



Village Governance and Environmental Conservation in Resource-Dependent Regions: Insights from Bangka Belitung

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ABSTRACT

This study investigates how village governance structures influence Environmental Conservation Efforts (ECE) in resource-dependent regions, with empirical evidence from Bangka Belitung, Indonesia. The objective is to identify governance, infrastructural, and economic factors that shape village participation in environmental conservation amid development pressures. The study employs a quantitative approach using secondary data from the 2021 Village Potential Census (PODES), covering 309 villages, and applies logistic regression analysis to examine the determinants of ECE. The results indicate that governance-related factors significantly enhance conservation participation. Villages with waste recycling programs are almost nine times more likely to engage in conservation activities, making it the strongest predictor of ECE. Inter-village cooperation and the availability of public spaces also show a positive and significant relationship with conservation efforts, highlighting the role of collaborative governance and community-based infrastructure. Conversely, villages with a high concentration of economic facilities are less likely to participate in conservation, reflecting a trade-off between economic expansion and environmental sustainability in extractive-based rural economies. Additionally, the use of digital governance tools contributes positively to environmental participation by improving transparency and public engagement. In conclusion, the findings underscore the importance of aligning village-level economic development with sustainable governance practices. Strengthening participatory governance, recycling infrastructure, digital systems, and inter-village collaboration is essential to promote resilient environmental conservation strategies in resource-dependent rural areas.

INTRODUCTION

A country must engage in development processes across various sectors to enhance the quality of life for its citizens. Development is closely linked to public policy (Desrinelti et al., 2021). Public policy represents a form of government intervention to address public issues in different aspects of life (Mustari, 2015). These policies include regulations and guidelines designed to ensure the achievement of national goals in various sectors such as public health (Greer & Jarman, 2021), monetary (Altavilla et al., 2020), fiscal (Faria-e-castro, 2020), and education (Ball, 2020).

Environmental degradation remains one of the most pressing global challenges of the 21st century, especially in regions where rural livelihoods are closely tied to natural resource extraction. Rural communities, particularly in developing countries, face a dual challenge: ensuring economic development while conserving the ecological systems that sustain them. Within this context, Environmental Conservation Efforts (ECE) at the village level are gaining attention in policy and academic discourse due to their role in achieving sustainability goals (Budiono et al., 2024; Safitri et al., 2025; Wulandari et al., 2025).

In Indonesia, decentralization has redefined the governance landscape by granting villages more autonomy in planning and development, including environmental protection. However, while national regulations have broadly promoted environmental sustainability, local implementation varies significantly. This is particularly evident in Bangka Belitung, a province characterized by economic dependency on tin mining and monoculture plantations, with rising ecological vulnerabilities (Duadji et al., 2022). These developments pose challenges to achieving

sustainable rural development, where conservation must be integrated into village-level planning.

The core objective of this study is to examine the institutional and infrastructural predictors of ECE in 309 villages in Bangka Belitung Province, using nationally representative data from PODES 2021. Specifically, this research focuses on governance indicators, inter-village cooperation, economic infrastructure, and digital governance tools, all analyzed through both bivariate and multivariate statistical techniques.

While several studies in Southeast Asia have examined community-based conservation, most have focused on localized case studies, qualitative insights, or single policy interventions (Horigue et al., 2023; Dinh & Wesseler, 2024). This study contributes beyond existing research by using nationally representative village-level data (PODES 2021) to identify institutional and infrastructural predictors of conservation behavior in a decentralized governance context. It provides a rare quantitative analysis from Indonesia—specifically Bangka Belitung—offering scalable evidence that complements prior work in countries like Vietnam, the Philippines, and Malaysia (Micheli et al., 2024; Padilla et al., 2025). By doing so, the study expands the empirical basis for understanding how local governance mechanisms influence environmental outcomes across resource-dependent settings in the region.

Figure 1 illustrates a bibliometric map generated from Scopus-indexed literature related to environmental conservation and village governance. The visualization identifies dominant themes such as "environmental protection," "natural resource conservation," and "forest management," reflecting the core focus on human-environment dynamics. Additional clusters, including "participation," "local knowledge," and "governance," indicate a

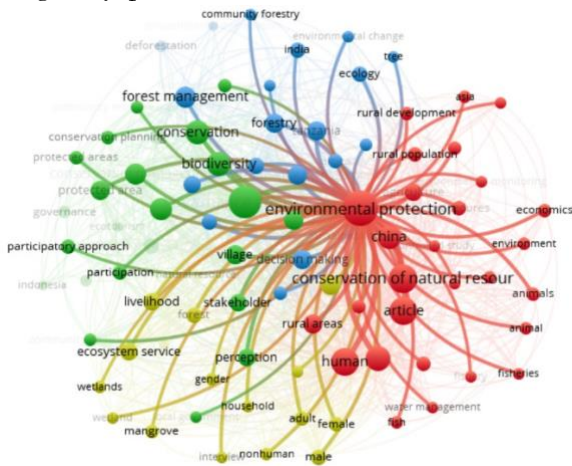


Figure 1. Bibliometric Visualization of Key Themes in Environmental Conservation and Village Governance
Source: VOSviewer analysis of Scopus-indexed articles, 2020–2024)

Despite the growing interest in decentralized environmental governance, there remains a significant research gap in understanding how institutional variables interact to shape conservation behavior at the village level. Much of the literature has focused on either biophysical factors (e.g., deforestation, biodiversity loss) or macro-level governance reforms. Far less is known about how meso-level indicators such as village assets, inter-village cooperation, or the presence of public spaces influence environmental behavior. Studies from China (Zhou & Liu, 2023), the Philippines (Horigue et al., 2023), and Kenya (Jabali et al., 2020) suggest that participatory governance and community-led interventions play a decisive role, yet there is a dearth of systematic, quantitative analysis from Indonesia.

