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Socio-demographic and governance drivers of sanitation participation: Preliminary Evidence from Gorontalo City, Indonesia

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***Abstract*— This study examines household willingness to participate in community-based sanitation governance in Gorontalo Province, Indonesia, where marine natural capital is increasingly threatened by inadequate sanitation. A cross-sectional survey of 63 households was conducted using a structured questionnaire that measured governance performance, agency and empowerment, access, flexibility, and learning capacity. Exploratory factor analysis identified five latent dimensions, and subsequent cluster and logistic regression analyses tested the influence of socio-demographic and governance variables on willingness to participate. The hypothesis testing confirmed that socio-demographic characteristics (H1 gender, H2 age, H3 education, H4 occupation, H5 household expenditure, H6 household income) played limited roles, with only occupation and expenditure showing partial influence. In contrast, governance-related dimensions were decisive. Organizational performance (H7) and agency and governance (H8) did not reach significance in the binary model, but sanitation access (H9) strongly predicted willingness ($p < 0.01$), with flexibility also marginally significant. These results demonstrate that while socio-economic background shapes vulnerability, participation is primarily driven by equitable access and adaptive governance capacity. The findings underscore the urgent need for Gorontalo's sanitation policies to integrate governance strengthening with marine ecosystem protection, ensuring that community participation contributes directly to safeguarding marine natural capital.**

Keywords— sanitation governance; community participation; household willingness; sanitation access; coastal ecosystems

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I. INTRODUCTION

Sanitation has long been recognized as one of the fundamental pillars of public health, environmental protection, and sustainable development [1,2]. In regions where access to adequate sanitation remains limited, the implications extend far beyond household well-being to broader issues of ecological degradation, economic inequality, and governance failure [3,4]. The case of Gorontalo Province in Indonesia highlights these dynamics in a particularly acute way. Gorontalo, located on the northern arm of Sulawesi Island, is home to more than 1.1 million people and is characterized by a mixture of urban and coastal communities whose livelihoods depend heavily on fisheries, agriculture, and marine ecosystems [5]. The province's natural capital provides essential ecosystem services such as coastal protection, fish spawning grounds, and carbon sequestration [6]. However, these fragile systems are increasingly threatened by poor sanitation infrastructure, unmanaged household waste, and plastic leakage into rivers and seas. Indonesia as a whole has committed to ambitious sanitation targets through the Sustainable Development Goals, especially SDG 6 on clean water and sanitation, and through its national program known as 100-0-100 [7,8], which seeks to achieve universal access to safe drinking water, zero slums, and 100 percent access to sanitation. Despite these efforts, progress has been uneven across provinces, and Gorontalo is among those where sanitation challenges remain significant. The region still experiences widespread reliance on shared toilets, unimproved latrines, and direct discharge of household wastewater into rivers and coastal waters [5]. These practices not only compromise public health but also contribute directly to marine litter, which undermines the integrity of Gorontalo's marine ecosystems. As studies in other Indonesian regions have shown, poor sanitation and plastic leakage are often linked, as weak household-level waste management and insufficient infrastructure combine to create persistent environmental hazards [9–12].

In this context, community participation emerges as a vital component of any successful sanitation strategy. Governance frameworks increasingly emphasize that technical solutions alone are insufficient [13], unless they are coupled with social engagement and household willingness to participate. Participation can take multiple forms, from contributing to collective clean-up campaigns and adopting household-level hygiene practices to engaging in decision-making and supporting local leaves for sanitation services [14,15]. Willingness

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to participate is therefore both an indicator of social capital and a measure of governance legitimacy. Households that are willing to engage signal trust in local institutions and recognition of the shared responsibility to protect the environment [16–19].

The international literature on sanitation governance identifies several dimensions that shape participation. Organizational performance, reflected in the presence and effectiveness of sanitation task forces, community groups, and municipal agencies, is widely recognized as foundational [20,21]. Where organizations are visible, competent, and responsive, households are more likely to feel motivated to participate. Agency and governance, which involve opportunities for training, awareness campaigns, and involvement in planning, also play a crucial role in empowering communities to act [22,23]. Access remains perhaps the most basic dimension, as households are far less likely to engage when facilities are absent, inadequate, or unfairly distributed. Flexibility refers to the adaptability of systems, including the upgrading of household toilets or drainage to meet growing needs, and is central to the resilience of sanitation systems in the face of changing environmental conditions [24,25]. Finally, learning capacity, which encompasses education, local knowledge-sharing, and exposure to hygiene programs, ensures that participation is sustained over time through behavioral reinforcement and community norms [26,27].

