Understanding community willingness to participate in community-based sanitation programs: Insights from Labuan Bajo, Indonesia

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Abstract. This study investigates factors influencing community participation in adaptive environmental management programs in Labuan Bajo, Indonesia. Data from 477 residents were analyzed using binary logistic and probit regression models to evaluate the significance of sanitation infrastructure and community engagement. Results show that the presence of septic tanks ($p<0.05$ Logit; $p<0.01$ Probit) and proper maintenance ($p<0.05$ in both models) significantly enhance participation, emphasizing the importance of robust sanitation systems. Public toilets also positively impact participation ($p<0.01$ Logit; $p<0.05$ Probit), underscoring their role in public health promotion. Conversely, fecal sludge management shows no significant effect, highlighting a need for greater awareness. Community engagement is pivotal, with membership in local organizations ($p<0.01$ Logit; $p<0.05$ Probit) and involvement in sanitation teams ($p<0.01$ in both models) positively influencing participation. Educational outreach, particularly extension services ($p<0.001$ in both models) and training ($p<0.01$ in both models), emerges as a key driver, demonstrating the importance of knowledge dissemination. These findings offer actionable insights for policymakers to enhance community involvement in sanitation programs, particularly in coastal regions with similar characteristics.

Keywords: community-based sanitation, community participation, binary logistic regression, probit regression, coastal urban management

1. Introduction

The rapid urbanization of coastal regions in Indonesia, exemplified by Labuan Bajo, presents unique challenges for urban planning and environmental management. Labuan Bajo, located on the island of Flores in eastern Indonesia, is not only a vital fishing community but also a growing tourism hub due to its proximity to Komodo National Park. This dual role, as both a residential area and a tourist destination, places immense pressure on local infrastructure, particularly sanitation systems. Coastal communities like Labuan Bajo often face critical

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environmental and public health issues related to inadequate sanitation facilities [1], which can lead to the contamination of coastal waters, a decline in marine biodiversity, and an increase in waterborne diseases. Ensuring effective sanitation management in such regions is essential to both human health and environmental sustainability.

In the context of Indonesia's broader push toward improving sanitation coverage through the "100% Sanitation" campaign, community-based sanitation (CBS) programs have emerged as an essential component of sustainable urban development. These programs focus on fostering local participation in the planning [2], execution, and maintenance of sanitation systems, recognizing that community engagement is critical to the success and longevity of these initiatives. However, despite the importance of CBS programs, the willingness of community members to actively participate in these efforts remains inconsistent. Understanding the factors that influence this willingness is crucial for ensuring the success of sanitation programs and addressing the challenges of sanitation management in coastal regions.

Labuan Bajo, as a rapidly growing town, is particularly susceptible to the consequences of poor sanitation [1]. The influx of tourists, combined with a relatively limited municipal sanitation system, has exacerbated existing waste management challenges, resulting in localized pollution, degradation of the marine environment, and risks to public health. Addressing these issues through CBS programs necessitates active community involvement, yet participation remains variable. In some areas, residents are actively engaged in sanitation management, while in others, apathy, resource constraints, or a lack of awareness impede participation.

The research on community-based sanitation in Indonesia, particularly in coastal settings like Labuan Bajo, has traditionally focused on infrastructural and policy aspects. Less attention has been given to the socio-cultural and economic factors that influence community engagement in these programs [3], [4], [5]. The effectiveness of CBS programs hinges on understanding what drives or hinders local participation. This study seeks to fill this gap by examining the factors influencing community willingness to participate in CBS programs in Labuan Bajo.

Several key factors affect community engagement in CBS programs. Access to proper sanitation infrastructure, awareness of the health risks associated with poor sanitation [6], and the economic benefits of clean environments are likely drivers of participation. Additionally, social capital reflected in the strength of local institutions, community trust, and networks plays a crucial role in mobilizing community action [7]. Understanding these dimensions is essential for tailoring CBS programs to the specific needs and capacities of coastal communities.

