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Sustainability Assessment of Cooperative-Based Community Forest Management in Bengkalis Regency, Indonesia

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Abstract. Community Forestry (HKm) is one of the social forestry programs in Indonesia that aims to improve community welfare while maintaining forest sustainability. This study aims to evaluate the sustainability status of HKm managed by the Sri Bina Daerah Consumer Cooperative in Bengkalis Regency, Riau Province. The study was conducted in a 3,235.36-hectare HKm area using a survey method through field observations, interviews, and literature studies. A total of 72 community respondents and four stakeholders were selected purposively. Sustainability analysis was conducted using Multidimensional Scaling (MDS) with a modified Rapid Appraisal for Social Forestry (RAP-SPFA) approach on ecological, economic, and socio-cultural dimensions. The results showed that the ecological dimension had a sustainability index of 61.92 (fairly sustainable), supported by relatively good vegetation cover and moderate biodiversity. However, secondary vegetation still dominated, natural forest was limited, and peat hydrological disturbances occurred due to drainage canals. The socio-cultural dimension obtained an index of 47.44 (less sustainable) due to the community's low dependence on HKm resources and the declining application of local wisdom in forest conservation. The economic dimension had the lowest index at 9.50 (unsustainable), reflecting the low contribution of Community Forests to community income, limited employment opportunities, and minimal diversification of forest-based businesses. Overall, Community Forest Management still shows disparities across sustainability dimensions, necessitating strengthened community businesses, improved market access, restored peat ecosystems, and enhanced local participation.

Keywords: Community Forestry; sustainability assessment; RAP-SPFA; peatland ecosystem; social forestry; sustainable forest environment.

I. INTRODUCTION

Forests are natural resources that play a strategic role in supporting environmental sustainability, the economy, and social life [1]. Ecologically, forests play a role in water management, erosion control, carbon sequestration, and climate stabilization, which are key aspects in maintaining environmental balance and supporting climate change mitigation efforts [2]. From an economic perspective, forests provide wood and non-timber forest products that serve as sources of income for communities and support production and business activities at local and national scales [3]. Furthermore, forests also have crucial social and cultural functions, particularly for communities living around forest areas, as forests serve as a source of livelihood, cultural living space, and the basis for the sustainability of local community life [4]. In Indonesia, Social Forestry is also known as Community Forestry, or Hutan Kemasyarakatan (HKm) [5].

Social Forestry is a sustainable forest management system implemented within state forest areas, privately owned forests, or customary forests, involving local communities or customary law communities as the primary actors [6]. The goal is to improve community welfare while maintaining environmental balance and

social and cultural dynamics. Social Forestry is implemented through several schemes: Village Forests, Community Forests, Community Plantation Forests, Customary Forests, and Forestry Partnerships. The government has established guidelines for Social Forestry management areas through the Indicative Map of Social Forestry Areas (PIAPS), covering approximately 15,143,866.86 hectares. The forest area in Riau Province covers 5,335,035 hectares, or approximately 59.32% of the province's land area, divided into conservation, protection, and production functions. It serves as the primary basis for the development of Social Forestry, including the Community Forestry (HKm) scheme [7].

One of the holders of a Community Forest Management Agreement (HKm) in Riau Province is the Sri Bina Daerah Consumer Cooperative, which manages approximately 3,283 hectares in Bengkalis Regency. However, the existence of an HKm management agreement and the strengthening of legal management access do not automatically guarantee sustainable forest management. At the basic level, HKm management still faces various challenges, including limited institutional capacity, member participation levels, the sustainability of forest-based economic enterprises, compliance with legal provisions, and ecological pressures, particularly in peat areas [8]. To date, no comprehensive study has assessed the sustainability of HKm management by the Sri Bina Daerah Consumer Cooperative, taking into account the interrelationships among ecological, social, and economic factors.

Given these conditions, an analysis is needed to comprehensively assess the sustainability of Community Forest management at the site level. This study uses the Multidimensional Scaling (MDS) approach, adapted from the RAPFISH method, to assess the sustainability of Community Forest management based on ecological and socioeconomic factors. This approach is considered relevant because it not only produces a sustainability index but also identifies sensitive attributes that most influence management sustainability.

