International Journal of Sustainable Development and Planning
Vol. 17, No. 2, April, 2022, pp. 399-411
Journal homepage: http://iieta.org/journals/ijsdp

Sustainability Strategy for Industrial Plantation Forest Management in Riau Province, Indonesia

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https://doi.org/10.18280/ijsdp.170205

Received: 19 November 2021
Accepted: 28 January 2022

Keywords:
industrial forest, multidimensional scaling, sustainable development sustainability index

ABSTRACT

Riau Province is known as an area rich in forest resources. Most of the forest area is used for industrial plantation forest management. The existence of this industrial plantation forest also supports the forest product processing industry and other industries. This study aims to develop a strategy for the sustainability of industrial plantation forest management based on 4 dimensions of sustainability. To develop a sustainable strategy for industrial plantation forest management, Multidimensional Scaling (MDS) analysis is used with the help of RapHTI (modified Rapfish) software and prospective analysis. The results showed that the sustainable management of industrial plantation forests is an effort to accelerate national development from the ecological, economic, social, and institutional aspects. Strategies for empowering rural communities, strengthening village institutions, strengthening inter-institutional cooperation, and optimizing economic benefits are strategic steps in realizing sustainable management of industrial forest plantations. The proposed strategy for sustainable industrial plantation forest management is in line with the sustainable development goals (SDGs) in Riau Province, Indonesia.

1. INTRODUCTION

The national development policy has determined that environmental development is directed at maintaining and improving the preservation of environmental functions and quality [1]. The sustainability concept in natural resource management must apply the principles of justice in the environmental/ecology, economy, and social sectors [2]. Sustainable development in social sectors relates to human customs, values, and institution relationships. Economically, sustainable development involves the allocation and distribution of resources, while in ecology sectors involves economy and social contributions and their effects on the environment and its resources [3]. Policies must be able to encourage forest management, reforestation, agricultural land nutrition management, and wetland restoration [4]. One of the measures to maintain forest sustainability is the utilization of management through the concept of industrial plantation forest.

The adoption of large-scale industrial timber plantations in Indonesia began in the mid-1980s due to increasing demand for industrial timber and declining supply from natural forests. A clear legal basis is needed regarding land certainty and security to encourage the development of industrial forest plantations. The legality of land ownership is expected to provide new enthusiasm for developing plantation forests [5]. Industrial plantation forest management requires land use planning to maintain peatland productivity [6]. Poor management of industrial plantation forests will cause environmental or ecological losses, such as damage to soil, water, and watersheds [7]. Industrial plantation forests have economic and ecological potential. Ecologically, it plays a role in preserving biomass and carbon dioxide and reducing carbon dioxide emissions, while economically, forest production is the main source of raw materials for several industries [8, 9]. Unsustainable management of industrial plantation forests will cripple people's livelihoods and reduce their incomes. In the social sector, it will also cause conflict between the company and the surrounding environment.

This research was conducted at an industrial plantation forest management company in Riau Province. The management of industrial plantation forests in Indonesia is guided by the Indonesian Forestry Certification Cooperation (IFCC). The award is to encourage and improve sustainable forest management in Indonesia related to industrial plantation forest management. In addition, the factors that influence the management of industrial forest plantations to achieve sustainability are still limited. Therefore, the formulation of a sustainable industrial forest plantation management strategy is an interesting topic to study. Sustainable management of industrial forest plantations seeks to involve the community to reduce conflicts that occur and empower the community both socially and economically. Therefore, it is necessary to conduct an in-depth study that observes the sustainability of industrial plantation forest management from various dimensions, such as ecological, economic, social, and institutional in order to obtain a sustainable industrial

plantation forest management strategy in Riau Province, Indonesia.

2. RESEARCH METHODS

This research on industrial forest plantations was conducted in Riau Province, Indonesia. Map and area of industrial plantation forest availability in Riau Province are presented in Figure 1 and Table 1.

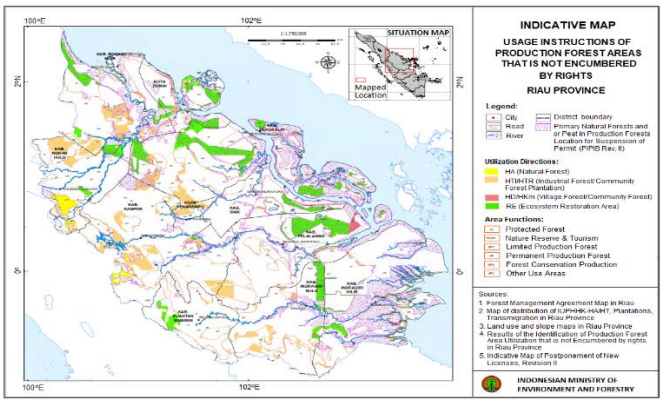

Figure 1. Map of the availability of industrial plantation forests in Riau Province

Table 1. Area of industrial forest plantation in Riau Province

District /City	Area of Industrial Plantation Forest in Riau Province (Ha)		
	Limited production forest (Ha)	Permanent Production Forest (Ha)	Total Area of Industrial Plantation Forest (Ha)
Kuantan Singingi	53,182	87,181	140,363
Indragiri Hulu	79,567	119,664	199,231
Indragiri Hilir	152,316	228,709	381,025
Pelalawan	64,183	612,069	676,252
Siak	6,310	326,679	332,989
Kampar	114,980	163,160	278,140
Rokan Hulu	120,264	54,939	175,203
Bengkalis	110,471	330,848	441,319
Rokan Hilir	150,758	237,546	388,304
Kepulauan Meranti	150,174	42,962	193,136
Pekanbaru	579	1,279	1,858
Dumai	12,218	130,415	143,633

Table 1 provides an explanation that the availability of limited production forest in Riau Province is 12,218 hectares and permanent production forest is 130,415 hectares with a total industrial plantation forest area of 143,633 hectares. Limited production forest is a forest area with a factor of slope class, soil type and rainfall intensity after being multiplied by a weighing number which has a total value between 125-174, excluding protected areas, nature reserve forests, nature conservation forests and hunting parks. Production forest remains a forest area with a factor of soil type, slope class, and forest intensity whose value is below 125 after being multiplied by a number of weights. This forest is not a nature reserve forest area, protected forest, hunting park, or nature conservation forest. In other words, both permanent production forest and limited production forest are part of industrial plantation forest. The determination of multi-dimensional industrial plantation forest management is supported by primary data collected. Collection through field surveys, including observation, verification of secondary data, and interviews with relevant stakeholders. Secondary data is obtained from reports issued by government agencies. The flow chart of research method shown in Figure 2.

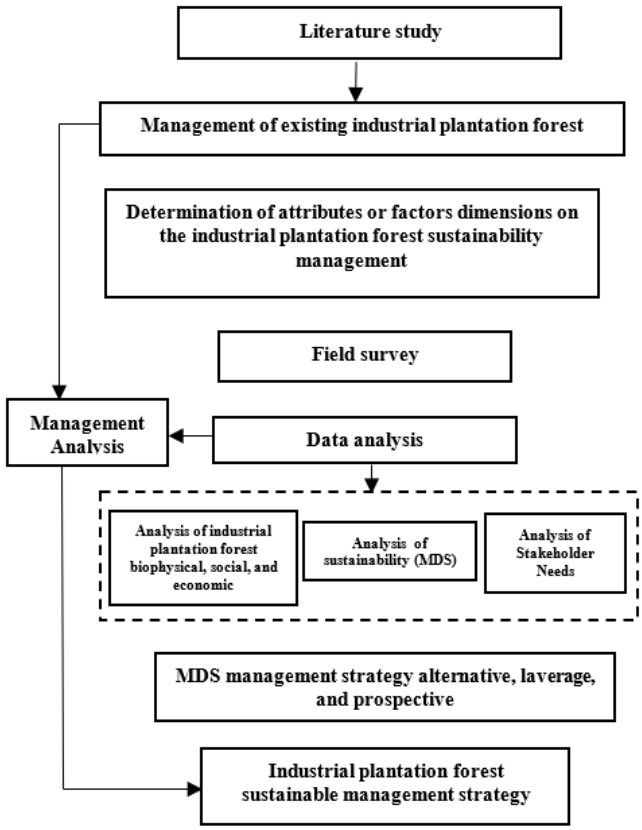

Figure 2. Research method chart flow

This research is an analytical descriptive study for creating a systematic, factual, and accurate description of the particular population or area characteristics. The data required in this study were primary and secondary. Primary data were obtained through direct observations of the object under study and interviews with the resource person. Information was obtained using Participatory Rural Appraisal (PRA) approach. PRA is a method to approaching a group of society to further gaining information. PRA has participatory research source related to research conducted on the field including village area for certain short-time. PRA method has been widely used in research about agriculture and forestry [10-12]. Secondary data were collected from various sources, such as research reports, scientific research journals, proceedings, higher education institutions, supporting documents, and reports from related agencies.