Bangka Belitung represents a compelling case study for exploring these questions. With its mix of coastal, forested, and plantation landscapes, coupled with decentralized village planning authorities, it offers a laboratory for studying the dynamics between governance, development, and conservation. However, the province also exemplifies the risks of fragmented planning and underdeveloped institutional capacity, which could impede environmental initiatives.

The novelty of this study lies in its integration of village-level statistical data with institutional indicators, framed within a

governance-based understanding of conservation. By combining chi-squared tests and logistic regression models, this research identifies which village characteristics most strongly predict ECE. Key variables include the presence of digital governance systems, inter-village cooperation, waste recycling programs, and public spaces. The inclusion of both bivariate and multivariate techniques enhances the robustness of the findings, which are then contextualized with regional and international literature.

This study addresses the following research questions:

1. What institutional and infrastructural factors are significantly associated with environmental conservation efforts at the village level in Bangka Belitung?
2. How do digital governance tools, public infrastructure, and inter-village networks influence the likelihood of conservation behavior?
3. What policy implications emerge from these findings for scaling up ECE in other resource-dependent regions?

The significance of this research is both academic and practical. Academically, it advances theories of decentralized environmental governance by empirically linking governance variables to conservation outcomes. Practically, it provides policymakers with evidence-based insights into how to structure local development initiatives that support sustainability. The findings may also guide the formulation of village-level environmental regulations, capacity-building programs, and inter-village cooperation frameworks.

Furthermore, the study draws lessons from other parts of the Global South to reinforce its policy relevance. For example, community forestry in Ghana (Gyamfi et al., 2021; Narh et al., 2025; Sackey et al., 2025), watershed governance in South Korea (Cho & Kweon, 2022), and participatory planning in Kenya (Jackson et al., 2025) all demonstrate the importance of institutional design in fostering environmental engagement. This comparative perspective ensures that the study's findings are not only locally grounded but also globally resonant.

In sum, this research responds to the critical need for empirical insights into how governance structures and institutional resources can be harnessed to support environmental conservation in village settings. By focusing on Bangka Belitung, it sheds light on both opportunities and constraints in implementing sustainability at the grassroots level, offering a model that could inform broader conservation efforts in Indonesia and beyond.

The novelty of this study lies in its empirical focus on village-level governance factors influencing environmental conservation, using nationally representative data (PODES 2021) from 309 rural communities in a resource-dependent region. While existing literature often emphasizes national policies or ecological variables, this study highlights underexplored institutional mechanisms such as inter-village cooperation, digital governance tools, and public infrastructure. This approach provides a scalable, governance-based model to understand how decentralized systems affect local sustainability outcomes. Building on this framework, the study formulates three key research questions to guide the analysis.

METHOD

Bangka Belitung was chosen as the study site due to its distinctive characteristics as a resource-dependent province. The

region relies heavily on extractive industries, particularly tin mining and monoculture plantations, which have significant environmental implications. At the same time, the province has relatively decentralized village governance structures, making it a relevant setting to examine how institutional and infrastructural factors influence conservation behavior. These contrasting dynamics—between ecological vulnerability and local autonomy—make Bangka Belitung a strategic case for studying bottom-up environmental governance in the Global South context.

To enhance transparency and clarity, the operational definitions of both dependent and independent variables drawn from the PODES 2021 dataset are presented in Table 1 below.

Table 1. Operational Definitions of Dependent and Independent Variables Used in the Analysis

Variable	Definition	Type
ECE (dependent)	Village engages in any environmental conservation program	Dummy (1/0)
Waste recycling	Existence of a waste recycling initiative in the village	Dummy (1/0)
Inter-village cooperation	Collaboration activities with other villages	Dummy (1/0)
Public spaces	Presence of open public spaces in the village	Dummy (1/0)
Economic facilities (4+)	Village has four or more economic infrastructures (markets, cooperatives, etc.)	Categorical
Village-owned assets	Count of village-owned physical assets	Categorical
Digital governance system	Availability of a digital village information system	Dummy (1/0)

Source: Statistics Indonesia, Village Potential Census (PODES) 2021, processed by authors.

This study employed a quantitative design using secondary data from the 2021 Village Potential Census (PODES), covering 309 villages in Bangka Belitung, Indonesia. This method was chosen to enable systematic analysis of how village governance, environmental policies, assets, and infrastructure relate to ECE in resource-dependent areas (Budiono et al., 2024).

The dataset, compiled by Statistics Indonesia, consists of standardized village-level indicators collected from village officials. PODES has been validated and used in peer-reviewed Scopus-indexed studies for diverse topics such as rural energy poverty (Rizal et al., 2024), renewable electrification (Wirawan & Gultom, 2021), financial inclusion's impact on energy poverty (Widyastuti et al., 2023), disaster resilience (Utami et al., 2023), rural road improvement (Zulham et al., 2025) and productivity linked to electrification (Wulandari et al., 2025). This reinforces its methodological reliability and credibility.