II. METHODS

2.1. Place and Time of Research

The research location was the HKm area of the Sri Bina Daerah Consumer Cooperative, located in Kelemantan Barat Village, Bengkalis District, and in Kembung Baru Village, Kembung Luar Village, and Teluk Lancar Village, Bantan District, Bengkalis Regency, Riau Province, covering an area of 3,235.36 hectares. Data processing and analysis were conducted at the Geographic Information Systems (GIS) Laboratory of the Forest Area Stabilization Center, Region XIX. The research and data processing took place over two months, from February to March 2026. The research location is shown in Figure 1.

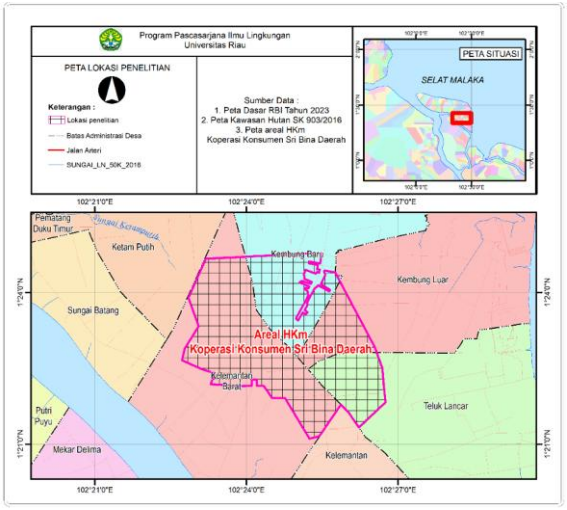

Figure 1. Research Location

2.2. Population and Sampling Techniques

The population in this study includes all objects and subjects that are the focus of the study, namely the forest ecosystem, managers or stakeholders, communities living around forest areas, and members of the Community Forest Management Unit (HKm). The sample is a subset of the population, selected to represent the population's overall characteristics. In this study, the sample consisted of observation plots for biophysical condition analysis, stakeholders, and community members living around the forest area. Respondents were selected using purposive sampling, a method that selects samples based on specific criteria in accordance with the research objectives [9].

Respondents in this study consisted of two groups: stakeholders and community respondents. The stakeholder respondents consisted of four individuals representing stakeholders involved in area management. Meanwhile, the community respondents were members of the HKm cooperative from several villages surrounding the area. The number of community respondents was determined using the Slovin formula [9; 10], with an error tolerance to ensure the sample remains representative. Based on these calculations, the total number of community respondents was 72. Respondents were distributed proportionally according to the conditions and representation of each village. Thirty-one respondents came from West Kelemantan Village, two from Kembung Baru Village, 22 from Kembung Luar Village, and 17 from Teluk Lancar Village. Interviews were also conducted with key informants [11], including the Bengkalis Island Forest

Management Unit (UPT KPH), the Kampar Social Forestry Center, the Region XIX Forest Area Stabilization Center, and the Chairperson of the Sri Bina Daerah Consumer Cooperative, which manages the HKm.

2.3. Data collection

Data collection in this study was conducted through surveys, field observations, interviews, and a literature review. Primary data was collected through field observations and interviews, while secondary data was obtained through a literature review. The types and data collection techniques used are shown in Table 1. This research focuses on three dimensions: Ecology, Social, and Economy. The ecological, social, and economic dimensions are the three main pillars of interrelated interests in social forestry management, as the program's success is determined not only by the sustainability of forest resources but also by community well-being and economic benefits. Focusing on these three dimensions is necessary to ensure that forest utilization increases community income and quality of life without reducing the forest's ecological functions for current and future generations.