The data collection was restricted to the information about four dimensions of sustainable development, namely ecology, economy, socio-cultural, and institution dimensions. The selection of dimensions was based on common conditions found in the field. The scores for each attribute were analyzed using multi-dimensional analysis to determine one or several points that reflect the position of the development sustainability against two reference points, good points, and

poor points. The definitive score was the mode value to reflect the sustainability position under study relative to the good and poor points using the MDS statistical ordinance technique. The estimated score for each dimension is expressed on a scale of 0% (poor) to 100% (good). Sustainability analysis was carried out using MDS approach run with the RapHTI (modified Rapfish) software. Rapfish, which stands for Rapid Appraisal for Fisheries, is a Non-Parametric Multidimensional Scaling approach. Several previous studies have also used modified analysis of rapfish in Herdiansyah's research to analyze Renewable Natural Resource Conflict Management at the Indonesia-Malaysia Border: Environmentally Sustainable Approach.

In addition, Prospective analysis is used to find out information about key factors and strategic scenarios for industrial forest plantation management according to stakeholder needs. It is needed to see the possibilities that will occur in the future. The prospective analysis was carried out through three stages:

(1) determining the key factors in the current condition from the results of the MDS,
(2) determining the key factors resulting from the needs analysis of stakeholders,
(3) determining key factors from the results of the combined analysis between the results of the first and second stages or a combination of existing conditions and need analysis.

After obtaining the key factors, then the influence and dependence matrix analysis is carried out to see the position of each factor in the system using prospective analysis software as presented in Figure 3.

The next stage of prospective analysis is morphological analysis with the aim of obtaining possible future domains so that the strategic scenarios obtained are consistent, relevant and credible. This stage is done by defining several conditions that may occur in the future from all the selected key factors. The key factors with several possible future states are presented in Table 2.

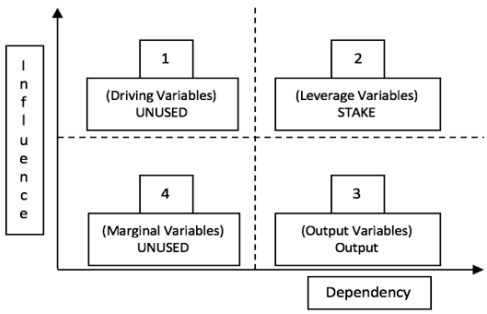

Figure 3. Level of influence and dependence between factors in the system

Table 2. Key factors and some possible circumstances in the future

Factor	Possible circumstances		
1	1A	1B	1C
2	2A	2B	2C
3	3A	3B	3C
.....	.....	.....	.....
N	nA	nB	nC

The morphological analysis was followed by a consistency analysis to reduce the dimensions of the combination of key factors in formulating future scenarios through the identification of inconsistencies among key factor states. The implementation of this stage by listing the conditions that cannot or is very unlikely to occur simultaneously to produce incompatible pairs.

The final stage of the prospective analysis is to develop a design scenario for the management of industrial forest plantations in Riau Province, Indonesia. This scenario is a combination of several key factors that may occur in the future minus a combination of circumstances that are unlikely to occur simultaneously.

3. RESULTS

The factors that influence the industrial plantation forest management were based on the interviews with stakeholders ranging from village officials, academics, non-governmental organizations, and the Environmental and Forestry Service of Riau Province. Land use is a form of power competition between stakeholders. Therefore, land use must be maximized to involve stakeholders to realize good governance [13].

3.1 Multidimensional sustainability attributes of industrial plantation forest management

Good management of industrial forest plantations should involve stakeholders in realizing sustainable forest management. Therefore, it is very necessary to develop attributes for the sustainability of industrial plantation forest management based on the needs of stakeholders. Table 3 serves the opinion of each stakeholder on the industrial plantation forest management based on the ecology, economy, socio-cultural, and institution dimensions.

3.2 The sustainability index and status of industrial plantation forest management in Riau Province

The sustainability analysis of the industrial plantation forest management was through evaluating the four management dimensions, namely ecology, economy, social, and institution. Each dimension was assessed based on the indicator attributes of sustainability.

3.2.1 Ecology dimension

Based on the results of the RapHTI analysis of ecological attributes, there are seven attributes that affect the ecological dimensions of industrial plantation forest management. In the following, the results of the RapHTI analysis on the attributes of the ecological dimension are presented.

Figure 4 shows that the value of the sustainability index on the ecological dimension is in the position of 81.46%. This figure illustrates that the management of plantations and industries based on the ecological aspect is in the good category, which is in the position of the 75.01% – 100.00% value range.

Based on the analysis of leverage, 2 of the 7 attributes have high leverage on the sustainability of industrial forest plantations, namely the availability and application of environmentally friendly technologies for the production process with a sustainability value of 12.75, and sustainable harvesting of wood and non-timber. timber forest products for each forest type with a value of 10.51. We can see these results in Figure 5.

Table 3. The opinion of each stakeholder on the industrial plantation forest management

No	Dimension	Attribute
1	Ecology	Demarcation of industrial plantation forest area boundaries
		Characteristics of compact plantation and not fragmented due to land occupancy
		Supply of wood in a sustainable manner and the presence of natural forest saplings
		Protection of protected flora and fauna
		Protection and security of forests and their functions
		Sustainable harvest rates for each type of main timber and non-timber products in each type of ecosystem
		Availability and application of environmentally friendly technologies for the production process
2	Social	Community education level
		Population growth rate (%/year)
		Village and customary officials can reduce conflicts between companies and the community
		Participation in industrial plantation forest management
		Social conflict
		Conflict Management
		Protection, Development, Improving Welfare, and Occupational Health and Safety (OHS)
3	Economy	The income of the community around the industrial plantation forest area
		Realization of logging following the logging/harvesting/utilization work plan in the working area
		An adequate level of investment and reinvestment
		Direct economy benefits of non-timber forest products to the communities around industrial plantation forest
		Employment
		Meeting the economy needs of the community in various schemes according to the legislation, both reforestation and CSR
		Business opportunities around the plantation
4	Institution	Capacity and Mechanisms for Implementation Planning
		Monitoring of industrial plantation forest Companies
		The existence of formal and informal institutions in the industrial plantation forest management involving various elements, including the community, government, and companies
		Law enforcement against illegal logging and forest encroachment violations
		Availability of management plans by industrial plantation forest companies

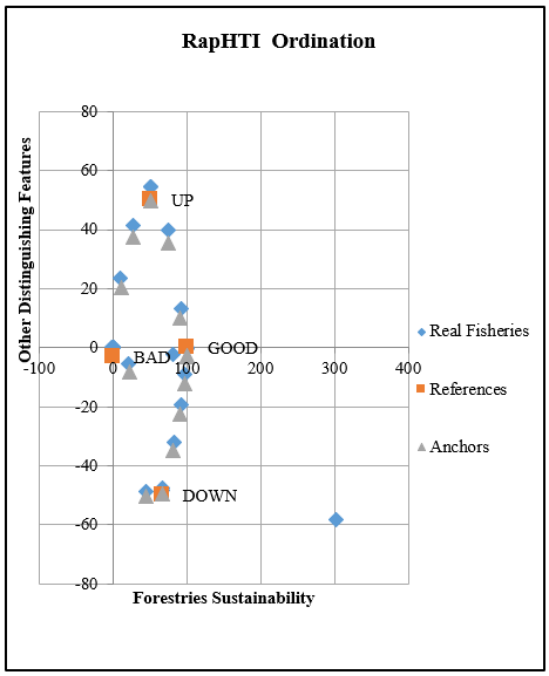

Figure 4. The sustainability status in the ecology dimension of industrial forest plantation management (Source: private)

Leverage analysis is an integral step of the RapHTI analysis process. Leverage of attribute is the output of the RapHTI software (Modification of Rapfish) which serves to show variables that are levers or attributes that are sensitive to sustainability, especially the sustainability of industrial plantation forest management. The criteria for determining the main lever attribute is based on the extreme bar, where the attribute has a value that is large enough than the other attributes. The attributes identified are based on stakeholder needs in determining the sustainability of industrial plantation forest management as previously presented in Table 3.