The Gorontalo context provides an important test case for these governance dimensions because of its socio-economic diversity and its dependence on marine natural capital. Urban households in Gorontalo City typically experience better access to facilities, though these are not always adequate, while coastal households in surrounding districts often face acute shortages and environmental vulnerability. Flooding, seasonal storms, and reliance on riverine systems increase the risks of waste discharge directly into marine environments [28,29], threatening both local livelihoods and wider ecological integrity. At the same time, Gorontalo's population remains heavily reliant on fishing and coastal resources [30,31], which creates a direct incentive to safeguard marine ecosystems, though not always matched by the capacity or governance systems required.

Household willingness to participate in sanitation governance in Gorontalo can therefore be understood as both a social and ecological necessity. From a social perspective, participation addresses inequalities in access and helps build collective resilience. From an ecological perspective, participation is essential to protect marine ecosystems that sustain the local economy and contribute to Indonesia's commitments to marine and coastal conservation. The intersection of these perspectives underscores the novelty of studying sanitation not only as a public health or infrastructural issue but also as a matter of marine natural capital protection. Existing studies on sanitation in Indonesia have tended to focus on larger urban centers, where problems of slum upgrading, wastewater treatment, and flood control dominate [32–36]. Fewer studies have explored smaller provinces such as Gorontalo, where population density is lower but ecological vulnerability is higher. This creates a gap in both the academic literature and policy debates, since lessons learned in large metropolitan contexts do not always translate to border provinces with different socio-economic and environmental realities. In particular, little is known about how households in such contexts perceive sanitation governance, what motivates their willingness to participate, and how governance dimensions intersect with socio-demographic characteristics to shape outcomes. Addressing this gap is especially urgent as Gorontalo and similar provinces face increasing pressures from urbanization, migration, and climate-related hazards.

The preliminary nature of this study reflects both methodological and practical considerations. In governance and resilience research, preliminary studies with smaller samples are often used to test instruments, identify latent factors, and generate baseline evidence that can inform larger-scale studies [37–39]. The objective of this study, therefore, is to explore the socio-demographic and governance factors that shape household willingness to participate in sanitation governance in Gorontalo, with particular attention to the protection of marine natural capital. By examining both individual and systemic dimensions, the study seeks to fill a gap in the literature, provide preliminary evidence for policymakers, and contribute to Indonesia's broader efforts to achieve sustainable sanitation and marine ecosystem protection. The novelty of the study lies in its integration of governance analysis with ecological concerns, its focus on a border province often overlooked in national debates, and its use of preliminary methods to generate actionable insights for both scholarship and practice.

II. METHOD

A. Study Location and Context

This study was conducted in Gorontalo Province, located on the northern arm of Sulawesi Island, Indonesia. Gorontalo is known for its rich coastal and marine ecosystems, including mangroves, seagrass beds, and coral reefs, which provide essential ecosystem services and sustain local fisheries. Despite these natural assets, the province continues to face significant challenges in basic infrastructure and public health. Sanitation is among the most pressing concerns, as inadequate toilet facilities, shared latrines, and poorly managed wastewater systems expose communities to heightened risks of disease outbreaks and environmental contamination. Gorontalo's demographic profile illustrates a diverse mix of urban and coastal settlements. The capital city, Gorontalo City, is undergoing rapid urban expansion, while many surrounding districts maintain largely rural or semi-urban characteristics. Coastal villages in particular continue to struggle with access to improved sanitation services, relying heavily on shared facilities or direct disposal into rivers and coastal waters. National statistics suggest that many households in Gorontalo remain without safely managed sanitation, placing the province below national averages for access to improved sanitation services. This context makes Gorontalo a strategic site for studying sanitation governance and community participation. The province

encapsulates many of the broader challenges Indonesia faces in achieving Sustainable Development Goal 6 on clean water and sanitation. It also provides insights into how community resilience and governance capacities interact with socio-demographic characteristics to influence household participation in sanitation management.