Table 1.
Types and Techniques of Data Collection

Parameter	Data Details	Data collection technique
Ecology	1. Forest land cover conditions 2. Peat ecosystem conditions 3. Tree species diversity	Interview, Observation
Economy	1. Contribution of HKm to members' income 2. Employment absorption rate	Interview
Social and Cultural	1. Level of community dependence on HKm areas 2. Local cultural practices in forest area conservation	Interview

2.4. Data Analysis

This research was conducted through an analysis of the existing conditions and the sustainability status of HKm in the ecological, economic, and socio-cultural aspects. The analysis used a descriptive, qualitative, and quantitative approach based on primary data from field observations and in-depth interviews, as well as secondary data from policy documents, management reports, and related statistical data. The sustainability status was analyzed using the Multidimensional Scaling (MDS) method with a modification of the RAP-SPFA from the RAPFISH program. Each dimension was assessed based on 3 attributes with a score of 0–2, resulting in a total of 32 attributes obtained through interviews with HKm managers and communities. The data were then analyzed using Rap-SPFA software to generate a sustainability index for each dimension with a value range of 0%–100%, where values closer to 100% indicate a better level of sustainability (Table 2).

Table 2.
Category of Sustainability Status of Management of HKm of Sri Bina Daerah Consumer Cooperative

Index Value	Category
0,00-25,00	Bad (Not sustainable)
25,01-50,00	Poor (Less Sustainable)
50,01-75,00	Fair (Quite Sustainable)
75,01-100,00	Good (Very Sustainable)

Source: [12]

III. RESULTS AND DISCUSSION

3.1. Existing Conditions

3.2.1. Existing conditions of the ecological dimension

The existing ecological conditions of HKm areas are a crucial aspect that needs to be analyzed to determine the sustainability of area management and the environmental pressures that occur [13]. This analysis is conducted by examining various variables that represent the area's biophysical conditions, including forest land cover, peat ecosystem conditions, and vegetation diversity.

a. Land cover

Based on the interview results, most HKm areas have moderate to good vegetation cover with a density of 50%–75%, representing 57 respondents (79%). This condition indicates that the ecosystem is relatively well-maintained and still capable of supporting ecological functions such as soil protection, water management, and habitat for flora and fauna. However, there are still areas with low vegetation cover (<50%), as many as 11 respondents (15%), indicating ecosystem pressure or disturbance. Meanwhile, areas with very dense vegetation cover (>75%) were only 4 respondents (6%), so optimal vegetation conditions are still limited and require ongoing management and rehabilitation efforts. The dominance of moderate to good vegetation cover indicates that HKm's

ecological condition is still relatively well maintained and able to support environmental functions optimally [14]. However, the presence of areas with low cover indicates the need for rehabilitation and sustainable management to prevent ecosystem degradation (Ekka et al., 2023). Land cover attributes are presented in Table 34.

Table 3.
Land Cover Attributes

	Category	Number	Percentage
1.	<50% of the HKm area is covered by dense vegetation.	11	15
2.	50%-75% of the HKm area is covered by dense vegetation.	57	79
3.	>75% of the HKm area is covered by dense vegetation.	4	6
	Total	72	100

Source: Data Processing Results, 2026.

Based on the results of field observations, land cover in the HKm area consists of swamp shrubs, planted forests, open land, natural forests in the form of secondary swamp forests, plantations, and dryland agriculture mixed with shrubs. The results of land cover analysis based on Thematic Geospatial Information (IGT) data on land cover issued by the Ministry of Forestry in 2025, in the Hkm area of a total area of 3,235.36 hectares, land cover is dominated by swamp shrubs covering 1,309.87 hectares (±40.5%), followed by planted forests covering 966.30 hectares (±29.9%), and open land covering 370.42 hectares (±11.4%). Meanwhile, natural forest cover in the form of secondary swamp forests only reached 219.46 hectares (±6.8%), as shown in Figure 1, with the remainder consisting of plantations and dryland agriculture mixed with shrubs. This composition reflects that land cover at the research location is dominated by secondary vegetation and non-forest land uses. This condition indicates that the HKm area has experienced significant degradation, characterized by a low proportion of natural forest and a high dominance of shrubs and open land [15].

b. Peat ecosystem conditions

Based on interviews, the peat ecosystem in the study area is predominantly in the moderate category, meaning it is partially disturbed but still has potential for recovery. This situation indicates the need for sustainable peat management and restoration efforts to prevent further damage [16].