The vertical and horizontal axes in the figure explain that the vertical axis contains the attributes of each dimension of industrial plantation forest management. While the vertical axis is the bar value resulting from the leverage analysis of the RapHTI software.

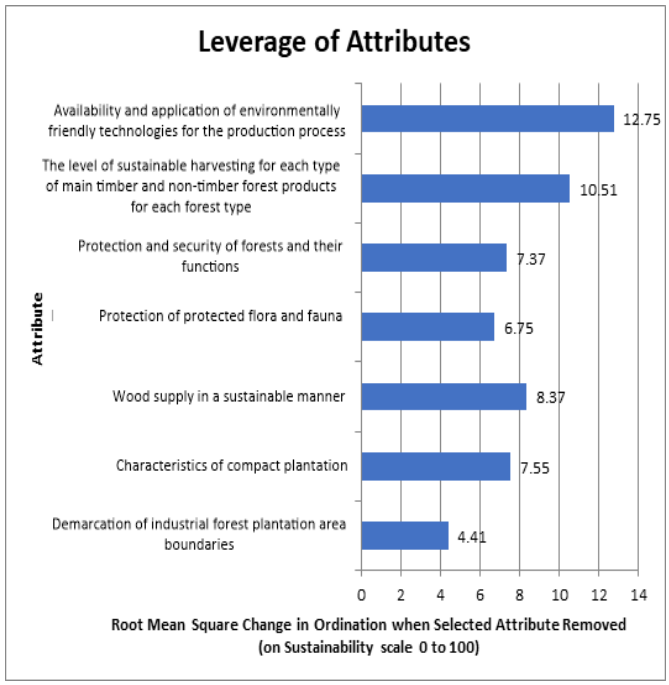

Figure 5. The Leverage Analysis for each attribute on the ecology dimension of industrial forest plantation management

The results of the analysis of leverage on the 7 attributes of ecological sustainability above, illustrate that there are 2

attributes that have higher leverage than the other 5 attributes, namely the availability and application of environmentally friendly technology for the production process and the attribute of sustainable harvesting levels. The application of environmentally friendly technology aims to minimize environmental damage, both biotic and abiotic environments. Abiotic environmental damage includes damage to soil, water, and air contained in industrial forest plantations [14]. Timber harvesting and planting activities will compact the soil and may cause runoff, and reduce water quality and quantity [15].

Environmentally friendly technologies may include the use of biopesticides, organic fertilizers, and clear cutting systems in logging to reduce soil compaction or canopy openness due to harvesting [16]. This technology will reduce soil and water damage. Some examples of environmentally friendly technologies such as reducing the impact of logging, the use of mycorrhizae, trichoderma, and so on. Environmentally friendly technology can increase sustainability in the ecological dimension because it increases environmental sustainability [17, 18].

Sustainable harvesting is a key in the durable ecology dimension of industrial plantation forest management [19]. Sustainability starts from harvesting by calculating the period and cycle of the logging. Each logging period in industrial plantations is determined based on the optimum profit value and diameter so that the logging cycle is in a 5-6 year period. The certain blocks that can be cut down are also determined in every period.

Sustainable harvesting will reduce landscape and canopy openness due to logging while reducing temperature increases during harvesting. It also provides an opportunity for wild animals to take refuge in germplasm conservation areas. The results of the research by Syafe'i et al, stated that the sustainability of community forest business can be achieved if the entire forest system can take place dynamically [20]. The basic measure of sustainable forest management will be formed if the benefits and expectations can be realized and the existing constraints can be controlled and dealt with. The initial reference used in determining the basic measures of community forest management in Baru District was the modification of the measures developed by the Indonesian Ecolabelling Institute for the Sustainable Community-Based Forest Management certification scheme.

The study of indicator criteria in community forest management found eight basic indicators that are needed in sustaining production in community forests. These indicators are (1) clear land status and boundaries, (2) land-use change, (3) planting, maintenance, and harvesting intensity, (4) forest management infrastructure, (5) market access capability, (6) market certainty, (7) market information system, and (8) contribution to the improvement of local social and economy conditions. The motivation of the community to plant forests is a response to increasing market needs. However, this activity has not been followed by forest management techniques and institutions that can guarantee the integrity of forest benefits economically, ecologically, and socially [21].

3.2.2 Economy dimension

Based on the results of the RapHTI analysis of economic attributes, there are seven attributes that affect the economic dimension of industrial plantation forest management. In the following, the results of the RapHTI analysis on the attributes of the economic dimension are presented in Figure 6.

Figure 6 shows that the value of the sustainability index on the ecological dimension is in the position of 71.36%. This figure illustrates that plantation and industrial management based on economic aspects are in the fairly sustainable category, which is in the position of a value range of 50.01% – 75.00%.

Based on the analysis of leverage, 2 of the 7 attributes have high leverage on the economic sustainability of industrial plantation forests, namely business opportunities around the forest with a sustainability value of 12.52, and the fulfillment of community needs with a value of 9.88. We can see these results in detail in Figure 7.

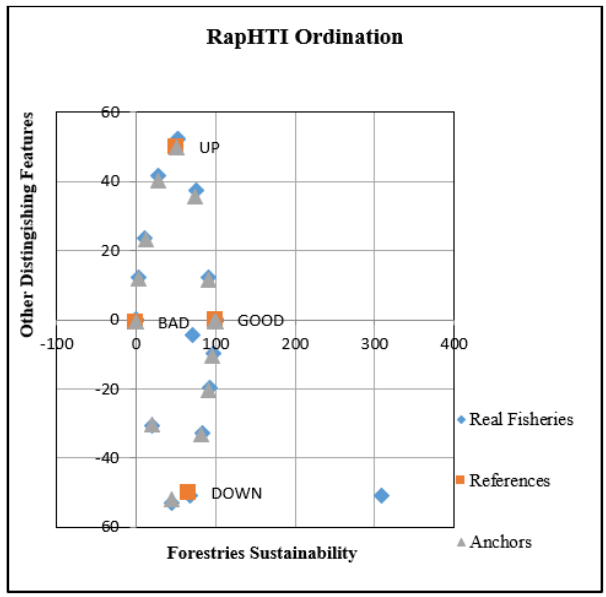

Figure 6. The sustainability status for the economy dimension of industrial forest plantation management based on the RapHTI analysis

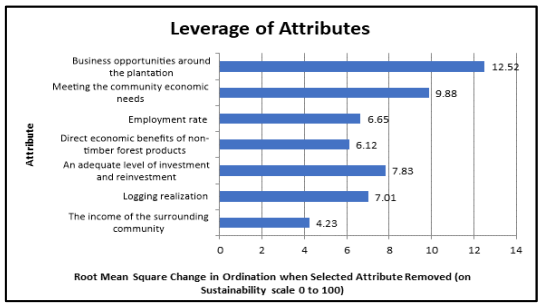

Figure 7. The leverage analysis for each attribute on the economy dimension of industrial forest plantation management

The results of the analysis of leverage on the 7 attributes of economic sustainability above, illustrate that there are 2 attributes that have higher leverage than the other 5 attributes, namely business opportunities around the forest and meeting community needs. Considering these two main leverage attributes affect sustainability in the economy dimension, they need to be taken into account in determining the sustainability status of industrial plantation forest management. These two attributes can be decisive in the sustainable management of industrial plantations.

Business opportunities are related to the economy alleviation of the community, especially less fortunate people. The diversity of forest wealth should be able to become a focus

place for the surrounding community in meeting their daily needs. Yet, poverty is often found in abundant resource places. This is a big problem that must receive serious attention from various parties and find a solution immediately. Poverty can trigger other actions that are not expected and can cause a disruption of forest sustainability. Actions that may occur include forest encroachment and illegal logging.

Several causes for poverty surrounding the forest are still being observed, including a large number of vacant lands around forest areas and the lack of incentives provided by the government for the communities. The program that can be done is to give the community a role to empower the land around the forest area, such as Community-Based Forest Management (CBMF). Also, the government can provide incentives through technical assistance and opening up markets for non-timber forest products to increase business opportunities around industrial plantations.