Furthermore, coastal communities are particularly vulnerable to environmental degradation caused by inadequate sanitation management [8], [9]. The improper disposal of sewage and other waste products into coastal waters can have devastating effects on marine ecosystems [10], which are vital to both the tourism and fishing industries that sustain the local economy. This environmental degradation, in turn, can lead to a decline in the very resources that these communities depend on, creating a feedback loop of environmental harm and economic loss. Therefore, an effective sanitation program that has the buy-in and participation of the local community is not just a matter of public health but also a critical component of environmental conservation and sustainable development.

The study aims to investigate how various socio-economic, infrastructural, and community-related factors influence the willingness of Labuan Bajo residents to participate in CBS programs. By employing binary logistic and probit models, the study identifies key factors driving or hindering community participation in CBS initiatives. Understanding these dynamics will not only contribute to the academic discourse on community-based environmental management but also offer actionable insights for policymakers and

practitioners looking to implement or improve CBS programs in Labuan Bajo and similar coastal urban environments.

2. Method

This study employed a comprehensive methodological approach to assess the adaptive capacities and willingness to participate in environmental management programs among the coastal community of Labuan Bajo. A cross-sectional survey design was utilized, allowing for data collection at a single point in time from a broad segment of the population. This design was selected for its efficiency in providing a snapshot of current attitudes and behaviors related to environmental and waste management issues.

To capture a representative sample of community perspectives, the study involved 477 adult residents of Labuan Bajo, selected through stratified random sampling. This technique ensured diversity across key demographic factors such as age, gender, income levels, and educational backgrounds. The stratification was designed to reflect the social structure of the community, ensuring that all segments of the population were adequately represented.

Data collection was conducted using an online survey platform, chosen for its broad reach and the convenience it provides to participants. The survey incorporated both closed and open-ended questions, enabling the collection of quantitative data for statistical analysis and qualitative insights for deeper exploration of the community's perceptions and motivations. Key variables covered in the online questionnaire included the following areas:

1. The importance of sanitation infrastructure, which included aspects like the necessity of septic tanks and public toilets, and the management of fecal sludge.
2. Community involvement, which was measured by the level of participation in organizations, the influence of community members on sanitation decisions, and active engagement in sanitation-related activities.
3. Demographic variables that included gender and income levels, providing context to the responses and helping to identify patterns across different segments of the community.

The online survey method facilitated efficient data collection and allowed for a quick turnaround in managing and analyzing responses. Conducting the surveys in the local language ensured comprehension and accuracy, thereby enhancing the reliability of the data. Trained researchers closely monitored the data collection process, promptly addressing any issues in real time to maintain the integrity of the survey.

The integration of quantitative data from the closed-ended questions with qualitative insights from the open-ended responses provided a comprehensive view of the community's adaptive capacities and their readiness to engage in sustainability initiatives. This dual approach enriched the understanding of how various variables influence environmental management behaviors among the residents of Labuan Bajo.

In this study, binary logistic regression and probit regression models were employed to analyze the data and identify factors influencing the community's willingness to participate in adaptive environmental management programs. These statistical methods are particularly suitable for analyzing dichotomous dependent variables, such as binary responses indicating willingness or unwillingness to participate in environmental initiatives.

Before performing the regression analyses, the survey data were meticulously prepared and coded. Variables such as the perceived importance of sanitation facilities (e.g., septic tanks and public toilets), active community participation, and engagement with local sanitation teams or training programs were coded as binary outcomes. For instance, responses acknowledging the importance of septic tanks were coded as '1' for "very important" and '0' for "otherwise." This systematic approach to data preparation ensured accuracy and

facilitated meaningful insights into the factors driving community engagement in environmental management programs.

The binary logistic regression model estimated the probability of community members' willingness to participate based on predictor variables. It provided coefficients that explained the direction and magnitude of the relationship between each independent variable and the dependent variable of willingness to participate. These coefficients are expressed in terms of changes in the log odds of the outcome for a one-unit change in the predictor variable [11], [12].