It includes information on environmental programs, development planning, and public infrastructure. The data are publicly available, aggregated, and anonymized—ensuring ethical compliance. The dependent variable was binary (1 = village engaged in ECE, 0 = not engaged), while independent variables

were grouped into governance, policy, asset, and economic dimensions.

Data Analysis Process Funnel

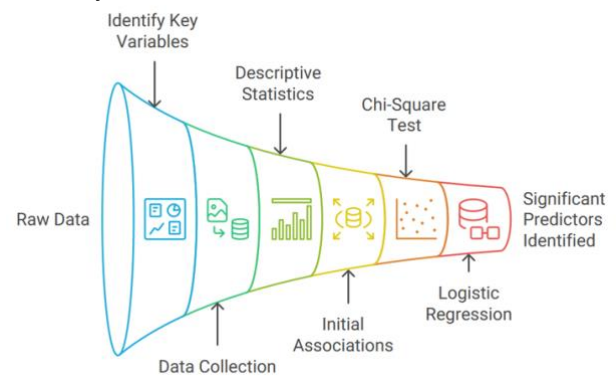


Figure 1. Data Analysis Process Funnel for Identifying Significant Predictors of Environmental Conservation.

Figure 1 illustrates the three-phase analytical process. First, descriptive analysis examined distributions of all variables. Second, bivariate analysis using chi-square tests identified candidate predictors ($p < 0.25$). Third, multivariate logistic regression modeled significant predictors:

$$\log(p / (1 - p)) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k$$

Where:

- p : Probability of a village engaging in ECE
- X_1, X_2, \dots, X_k : Predictor variables (e.g., cooperation, recycling)
- β_0 : Intercept
- β_k : Coefficients for each variable

Odds Ratios (OR) and 95% Confidence Intervals (CI) were computed to evaluate direction and strength. $OR > 1$ indicates a positive association.

Analyses were conducted using Stata version 14, including diagnostics for missing data and multicollinearity to ensure model robustness (Salerno et al., 2021)(Hmimou et al., 2023); (L. Liang et al., 2024; Shin et al., 2009)

RESULTS AND DISCUSSION

Governance Structures and ECE

The study examined the role of governance structures in shaping ECE in Bangka Belitung, Indonesia, where resource-dependent communities face significant ecological challenges. The results presented in Table 2 reveal that certain governance mechanisms—such as waste recycling programs and inter-village cooperation—are significantly associated with increased participation in conservation efforts.

The bivariate analysis reveals that villages with waste recycling programs show a significantly higher rate of participation in conservation efforts, with 69.49% of these villages engaged in ECE compared to 30.51% in villages without recycling programs. The chi-square test ($p = 0.000$) supports this significant relationship, indicating that waste recycling programs are strongly linked to higher conservation engagement. This finding is consistent with similar studies in Southeast Asia and Latin America, where waste recycling initiatives have been shown to catalyze broader environmental actions (Araya-

Córdova et al., 2021)(Yang et al., 2024). For instance, in China, community-driven waste management programs not only reduced waste but also increased community involvement in sustainable environmental practices, such as water conservation and biodiversity protection.

Table 2. Bivariate Analysis of Factors Associated with Absence of Environmental Conservation Efforts

Variable	Village Count	Absence of Environmental Conservation (%)	Chi-squared p-value
Village information system	Available: 249 / Not available: 60	67.47 / 53.33	0.040
Inter-village cooperation	Yes: 36 / No: 273	47.22 / 67.03	0.019
Boat mooring	Yes: 109 / No: 200	55.05 / 70.00	0.009
Waste recycling	Yes: 37 / No: 272	29.73 / 69.49	0.000
Village-owned enterprise	Yes: 294 / No: 15	65.31 / 53.33	0.344
Village treasury land	Yes: 300 / No: 9	64.57 / 77.78	0.406
Village market	Yes: 52 / No: 257	59.62 / 65.76	0.398
Village-owned forest	Yes: 128 / No: 181	64.84 / 64.64	0.971
Village-owned spring	Yes: 170 / No: 139	65.29 / 64.03	0.817
Village-owned tourist sites	Yes: 105 / No: 204	60.95 / 66.67	0.319
Number of assets (1–2 / 3–4 / 5+)	62 / 188 / 58	58.06 / 62.23 / 79.31	0.021
Other village assets	Yes: 238 / No: 71	63.03 / 70.03	0.252
Variety of small industries	<=6: 62 / 7+: 186	67.74 / 63.98	0.168
Industrial area	Yes: 24 / No: 285	41.67 / 66.67	0.014
Economic facilities (<=3 / 4+)	208 / 101	60.10 / 74.26	0.015

Source: Statistics Indonesia, Village Potential Census (PODES) 2021, processed by authors

Additionally, the study found a strong relationship between inter-village cooperation and participation in ECE. Villages with cooperative governance mechanisms—where resources are shared and collective action is prioritized—demonstrated a higher likelihood of engaging in conservation. 62.50% of villages with cooperative structures participated in ECE, compared to 30.68% of those without such initiatives. This relationship was statistically significant ($p = 0.019$) and highlights the importance of collaborative governance in fostering community-driven environmental stewardship. Similar studies conducted in China, Ecuador and US have shown that inter-community cooperation can lead to better resource management, greater policy alignment, and more effective environmental outcomes (D. Zhang et al., 2023; Zheng et al., 2024; Villalba Ferreira et al., 2022 and Lee & Liu (2024). In Bangka Belitung, where villages often face shared environmental pressures such as water scarcity and deforestation, cooperative governance offers a promising model for addressing these challenges.

