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Ecological and Socio-Economic Factors on the Rate of Participation and Sustainable Forest Management

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ABSTRACT

This research was conducted to examine the effect of ecological, social and economic factors on the rate of partcipation of local communities on sustainable forest management. This research also want to examine the effect of ecological, social and economi factors on the forest sustainability and exploring the mediating role of rate of partcipation of local communities to increase the sustainability level of forest management. In this study, social forestry is examined from a comprehensive viewpoint that includes economic, societal, and ecological factors in order to illustrate the factors that influence local community participation in sustainable forest management in Riau, Indonesia. The use of Partial Least Square- Structural Equation Modeling (PLS-SEM) with Smart PLS software has revealed that both ecological and socio-economic factors determine the level of local community participation in sustainable forest management. The results have the potential to serve as a point of reference in the advancement of environmental science and environmental sociology, along with providing theoretical understanding about customary forests and local communities. Additionally, the practical implications of the findings can guide the sustainable development of forest resources. Ultimately, these findings are expected to yield optimal solutions for local communities in their efforts to manage customary forests sustainably.

Keywords: Ecology, Socio-Economic Determinants, Rate of Participation, Forest Management, Sustainability
JEL Classifications: Q01; Q23; Q57

1. INTRODUCTION

Studies have shown that social forestry can provide employment, income, and products such as fuelwood, fodder, and fruits to rural communities living in and around forests (Essougong et al., 2019; Hajjar et al., 2021). In terms of the ecological benefits, social forestry can contribute to biodiversity conservation, carbon sequestration, and environmentally sustainable forest management practices (Ahammad et al., 2021). Likewise, agroforestry systems also supply various raw materials like rubber, gum arabic, and spices. To optimize the benefits of forests for local communities, Indonesian government policies related to forests was concerning social forestry. There are five social forestry schemes, namely village forest, community forestry, community plantation forest, partnership forest and customary forest. This policy was motivated by social forestry to reduce poverty, unemployment and inequality in the management/utilization of forest areas (Wong et al., 2020), through efforts to provide legal access to local communities or customary law communities in the form of forest management or recognition and protection of customary law communities for community welfare and preservation of forest resources (Abby et al., 2019).

Previous research have shown that ecological and socio-economic factors have a significant effect on forest sustainability (Ouyang et al., 2021; Khan and Hou, 2021; Zahraee et al., 2020). Forests

are dependent on various ecological factors, such as climate, soil, water availability, topography, and biotic factors like plant and animal species (Bayat et al., 2021). These factors play a crucial role in determining the health and productivity of forests and their ability to sustainably provide various environmental, economic, and social benefits (Raihan et al., 2023). Therefore, protecting and managing diverse species of forest ecosystems with proper consideration of ecological factors is critical for ensuring forest sustainability. As such, it is necessary to establish incentives and regulations to promote responsible forest management practices that consider the ecological factors and ensure sustainable forest management (Walle and Nayak, 2020). This showed that socio-economic factors play a crucial role in determining the level of participation of local communities in sustainable forest management (Savari et al., 2020). There are many socio-economic factors that affect the participation rate of local communities, including cultural beliefs and practices, trust in government institutions and policies, access to information and resources, economic opportunities and incentives, and socio-economic status.

This research was conducted to examine the effect of ecological, social and economic factors on the rate of partcipation of local communities on sustainable forest management. This research also want to examine the effect of ecological, social and economi factors on the forest sustainability and exploring the mediating role of rate of partcipation of local communities to increase the sustainability level of forest management. The theoretical framework used in this study of social forestry is premised on the idea that the management of forests should integrate the needs and perspectives of local communities, while safeguarding the ecological integrity of the forest ecosystems (Ojha et al., 2022). In other words, social forestry seeks to strike a balance between the socioeconomic interests of forest-dependent communities, and the ecological preservation of the forests on which they rely (Savari et al., 2022). Social forestry is rooted in the principles of sustainable development, community participation, and empowerment (Octavia et al., 2022). It emphasizes the need to involve local communities in all stages of the forest management process, and to ensure that their rights and interests are respected in decision-making, planning, implementation, and monitoring (Yami and Mekuria, 2022; Sapkota et al., 2020). Social forestry recognizes that forests are not just sources of timber and non-timber forest products, but also serve a range of vital ecological, cultural, and spiritual functions (Akomaning et al., 2023). In summary, the theoretical framework of social forestry emphasizes the need to integrate ecological, social, and economic considerations in forest management, and to involve local communities in the decision-making and management processes. It seeks to promote sustainable and equitable use of forest resources, while ensuring the preservation of forest ecosystems for future generations.