Probit regression was used alongside logistic regression to offer an additional perspective on the data. While both models are similar, the probit model employs a cumulative normal distribution function to link the independent variables with the dependent binary outcome, making it particularly useful under the assumption of a normally distributed error term. To assess how well the models fit the data, several goodness-of-fit metrics were examined. The Log-likelihood function provided an indication of the model's fit to the data, while McFadden's Pseudo R-squared offered a measure of the model's explanatory power relative to a model without predictors [11], [12]. Additionally, the Akaike Information Criterion (AIC) was computed to evaluate model complexity and the trade-off between goodness-of-fit and the number of parameters included.

The coefficients from both the logistic and probit models were interpreted to identify statistically significant predictors. Variables with p-values less than 0.05 were considered significant, suggesting that the observed associations were unlikely to have occurred by random chance. This analysis was pivotal in determining which elements of community structure, levels of participation, and demographic characteristics significantly influenced willingness to engage in adaptive practices.

3. Result and Discussion

The study explored the perceptions of sanitation importance among local coastal communities in Labuan Bajo. A survey was conducted to evaluate several sanitation-related variables to understand their significance within the community. Key variables included Septic Tank, Septic Tank Draining, Public Toilet, Fecal Sludge Management, and measures of community engagement such as Participation of Organizations and Active Community Participation. These variables were assessed on a dichotomous scale, where a score of 1 indicates "very important" and 0 indicates otherwise. The descriptive statistics revealed a relatively high level of importance attributed to sanitation infrastructure, with Septic Tanks and Public Toilets recording mean scores above 0.4. This suggests that a significant portion of the community recognizes the critical role of these facilities in maintaining public health. Additionally, the mean scores for Active Community Participation and Sanitation Teams highlight a strong commitment to ongoing sanitation initiatives, aligning with existing literature that underscores the importance of community engagement in enhancing sanitation management [13].

Table 1. Descriptive analysis result.

Variables	Mean	Std. Deviation
Constant	0.503	0.501
Septic tank (1=very important; otherwise=0)	0.512	0.500
Septic tank draining (1=very important; otherwise=0)	0.430	0.496
Public toilet (1=very important; otherwise=0)	0.468	0.499
Fecal sludge management (1=very important; otherwise=0)	0.461	0.499
Participation of organizations (1=very important; otherwise=0)	0.419	0.494
Sanitation team (1=very important; otherwise=0)	0.478	0.500
Extension (1=very important; otherwise=0)	0.390	0.488
Training (1=very important; otherwise=0)	0.447	0.498
Community influence (1=very important; otherwise=0)	0.375	0.485
Active community participation (1=very important; otherwise=0)	0.535	0.499
Gender (1=Female; otherwise=0)	0.606	0.489
Income (1=More than IDR 3.000.000, -; otherwise=0)	0.335	0.473

3.1 Community Perceptions of Sanitation Importance

Moreover, the survey captured demographic variables such as gender and income, offering valuable insights into the socioeconomic backdrop of the respondents. A higher mean score for women compared to men may indicate greater involvement or concern among women regarding household and community hygiene, a trend corroborated by global sanitation studies [14], [15], [16], [17]. Additionally, the income variable suggests that higher-income groups are more likely to perceive sanitation as very important. This could be attributed to their greater exposure to health and environmental education, aligning with findings from previous research that links economic status with heightened environmental awareness [18], [19]. This comprehensive analysis of sanitation perceptions in Labuan Bajo is essential for developing targeted and effective sanitation policies and programs. By understanding these perceptions, policymakers and planners can design interventions that align with community priorities and address specific needs. Such strategies are pivotal in enhancing overall public health and promoting environmental sustainability in coastal areas.