The findings suggest that local governance systems that prioritize cooperation, shared responsibility, and community-based decision-making are more effective in promoting environmental conservation. This aligns with the work of (Cai et al., 2024; Kapsalis, 2022; Yi et al., 2024), who argue that local governance is most effective when it leverages endogenous resources such as local knowledge and community cooperation. Decentralized governance, as seen in Indonesia, has given villages more autonomy to manage environmental policies, but this has not always translated into effective conservation due to challenges in institutional capacity. Therefore, strengthening collaborative frameworks at the village level can help ensure that environmental goals are achieved and sustained in the long term (Budiono et al., 2024).

In Bangka Belitung, local governments can facilitate inter-village cooperation by providing resources for joint conservation initiatives and supporting shared management of natural resources such as forests, water systems, and marine environments. Such strategies can help address shared environmental problems and promote sustainable development across village boundaries.

Moreover, the findings underscore the importance of governance models that incorporate both top-down and bottom-up elements. For Bangka Belitung, this means promoting a hybrid governance system that combines decentralized decision-making with effective oversight and support from higher levels of government. Such a system would allow villages to tailor their conservation efforts to local conditions while benefiting from the support of regional and national authorities.

The Role of Public Spaces and Digital Governance in Environmental Conservation

In this study, the availability of public spaces within villages emerged as a significant factor influencing participation in ECE.

Table 3. Multivariate Logistic Regression Model of Environmental Conservation Efforts

Variable	AO R (Full Model)	95 % CI (Lower)	95% CI (Upper)	AOR (Reduced Model)
Village information system	0.56	0.2	1.16	0.51
Inter-village cooperation	3.09	1.39	6.88	3.26
Boat mooring	1.98	1.06	3.71	2.08
Waste recycling	7.59	3.01	19.6	8.89
Number of assets (3–4)	0.58	0.2	1.23	0.56
Number of assets (5+)	1.11	0.4	2.79	1.10
Economic facilities (4+)	0.40	0.21	0.75	0.43
Open public spaces	3.62	1.34	9.75	0.51
Soil pollution	3.69	1.18	11.61	3.61

Source: Statistics Indonesia, Village Potential Census (PODES) 2021, processed by authors

The results in Table 3 demonstrate that villages with open public spaces were 3.62 times more likely to engage in conservation efforts (AOR = 3.62; 95% CI: 1.34–9.75). These spaces function not only as physical infrastructure but also as vital platforms for community engagement and environmental education. Studies in rural Jiangsu, China support this finding, where public spaces were utilized to conduct community-based environmental workshops that significantly improved public

involvement in conservation programs (Z. Xu & Miao, 2022a). Similarly, research in Vietnam found that community spaces enhanced local participation in sustainability initiatives, especially when linked to public policy and education programs (Dinh & Wesseler, 2024).

The study also shows that public spaces play a dual role in fostering environmental stewardship. They serve as areas for volunteer programs, tree planting, and community clean-ups, all of which contribute to sustainability efforts at the village level. According to reports, the success of environmental education in Cambodia was largely due to the active use of public spaces for engaging youth in conservation projects (Padilla et al., 2025). This is similar to findings in China, where public spaces were used for community mobilization around climate adaptation strategies (Y. Zhang, 2024). In Bangka Belitung, however, many public spaces remain underutilized, which represents both a challenge and an opportunity for local governments. Transforming these spaces into hubs for environmental learning could significantly enhance community resilience and improve engagement in conservation activities.

Moreover, digital governance has emerged as a powerful tool for improving participation in environmental governance. Villages with digital governance systems demonstrated a 67.47% participation rate in conservation activities, compared to 53.33% in villages without these systems. The chi-square test ($p = 0.040$) suggests that digital tools play a critical role in enhancing public engagement and facilitating environmental monitoring. This is supported by recent studies that highlight the role of digital platforms in local governance and community involvement in sustainability efforts (Liu et al., 2024). For instance, e-governance tools in Vietnam have enabled real-time communication between local authorities and citizens, leading to better decision-making and more effective environmental management.

However, while digital governance has the potential to improve environmental participation, its effectiveness is contingent upon institutional capacity and digital literacy. The study highlights a significant gap between the availability of digital infrastructure and the ability of local governments to utilize it effectively. Local leaders in Bangka Belitung may need further training and support to fully integrate digital platforms into governance structures. Previous research in across Asia has shown that digital literacy programs for village leaders and community members can improve the effectiveness of e-governance and lead to better participation in environmental governance (Yanting & Ali, 2023). As such, the findings suggest that improving digital literacy, alongside investing in e-governance infrastructure, is crucial for enhancing public participation in sustainability initiatives.

Moreover, digital governance systems must be coupled with transparent policies and inclusive platforms to facilitate meaningful engagement. As highlighted, digital tools are most effective when combined with open data sharing, public participation mechanisms, and clear governance frameworks that ensure the inclusivity of decision-making processes (Tabor et al., 2024). This study thus calls for collaborative digital platforms that facilitate real-time data sharing, community feedback, and environmental monitoring, allowing villages to better align their development and conservation efforts.