2. LITERATURE AND HYPOTHESIS DEVELOPMENT

Ecological factors play a crucial role in determining the rate of participation of local communities in sustainable forest management initiatives (Savari et al., 2020; Poudyal et al., 2019). Healthy forests are an important resource for local communities, providing them with a wide range of benefits such as food, shelter, medicine, and other resources. However, certain ecological factors can negatively impact the forest ecosystem, leading to reduced forest productivity, decreased biodiversity, and increased vulnerability to natural disasters. One of the key ecological factors that affects the rate of community participation in forest management is the availability of natural resources (Poudyal et al., 2019; Surya et al., 2020). Local communities are more likely to invest time and effort in sustainable forest management when they have access to an abundance of resources, such as timber, non-timber forest products, and game animals. Conversely, when natural resources are scarce, communities may become less interested in participating in forest management initiatives, as the benefits of doing so become less tangible. Another important ecological factor that influences community participation is the state of the forest ecosystem itself (Derkyi et al., 2021). When forests are healthy and resilient, with a diverse array of plants and animals, communities are more motivated to protect and manage them sustainably. However, when forests are degraded or depleted, and biodiversity is reduced, communities may feel less invested in protecting and using them sustainably. Furthermore, various environmental stresses such as pollution, climate change, deforestation, and soil degradation also impede the participation rate of local communities to sustainable forest management (Seddon et al., 2021). Climate change, for instance, has reduced water and soil fertility, which has led to a decrease in the quality and yield of crops, worsening food insecurity and increasing poverty (Chowdhury and Hossain, 2021).

Social factors can affect how local communities interact with forest management initiatives (Humphries et al., 2020), as some may be more willing to participate in sustainable management practices while others may resist. Trust in government institutions and policies is another vital factor affecting community participation in forest management. Communities that have had bad experiences with government institutions in the past may be less likely to trust their involvement in forest management, while those that have had positive experiences may be more willing to participate. Access to information and resources is also crucial in determining the level of participation in forest management initiatives (Muttaqin et al., 2019). Communities that have access to information about sustainable forest management practices and their implementation are more likely to participate. In contrast, those who lack access to information may be less informed and, therefore, less willing to participate. Economic opportunities and incentives can also have a significant impact on community participation (Fasona et al., 2019). Economic factors play a critical role in the rate of participation of local communities to sustainable forest management. These factors include the economic conditions of the community, such as poverty levels and employment opportunities, and the value of timber and other forest resources. Overall, socio-economic status is also an essential factor in determining community participation in forest management. Communities that are impoverished may not have the resources to participate fully in forest management initiatives, while those that are more prosperous may be better equipped to participate and influence sustainable management efforts. In conclusion, socio-economic

factors play a critical role in determining the level of community participation in sustainable forest management. Therefore, it is essential to take into account these factors while designing and implementing forest management initiatives to ensure the active participation of local communities (Asmin et al., 2019). Accordingly, the following hypotheses were proposed:

- H1. Ecological Factors has a significant effect on Rate of Participation
- H2. Ecological Factors has a significant effect on Forest Sustainability
- H3. Social Factors has a significant effect on Rate of Participation
- H4. Social Factors has a significant effect on Forest Sustainability
- H5. Economic Factors has a significant effect on Rate of Participation
- H4. Economic Factors has a significant effect on Forest Sustainability
- H7. Rate of Participation has a significant effect on Forest Sustainability
- H8. Rate of Participation mediates the relationship between Ecological Factors, Social Factors and Economic Factors and Forest Sustainability.

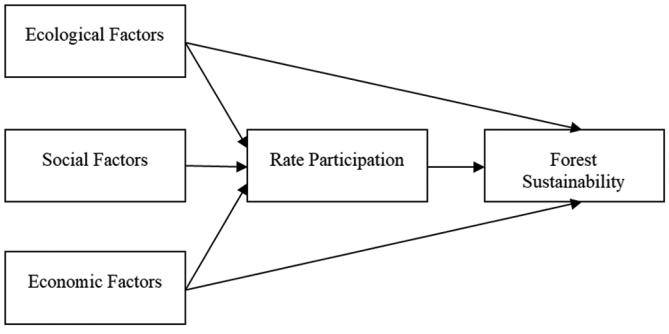
3. RESEARCH METHODS

This study investigates the existing condition of customary forests in Kampar, Riau from an ecological, social and economic perspective. The empirical assessment was conducted to examine the ecological and socio-economic factors on increasing rate of participation of local communities in sustainable forest management (Figure 1). The method used in this research was quantitative in nature. The research was conducted in Kampar, Riau, Indonesia in period between July to December 2022.