3.2 The Role of Community Engagement

Table 2 provides a detailed analysis of the factors influencing the willingness of Labuan Bajo's coastal community to participate in sanitation initiatives, utilizing Binary Logit and Binomial Probit Models. The goodness of fit for the logistic regression analysis is quantified using the Log Likelihood Ratio (LLR) and Chi-Square statistics. In Table 2, the LLR of 99.170 is notably higher than the Chi-Square value of 26.217. This disparity underscores the model's effectiveness, as a higher LLR compared to the Chi-Square value suggests a strong model that adequately explains the variability in the response variable with the predictors included. Essentially, the LLR exceeding the Chi-Square demonstrates that the model's predictions closely align with the observed outcomes, indicating a good fit and reliable

parameter estimates [11], [12]. This robust fit validates the conclusions drawn from the model regarding the factors influencing community participation in sanitation initiatives.

The study examines several variables related to sanitation infrastructure and community engagement, assessing their impact on participation likelihood. Regarding infrastructure, the presence of a septic tank significantly increases the likelihood of community participation, with coefficients indicating a strong positive effect ($p<0.05$ for Logit and $p<0.01$ for Probit). Similarly, septic tank draining is associated with increased participation ($p<0.05$ for both models), suggesting that maintenance aspects of sanitation are critical to community engagement. Public toilets also exhibit a positive correlation with participation willingness ($p<0.01$ for Logit and $p<0.05$ for Probit), highlighting their importance in public health efforts. However, fecal sludge management does not show a statistically significant impact in either model, indicating a potential area for increased awareness and investment to enhance community involvement.

Community engagement factors, such as participation in organizations ($p<0.01$ for Logit and $p<0.05$ for Probit) and the involvement of sanitation teams ($p<0.01$ for both models), demonstrate significant positive effects. These findings emphasize the role of organized community actions in enhancing participation in sanitation efforts. Educational and extension activities are also critical, with extension services ($p<0.001$ for both models) and training ($p<0.01$ for both models) significantly influencing participation. These results underscore the importance of educational outreach in fostering community engagement in sanitation initiatives.

The broader dynamics of community influence are reflected in the community influence variable, which shows a significant positive impact on participation ($p<0.001$ for both models). This finding highlights the importance of community leaders and influencers in mobilizing collective action. Conversely, active community participation did not show a significant correlation, suggesting that while general community involvement is high, it does not necessarily translate into specific actionable behaviors in sanitation without targeted interventions.

Gender exhibits a positive correlation with participation ($p<0.05$ for both models), indicating that women may be more likely to engage in community sanitation programs. In contrast, higher income levels negatively impact participation, although this effect is not statistically significant. This could be attributed to differing priorities or alternative options available to higher-income residents.

These findings provide critical insights for policymakers and urban planners as they develop community-specific interventions aimed at improving sanitation facilities and participation in Labuan Bajo. The data suggests that enhancing infrastructure, coupled with strong community engagement and educational programs, can significantly increase participation in sanitation efforts, ultimately contributing to better public health outcomes and improved urban sustainability.

Table 2. Logit and probit analysis result for willingness to participate.

Variables	Binary Logit Model for Binary Choice		Binomial Probit Model	
	Coef.	S.E	Coef.	S.E
Constant	-2.975*	0.356	-1.629***	0.184
Septic tank (1=very important; otherwise=0)	0.676*	0.234	0.373***	0.139
Septic tank draining (1=very important; otherwise=0)	0.399*	0.240	0.201	0.142
Public toilet (1=very important; otherwise=0)	0.467**	0.233	0.242*	0.139
Fecal sludge management (1=very important; otherwise=0)	0.103	0.227	0.023	0.135
Participation of organizations (1=very important; otherwise=0)	0.501**	0.232	0.254*	0.139
Sanitation team (1=very important; otherwise=0)	0.529**	0.237	0.280**	0.142
Extension (1=very important; otherwise=0)	0.668***	0.230	0.366***	0.138
Training (1=very important; otherwise=0)	0.556**	0.233	0.305**	0.140
Community influence (1=very important; otherwise=0)	0.610***	0.231	0.360***	0.139
Active community participation (1=very important; otherwise=0)	-0.007	0.240	0.003	0.144
Gender (1=Female; otherwise=0)	0.434*	0.223	0.278**	0.131
Income (1=More than IDR 3.000.000, -; otherwise=0)	-0.254	0.226	-0.15	0.133
Goodness of Fit				
Log likelihood function	-254.721		-257.795	
Log likelihood ratio	99.170		93.021	
McFadden Pseudo R-squared	0.163		0.153	
AIC/N	1.123		1.135	
Chi Square	26.217 (df=12; 0.01)			

Notes: ***, **, * are significant differences at $p < 0.01$, $p < 0.05$, and $p < 0.1$, respectively.