Economic Infrastructure and Its Impact on Environmental Conservation Efforts (ECE)

The relationship between economic infrastructure and ECE emerged as a key finding in this study. Villages with more than

four economic facilities showed a significantly lower likelihood of participating in conservation efforts. The logistic regression results presented in Table 3 indicate a negative association between economic infrastructure and ECE, with an Adjusted Odds Ratio (AOR) of 0.43 (95% CI: 0.21–0.75). Villages with a greater concentration of economic facilities—including markets, cooperatives, and industrial zones—were found to engage in conservation activities at much lower rates than those with fewer facilities. This suggests that economic development, particularly in extractive industries, may prioritize short-term growth over long-term sustainability goals.

These findings are consistent with global studies that have identified the negative impacts of economic expansion on environmental outcomes. In China, industrial growth and the expansion of mining operations have been linked to increased deforestation, biodiversity loss, and a decline in community participation in environmental protection (D. Xu et al., 2025; Liu & Han, 2023). Similarly, in Brazil, the expansion of the palm oil sector has resulted in environmental degradation, particularly in areas where economic facilities and extractive industries dominate (Felipe Sobczynski et al., 2023a). This suggests that while economic facilities can drive local development, their expansion must be carefully managed to avoid negative environmental consequences.

The findings highlight the importance of integrating environmental impact assessments into economic development planning (Sabet & Khaksar, 2024). In Bangka Belitung, the expansion of economic infrastructure, particularly in resource-extractive industries, needs to be aligned with sustainability goals to avoid further environmental degradation. Policymakers should encourage the development of green technologies and eco-friendly infrastructure that can support both economic growth and environmental sustainability. The implementation of environmental safeguards, such as sustainable land-use policies and carbon offset programs, could mitigate the potential negative effects of industrial expansion on local ecosystems and community conservation efforts.

Furthermore, the positive relationship between economic facilities and economic development must be carefully considered in the context of resource-dependent regions like Bangka Belitung. While economic growth can provide financial resources for conservation, it also comes with trade-offs. As Szabo et al. (2022) argue, regions heavily dependent on. The challenge for Bangka Belitung lies in finding a balance between economic growth and environmental preservation. Policymakers must develop strategies that promote sustainable development, such as eco-tourism, agroforestry, and renewable energy initiatives, which provide economic benefits without compromising the environment.

Village-Owned Assets and Their Influence on ECE Participation

In addition to governance and economic factors, the analysis of village-owned assets provided valuable insights into their influence on ECE. Village-owned assets—such as forests, boat moorings, and communal resources—were hypothesized to play a significant role in shaping local participation in environmental conservation. The bivariate analysis in Table 3 did not show a statistically significant relationship between asset ownership and ECE ($p = 0.344$). However, the multivariate regression analysis in Table 3 revealed a more complex relationship, with villages possessing 3–4 assets exhibiting a lower likelihood of

participating in ECE (AOR = 0.56), while those with 5 or more assets showed a neutral effect (AOR = 1.10).

These results suggest that resource ownership alone is not sufficient to guarantee effective conservation outcomes. Similar findings have been observed in Ghana's decentralized forest governance, where legal ownership of resources did not necessarily lead to sustainable management without proper governance frameworks (Mawutor & Hajjar, 2022). In Bangka Belitung, village-owned forests and communal spaces may not be fully utilized for conservation unless governance structures support participatory management and provide adequate incentives for resource stewardship.

The study suggests that asset accumulation must be complemented by effective governance structures and institutional support to realize their full conservation potential. For example, eco-tourism or sustainable forest management programs could serve as viable models for turning village-owned assets into economic drivers while simultaneously supporting biodiversity conservation. Moreover, aligning national conservation goals with local asset management strategies can help villages mobilize resources for environmental protection. As Tarun et al. (2024) point out, community-based forest management programs that involve local communities in resource decision-making can enhance conservation outcomes and improve the livelihoods of rural populations.

The Influence of Marine Resource Dependence on ECE

The study also examined the role of marine resource dependence, as indicated by the presence of boat moorings in the villages of Bangka Belitung, in shaping participation in ECE. Villages with boat moorings, which are indicative of reliance on marine resources, were more likely to engage in ECE. Specifically, the logistic regression analysis in Table 3 revealed an Adjusted Odds Ratio (AOR) of 2.08 (95% CI: 1.06–3.71), suggesting that villages with marine-related assets are more likely to participate in environmental conservation activities compared to those without such assets.

This finding aligns with studies in Indonesia's coastal regions and Baja California, where fisher-dependent communities have demonstrated stronger inclinations toward marine conservation as part of their local development strategies (Micheli et al. (2024)). In these areas, the interdependence between local livelihoods and the health of marine ecosystems has led to increased participation in marine conservation programs. In Bangka Belitung, the presence of boat moorings indicates a significant reliance on marine resources, which may explain the stronger conservation outcomes in these villages.

The relationship between marine resource dependence and ECE suggests that villages heavily reliant on coastal ecosystems are more motivated to protect those resources (Aldasoro-Said & Ortiz-Lozano (2021)). This highlights the importance of aligning economic incentives with conservation goals. In this context, sustainable fisheries management, marine protected areas, and eco-tourism initiatives could be viable strategies to strengthen conservation in marine-dependent villages. Moreover, policy interventions that promote sustainable fishing practices and offer economic alternatives to overfishing can help balance economic needs with marine ecosystem preservation.

