all of which are in a highly sustainable status with an index value of 78.78.

The findings of this study should be viewed taking into account several limitations. The first is the analytical tool used. RAP-MDS has been widely used by researchers to determine sustainability status because it is simple and comprehensive. It is hoped that in the future other researchers can use different analytical tools that are more complex which can also be used to determine sustainability status. The second limitation concerns the attributes/variables and indicators used. By using different attributes/variables in a dimension, it can produce different sustainability status result.

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