3.3 Participations Rates Affected by Social Structure

Social structure significantly influences participation rates in community programs, as it shapes individuals' perceptions, motivations, and behaviours. In this study, socio-demographic factors such as gender and income emerge as critical determinants of willingness to participate (WTP) in sanitation programs. Out of the total respondents, 454 individuals (95%) expressed willingness to participate, while 23 individuals were unwilling to participate. Although the bar chart focuses on those who willing to participate, this distribution provides important context about the overall participation trend.
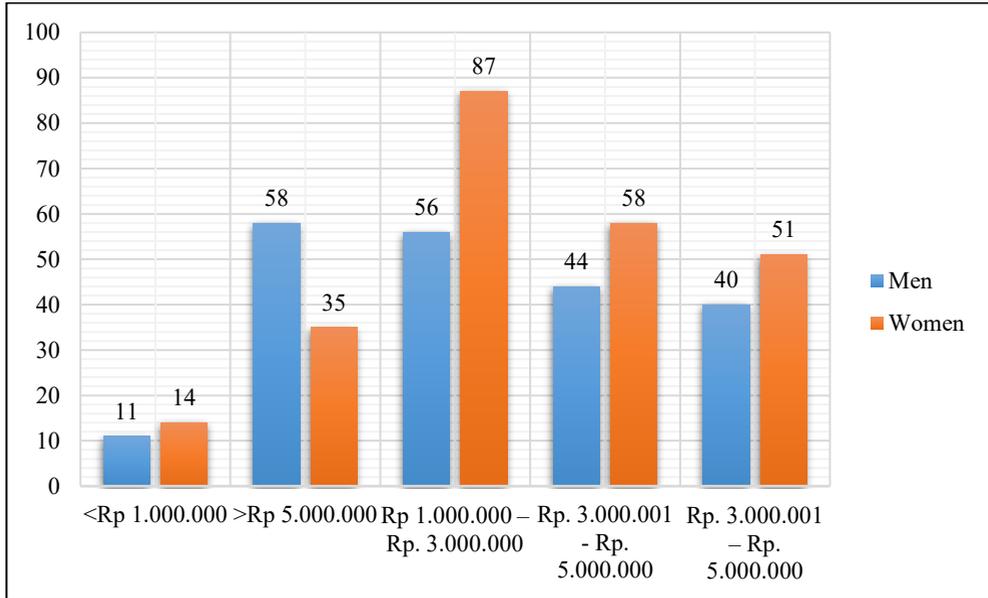
Fig. 1. Participation Rates by Gender and Income

The analysis of socio-demographic factors and their impact on participation in sanitation programs reveals several important insights. Regarding gender, regression analysis shows a negative and significant coefficient ($p<0.05$), indicating that women are generally less willing to participate in sanitation programs compared to men. This could be attributed to cultural or social norms that restrict women's involvement in public decision-making or community activities. Income also plays a significant role, with a negative and significant coefficient ($p<0.01$), suggesting that individuals with higher incomes are less inclined to engage in such programs. Wealthier individuals may prefer to address sanitation issues independently or may have higher expectations of program quality, leading to disengagement when those expectations are not met.

In terms of the most influential factors, the knowledge about sanitation policy stands out, as a positive and significant coefficient ($p<0.05$) shows that increasing public awareness about sanitation policies boosts willingness to participate. This highlights the importance of education and outreach campaigns. Additionally, community support has a similar effect, with a positive and significant coefficient ($p<0.01$) suggesting that fostering open communication and dialogue within the community enhances engagement. The role of government also proves crucial, as a positive and significant coefficient ($p<0.05$) indicates that strong leadership and commitment from local governments are vital in encouraging public participation.