Based on field observations, the peat ecosystem in the HKm area has been disturbed in several areas, as indicated by the presence of intensive canals in the former PBPH HTI PT Rimba Rokan Lestari area (Table 4). These canals have the potential to alter the natural hydrology of the peat through drainage processes, thereby lowering the groundwater level and increasing the risk of peat drought [17]. Furthermore, based on the 2011 National Peat Map (Figure 2), the majority of the area is dominated by deep peat with a depth of >300 cm and an area of approximately 2,252,914 hectares. This condition underscores the important ecological role of peat as a carbon store and water regulator, underscoring the need for hydrological restoration efforts and ecosystem-based management to sustain peat's protective function.

Table 4.
Peat Ecosystem Condition

	Category	Number	Percentage (%)
1.	Damaged (dry, drained, burned).	11	15
		59	82
2.	Moderate (partially disturbed, can be restored).	2	3
3.	Good (natural vegetation is not damaged).		
	Total	72	100

Source: Data Processing Results, 2026

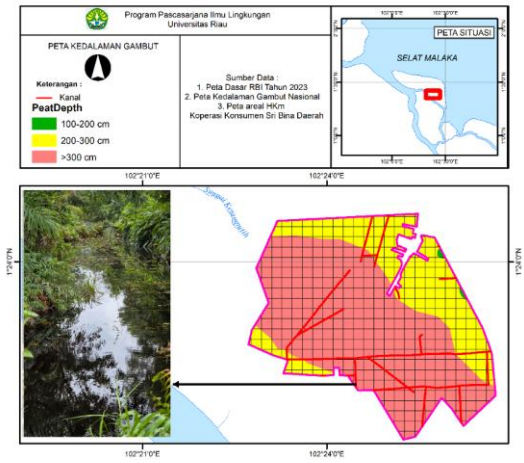

Figure 2. Peat Depth Map in HKm area

c. Vegetation diversity

Based on field observations, the composition of vegetation at the seedling, sapling, pole, and tree levels in the Community Forest (HKm) area shows a fairly good

level of species diversity, with certain species dominating at each growth stage. At the seedling stage, 7 species were identified, dominated by acacia (Acacia crassicarpa), red kelat (*Syzygium sp.*), and balam (*Palaquium sp*.), indicating that the initial vegetation regeneration was progressing well. At the seedling stage, 23 species were found, dominated by red kelat (*Syzygium sp*.), medang (*Litsea sp*.), and balam (*Palaquium sp*.), indicating sustainable vegetation growth. Meanwhile, at the pole stage, 13 species were found, dominated by copal (*Dacryodes sp*.), balam (*Palaquium sp*.), and pulai rawa (*Alstonia pneumatophora*), indicating the high adaptability of several species to the peat swamp ecosystem. In addition, 14 tree species were found in the HKm area with varying Important Value Index (INP) values, with Acacia crassicarpa having the highest value of 111.19%, indicating its dominant role in the vegetation community. The high presence of acacia in an ecosystem often indicates that the ecosystem has experienced disturbance [18]. However, the presence of various other local species indicates that this area still has potential biodiversity and opportunities for ecosystem restoration through sustainable management [19]. The following table presents the tree species found in the HKm area.

Table 5.
Tree Types in the HKm Area of the Sri Bina Regional Consumer Cooperative

No	Local Name	Species	IVI (%)
1	Akasia carpa	*Acacia crassicarpa*	111.19
2	Pulai rawa	*Alstonia pneumatophora*	18.07
3	Tenggek Burung	*Bridelia tomentosa*	5.17
4	Medang	*Litsea* sp.	29.81
5	Balam	*Palaquium* sp.	41.88
6	Meranti batu	*Shorea leprosula*	8.82
7	Punak	*Tetramerista glabra*	26.50
8	Geronggang	*Cratoxylum arborescens*	10.58
9	Ramin	*Gonystylus bancanus*	8.61
10	Tembesu	*Fagraea fragrans*	16.09
11	Kelat Putih	*Syzygium* sp.	5.65
12	Gasing	*Dyera costulata*	6.94
13	Terentang	*Campnosperma coriaceum*	5.17
14	Mahang	*Macaranga* sp.	5.53