The sampling method used was purposive sampling method by selecting locals with sufficient participation and knowledge about sustainable forest management. The research was conducted in two villages, with 120 respondents selected as the sample. Collecting data was an important element in any research. Data collection used questionnaires directly distributed in a survey to respondents in research location.

The ecological factors that were examined in this research included the forest type, age, and health, as well as the presence of invasive species and natural disasters. The social factors included the level of education and awareness of local communities, the presence of conflicts between local communities and forest management authorities, and the level of trust and cooperation between local communities and forest management authorities. The economic factors included the availability of alternative livelihood options for local communities, the level of economic incentives and benefits provided by forest management authorities, and the level of economic dependence of local communities on forest resources.

Figure 1: Conceptual framework



The analysis of the data was by using Partial Least Square – Structural Equation Model (SEM – PLS). Descriptive analysis was also used to determine the Important Value Index (IVI) in terms of vegetation found in the forests. The reasons for using PLS-SEM was that PLS-SEM has greater statistical power than other SEM approaches, particularly when there are small to moderate correlations between variables. Also, the Partial Least Squares-Structural Equation Model (PLS-SEM) is ideal for small sample sizes, making it a practical and effective option for research studies with limited sample sizes.To validate the model, this study also conduct bootstrapping techniques, which can provide a more accurate assessment of the model's fit and predictive power.

4. RESULTS

4.1. Ecological Overview of Research Location

The Ghimbo Bonca Lida Forest was located in Kampar and Ghimbo Pomuan forest was located in Koto Perambuhan, Riau Indonesia (Figure 2).

In terms of biodiversity, the flora and fauna in the Ghimbo Bonca Lida and Ghimbo Pomuan Customary Forests have the potential to become objects to be developed by the Kenegerian Kampa local communities. The position of the two areas of customary forest is located in the middle of an oil palm plantation and far from other natural forests, so there is absolutely no area that can become a connection ecosystem or corridor for biodiversity that can prevent species or genetic extinction. To determine significant value index, according to Alhamd (2021) the Important Value Index (IVI) is the sum of two or more relative values (relative density, relative frequency, and relative dominance) with a maximum value of 300% so that a more representative and accurate value will be obtained. To examine seedling level, it was conducted through survey with 2x2 m plots included 25 plots. The following are the 5 types of vegetation at the seedling level with the highest IVI found in the study location (Table 1). Table 2 showed the types of tree-level vegetation found in the study location.

Table 1: The IVI of the 5 highest species at the research location

Scientific name	K	KR	F	FR	INP
Palaquium gutta	0.600	16,83	0.40	7.35	24.18
Palaquium sp	0.100	6.03	0.08	1.47	17.50
Santiria laevigata B.L	4.000	6.35	0.48	8.82	15.17
Anisophyllea disticha	3.400	5.40	0.44	8.09	13.49
Ixonanthes icosandra Jack.	5.100	8.10	0.20	3.68	11.77