The existence of business opportunities to improve sustainability in the management of industrial plantation forests is caused by the joint desire of the parties who have businesses around the plantations in realizing the economic sustainability of the community. This is in line with the results of research by Nugraha, et al which defines that business opportunities and business viability are sustainability factors in the economic dimension of forest management [22]. The results of Iqbal and Septina's research also show that non-timber forest products (NTFPs) can provide a faster income than wood or trees. NTFPs are also an alternative job for the community [23].

The economy benefit gained from the industrial plantation forest should include a portion devoted to the forest itself, such as reforestation funds and forest product fees. Therefore, the current investment from the private sector needs to be increased, including the participation in supporting sustainable industrial plantation forest management [24]. Some of the funds obtained by the company must also be returned to the community through corporate social responsibility (CSR) funds.

The CSR fund is expected to help the surrounding community in fulfilling their needs, especially their primary, secondary, and tertiary needs. Primary needs can be met by opening job vacancies for unemployed individuals, assisting with existing facilities and infrastructure in the village, and providing program assistance to improve the quality of the community via village community empowerment.

The existence of financial support from companies and the government can improve the sustainability of forest management because of the guarantee of funds [25]. Azwar et al, states that the CSR funds can support the sustainability of the indigenous forest management in Rumbio, Riau [26]. The results of Wulandari et al's research show that, economically, financial support also helps increase people's income because they participate in receiving tourist visits to Nagari Sirukam, such as providing lodging [27].

3.2.3 Social Dimension

Based on the results of the RPHTI analysis of social attributes, there are six attributes that affect the social dimension of industrial plantation forest management. The results of the RapHTI analysis on the attributes of the social dimension are presented in Figure 8.

Seven attributes affect the social dimension of industrial plantation forest management with the sustainability index value of 66.34%, categorized as moderately sustainable (50.01%-75.00%) (Figure 8).

Figure 8 shows that the value of the sustainability index on the social dimension is in the position of 66.34%. This figure illustrates that the management of industrial forest plantations based on social aspects is in the fairly sustainable category, which is in the position of a value range of 50.01%-75.00%.

Based on the analysis of leverage, 2 of the 6 attributes have high leverage on the social sustainability of industrial plantation forests, namely protection of work safety and security with a sustainability value of 14.84, and industrial plantation plans with a value of 10.16. We can see these results in detail in Figure 9.

The results of the analysis of leverage on the 6 attributes of social sustainability above, illustrate that there are 2 attributes that have higher leverage than the other 4 attributes, namely protection of work safety and security and industrial plantation forest plan. Considering that these two main lever attributes affect sustainability in the social dimension, it is necessary to take them into account in determining the sustainability status of industrial plantation forest management.

Occupational Health and Safety (OHS) includes protection when going to, during, and back from work. OHS seeks to improve worker safety from harm during work activities. Workers are the most important pillar in the management of industrial plantation forest. Workers whose health and safety are guaranteed will improve work ethic and increase motivation at work. Those who come from the surrounding community have contributed to the sustainability of industrial plantation forest management as they already have work guarantees.

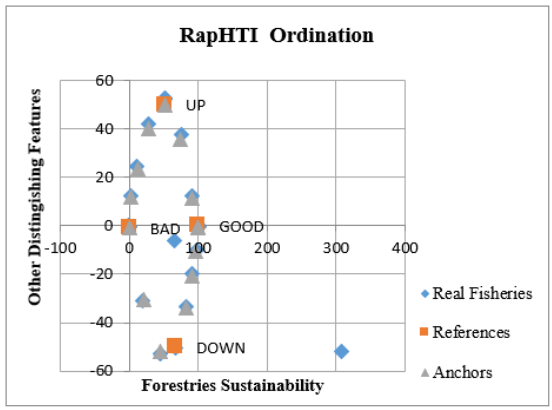

Figure 8. The sustainability status for the social dimension of industrial forest plantation management based on the RapHTI analysis

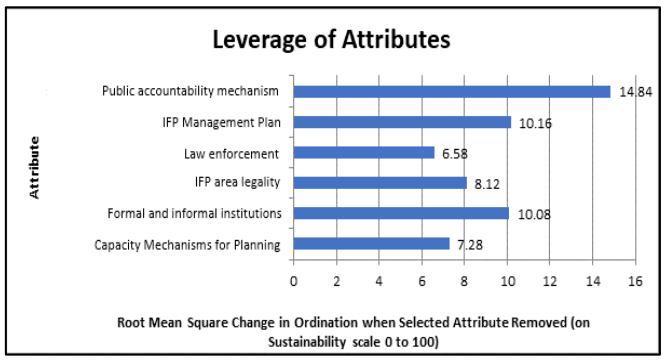

Figure 9. The leverage analysis for each attribute on the social dimension of industrial forest plantation management

The existence of community empowerment through this training received a good response from the participants because it can increase knowledge about lifting methods, understand standard K3 operational procedures, and can minimize the risk of work accidents. Improved OHS management makes employees feel comfortable and dedicated to continuing activities in forest management. The results of this study are in line with the opinion of Herlina et al, who stated that K3 in forest management in Perum Perhutani improves the performance of workers in the company [28].

The process of resolving land conflicts between the company and the community is carried out in consultation mediated by village or sub-district officials. No matter how big the problem, it must be resolved through a deliberation process with a great sense of responsibility. The source of the conflict depends on the interest parties in existing resources [29].

The number of institutions that play a role in managing forest resources can create a conflict of interest because each institution tends to prioritize its sector rather than conservation and social functions. As a result, forests become a source of conflict because many parties have an interest in their management, both interpersonal conflicts and conflicts with state institutions or companies [30].

3.2.4 Institution dimension

Six attributes that affect the institutional dimensions of industrial forest plantation management have a sustainability index value of 76.38% which is included in the very sustainable category, which is in the index range of 75.01% - 100.00%. Further results of the analysis can be seen in Figure 10.

Based on the leverage analysis in Figure 11, it is known that 2 of the 6 analyzed attributes have high leverage on the sustainability of industrial plantation forest management, namely the public accountability mechanism and the industrial plantation forest management plan with sustainability values of 14.84 and 10.16, respectively. Thus, these two attributes need attention in determining the sustainability status of industrial plantation forest management.

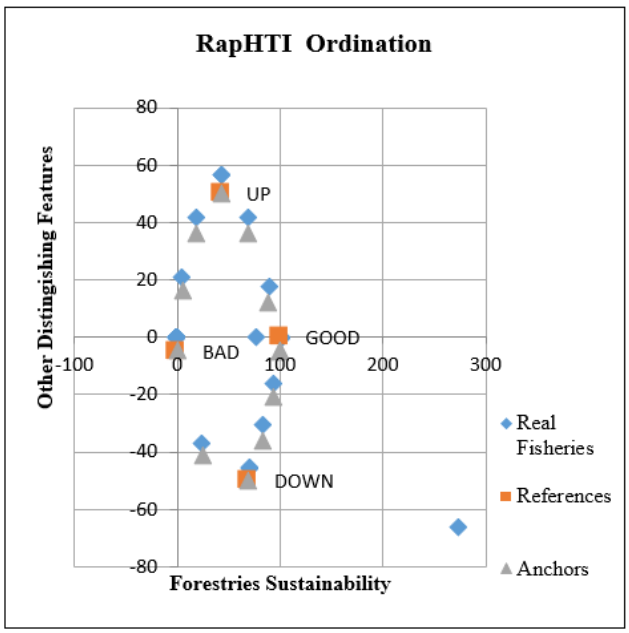

Figure 10. The sustainability status for the institution dimension of industrial forest plantation management based on the RapHTI analysis

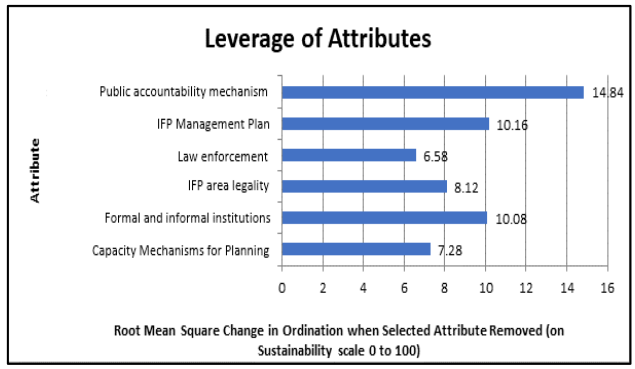

Figure 11. The leverage analysis for each attribute on the institution dimension of industrial forest plantation management

The management of industrial plantation forests is regulated through the provisions of laws and regulations. There are formal institutions involved in the management of industrial plantation forests, such as companies, the Forestry Service, and the Ministry of Environment and Forestry. Non-Governmental Organizations are also informal institutions that have adequate administrative capacity to facilitate cooperative relationships with the government and companies.