Source: Research and analysis results, 2026

3.1.2. Existing conditions of the economic dimension

The economic conditions of communities within HKm areas are a crucial indicator for assessing the success of social forestry, particularly in improving community welfare and economic independence [20]. HKm programs are not only focused on forest preservation but also on the productive and sustainable use of forest resources to support community income [21]. Therefore, an economic analysis is necessary to assess the extent of HKm's contribution to the economic well-being of group members.

a. HKm Contribution to Members' Income

Based on the interview results, the contribution of HKm activities to members' income is still relatively low. This is indicated by the majority of respondents whose income falls below the Regency Minimum Wage (UMK) (Table 4.4). Referring to the classification used, this condition is included in the low category (score 0), meaning income that is not yet able to reach the Bengkalis Regency UMK standard of IDR 4,155,317.75 [22]. The low contribution of HKm to members' income indicates that the utilization of forest areas has not been able to provide optimal economic value for the community [23]. This condition is thought to be influenced by limitations in forestry business development, inadequate market access, and low added value of the resulting products. Therefore, efforts are needed to strengthen the productive economic aspects, including developing business diversification, increasing product added value, and expanding market access, so that HKm can make a more significant contribution to members' welfare.

Table 6.
HKm Contribution Attributes to Member Income.

Category		Number	Percentage (%)
Income < Minimum Wage	<	71	98
Income = Minimum Wage	=	1	2
Income > Minimum Wage	>	0	0
Total		72	100

Source: Data processing results, 2026

b. Labor Absorption Rate

Based on interview results, the labor absorption rate in HKm activities is still relatively low (Table 7).

Table 7.
Labor Absorption Rate Attributes

Category	Number	Percentage (%)
<10% local communities	43	60
10% – 30%	29	40
>30%	0	0
Total	72	100

This low level of labor absorption indicates that HKm activities have not been able to create extensive employment opportunities for the surrounding community [24]. This may be due to the limited types of businesses being developed, which are still dominated by simple uses of forest products such as honey, thus not requiring a large workforce. Furthermore, the lack of business diversification and further processing also limits community involvement in the production chain. Therefore, the development of more diverse and value-added businesses is needed so that HKm can play a greater role in absorbing labor and improving the welfare of the surrounding community. With business development, labor absorption will increase, which will have positive implications for HKm management [25].

3.1.3. Existing conditions of social and cultural dimensions

Social and cultural conditions in HKm management have a strategic role in strengthening community participation, increasing local institutional capacity, and maintaining social and cultural values related to forest management [26]. The social forestry program also encourages community empowerment by increasing access to forest resources, strengthening forest farmer groups, and increasing the role of communities in decision-making (KLHK, 2021). In addition, community involvement has been shown to contribute to improving social welfare, equalizing access to resources, and reducing tenurial conflicts [27].

a. Level of Community Dependence on HKm

Based on the interview results, the community's level of dependence on the HKm area is relatively low (Table 4.7). This finding aligns with in-depth interviews conducted with the Head of the HKm Cooperative and several community members, who stated that the current level of dependence on HKm is still relatively low. This is because many cooperative members still work outside the region, such as in Malaysia, to meet their living needs. Referring to the assessment criteria [28], this condition is categorized as low, indicating that the utilization of HKm as a primary source of livelihood is not yet optimal. Therefore, efforts are needed to develop more productive and sustainable forest-based businesses so that the community's dependence on HKm can increase positively without reducing the area's ecological function.

Table 8.
Level of Community Dependence on HKm

Category	Number	Percentage (%)
<50%	52	73
50–80%	16	22
>80%	4	5
Total	72	100

Source: Data processing results, 2026

b. Local Cultural Practices in Forest Conservation

Based on interviews, local cultural practices in forest conservation in HKm areas are very low. This condition indicates that local wisdom values in forest management are starting to decline and are not yet a primary part of current HKm management activities (Table 9).