Figure 2: Location map of the forests

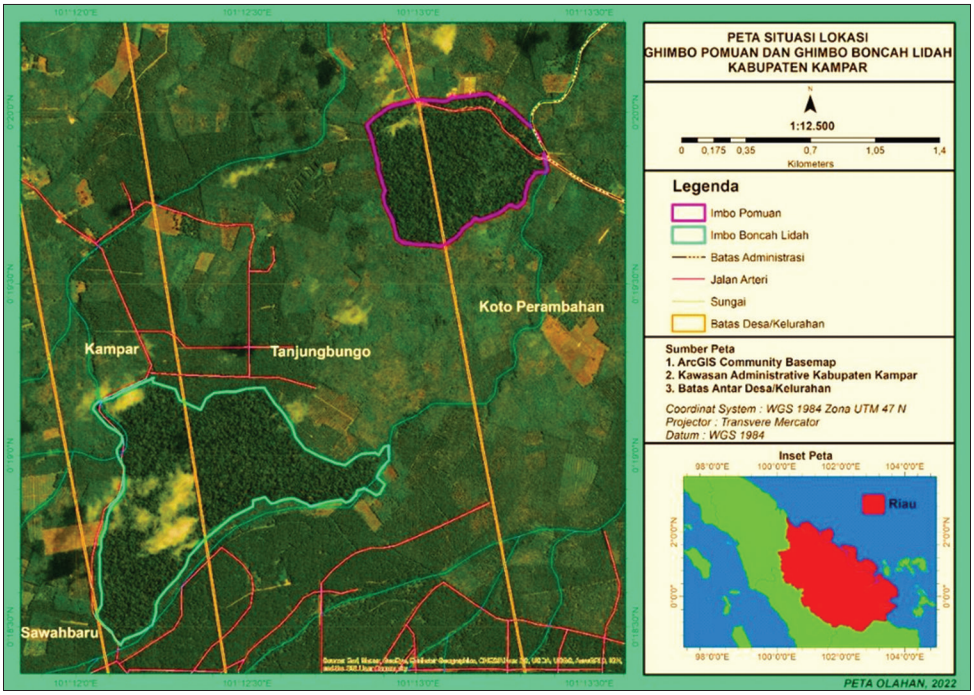


Table 2: IVI level of the 5 highest tree species at the research location

Scientific name	D	DR	F	FR	K	KR	INP
Lithocarpus encleisacarpus Korth	3.59	14.90	0.68	12.14	21.00	13.29	40.33
Artocarpus kemando	1.30	5.38	0.32	5.71	0.00	6.33	17.43
Santiria laevigata B.L	1.30	5.40	0.24	4.29	8.00	5.06	14.74
Endospermum diadenum MA	1.22	0.05	0.24	4.29	8.00	5.06	14.40
Syzygium cerasiforme	2.77	11.50	0.08	1.43	2.00	1.27	14.19

At the tree level, the highest IVI value was found for the menpening species. This is because apart from propagating by seeds, dizzy also propagates by roots. Its distribution is very wide because it is assisted by fruit predators. Compared to other types of growth, it is classified as very fast, especially in open areas and has a high moisture content. To examine wildlife species diversity index, the types of animals found in Ghimbo Pomuan and Bonca Lida were found either directly or from interviews with the community. Furthermore, zones are part of customary forest areas with a certain area and boundaries that are made relatively permanent to increase management effectiveness and efficiency. The zoning process takes into account the biophysical characteristics of the field, natural resource potential, and the socio-economic conditions of the surrounding local communities. The zones are divided into Protection zones, Utilization Zones, Ecotourism Special Use Zones, Roads and Limited Use Zones and Rehabilitation Zones (Figure 3).

4.2. Population Characteristics

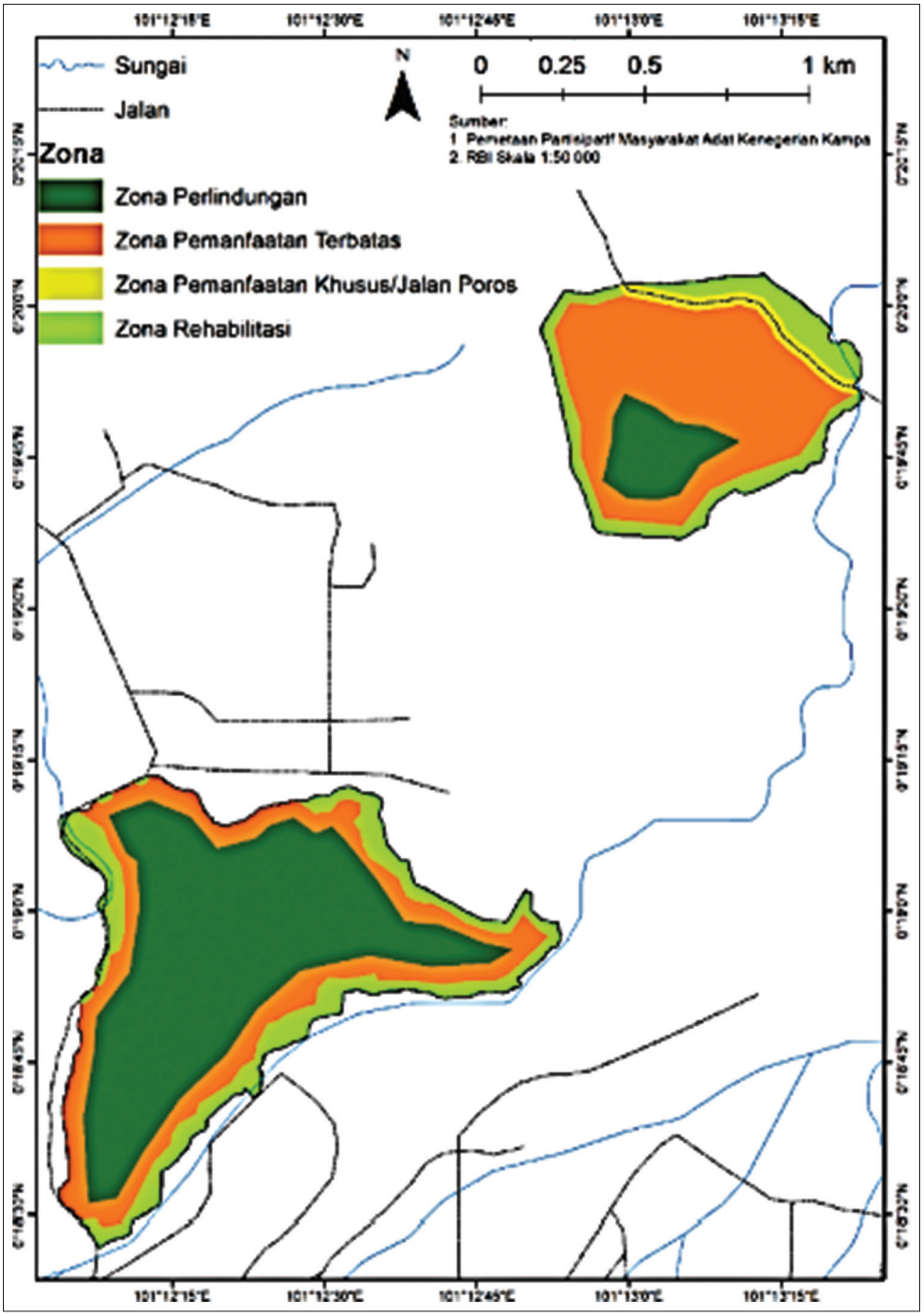
The economic condition of the community certainly influences efforts to preserve customary forests. The following presents the composition of the population based on livelihoods (Table 3).