The company's public accountability mechanism can take the form of an audit conducted by the Environment Agency and supervision by the Provincial Forestry Service and the Ministry of Environment and Forestry. This mechanism is to increase the company's responsibility to the community in managing industrial plantation forests through an institutional arrangement approach. Syahza et al said that the institutional arrangement strategy aims to create added economic value to accelerate the increase in people's economic development [29].

The results of the research by Wulandari et al, showed that before obtaining a village forest management permit / nagari forest, the Nagari Sirukam community was able to manage sloping land which was generally forest. Local institutions have an important role, as can be seen from the positive impact that the community has had after the existence of the nagari forest. These positive impacts include the improvement of community skills and income. In addition, management by local nagari institutions ensures the availability of water for the community, not only the people of Nagari Sirukam but also the surrounding villages [27].

This is following the concept of the shared value approach, which is the strategic interest of the company to pursue activities that are inclusive and beneficial to all stakeholders and society as a whole. The idea is to create partnerships with relevant stakeholders, including communities, NGOs, and academics. The occurrence of trade-offs between the dimensions of economy, ecology, and social sustainability often occurs in the field. However, the concept of shared value provides a perspective on the interdependence relationship between business and society [31].

Industrial plantations have long-term and short-term plans. Industrial plantations must also prepare an annual management plan to carry out activities within one year. This management plan becomes the company's reference in carrying out its activities. A good management plan will increase the sustainability of industrial plantations because it can anticipate and plan. The management plan provides an overview of the activities implemented in the future and improves the sustainability of activities within an institution

through sustainable forest management efforts [32]. Efforts that can be made are: 1) involving the surrounding community in the formulation of policies that have a good impact on their lives; 2) facilitate local communities to develop knowledge to improve their standard of living; 3) facilitating community knowledge-building activities to gain widespread recognition through the 'intellectual property rights' mechanism [33].

3.3 Multidimensional sustainability status

The RapHTI analysis for all management dimensions obtained an ordinance value of 63.71% which is categorized as quite sustainable. This condition indicates that the management of industrial forest plantations is only sufficient or in a state of concern for the stakeholders.

This result was validated with a Monte Carlo value of 56.66%, indicating a very small difference of 0.65% or less than 1%. This value indicates that the effect of error, or the impact of misjudgment is relatively small. Kavanagh and Pitcher stated that Monte Carlo values can be used as validation for the impact of random errors [34]. Monte Carlo analysis can be an indicator of errors caused by scoring on each attribute, multidimensional scoring variations due to differences of opinion, repeated data analysis processes, and data input errors or missing data [29]. The results of the analysis can be seen further in Figure 12.

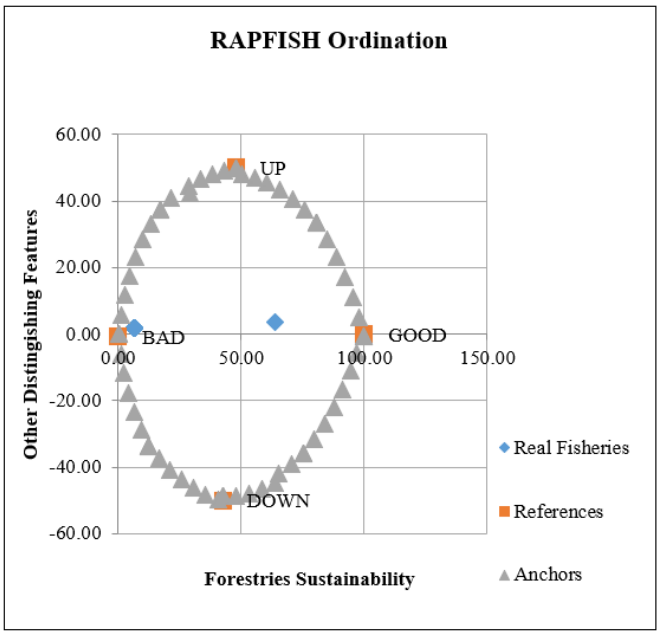

Figure 12. Multidimensional level of sustainability of industrial forest plantation management

The validity of the RapHTI results can also be seen from the results of the goodness of fit test at the Squared Correlation (R2) value of 0.9574 or close to 1. The R2 value that is closer to 1 means that the existing data is mapped more perfectly. It indicates that more than 95% of the model can be explained well, and the remaining <5% is explained by other factors/attributes. If the R2 value is above 80%, then the sustainability index estimation model is good and adequate. On the other hand, the result of the inaccuracy test (a lack of fit measure) or the stress value was 0.1284 or close to 0. The closer the stress value is to zero, the more similar the output is to the actual situation and vice versa. The tolerable stress value is less than 20%.

Table 4. Sensitive attributes affecting sustainability index in industrial forest plantation management

Dimension	Sensitive Attribute
Ecology	Availability and application of environmentally friendly technologies for the production process
	The level of sustainable harvesting for each type of main timber and non-timber forest products for each forest type
Economy	Meeting the needs of the community
	Business opportunities around industrial forest plantations
Social	Conflict Management
	OHS management
Institution	Public Accountability Mechanism
	industrial plantation forest Management Plan

Table 4 presents the sensitive attributes of each dimension. The sensitive attribute is a key factor that has a dominant influence and is useful in determining the policies of related parties in increasing the sustainability index in the industrial plantation forest management based on the principles of sustainable development.

Based on Table 4, the sensitive attributes on the ecological, economic, social, and institutional dimensions are the concern of industrial plantation forest managers in making positive contributions to the parties involved in sustainable industrial plantation forest management. These attributes generally have in common with priorities that need to be improved to improve the sustainability status of mangrove ecosystems, namely changes in mangrove areas, increasing community knowledge about mangrove ecosystems, conflicts of interest, and local wisdom [35]. This is also in line with the research of Syahza et el who said that the management and utilization of peatlands has contributed to the economy, even as the main source of livelihood for coastal communities. Utilization of peatland based on local wisdom can preserve the peat ecosystem [36].

3.4 Stress value and coefficient of determination

The coefficient of determination (R2) explained the contribution of each attribute to the sustainable system, as served in Table 5.

Table 5. Stress value and coefficient of determination in MDS RapHTI analysis results of IFP management

Dimension	MDS Index	Stress	R^2 (%)	Iteration
Ecology	81.46	0.31	0.86	4
Economy	71.36	0.31	0.87	4
Social	66.40	0.31	0.87	4
Institution	76.38	0.26	0.89	4

Table 3 shows that the average stress value and R2 of the dimensions are 0.30 and 87.25%, respectively. A good stress value is below 0.25, indicating the goodness of fit in the MDS, and the attribute configuration can reflect the original data. The R2 value of 0.87 shows that the attributes or factors assessed in each dimension contribute 87.25% to the sustainability of the system under study. A good R2 value if it is greater than 80% or close to 100%.

3.4.1 Effect of error

Evaluation of the effect of random error using Monte Carlo analysis aims to determine: (a) the effect of attribute scoring errors, (b) the effect of scoring variations, (c) the stability of

the repeated MDS analysis, (d) error in data entry or missing data, and (e) acceptable stress values if <20%. The results of the Monte Carlo analysis on all dimensions are presented in Table 6.

Table 6. Results of Monte Carlo Analysis for each dimension of RapHTI at 95% confidence interval

Dimension	MDS RapHTI	Monte Carlo*	Difference (MDS – MC)
Ecology	81.46	83.92	-2.46
Economy	71.36	67.74	3.62
Social	66.40	65.95	0.45
Institution	76.38	74.92	1.46

The RapHTI analysis between MDS ad Monte Carlo analysis for the sustainability of industrial plantation forest management shows no significant difference (Table 5). The small difference in the results indicates that:

(1) Errors in attributes scoring are relatively small.
(2) The variety of scoring due to differences of opinion is relatively small.
(3) The iterative analysis process is relatively stable; and
(4) Errors in data entry and missing data can be avoided.