Table 9.
Local Cultural Practices in Forest Conservation

Category	Number	Percentage (%)
No local cultural practices	63	88
Exist but poorly maintained	9	12
Exist and well maintained	0	0
Total	72	100

Source: Data processing results, 2026

However, based on interviews with the head of the operational unit and supported by literature, several local cultural practices that once flourished in the community remain poorly maintained. Examples include mutual cooperation in forest protection, traditional land management, and local wisdom in fire control, such as the technique of merun (threshing) and water management. These practices have been shown to play a crucial role in maintaining the balance of forest and peatland ecosystems [29]. However, with changes in social, economic, and livelihood patterns, these practices have been abandoned or are no longer consistently practiced [30]. Referring to the assessment criteria [31], the level of local cultural practices in this study is categorized as low, indicating that

local wisdom has not been optimally integrated into Community Forest Management (HKm).

3.2. Sustainability Level of Community Forest Management (HKm) of the Sri Bina Regional Consumer Cooperative

To determine the sustainability status of the Sri Bina Regional Consumer Cooperative's HKm, a RAP-SPFA analysis was used with several statistical parameters. Based on the MDS analysis using RAP-SPFA (Special Forest Area), the sustainability status index value for the ecological dimension (Figure A) of Community Forest Management (HKm) is 61.92%. This value indicates a fairly sustainable condition. This sustainability status determination is that a score between 50.0 and 75.0 is classified as moderately sustainable [32]. Sustainability status of mangrove forest management in Batu Ampar Regency, based on the ecological dimension, is also categorized as moderately sustainable, with an index of 54.49%. The results of the sustainability index analysis are shown in Figure 3.

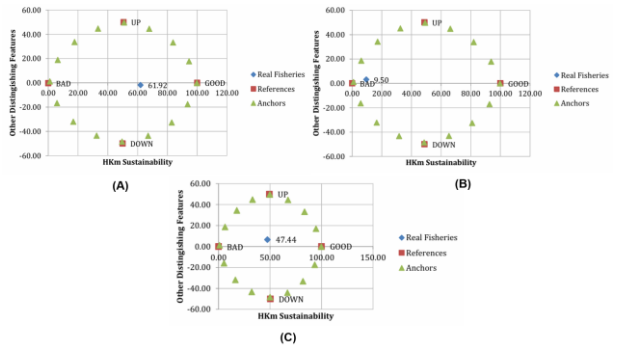

Figure 3. Rap-SPFA Ordinance related to the Sustainability Level of Community Forest Management (HKm). A = Ecological Dimension, B = Economic Dimension, C = Social and Cultural Dimension

The ordination graph in Figure A (ecological dimension) shows that the Community Forest (HKm) sustainability index value of 61.92 is in the moderately sustainable category. The ordination point position, which is closer to the GOOD (100) point than the BAD (0) point, indicates that the ecological condition of the HKm area is relatively good and its management has been able to support the sustainability of environmental functions, although several ecological attributes still need to be improved. The distribution of anchor points in the graph indicates that the Multidimensional Scaling (MDS) ordination process is running well, so the analysis results can fairly accurately represent the ecological sustainability of the HKm. Conceptually, these results align with the theory of sustainable forest management, which emphasizes the importance of maintaining a balance between ecological, economic, and social functions in forest resource management [33]. In the context of HKm, the ecological dimension is the primary basis for sustainability because it is directly related to the ecosystem's ability to provide environmental services such as water management, biodiversity conservation, and climate change mitigation [34].

The RAP-SPFA (Regional Community Forest Management) shows a sustainability status index value of 9.50% for HKm management in Figure B (economic dimension). This value indicates that the economic dimension is in the unsustainable category. This low value is likely due to the suboptimal implementation of HKm management activities by the Sri Bina Daerah Consumer of forest areas. However, the distribution of anchor points forming the ordination pattern indicates that the Multidimensional Scaling (MDS) analysis can still be used to representatively depict the economic sustainability of HKm.

The RAPSPFA ordination results in Figure C (social and cultural dimensions) show a sustainability index value of 47.44, indicating that the socio-cultural aspects of HKm management are still in the less sustainable category. The ordination points below the threshold of 50 reflect that community social support, stakeholder participation, preservation of local cultural values, and social institutional capacity have not been optimally implemented to support sustainable area management. This situation demonstrates the continued need to strengthen community empowerment, increase local community involvement, and integrate local wisdom into HKm management to more effectively achieve socio-cultural sustainability. Nevertheless, the relatively stable anchor distribution pattern indicates that the Multidimensional Scaling (MDS) ordination configuration adequately represents the socio-cultural conditions of HKm.