Table 3: Population characteristics by economic condition

Sector	Subsector	Amount	Total
Agriculture	Farmer	14	21
	Farm workers	2	
	Farm owner	5	
Farm	Individual farm	6	57
	Farm business workers	6	
	Farm business owner	45	
Small industry and household crafts	Mechanic	27	77
	Tailor	35	
	Baker	15	
Medium and large industrial sector	Private sector employee	719	719
Service sector	Civil servant	92	706
	Army	1	
	Police	4	
	Private doctor	8	
	Retired army	1	
	Retired civil servants	25	
	Driver	20	
	Other entrepreneurs	555	

Table 3 showed that the majority of Kampar Village residents work in the medium and large industrial sector, namely as private employees as many as 706 people, then in the service sector with the largest number being self-employed, namely as many as 555 people, the rest are spread in the agricultural sector. animal husbandry, small industry and household crafts. Previous studies have examined the relationship between traditional forest knowledge and sustainable forest management. From a social perspective, the studies include a description of traditional forest knowledge and its key role in forest management and the

Figure 3: Zoning map of the forests



implications for maintaining traditional forest knowledge towards sustainable forest management.

4.3. Quantitative Analysis

The first analysis was to show a statistical analysis used to identify underlying dimensions or constructs in a set of data. The value of loading factors was used, referring to the percentage of the total variance in a set of data that is explained by a specific factor or group of factors. Loading factors were examined in factor analysis to show the values of ecological factors, social factors, economic factors, Rate of Participation, and forest sustainability (Table 4).

The findings presented in Table 1 indicate that items pertaining to Ecological Factors (ECL1-ECL5) exhibit loadings that range between 0.7490.804. Similarly, Social Factors items (SOC1-SOC5) are found to have loadings within the range of 0.8080.867. Economic Factors items (ECO1-ECO3) are also seen to have loadings between 0.7930.908, while the Rate of Participation (RP1-RP3) items have loadings within the range of 0.7620.804. Finally, the Forest Sustainability variable (FS1-FS4) is shown to produce loading values ranging from 0.7190.855.

To examine reliability, Cronbach's alpha was used as a measure of internal consistency reliability which calculates the correlation between all items in a scale. It indicates how well the items in

a scale work together and how consistent they are in measuring the same construct. A high value of alpha (usually above 0.6) signifies that the scale has good internal consistency. The results showed that all variables have Cronbach's alpha >0.6. Thus, all variables used in this study were considered reliable. The results showed the Composite Reliability (CR) as another measure of internal consistency reliability. The values obtained from the analysis (Table 5) showed CR which indicates inter-correlated variable. The results showed a score above 0.7 suggesting good reliability for ecological factors (0.886), social factors (0.921), economic factors (0.890), rate of participation (0.826) and forest sustainability (0.872). The analysis also showed the Average Variance Extracted (AVE) as the amount of variance ranges from 0 to 1, with a score above 0.5. This indicates that the constructs (Ecological Factors, Social Factors, Economic Factors, Rate of Participation, Forest Sustainability) is capturing a good amount of variation in the data.