The RapHTI MDS analysis shows that all of the attributes assessed are quite accurate and accountable, indicated by the stress value and the coefficient of determination of 0.25 and 0.8725, respectively. The results of the analysis are adequate if the stress value is less than 0.25 (25%) and the coefficient of determination is close to 1.0.

The results of this analysis indicate that the overall management of industrial forest plantations is not good enough, so a strategy is needed to realize sustainable management of industrial forest plantations in accordance with sustainable development policies in Riau Province, Indonesia.

3.5 Radar chart

The radar chart below shows the index position and multidimensional sustainability status of industrial plantation forest management was shown by radar chart (Figure 13) and detail annotation by Table 7.

Table 7. Index and status of multidimensional sustainability of IFP management

No	Dimension	Index	Category	Status
1	Ecology	81.46	Good	Highly Sustainable
2	Economy	71.36	Adequate	Moderately Sustainable
3	Social	66.40	Adequate	Highly Sustainable
4	Institution	76.38	Good	Moderately Sustainable

The radar chart shows that 2 of the 4 dimensions in industrial plantation forest management are highly sustainable, while the others are moderately sustainable management. The sustainability value ranges from 66-82%, with social of 66.40%, 76.83% for institution, 71.36% for economy, and 81.46% for ecology. In other words, one dimension has a greater influence, and the two other dimensions have an almost equal effect on industrial plantation forest management.

Several previous studies related to protected forest management found mixed results. For example, a study conducted by Karlina et al. entitled Analysis of the Sustainability of Mangrove Protection Forest Management in Batu Ampar, Kubu Raya Regency, West Kalimantan Province. The results showed that the sustainability status of mangrove protected forest management in Batu Ampar Regency was quite sustainable on ecological criteria and less sustainable on economic and social criteria [27].

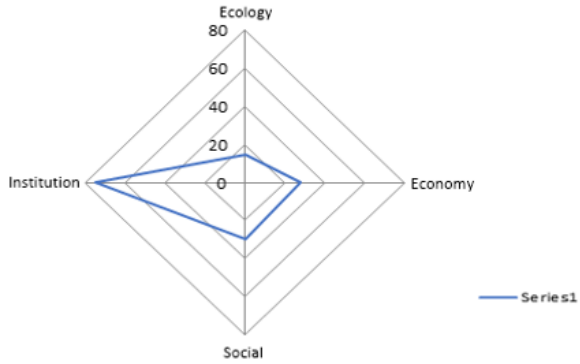

Figure 13. The analysis results of sustainability index and status of industrial forest plantation management

3.6 Sustainability strategy for industrial plantation forest management in Riau Province

3.6.1 Institutional prospective analysis

Based on the results of the prospective institutional analysis carried out, the direct and indirect effects of the factors that affect the sustainability of industrial forest plantation management are obtained.

Direct influence. The results of measuring the value of the direct influence of the factors that affect the sustainability of industrial forest plantation management, can be presented through Table 8.

Table 8. Global strength and global strength value weighted from the direct effects of each factor

Factors	Global Power	Global Strength Weighted
Company	-	-
Riau Province Forestry Service	0.01	0.06
Environmental agency	0.11	0.66
Others Company	0.26	1.61
Public	0.22	1.36
NGO	0.22	1.31

It is known that other companies are the factors that most influence the sustainability of industrial forest plantation management with an influence value of 0.26 and a weighted global strength value of 1.61.

Indirect Influence. The results of measuring the value of the indirect influence of factors that affect the sustainability of industrial forest plantation management can be presented in Table 9.

Table 9. Global strength and global strength value weighted from the indirect effects of each factor

Factors	Global Indirect Influence
Company	-
Riau Province Forestry Service	-
Environmental agency	3
Others Company	6
Public	5
NGO	5

Table 10. Global indirect dependency value

Factors	Global Indirect Influence
Company	10
Riau Province Forestry Service	7
Environmental agency	2
Others Company	-
Public	-
NGO	-

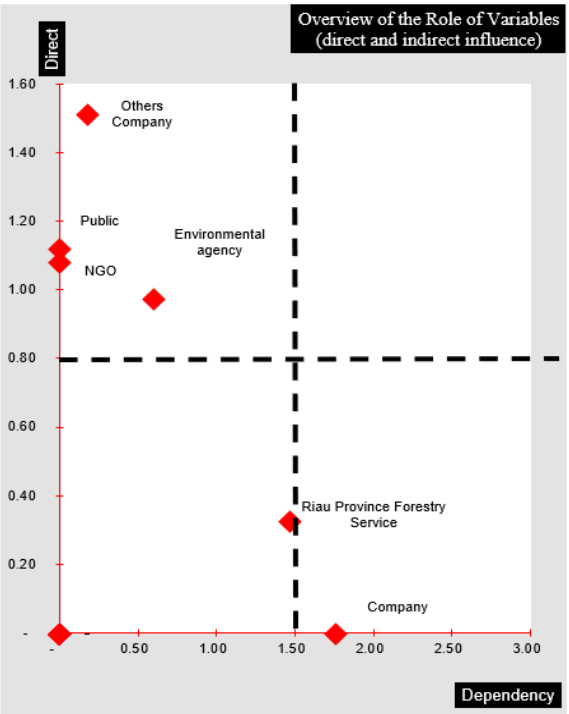

Figure 14. An overview of the level of importance of the factors that influence the system under study

It is known that there are four factors that have an indirect influence on the sustainability of industrial forest plantation management, namely environmental agencies, other companies, communities, and NGOs.

Next, through Table 10, it can also be seen the factors that have indirect dependence. The 3 factors that have the most indirect dependence are the Company, the Riau Provincial Forestry Service, and the Environment Agency. Overall, it can be seen in the prospective analysis quadrant in Figure 14.

Based on the results of the analysis, there are four factors that have a very high influence on the sustainability of industrial plantation forest management. The four factors consist of one main determinant of success (input factors) and three connecting/supporting factors of success (stakes factors). One of the main factors determining the success of industrial plantation forest management is other companies.

The determining factor (input factor) in quadrant I is the institutional capacity factor. These factors have a very strong influence in determining the success of industrial plantation forest management. In addition, these factors are also not influenced by other factors in the system. These results indicate that the relevant institution is the institution that determines the sustainability strategy in the management of industrial forest plantations in Indragiri Hulu Regency. This is in line with the results of research by Wulandari et al, which stated that collaboration between related agencies made village forest management run well [37].

3.6.2 Prospective analysis of industrial forest plantation management strategies

Based on the results of the prospective strategy analysis carried out, the direct and indirect effects of the factors that affect the sustainability of industrial plantation forest management are obtained.

Direct Influence. The results of measuring the value of the direct influence of factors that affect the sustainability of industrial plantation forest management can be presented in Table 11.

Table 11. Global strength and global strength value weighted from the direct effects of each factor

Factors	Global Power	Global Strength Weighted
Community Forest Management	-	-
Community empowerment through CSR	0.00	0.04
Increasing people's income	0.01	0.12
Development of village facilities and infrastructure	0.01	0.24
Environmental quality improvement	0.02	0.33
Construction of corridors and wildlife areas	0.02	0.32
Improving the quality and quantity of conservation areas	0.07	1.04
Improving the quality and quantity of conservation areas	0.10	1.60
Adoption of local community culture and wisdom	0.07	1.03
Community alternative livelihood development	0.09	1.49
Increased assistance for agricultural cultivation intensification	0.10	1.60
Company conflict resolution with community	0.20	3.21

Table 12. Global indirect influence value

Factors	Global Indirect Influence
Community Forest Management	-
Community empowerment through CSR	-
Increasing people's income	3
Development of village facilities and infrastructure	5
Environmental quality improvement	5
Construction of corridors and wildlife areas	9
Improving the quality and quantity of conservation areas	13
Improving the quality and quantity of conservation areas	17
Adoption of local community culture and wisdom	13
Community alternative livelihood development	17
Increased assistance for agricultural cultivation intensification	20
Company conflict resolution with community	28

It is known that conflict resolution between companies and

communities is the factor that most influences the sustainability of industrial forest plantation management with an influence value of 0.20 and a weighted global power value of 3.21.

Indirect Influence. The results of measuring the value of the indirect influence of the factors that affect the sustainability of industrial forest plantation management can be presented in Table 12.

Through Table 13, there are ten factors that have an indirect influence on the sustainability of industrial plantation forest management, ranging from increasing community income to conflict resolution between companies and communities. Furthermore, through Table 13, it can also be seen the factors that have indirect dependence. The 10 factors that have the most indirect dependence include the forest factor with the community to the development of community alternative livelihoods. Overall, it can be seen in the prospective analysis quadrant in Figure 15.