B. Research Design

The study employed quantitative, cross-sectional survey design. This design was selected to provide a snapshot of household perceptions, governance capacities, and resilience practices at a single point in time. While qualitative approaches can capture narratives and lived experiences, the choice of a quantitative survey allowed for the systematic collection of standardized data from a larger sample of respondents, facilitating the use of statistical techniques to uncover patterns and test hypotheses. The research was designed as a preliminary but structured attempt to measure latent governance and resilience dimensions in sanitation management. By applying statistical tools such as exploratory factor analysis, cluster analysis, and logistic regression, the study sought to identify underlying constructs, classify households into participation profiles, and examine determinants of participation. This design ensures replicability and lays the foundation for future longitudinal or comparative studies in other Indonesian provinces.

C. Sampling Strategy

The study targeted adult residents of Gorontalo Province, Indonesia, encompassing both men and women aged 18 years and above. Households were selected as the unit of analysis because decisions related to sanitation practices, facility use, and participation in community initiatives are typically made collectively within families. In 2024, the province's population was estimated at around 1.2 million, although figures vary slightly depending on the source: 1,227,794 according to Wikipedia's 2024 update, 1,192,737 based on the 2022 Statistics Indonesia (BPS) census, and 1,171,681 from the 2020 census. The majority of residents identify as Muslim, shaping the cultural and social context within which sanitation practices are embedded. As a preliminary investigation, the sample size was not determined using population-based formulas but instead followed methodological guidance, which suggests that 30 to 50 respondents are sufficient for exploratory studies and pilot testing of research instruments (Hill, 1998; Johanson & Brooks, 2010). To enhance statistical reliability and surpass this minimum, the study successfully recruited 63 valid respondents in September 2025. Although modest, this sample was adequate for exploratory factor analysis and regression modeling in small-scale governance studies, enabling the identification of patterns that can inform more extensive follow-up research.

A stratified random sampling strategy was applied to capture variation across settlement types. Strata were defined by geographic and socio-economic contexts, differentiating between urban households in Gorontalo City and coastal households in surrounding districts. This distinction was necessary because urban residents generally enjoy greater access to sanitation facilities and municipal services, while coastal communities face unique challenges such as limited infrastructure, recurrent flooding, and the direct discharge of waste into rivers and coastal waters. Within each stratum, households were randomly selected to minimize bias and improve representativeness. The final sample reflected socio-demographic diversity across gender, age, marital status, education, occupation, and household income. This heterogeneity was essential, as it allowed the study to assess how governance and resilience factors intersect with social characteristics to influence household willingness to participate in sanitation management. While exploratory in nature, the diversity of responses provides a valuable baseline for understanding sanitation governance in Gorontalo and lays the foundation for larger, more comprehensive studies.

D. Instrument Development

The survey instrument was designed to capture both governance-related dimensions and household-level characteristics, reflecting the complexity of sanitation issues in Gorontalo Province. The questionnaire was divided into several thematic sections that addressed demographic information, household sanitation practices, governance and organizational performance, community agency and empowerment, access and flexibility of sanitation systems, and learning capacity within communities. This structure ensured that the instrument was comprehensive while remaining logically organized for respondents. The development of items was informed by established frameworks in sanitation governance and resilience studies, which were then carefully adapted to fit the specific context of Gorontalo. The dimension of organizational performance included questions on how respondents perceived the presence and effectiveness of local sanitation organizations, whether emergency repair task forces were available, the role of community sanitation groups, and the presence of incentives that encourage active participation. Agency and governance were measured by asking about opportunities to access training, involvement in planning processes, the frequency of neighborhood clean-up activities, the availability of public toilets, and the presence of government-led sanitation campaigns.

Access was another central construction, captured through items addressing the adequacy of drainage systems, the availability of communal wastewater treatment plants, the fairness of facility distribution across communities, and the extent to which residents felt included in sanitation-related decision-making. The construct of flexibility focused on how adaptable sanitation systems were to changing conditions, including the upgrading of household toilets and wastewater treatment plants to meet population growth or increasing demand. Finally, learning capacity was assessed through questions on residents' exposure to clean and healthy living education, participation in weekly sanitation programs, and the sharing of local knowledge related to sanitation practices. All items in

these sections were measured on a five-point Likert scale, ranging from strongly disagree (1) to strongly agree (5). This format was selected because it allowed respondents to express varying degrees of agreement or disagreement, facilitated later analysis through exploratory factor analysis, and enabled the calculation of reliability indicators such as Cronbach's alpha.