Table 6 showed the Outer Variance Inflation Factor (VIF) as a measure of the degree of multicollinearity in a multiple regression analysis. Generally, low Outer VIF values are desirable for regression models. The results showed low values of Variance Inflation Factor for all items. This means that there is no multicollinearity in the model.

Table 7 showed the model fit summary. The results showed Standardized Root Mean Squared Residual to measure the average standardized difference between the observed correlation and the reproduced correlation in the model. The results obtained values below 0.08. This indicates good fit. The value of d_ULS and d_G are two measures of the degree of discrepancy in the model. The analysis obtained lower values which indicates better fit. Furthermore, Chi-square obtained small values. This indicates better fit. Moreover, NFI (Normed Fit Index) to measure the degree of fit of the model obtained the value above 0.9 indicating good fit. Overall, model in PLS-SEM in this study was declared fit (Table 4).

Structural analysis demonstrated that ecological factors, such as environmental conditions and resource availability, have a significant impact on the rate of participation of local communities in certain activities or behaviors regarding forest management. The T statistic of 2.157 indicates that the effect size is moderate, and the P = 0.001 suggests that this result is highly statistically significant (Table 8 and Figure 4). Thus, the first hypothesis is accepted. These findings are consistent with previous research that has identified the importance of ecological factors in shaping human behavior and suggest that interventions or policies targeting these factors could be effective in promoting participation in desired activities or behaviors (Ouyang et al., 2021; Khan and Hou, 2021). The statistical output as shown in Table 8 revealed that ecological factors play a critical role in ensuring the sustainability of forests. Specifically, the findings suggest that ecological factors have a significant positive effect on forest sustainability. The T-statistics value of 2.027 and a p-value of 0.002 indicates that the results are statistically significant. Moreover, the sample mean of 0.303 indicates that forests with higher levels of ecological factors are more sustainable than those with lower levels. Thus, the second hypothesis is accepted. These results are consistent with the existing body of research on forest sustainability and highlight the

Table 4: Loading factors

Items	Ecological Factors	Social Factors	Economic Factors	Rate of participation	Forest sustainability
ECL1	0.804				
ECL2	0.785				
ECL3	0.749				
ECL4	0.777				
ECL5	0.787				
SOC1		0.855			
SOC2		0.867			
SOC3		0.833			
SOC4		0.808			
SOC5		0.819			
ECO1			0.793		
ECO2			0.861		
ECO3			0.908		
RP1				0.804	
RP2				0.762	
RP3				0.783	
FS1					0.855
FS2					0.813
FS3					0.784
FS4					0.719

Table 5: Reliability and validity

Variable	Cronbach's alpha	rho_A	Composite reliability	Average variance extracted
Ecological factors	0.843	0.855	0.886	0.610
Social factors	0.893	0.899	0.921	0.700
Economic factors	0.829	0.935	0.890	0.731
Rate of participation	0.687	0.693	0.826	0.613
Forest sustainability	0.806	0.825	0.872	0.631

importance of considering ecological factors in efforts to promote sustainability in forest management (Ojha et al., 2022; Soe and Yeo-Chang, 2019; Wang et al., 2022).

The assumption that social factors play an important role in determining the rate of participation, indicated by with Original Sample (O) of 0.211, T Statistics (|O/STDEV|) of 2.164, and P = 0.000. The statistically significant T statistics and low P value indicate that the association between social factors and participation rate. Thus, the third hypothesis was accepted. These findings are consistent with previous research on the topic, which has repeatedly found that social factors such as social norms, social support, and social influence can strongly influence participation rates (Savari et al., 2019). The results also suggest that social factors have a significant effect on forest sustainability. This is indicated by T Statistics (|O/STDEV|) of 3.108, and P = 0.000. Overall, the results suggest that efforts to increase participation in various activities should consider the role of social factors and incorporate strategies to leverage and enhance these factors. Thus, the hypotheses regarding the effects of social factors on Rate of Participation (H3) and Forest Sustainability (H4) were accepted.