However, the effectiveness of marine conservation depends not only on community engagement but also on institutional capacity and policy support (Zhao et al. (2022)). The study points to the need for integrated coastal zone management and

collaborative governance to ensure that marine resource management aligns with broader environmental and development policies. Such integration can enhance community resilience to climate change impacts while preserving vital marine ecosystems.

The Role of Digital Governance Systems in Enhancing ECE

The role of digital governance systems in influencing ECE was another significant finding from the analysis. Digital tools such as village information systems were found to be strong predictors of environmental participation. Villages with digital governance platforms exhibited a higher rate of ECE participation (67.47%) compared to those without these systems (53.33%), with a chi-square p-value of 0.040 indicating statistical significance. This demonstrates that digital platforms can enhance public engagement, improve data transparency, and facilitate community participation in sustainability planning.

The importance of digital governance is supported by recent studies that highlight the role of digital tools in improving environmental management. For example, Khalid et al. (2024) argue that e-governance systems provide real-time data sharing and decision-making tools, which improve the efficiency of local governance and foster greater public participation in environmental protection. Similarly, Wang & Guo (2024) found that digital platforms help local governments and communities make data-driven decisions, enhancing the effectiveness of conservation policies.

However, the impact of digital governance is contingent on the institutional capacity of local governments to utilize these systems effectively. In Bangka Belitung, where digital literacy among village leaders may be limited, there is a need for capacity-building programs to ensure that digital tools are used effectively. Training programs for local officials and public awareness campaigns can help bridge the gap between digital infrastructure and effective governance. Furthermore, policy frameworks should be developed to integrate digital governance with participatory planning, ensuring that e-governance systems are used to enhance community involvement in environmental decision-making.

The Influence of Village Assets on ECE Participation

The role of village-owned assets in shaping participation in ECE was examined through both bivariate and multivariate analysis. Table 3 shows that ownership of certain assets, such as forests, boat moorings, and communal resources, can influence a village's involvement in conservation activities. However, the analysis revealed a more nuanced relationship between asset ownership and ECE. Villages with 3–4 assets exhibited a reduced likelihood of engaging in ECE, as shown by an Adjusted Odds Ratio (AOR) of 0.56 (95% CI: 0.26–1.20), suggesting that moderate levels of asset ownership may not automatically translate into higher participation in environmental conservation.

The lack of a significant relationship between village assets and ECE in Table 3 ($p = 0.344$) aligns with findings from other regions, where resource ownership alone did not ensure effective resource management or conservation outcomes. For instance, studies on decentralized forest governance in China indicate that legal ownership of resources without an appropriate governance framework can result in ineffective conservation management (W. Liang et al., 2024). Similarly, in Indonesia, resource-rich villages often face challenges in effectively managing their natural

resources, such as forests, due to gaps in institutional capacity and governance structures (Setiawan et al., 2024).

This finding underscores the importance of governance frameworks that support participatory resource management. In Bangka Belitung, villages with 5 or more assets showed a neutral effect on ECE participation (AOR = 1.10), which suggests that the effectiveness of asset ownership is contingent upon the quality of governance and management practices. For example, eco-tourism, sustainable agriculture, and agroforestry initiatives can transform village-owned assets into economic opportunities while simultaneously supporting conservation goals. Research in Southeast Sulawesi demonstrates how community-based natural resource management programs have successfully integrated local assets into sustainable development models (Setiawan et al. (2024).

Economic Development and the Trade-offs with Conservation

The negative correlation between economic facilities and ECE highlights the trade-off between economic development and environmental protection. Table 3 shows that villages with more than four economic facilities had a significantly lower likelihood of participating in ECE, with an AOR of 0.43 (95% CI: 0.21–0.75). This suggests that the expansion of economic infrastructure, particularly in extractive industries, can undermine environmental commitments by prioritizing short-term economic gains over long-term sustainability goals. The expansion of economic infrastructure, such as markets and industrial zones, has been shown to reduce community engagement in conservation efforts, a finding that mirrors the experiences of China, Brazil, and Indonesia, where economic growth often results in environmental degradation (Ali et al., 2018; Reale et al., 2022; Miller et al., 2020).

This study provides additional evidence that resource-dependent villages in regions like Bangka Belitung face significant challenges in balancing economic growth with environmental protection. Economic growth in resource-extractive industries often leads to the degradation of natural ecosystems and biodiversity. Policymakers should take these trade-offs into account when designing economic development plans. Integrating environmental safeguards, such as sustainable land-use policies and eco-friendly business practices, into economic development strategies is critical for ensuring that growth does not come at the expense of the environment. The findings suggest that economic infrastructure should be evaluated for its long-term ecological impacts, with environmental impact assessments and green technologies prioritized in resource-intensive industries.

Furthermore, as Han (2024); and Suleymanov et al. (2023) argue, there is a growing need for sustainable development policies that incorporate both economic development and environmental sustainability. Green technologies, such as renewable energy, eco-tourism, and sustainable agriculture, can serve as alternative pathways for economic development without compromising environmental goals. Policymakers should consider supporting these sectors through incentives and performance-based funding mechanisms, which would encourage local communities to adopt sustainable practices while still benefiting from economic development.