Further insights reveal that the presence of international organizations positively influences willingness to participate ($p<0.01$), likely due to increased credibility and resources. Finally, economic considerations, such as introducing equitable funding schemes, are essential for making sanitation programs accessible to a wider range of income groups.

3.4 Implications for Policy and Practice

The findings of this study provide valuable insights into the adaptive capacities and willingness to participate within coastal communities, particularly focusing on key sanitation aspects such as septic tank importance, community engagement, and educational

interventions. These elements are vital for shaping environmental sustainability practices in coastal areas, which are highly susceptible to pollution and systematic sanitation challenges.

Septic tanks were identified by the community as highly important, reflecting a clear recognition of the need for proper waste management systems to maintain environmental health and community well-being. The emphasis placed on septic tank draining further highlights the community's understanding of regular maintenance as essential to prevent environmental contamination. This recognition aligns with studies that underscore the critical role of effective waste management infrastructure in mitigating pollution and preserving marine ecosystems in coastal regions [20]. Public toilet accessibility also emerged as a significant factor, underscoring the community's demand for better public sanitation facilities. This finding is particularly relevant for tourist-heavy coastal areas, where adequate public sanitation can substantially influence environmental health and visitor experiences [21]. Enhancing these facilities directly impacts the ecological footprint of tourism, a concept extensively discussed in sustainable tourism literature [22].

The study also highlights the significant impact of community-driven initiatives, such as the involvement of local organizations and sanitation teams, on the willingness to participate in adaptive programs. The active role of community groups bridges the gap between local needs and government sanitation strategies, ensuring that initiatives are culturally appropriate and effectively implemented. This community-centric approach is supported by literature indicating that local engagement in environmental decision-making leads to more sustainable and widely accepted outcomes [23].

Furthermore, training and extension services demonstrated a positive influence on participation willingness, underscoring the power of knowledge dissemination and capacity building in fostering proactive community behaviors. These findings emphasize the importance of continuous education and awareness programs that equip communities with the necessary skills and knowledge to manage their waste sustainably [24]. However, the results also indicate that not all traditionally influential factors significantly affect the willingness to adapt. For instance, the active participation of community members did not show a significant effect, suggesting potential barriers such as time constraints, lack of immediate benefits, or insufficient incentives. This calls for a reassessment of how community involvement is facilitated and incentivized within adaptive programs.

Interestingly, the study revealed gender differences in participation, with women being more likely to engage in adaptive services. This finding may reflect a higher level of environmental awareness among women or a greater involvement in community welfare, aligning with global studies that often highlight women's pivotal role in community-based environmental management. Conversely, the income variable indicated that higher economic status does not necessarily predict greater participation in adaptive services. This could be attributed to higher-income individuals having more resources to mitigate personal risks without relying on community initiatives. This aspect is consistent with studies discussing the complex interplay between income levels and environmental engagement [25].

Collectively, these insights enhance our understanding of community dynamics in coastal regions and inform the design of tailored, effective environmental management strategies that align with community needs and capacities. Future research should further investigate barriers to active community participation and explore the differential impacts of gender and income on environmental adaptive behaviors, thereby refining policy approaches for these vulnerable settings.

4. Conclusion

This study investigated the factors influencing the willingness of the Labuan Bajo coastal community to participate in adaptive environmental management programs. Using binary logistic and probit regression models, we analyzed responses regarding the importance of various sanitation facilities and community involvement in environmental practices.

Our findings reveal that certain factors, such as the perceived importance of septic tanks and active involvement in sanitation teams, significantly influence the community's willingness to engage in adaptive behaviors. Conversely, some expected influential factors, such as active community participation, did not show a significant impact. This suggests that external factors, including economic or cultural barriers, may be shaping these behaviors.

The analysis indicates that providing adequate resources and enhancing community education on environmental issues can effectively increase participation in sustainable practices. For policymakers and urban planners, these insights underscore the need for targeted strategies that address both resource availability and community engagement to foster adaptive capacity in coastal communities more effectively.

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