The leverage analysis results indicate that HKm area protection (4.78) is the most sensitive attribute in the ecological dimension, followed by forest fire frequency (3.56), fauna diversity (3.36), and peat ecosystem condition (3.16). High leverage values indicate that changes in these attributes will have the greatest impact on the ecological sustainability status of HKm (Figure 4).

The high sensitivity of the area protection attribute indicates that successful HKm management is highly dependent on protecting the area from encroachment, illegal logging, and land conversion [35]. Furthermore, the high leverage values for forest fire frequency and peat ecosystem condition reflect the characteristics of the Bengkalis region, which is dominated by peatlands and is

vulnerable to fire. Therefore, ecological management strategies need to focus on strengthening area protection, fire control, and biodiversity conservation as an effort to sustainably maintain the ecological function of the forest.

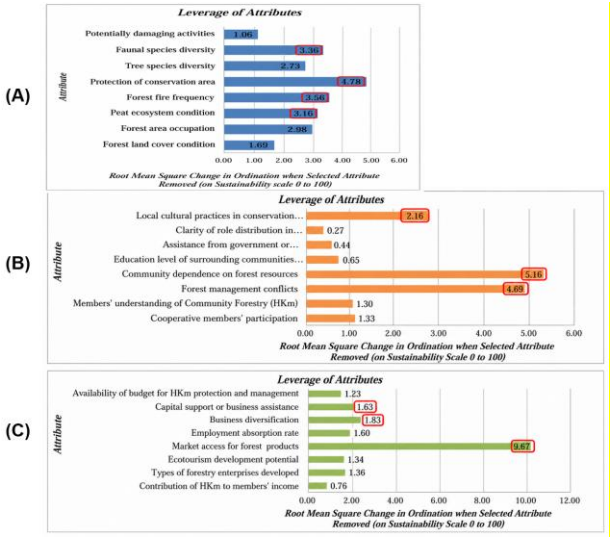

Figure 4. Leverage value. A= Ecology, B= Social, C= Economy

In the social dimension, the most sensitive attributes are the level of community dependence on forest resources (5.16) and forest management conflicts (4.69). These two attributes have a much higher leverage value than other social attributes, making them determining factors in the social sustainability of Community Forests (HKm). The high level of community dependence on forest resources indicates that the community's economic and social life remains closely linked to the existence of Community Forests (HKm). This situation can be an opportunity because it encourages communities to maintain forest sustainability, but it can also be a threat if economic needs lead to overexploitation. On the other hand, forest management conflicts have the potential to hinder management effectiveness, reduce community participation, and weaken institutions [36]. Therefore, strengthening collaborative governance, conflict resolution, and increasing community participation are crucial aspects in improving the social sustainability of Community Forests [37].

In the economic dimension, market access for forest products (9.67) was the attribute with the highest leverage value and was highly dominant compared to other attributes. This was followed by business diversification (1.83) and capital support or business assistance (1.63). These findings indicate that the economic success of Community Forest Management Units (HKm) is more determined by the community's ability to market forest products than by the production aspect itself. Although communities possess substantial forest product potential, economic benefits will not be optimal if market access remains limited. The high leverage value for market access indicates that improving marketing systems, strengthening business partnerships, and increasing product added value will have the greatest impact on increasing economic sustainability [38]. Furthermore, business diversification and capital support remain necessary to expand community income sources and increase the economic resilience of HKm-managing households.

IV. CONCLUSION

Based on the research results, the management of HKm shows unbalanced sustainability performance across dimensions. The ecological dimension is considered quite sustainable (61.92%), but still faces degradation due to the dominance of secondary vegetation, low natural forest, and peat hydrological disturbances. The socio-cultural dimension is less sustainable (47.44%) due to low community dependence and weakening local wisdom. The economic dimension is unsustainable (9.50%) due to low contributions to income and employment. Business enforcement, market access, and peat ecosystem restoration are needed to improve the HKm ecosystem.

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CONFLICT OF INTEREST

All authors have no conflict of interest regarding this publication.

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