The Influence of Village-Owned Assets on ECE Participation

The role of village-owned assets in shaping participation in ECE was examined through both bivariate and multivariate analysis. Table 3 shows the results of the bivariate analysis, which investigated the relationship between asset ownership and environmental behavior in the villages. The analysis revealed that villages with more village-owned assets—such as forests, boat moorings, and communal resources—tended to have higher participation rates in conservation activities. However, the *p*-value of 0.344 from the chi-squared test indicated that asset ownership did not show a statistically significant relationship with ECE at the bivariate level.

Despite the lack of significant results in the bivariate analysis in Table 3, the multivariate regression analysis in Table 2 provided a more nuanced understanding. Villages with 3–4 assets had a reduced likelihood of engaging in ECE (AOR = 0.56), while those with 5 or more assets had a neutral effect (AOR = 1.10). This suggests that moderate asset ownership does not necessarily lead to higher levels of environmental engagement. These findings are consistent with studies in China, where forest ownership alone did not guarantee successful sustainable management without strong governance frameworks (Friedman et al., 2020 and Butler et al., 2022).

The results also highlight that asset accumulation alone is insufficient to ensure effective conservation outcomes. Bangka Belitung presents a unique case where village-owned forests and communal assets may be underutilized unless there is sufficient institutional support and governance capacity. Eco-tourism, agroforestry, and other sustainable resource management practices should be explored as potential strategies for using these assets to both enhance conservation efforts and generate economic benefits for local communities. This aligns with the work of Tarun et al. (2024), which emphasizes the need for community-based resource management that integrates local assets into sustainable development strategies.

Economic Development and the Trade-offs with Conservation

The analysis also reveals a negative correlation between the number of economic facilities and ECE. According to the data in Table 3, villages with more than four economic facilities—such as markets, cooperatives, and industrial zones—were significantly less likely to participate in conservation efforts (AOR = 0.43; 95% CI: 0.21–0.75). This finding suggests that the expansion of economic infrastructure, particularly in resource-extractive industries, may divert attention from sustainable development goals and environmental protection.

This result supports global studies showing that economic development focused on extractive industries often leads to environmental degradation and diminished community participation in conservation. For instance, in China and Brazil, industrialization and economic growth in resource-rich regions have resulted in deforestation and the loss of biodiversity, as industrialization often takes precedence over environmental concerns (Tang et al. (2025) and Felipe Sobczynski et al. (2023)). In Bangka Belitung, where tin mining and palm oil production drive economic growth, the trade-off between economic development and environmental sustainability is particularly pronounced.

The study highlights the need for sustainable development policies that align economic growth with environmental goals. Green technologies, eco-friendly infrastructure, and environmental safeguards should be prioritized to ensure that the

benefits of economic development do not come at the expense of the environment. Policymakers should adopt impact assessments for new projects and performance-based incentives to encourage villages to integrate environmental concerns into their economic plans.

Integrating Environmental Education and Policy for Long-Term Sustainability

The findings underscore the essential role of environmental education in enhancing ECE at the village level. Public spaces and digital governance systems can serve as platforms for environmental learning and awareness-building. In Bangka Belitung, villages with active youth engagement in conservation programs demonstrated greater long-term sustainability in environmental initiatives. Studies, such as those conducted by [Ehara et al. \(2023\)](#), highlight the significance of involving youth in community forestry programs to ensure the continuity of conservation efforts. Similarly, in Jiangsu, China, public spaces were utilized for organizing workshops and training programs that successfully increased community participation in conservation ([Xu & Miao, 2022](#)).

Incorporating environmental education into village-level planning, school curricula, and youth initiatives is crucial for cultivating a generation more attuned to sustainable practices. This aligns with the findings of [Tiwarei & Nguyen \(2024\)](#), which emphasize that education is a cornerstone of community-driven environmental governance. The study suggests that Bangka Belitung could benefit from incorporating environmental education into the local development agenda, particularly in the school system and through youth engagement programs. Moreover, public spaces could serve as venues for tree-planting campaigns, clean-up events, and community workshops, reinforcing the idea that community-based education fosters collective responsibility for environmental conservation.

This study also emphasizes the need for policy alignment between economic development and environmental conservation. The findings indicate that economic facilities—such as markets and industrial zones—have a negative impact on ECE. The study suggests that sustainable development policies should promote green technologies and eco-friendly infrastructure alongside economic growth. Integrating environmental safeguards into the planning and approval process for new economic projects is crucial. Policymakers should consider performance-based incentives to encourage villages to meet environmental conservation goals while still promoting economic development.

Research by [Paudel et al. \(2024\)](#) supports these conclusions, highlighting that environmental policies must be integrated into economic planning to achieve sustainable outcomes. The findings suggest that Bangka Belitung, with its reliance on extractive industries, must balance economic growth with conservation by adopting policies that prioritize green technologies and sustainable practices.

Linking Findings to Broader Conservation Strategies

In addition to the economic-development-environmental trade-off, the study provides a clear pathway for integrating socio-economic factors with environmental conservation efforts in Bangka Belitung. Participatory governance, community-based management, and digital tools are central to creating effective sustainability models. The role of programs is crucial in localizing global sustainability goals and fostering shared ownership of

environmental resources. This study suggests that inter-village cooperation and digital governance systems can be leveraged to promote scalable conservation strategies that address both local needs and global sustainability goals.