Table 13. Global indirect dependency value

Factors	Global Indirect Addiction
Community Forest Management	29
Community empowerment through CSR	23
Increasing people's income	18
Development of village facilities and infrastructure	14
Environmental quality improvement	17
Construction of corridors and wildlife areas	11
Improving the quality and quantity of conservation areas	6
Improving the quality and quantity of conservation areas	3
Adoption of local community culture and wisdom	6
Community alternative livelihood development	3
Increased assistance for agricultural cultivation intensification	
Company conflict resolution with community	

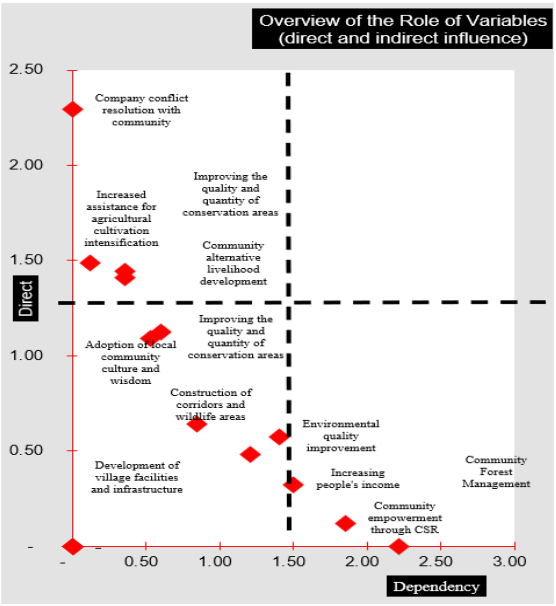

Figure 15. An overview of the level of importance of the factors that influence the system under study

Based on the results of the analysis, it can be seen that there are as many as four factors that have a very high influence on the sustainability of industrial plantation forest management (Figure 15). The four factors consist of one main determinant of success (input factors) and three connecting/supporting factors of success (stakes factors). One of the main factors determining the success of industrial plantation forest management is the resolution of conflicts between companies and communities.

There are three connecting/supporting factors, namely: (1) increasing assistance for intensification of agricultural cultivation; (2) cooperation with stakeholders around the company; and (3) development of community alternative livelihoods. These four factors can be said to be the dominant factors that will influence or determine the success rate of industrial plantation forest management in the future.

The determining factor (input factor) in quadrant I is the management strategy factor. These factors have a very strong influence in determining the success of industrial plantation forest management. In addition, these factors are also not influenced by other factors in the system.

This result is in line with Azwar et al.'s research, which states that the main determinants of sustainability are institutional capacity factors, government budgets, involvement of community institutions, tourism potential, and local cultural practice factors. An alternative priority strategy is the empowerment of forest area communities. Conclusion: The conceptual and structural model is symbolic through legal and institutional aspects, with determinants of institutional capacity, which is supported by connecting factors, namely tourism potential, local cultural practices, community institutional involvement, and budgeting, as well as the choice of community empowerment strategies to determine the sustainability of customary forest management. Rumbio Land [26].

3.7 Industrial plantation forest management strategy

To carry out various alternative strategies based on their priorities, a mutually supportive strategy is needed for effectiveness and efficiency in the management of industrial plantation forests. The determination of the management strategy is based on the various factors that have been identified and adapted to the ecological, economic, and socio-cultural conditions of the local community. From the various strategies formulated in Table 14, the following management strategies can be formulated.

Several strategies that can be formulated are related to empowering village communities and strengthening village institutions. In addition, it is necessary to strengthen cooperation and optimize economic benefits that lead to benefits for related parties. This result is in line with the research conducted by Soenarno et al. who stated that the community around the forest felt empowered by involving the community in forest management, namely by providing agricultural land. Perhutani also grants permission to communities who are members of LMDH to develop and utilize a small portion of the forest area to be empowered according to the ability of the population. Through reflection, thoughts, ideas and ideas and developing the skills of several people who can become businesses, various tourist attractions have emerged. Likewise with the existence of traditional markets and local culinary so that the growth and income of people's welfare increases. Economic growth continues to

grow, both in terms of quality improvement and social networking [17]. The results of this study were reinforced by Syahza et al who said that sustainable development offers a balance with high conservation value in every dimension, namely ecological, economic, and social [38]. The analysis of the dimensions of sustainable development is the basis for management to improve its performance, which focuses on the attributes in each dimension, this also applies to the management of industrial plantations [39].

Table 14. Formulation of sustainable industrial forest plantation management strategy

No	Institutional Prospective Analysis	Strategy Prospective Analysis	Strategy Formulation
1	Other companies	Company conflict resolution with community	Village Institutional Strengthening Strategy
2	Public	Increased intensification of agricultural cultivation	Strategy for community empowerment around forest areas
3	NGOs	Stakeholder cooperation around the company	Strategy for Strengthening Cooperation Networks
4	Environmental agency	Community alternative livelihood development	Economic Benefits Optimization Strategy

4. CONCLUSION

Sustainable management of industrial plantation forests is an effort to accelerate national development from the ecological, economic, social and institutional aspects. Strategies for empowering rural communities, strengthening village institutions, strengthening inter-institutional cooperation and optimizing economic benefits are strategic steps in realizing sustainable industrial forest management. This industrial forest plantation management strategy is in line with the Riau Province's SDGs in supporting sustainable development.

The Riau provincial government is advised to make policies for industrial plantation forest management that accommodate the needs of stakeholders to reduce the negative impacts of industrial plantation forest management. This industrial plantation forest management strategy can contribute in the ecological, economic, social and institutional fields for stakeholders, both regionally and nationally. Therefore, government policies must be guided by this industrial plantation forest management strategy.

This paper provides a reference for those interested in sustainable management of industrial plantations. The results can be applied by industrial forest plantation business actors and researchers to provide added value for forest conservation, and accommodate stakeholders. However, our research is limited to the ecological, economic, social and institutional aspects that contribute to the sustainability of industrial plantation forest management both regionally and nationally. Further research will focus on other aspects to produce strategic policies in Indonesia.

REFERENCES

[1] Achnes. S., Isyandi. B., Syahza. A., Hidir. A. (2020). The implementation of proper in the environmental management at the area of PT. Journal of Critical Reviews, 7(13): 817-823.

[2] Partelow, S., Winkler, K.J., Thaler, G.M. (2020). Environmental non-governmental organizations and global environmental discourse. PLoS ONE, 15(5): e0232945. https://doi.org/10.1371/journal.pone.0232945

[3] Theis, T., Tomkin, J. (2015). Sustainability: A comprehensive foundation. Connexcions Rice. University Houston, Texas.

[4] Syahza, A., Bakce, D., Irianti, M., Asmit, B., Hasbi, M. (2020). Potential development of leading commodities in efforts to accelerate rural economic development in coastal areas Riau, Indonesia. Journal of Applied Sciences, 20(5): 173-181. http://doi.org/10.3923/jas.2020.173.181

[5] Syahadat, E. (2013). Development strategy of forest plantation in east Kalimantan province. Journal of Forestry Social and Economic Research, 10(1): 33-47. https://doi.org/10.20886/jpsek.2013.10.1.33-47

[6] Borges, J.G., Balteiro, L.D., McDill, M.E., Rodriguez, L.C.E. (2014). The Management of Industrial Forest Plantations. Theoretical Foundations and Applications. Springer Nature, New York. http://dx.doi.org/10.1007/978-94-017-8899-1

[7] Syahza, A., Irianti, M., Nasrul, B. (2020). What's Wrong with palm oil, why is it accused of damaging the environment? In Journal of Physics: Conference Series, 1655(1): 012134. http://doi.org/10.1088/1742-6596/1655/1/012134

[8] Medeiros, G., Florindo, T., Talamini, E., Fett Neto, A. Ruviaro, C. (2020). Optimising tree plantation land use in Brazil by analysing trade-offs between economic and environmental factors using multi-objective programming. Forests, 11(7): 723. https://doi.org/10.3390/f11070723

[9] Farooq, T.H., Shakoor, A., Wu, X., Li, Y., Rashid, M. H.U., Zhang, X., Gilani, M.M., Kumar, U., Chen, X. Yan, W. (2021). Perspectives of plantation forests in the sustainable forest development of China. iForest 14: 166-174. https://doi.org/10.3832/ifor3551-014

[10] Chambers, R. (1994). Participatory rural appraisal (PRA): Challenges, potentials and paradigm. World Development. 22(10): 1437-1454. https://doi.org/10.1016/0305-750X(94)90030-2

[11] Preece, J. (2006). Participatory rural appraisal: Lessons for countries in the North? International Journal of Action Research, 2: 198-221.