Testing the effects of economic factors showed the significant effect of economic Factors has a significant effect on Rate of Participation (T statistics = 3.187 and P = 0.00), and on forest sustainability (T statistics = 2.137 and P = 0.001). The positive effect of economic factors on the rate of participation implies that individuals and communities are more likely to engage in forest conservation activities when economic incentives are provided. This showed that incentivizing sustainable forest management practices can encourage more individuals and local communities to participate in forest management activities (Soe and Yeo-Chang, 2019; Mbeche et al., 2021). Thus, the fourth and fifth hypotheses were accepted.

The hypothesis that the rate of participation has a significant impact on forest sustainability. The Original Sample (O) value of 0.336 indicates a positive correlation between participation rates and forest sustainability. The T Statistics (|O/STDEV|) of 3.601 and the P Values of 0.000 suggest that the results are statistically significant. Thus, the seventh hypothesis was accepted. In other words, the study found that higher rates of participation in forest sustainability programs lead to better outcomes for forest sustainability. These results are consistent with prior research on the importance of community participation in sustainable forestry management (Octavia et al., 2022; Raihan et al., 2023).

The indirect effects by mediating role of Rate of Participation showed that the full mediation of Rate of Participation in strengthening the effect of Ecological Factors (T statistics 3.013; P = 0.000), Social Factors (T statistics 3.032; P = 0.000) and Economic Factors (T statistics 3.071; P = 0.000) on Forest Sustainability (Table 9). The hypothesis that increased rate of participation enhances the impact of ecological, social, and economic factors on forest sustainability. The findings suggest that a higher rate of participation in forest management activities can facilitate better understanding and incorporation of ecological, social, and economic considerations into management decisions. This can lead to more sustainable and balanced management practices that not only preserve the forest ecosystem but also promote social and economic benefits for local communities.

Table 6: Outer variance inflation factor

Constructs	VIF
Ecological factors	
ECL1	1.822
ECL2	1.741
ECL3	1.824
ECL4	1.559
ECL5	1.920
Social factors	
SOC1	2.509
SOC2	2.831
SOC3	2.577
SOC4	1.917
SOC5	2.308
Economic factors	
ECO1	1.955
ECO2	1.973
ECO3	1.786
Rate of participation	
RP1	1.307
RP2	1.363
RP3	1.341
Forest sustainability	
FS1	2.015
FS2	1.681
FS3	1.832
FS4	1.517

Table 7: Fit summary

Measure	Saturated model	Estimated model
Standardized root mean squared residual	0.076	0.076
d_ULS	1.206	1.206
d_G	0.457	0.457
Chi-square	156.688	156.688
NFI	0.923	0.923

Table 8. Hypothesis testing

Hypothesis	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T STATISTICS (|O/STDEV|)	P-values	Information
Ecology≥Participation	0.306	0.123	0.091	2.157	0.001	Significant
Ecology≥Sustainability	0.203	0.303	0.095	2.027	0.002	Significant
Social≥Participation	0.211	0.225	0.097	2.164	0.000	Significant
Social≥Sustainability	0.312	0.306	0.082	3.108	0.000	Significant
Economic≥Participation	0.234	0.350	0.093	3.187	0.000	Significant
Economic≥Sustainability	0.210	0.221	0.098	2.137	0.001	Significant
Participation≥Sustainability	0.336	0.338	0.093	3.601	0.000	Significant