Before field deployment, the questionnaire was reviewed by sanitation experts to ensure that the constructs were valid and that the items accurately reflected the dimensions they were intended to measure. The instrument was also translated into the local language to ensure clarity and accessibility for all respondents, regardless of educational background. Revisions were made based on expert input to improve cultural relevance, remove potentially ambiguous phrasing, and ensure alignment with the realities of sanitation governance in Gorontalo. To further enhance reliability, the questionnaire was pilot tested with a small group of local residents. This step provided valuable feedback on whether the items were understandable, appropriate, and meaningful in the local context. Adjustments were then made to finalize the instrument for use in the main survey.

E. Data Analysis

In the first stage, exploratory factor analysis (EFA) was employed to identify latent constructs underlying sanitation governance and resilience. Principal component extraction was chosen as the extraction method, and varimax rotation was applied to enhance interpretability of the factor structure [40–43]. EFA was used to test whether the proposed five dimensions were statistically supported. Reliability of the constructs was tested using Cronbach's alpha, with values of 0.70 or above considered acceptable [44]. In the second stage, cluster analysis was applied to the factor scores to classify households into participation profiles. K-means clustering was selected because of its ability to partition respondents into distinct groups based on their sanitation governance and resilience characteristics. The number of clusters was determined using standard procedures such as examining within-group variance and interpretability. This stage aimed to reveal the heterogeneity of household participation in sanitation management within Gorontalo. In the third stage, binary logistic regression was conducted to examine the determinants of household participation and cluster membership [40,43,45–48]. Socio-demographic variables such as gender, age, marital status, education, occupation, and household income were included as independent variables alongside the governance factor scores derived from EFA. The dependent variable captured willingness to participate in sanitation governance activities, coded as 1 for willingness and 0 for unwillingness. Model fit was assessed using -2 Log Likelihood values, pseudo-R^2 measures (Cox & Snell and Nagelkerke), and classification accuracy. Significance of predictors was evaluated at standard thresholds ($p < 0.05$, $p < 0.01$, $p < 0.001$).

F. Hypothesis development

Figure 1 presents the conceptual framework of this study and the hypotheses that guide empirical analysis. At the center of the framework is household willingness to participate in sanitation governance, defined as the readiness of residents to engage in, support, and comply with community-based and government-led sanitation initiatives. This willingness is not only an individual behavioral choice but also a reflection of broader socio-economic conditions and governance performance. The framework therefore integrates sociodemographic predictors with governance-related factors to explain variation in household participation.

The sociodemographic dimensions are represented by hypotheses H1 through H6. Gender (H1) is expected to influence participation given that women often bear the primary responsibility for household sanitation and water use, which may increase their willingness to engage. Age (H2) is anticipated to shape participation patterns because younger residents may bring more adaptive and environmentally conscious attitudes, while older groups may possess greater experiential knowledge but sometimes exhibit resistance to behavioral change. Education (H3) is hypothesized to have a positive effect, as higher educational attainment is generally associated with better awareness of sanitation practices and greater understanding of health risks. Occupation (H4) introduces another layer, since residents engaged in informal or labor-intensive work may have less time or fewer resources to participate compared to those with stable employment. Household expenditure (H5) and household income (H6) are included as measures of economic capacity, with the expectation that financial stability increases the ability and willingness to contribute to sanitation-related activities or levies, although in some cases lower-income households may express higher willingness if they are more directly affected by sanitation challenges.

Governance and institutional dimensions are addressed through hypotheses H7 to H11. Organizational performance (H7) reflects the effectiveness of sanitation institutions, community task forces, and collective work programs. Stronger performance is expected to build trust and increase household willingness to engage. Agency and governance (H8) emphasizes training opportunities, awareness campaigns, and participation in decision-making processes, with the assumption that households are more willing to participate when they feel empowered and included in governance structures. Sanitation access (H9) is hypothesized to matter because adequate, fair, and equitable provision of sanitation facilities reduces barriers to participation and signals government commitment to public well-being. Sanitation flexibility (H10) relates to the adaptability of systems, such as the upgrading of household toilets or communal treatment facilities, which reassures residents that services can respond to changing needs and motivates them to contribute. Finally, learning capacity (H11) captures the role of knowledge-sharing, education, and community-based training in reinforcing behavioral change and sustaining participation. This factor is expected to foster long-term willingness by embedding

sanitation practices into local culture and collective identity.