[12] Cramb, R., Purcell, T., Ho., T.C.S. (2004). Participatory assessment of rural livelihoods in the central highlands of Vietnam. Agricultural System. 81: 255-272. http://dx.doi.org/10.1016/j.agsy.2003.11.005

[13] Juniyanti, L., Purnomo, H., Kartodihardjo, H., Prasetyo, L. B., Pambudi, E. (2021). Powerful actors and their networks in land use contestation for oil palm and industrial tree plantations in Riau. Forest Policy and Economics, 129: 102512. https://doi.org/10.1016/j.forpol.2021.102512

[14] Bowyer, J.L. (2008). The green movement and the forest products industry. Forest Products Journal, 58: 6-13.

[15] Mohr, C.H., Coppus, R., Iroume, A., Huber, A., Bronstert, A. (2013). Runoff generation and soil erosion processes after clear cutting. Journal of Geophysical Research, 118: 814-831. https://dx.doi.org/doi:10.1002/jgrf.20047
[16] Rondon, X.J., Gorchov, D.L., Elliottc, S.R. (2010). Assessment of economic sustainability of the strip clear-cutting system in the Peruvian Amazon. For Policy and Econ. 12: 340-348. https://doi.org/10.1016/j.forpol.2010.02.004
[17] Dulsalam, Soenarno, Sukadaryati. (2021). Trial performance of the zero waste harvesting method in three forest concession companies, Central Kalimantan Province, Indonesia. IOP Conference Series, 914: 012061. http://dx.doi.org/10.1088/1755-1315/914/1/012061
[18] Abukhadra, M.R., Shaban, M. (2019). Recycling of different solid wastes in synthesis of high-order mesoporous silica as adsorbent for safranin dye. Int. J. Environ. Sci. Technol., 16: 7573-7582. https://doi.org/10.1007/s13762-019-02231-8
[19] Sharma, M., Hammett, A.L. (2001). Making forest projects sustainable. Journal of Sustainable Forestry, 14: 129-145. http://dx.doi.org/10.1300/J091v14n02_08
[20] Safe'I, R., Hardjanto., Supriyanto., Sundawati, L. (2015). Development of a method for assessing the health of the community forest of Sengon (Falcataria moluccana (MIQ) Barneby & J.W. Grimes). Journal of Plantation Forest Research, 12: 175-187. http://dx.doi.org/10.20886/jpht.2015.12.3.175-187
[21] Purbawiyatna, A., Kartodihardjo, H., Alikodra, H.S., Prasetyo, L.B. (2011). Analysis of sustainability of private forest management in protection area. JPSL. 1: 84-92. https://doi.org/10.29244/jpsl.2.1.1
[22] Nugraha, D.R., Parikesit, T.H. (2018). Evaluating the level of economic sustainability of forest resources in Forest Management Unit (FMU) of Yogyakarta. Ecodevelopment Journal, 1(1): 35-38. https://doi.org/10.24198/ecodev.v1i1.37588
[23] Iqbal, M., Septiana, A.D. (2018). Pemanfaatan Hasil Hutan Bukan Kayu Oleh Masyarakat Lokal Di Kabupaten Sanggau, Kalimantan Barat. Journal of Dipterocarp Ecosystem Research, 4: 19-34. https://doi.org/10.20886/jped.2018.4.1.19-34
[24] Palmujoki, E. (2006). Public–private governance patterns and environmental sustainability. Environment, Development and Sustainability, 8(1): 1-17. https://doi.org/10.1007/s10668-004-6145-x
[25] Butler, M., Current, D. (2022). Evolution of community-based enterprise governance over time: lessons learned from the maya biosphere reserve. Small-scale Forestry, 21(1): 29-53. https://doi.org/10.1007/s11842-021-09486-5
[26] Azwar, B., Zulkarnain., M.A., Harlen. (2020). Index and management sustainability condition of kenegerian rumbio customary forest, Riau Province-Indonesia. International Journal of Environmental Science, 5: 241-252. http://www.iaras.org/iaras/journals/ijes
[27] Wulandari, C., Herwanti, S., Febriano, I.G. (2018). Peran Kelembagaan Nagari Dalam Pengelolaan Hutan Di Nagari Sirukam, Kabupaten Solok. Gorontalo. Journal of Forestry Research, 1: 2614-2058. http://dx.doi.org/10.32662/gjfr.v1i2.368
[28] Herlina, N., Nasihin, I., Nurdin., Yudayana, B., Prianto, A. (2020). Pelatihan Angkat Beban Dan Keamanan, Kesehatan, Dan Keselamatan Kerja (K3) Di Perum Perhutani Kesatuan Pemangkuan Hutan (Kph) Tasikmalaya. Journal pengabdian masyarakat. 3(2): 112-116. https://doi.org/10.25134/empowerment.v3i02.3475
[29] Syahza, A., Irianti, M. (2021). Formulation of control strategy on the environmental impact potential as a result of the development of palm oil plantation. Journal of Science and Technology Policy Management, 12(1): 106-116. https://doi.org/10.1108/JSTPM-06-2019-0059
[30] Ambarwati, M.E., Sasongko, G., Therik, W.M.A (2018). Dynamics of The Tenurial Conflict in State Forest Area (Case in BKPH Tanggung KPH Semarang). Sodaliti: Journal of Rural Sociology, 6(2). https://doi.org/10.22500/sodality.v6i2.23228
[31] D'Amato, D., Rekola, D.M., Wan, M., Cai, D., Toppinen, A. (2017). Effects of industrial plantations on ecosystem services and livelihoods: Perspectives of rural communities in China. Land Use Policy. 63: 266-278. https://doi.org/10.1016/j.landusepol.2017.01.044
[32] Sabar, A., Yusran, Y. (2017). Analisis Kebijakan Pengelolaan Hutan Pendidikan: Studi Kasus Hutan Pendidikan Bengo-Bengo Universitas Hasanuddin. Journal Hutan Dan Masyarakat, 9(2): 114-122. https://doi.org/10.24259/jhm.v9i2.2976
[33] Syahza, A., Hosobuchi, M. (2021). Innovation for the development of environmentally friendly oil palm plantation in Indonesia. In IOP Conference Series: Earth and Environmental Science, 716(1): 012014. http://doi.org/10.1088/1755-1315/716/1/012014
[34] Kavanagh, P., Pitcher, T.J. (2004). Implementing microsoft excel software for rapfish: A technique for the rapid appraisal of fisheries status. Fisheries Centre Research Reports, University of British Columbia, Canada, 12(2). http://doi.org/10.14288/1.0074801
[35] Noktasatria, A.Y., Farid, A. (2021). Sustainable evaluation of mangrove ecosystems using Rapfish in Ujung Piring village, Bangkalan District, Bangkalan Regency. Juvenil: Marine and Fisheries Scientific Journal 2(2): 146-156. http://doi.org/10.21107/juvenil.v2i2.10779
[36] Theresia, T., Boer, M., Pratiwi, N.T. (2015). Sustainability status of mangrove ecosystem management in Sembilang National Park, Banyuasin Regency, South Sumatera Province. Journal Ilmu dan Teknologi Kelautan Tropis, 7(2): 98996.
[37] Karlina, E., Kusmana, C., Marimin, M., Bismark, M. (2016). Analysis of sustainability of mangrove protection forest management in Batu Ampar, Kubu Raya Regency, West Kalimantan Province. Journal Analisis Kebijakan Kehutanan, 13(3): 201-219. https://dx.doi.org/10.20886/jakk.2016.13.3.201-219
[38] Syahza, A., Bakce. D., Irianti, M., Nasrul, B. (2021). Development of superior plantation commodities based on sustainable development. International Journal of Sustainable Development and Planing, 16(4): 683-692. https://doi.org/10.18280/ijsdp.160408
[39] Widiati, W., Mulyadi, A., Syahza, A., Mubarak. (2020). Analysis of plantation management achievement based on sustainable development. International Journal of Sustainable Development and Planning, 15(4): 575-584. https://doi.org/10.18280/ijsdp.150418