Figure 4: Full Model

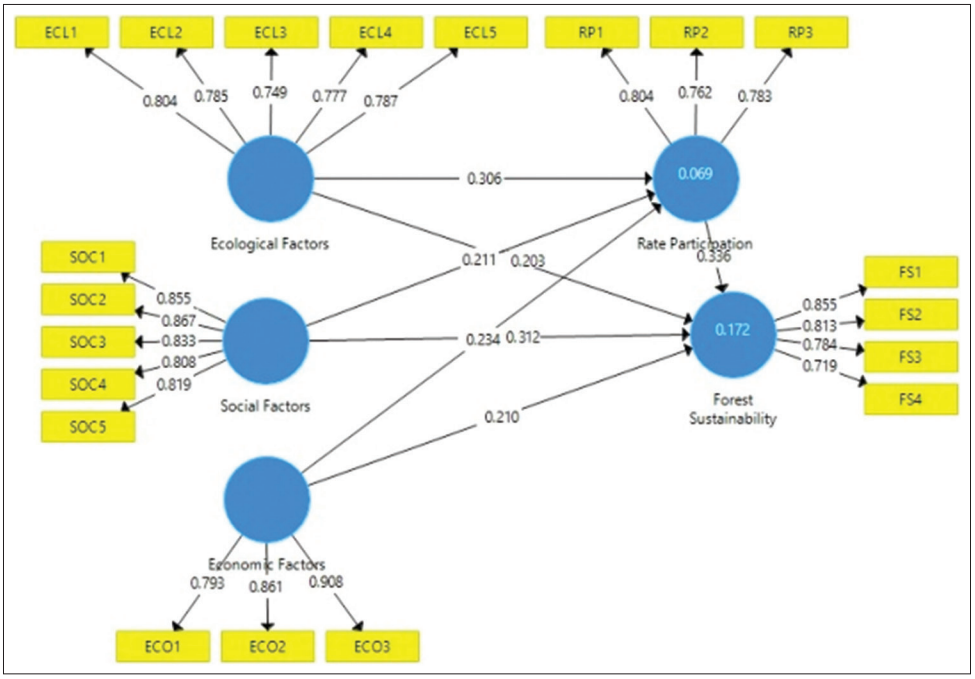


Table 9: Indirect effects

Hypothesis	Original Sample (O)	Sample Mean (M)	Standard deviation (STDEV)	T Statistics (|O/STDEV|)	P values	Information
ECOL≥ROP≥FST	0.082	0.078	0.039	3.013	0.000	Significant
SOC≥RoP≥FST	0.081	0.079	0.041	3.032	0.000	Significant
ECON≥RoP≥FST	0.085	0.080	0.042	3.071	0.000	Significant

*ECOL: Ecological factors, SOC: Social factors, ECON: Economic Factors, ROP: Rate of participation, FST: Forest sustainability

Overall, the study provides valuable insights into the role of participation in achieving sustainable forest management, highlighting the need for greater collaboration and engagement among stakeholders.

The results of the study showed that all three factors had a significant effect on the rate of participation of local communities in sustainable forest management. Ecological factors were found to be the most important predictors of the rate of participation, followed by social and economic factors. In addition, the rate of participation of local communities was found to mediate the relationship between ecological, social, and economic factors and the sustainability of forest management. The findings also highlight the primary objectives of social forestry to promote rural livelihoods, reduce poverty, conserve biodiversity, enhance ecosystem services, and facilitate community empowerment (Ojha et al., 2022). It emphasizes the need to design and implement forest management practices that are context-specific, socially inclusive, and environmentally sustainable. Social forestry approaches may involve the establishment of community-managed forests, agroforestry systems, participatory forest management schemes, and decentralized forest governance structures (Friedman et al., 2020). The study concluded that promoting the participation of local communities in sustainable forest management is essential to increase the sustainability level of forest management. The findings of this study can inform policies and strategies for forest management that prioritize the involvement of local communities and consider ecological, social, and economic factors.

5. CONCLUSION

The sustainability of forests depends on ecological factors such as climate change, deforestation, pollution, and the presence of invasive species. These factors must be managed to preserve the forest's health and productivity and ensure that forest ecosystems continue to provide resources for future generations. It is essential to address these issues and create policies that promote sustainable forestry practices to maintain the balance within the environment. Forest sustainability is necessary to protect these precious resources and maintain a balance within the environment. The sustainability of forests depends on many ecological factors that affect its health and productivity. In conclusion, ecological factors can influence individuals' rate of participation in various activities or programs, and understanding these factors is crucial for designing effective interventions and programs that promote participation and engagement. The availability of natural resources, the state of the forest ecosystem, and environmental stresses are all factors that must be considered when developing effective forest management policies and programs that can promote community engagement and ensure long-term sustainability.

As implications, the findings would imply the interplay between ecological and socio-economic factors can provide a deeper understanding of the mechanisms that drive community engagement and long-term forest sustainability. Insights from this research can help policymakers develop effective strategies that

consider the complex relationships between human activity and environmental issues. The ecological and socio-economic factors are interconnected, and their impact on forest sustainability is complex. Theoretical analysis can help identify the connections between these factors and how they contribute to long-term forest sustainability. Theoretical and practical research can offer insights into the effectiveness of different policies and regulations in promoting community engagement and long-term forest sustainability. This knowledge can be used to inform policy development and lead to more robust regulations that promote sustainable forest management practices.

The limitations of this research were lack of access to data and information about the socio-economic factors of communities living near forests. Moreover, variability in the socio-economic factors of different communities makes it difficult to generalize results. Future research was expected to develop more comprehensive methods of data collection and analysis that incorporate qualitative and quantitative data to understand the social-ecological system of communities living near forests. Future studies also need to investigate the impact of cultural and traditional practices on community engagement in forest management, and examine the role of governance, institutional arrangements, and policy interventions in promoting community engagement in forest management.

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