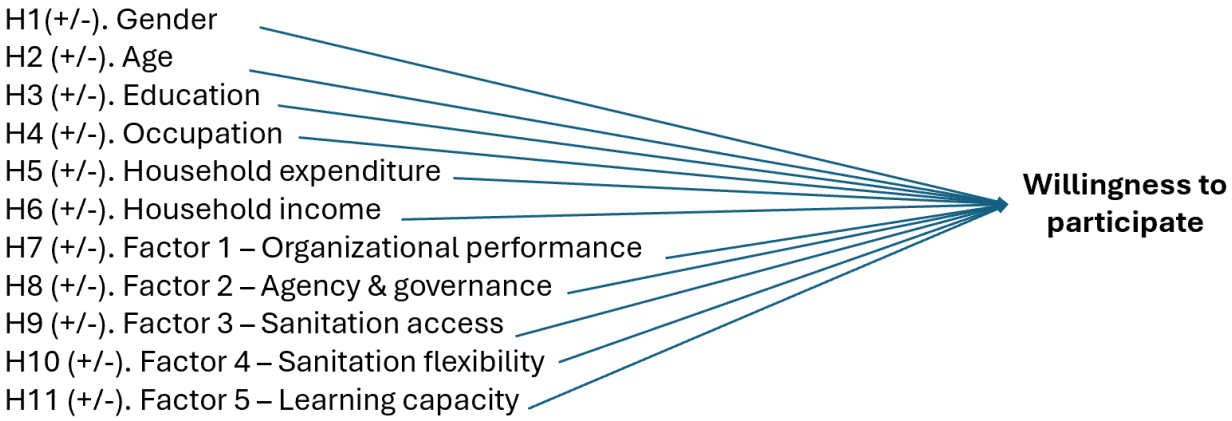

Figure 1. Conceptual framework and hypotheses of the study

III. RESULTS

Table 1 presents the results of the Exploratory Factor Analysis (EFA) conducted to validate the dimensional structure of governance and resilience in sanitation management within coastal communities of Gorontalo Province. The analysis produced five distinct factors, each demonstrating strong internal consistency with Cronbach's alpha values above the accepted threshold of 0.60, ranging from 0.613 to 0.937. The Kaiser-Meyer-Olkin (KMO) value of 0.809 indicated sampling adequacy, and Bartlett's Test of Sphericity was highly significant ($\chi^2 = 1534.081$, $df = 325$, $p < 0.001$), confirming the suitability of the dataset for factor analysis. Together, the five factors explained a cumulative variance above 75%, suggesting that the constructs reliably capture the governance and resilience dimensions under study.

The first factor, organizational performance in sanitation management, emerged as the strongest component with an eigenvalue of 8.269, accounting for 24.43% of the total variance and a Cronbach's alpha of 0.930. Items within this factor emphasized the effectiveness of community task forces, the establishment of sanitation groups, household involvement in planning and evaluation, and recognition for active participation in clean-up activities. The second factor, sanitation agency and governance, had an eigenvalue of 6.783 and explained 21.28% of the variance, with a Cronbach's alpha of 0.863. This dimension included training, public awareness campaigns, the availability of communal facilities, and the role of local organizations in promoting community sanitation. Sanitation access formed the third factor, with an eigenvalue of 1.942 and accounting for 15.77% of the variance, supported by a Cronbach's alpha of 0.875. Items in this factor focused on access to adequate toilets, drainage, wastewater treatment plants, and the role of residents in decision-making processes. The fourth factor, sanitation flexibility, recorded an eigenvalue of 1.716, explained 8.88% of the variance, and had a Cronbach's alpha of 0.937, reflecting the system's adaptability in upgrading sanitation facilities to meet community needs. The final factor, sanitation learning capacity, showed an eigenvalue of 1.461 and explained 7.21% of the variance with a Cronbach's alpha of 0.613, highlighting the importance of education, training, and sharing knowledge ssin sanitation practices.