The study also emphasizes the importance of cross-sectoral collaboration in resource-dependent regions. By integrating climate adaptation, disaster resilience, and environmental governance into local planning, policymakers can create a holistic approach to sustainability. As demonstrated by [King et al. \(2023\)](#) and [Sidney Correa et al. \(2024\)](#), when environmental initiatives are aligned with health, education, and disaster resilience, communities are more likely to embrace sustainability measures.

This study further suggests that the global shift towards climate adaptation provides an opportunity to reinforce local conservation efforts. [Banda et al. \(2024\)](#) argue that integrating environmental conservation with climate adaptation strategies improves resilience to climate risks, such as flooding and droughts. For Bangka Belitung, aligning conservation efforts with climate adaptation planning not only protects ecosystems but also strengthens the village's capacity to deal with climate-related vulnerabilities.

The empirical results of this study are consistent with several studies conducted in other developing regions, which emphasize the role of local governance and participatory infrastructure in promoting environmental conservation. For example, community-led recycling initiatives in Vietnam and participatory marine management in the Philippines have shown similar patterns of increased conservation engagement when local institutions are empowered. In the Indonesian context, [Budiono et al. \(2024\)](#) demonstrated that mangrove conservation efforts were more effective when supported by strong village leadership and decentralized planning. Likewise, [Setiawan et al. \(2024\)](#) found that community forest management in Southeast Sulawesi succeeded when aligned with local governance structures and economic incentives. This study reinforces and extends these findings by offering a province-wide, data-driven analysis that not only confirms the value of institutional support but also quantifies its relative influence across multiple variables.

Practical Implications for Village Governance.

These findings carry several practical implications for improving village-level environmental governance. First, village governments should prioritize the establishment of waste recycling initiatives and ensure that public spaces are accessible and actively used for environmental education and community mobilization. Second, facilitating inter-village cooperation—especially in shared ecological zones—can enhance collective action and resource efficiency. Third, integrating digital governance tools must go hand-in-hand with local capacity-building to ensure effective implementation. Lastly, economic development strategies in rural areas should incorporate environmental safeguards to avoid compromising long-term sustainability. Local policymakers, therefore, need to balance growth with ecological protection by embedding conservation priorities into village development planning frameworks.

CONCLUSION

This study provides a comprehensive analysis of the factors influencing ECE in resource-dependent villages in Bangka Belitung, Indonesia. The key findings reveal that governance structures, particularly inter-village cooperation, waste recycling programs, and the availability of public spaces, play a significant

role in fostering participation in conservation activities. Specifically, waste recycling programs were identified as the most significant predictor of ECE, with villages that had recycling programs being almost nine times more likely to engage in conservation efforts. Additionally, inter-village cooperation and open public spaces were positively correlated with increased participation in conservation activities, suggesting that collaborative governance and community involvement are essential drivers of sustainability.

On the other hand, economic infrastructure demonstrated a negative relationship with ECE, with villages having more than four economic facilities being less likely to engage in conservation. This finding highlights the trade-off between economic growth, particularly in extractive industries, and environmental sustainability. Furthermore, digital governance tools, including village information systems, were shown to enhance environmental participation by improving public access to data and enabling better governance.

These results underscore the importance of aligning economic development with sustainable governance to ensure that growth does not come at the cost of environmental protection. Multi-level governance that integrates local knowledge, community participation, and institutional support is essential for building resilient conservation strategies.

These findings carry clear implications for village governance policy. Policymakers should consider embedding environmental criteria into village development planning (RKPDs), including support for recycling infrastructure, community-managed public spaces, and platforms for inter-village cooperation. Furthermore, strengthening digital governance systems at the village level—paired with leadership training and public engagement—can enhance participation in conservation programs. Village governments need both institutional autonomy and technical support to translate sustainability goals into locally grounded initiatives. Integrating these policy directions into regional planning and funding mechanisms can help scale effective environmental governance across resource-dependent rural areas.

While this study offers valuable insights, there are several limitations to consider. First, the cross-sectional nature of the data limits the ability to infer causal relationships. A longitudinal study that tracks changes in conservation efforts over time would provide deeper insights into the long-term impact of governance models and policy interventions. Additionally, this study is focused on Bangka Belitung, which may limit the generalizability of the findings to other regions with different socio-economic and ecological contexts. Future research could explore similar models in other regions of Indonesia or in comparative studies with other countries in the Global South to assess the transferability of these governance frameworks.

Moreover, the study did not explore the role of social capital, such as community trust and social cohesion, which may play an important role in community-driven conservation. Future research could incorporate social capital metrics, such as trust in leadership, participation in community organizations, and intergenerational knowledge transfer, to further enhance the understanding of village-level environmental governance.

Lastly, it would be valuable to explore the effectiveness of policy interventions such as performance-based incentives and eco-certification programs that link economic rewards to conservation outcomes. Understanding how these policies influence community behavior could provide policymakers with

actionable insights for strengthening sustainable development in resource-dependent regions. In conclusion, the study contributes to the growing literature on decentralized environmental governance and offers practical recommendations for designing sustainable conservation policies. The integration of local governance, economic development, and environmental education is crucial for creating scalable conservation models that can be adapted to resource-dependent communities in Indonesia and beyond.

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