TABLE 1.
EXPLORATORY FACTOR ANALYSIS (EFA) RESULTS FOR GOVERNANCE AND RESILIENCE IN SANITATION MANAGEMENT

Factor and Items	Factor Loadings
Factor 1 – Organizational performance in sanitation management	
(Cronbach's α = 0.930; Eigenvalue = 8.269; Variance = 24.43%)	
Emergency repair mechanisms (community task force) are available to respond to septic tank leaks or clogged drainage channels in coastal settlements.	0.893
Community sanitation groups are established with clear leadership and joint work programs together with local government in coastal areas.	0.884
Coastal residents are actively involved in decision-making for sanitation planning and evaluation.	0.876
Community sanitation groups in coastal neighborhoods are supported and integrated into village-level programs.	0.875
Social incentives or recognition are provided for coastal residents who actively participate in community sanitation clean-ups.	0.845
Active sanitation training is delivered to residents, supported with digital learning modules on coastal environmental protection.	0.842
Community task forces are formed to maintain coastal drainage, carry out emergency repairs, and address septic tank failures.	0.812
Local health centers provide sanitation counseling and digital education on clean and healthy living (PHBS) for coastal communities.	0.614
Factor 2 – Sanitation agency and governance	
(Cronbach's α = 0.863; Eigenvalue = 6.783; Variance = 21.28%)	
Residents receive community-based sanitation training supported with digital coastal environmental education modules.	0.866
Regular coastal community clean-up (gotong royong) is organized every weekend.	0.827
Public toilets, communal WWTPs, and handwashing facilities are available in coastal neighborhoods.	0.778
Local health centers and village offices conduct regular awareness campaigns on sanitation in coastal areas.	0.761
Simple public toilets and open drainage channels are available at several neighborhood points in coastal communities.	0.75
Social rewards or incentives are provided for coastal residents who join sanitation clean-up activities.	0.744
Community emergency repair teams are available to handle blocked drains or septic tank leaks in coastal settlements.	0.717
Community sanitation groups are established with leadership structures and collective work programs in coastal neighborhoods.	0.64
Factor 3 – Sanitation access	
(Cronbach's α = 0.875; Eigenvalue = 1.942; Variance = 15.77%)	
Adequate public toilets, drainage systems, and communal WWTP facilities are available in coastal neighborhoods.	0.9
Coastal residents are involved in decision-making for sanitation planning and evaluation.	0.885
Community sanitation groups are established with leadership and joint work programs in coastal areas.	0.857
Community task forces are formed to handle emergency repairs of septic tanks and coastal drainage systems.	0.82
Local health centers provide PHBS (clean and healthy living) counseling with digital modules for coastal households.	0.703
Factor 4 – Sanitation flexibility	
(Cronbach's α = 0.937; Eigenvalue = 1.716; Variance = 8.88%)	
Simple public toilets and open drainage channels are available in several coastal neighborhoods.	0.835
Public toilets, communal WWTPs, and handwashing facilities are available for coastal residents.	0.816
Coastal sanitation facilities such as toilets, drainage, and WWTPs are maintained and upgraded when required.	0.715
Factor 5 – Sanitation learning capacity	
(Cronbach's α = 0.613; Eigenvalue = 1.461; Variance = 7.21%)	
Local health centers or village offices conduct regular sanitation counseling for coastal residents.	0.759
Coastal residents participate in sanitation learning activities (PHBS) organized on a weekly basis.	0.577
Properties	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.809
Bartlett's Test of Sphericity Approx. Chi-Square	1534.081; df=325; $p < 0.001$

Table 2 presents the results of the cluster analysis, which was conducted to categorize households in Gorontalo Province into distinct participation profiles based on their factor scores across the five-sanitation governance and resilience dimensions. The analysis yielded five clusters, each characterized by unique strengths and weaknesses, reflecting the diversity of community capacities and governance experiences in the province. The ANOVA results confirm that all five factors significantly differentiate the clusters, with p-values below 0.001, indicating that organizational performance, agency and governance, sanitation access,

flexibility, and learning capacity collectively serve as robust criteria for segmentation. Cluster 1, representing 12.70% of the sample, exhibited low organizational performance, moderate access, very low flexibility, but notably strong learning capacity. This profile was labeled "Knowledge-Reliant but Rigid," describing communities that rely heavily on training and education but lack adaptive and organizational support. Cluster 2, the largest group comprising 63.49% of respondents, demonstrated high organizational performance, positive agency and governance, strong access, and relatively balanced scores across dimensions. This cluster was designated "Well-Organized and Majority Supported," signifying the majority of households with effective institutions, governance, and adequate access to sanitation.

Cluster 3, which accounted for 7.94% of the sample, was weak across nearly all factors, particularly agency and access, with only slight organizational strength. This group was classified as "Disempowered and Isolated," reflecting marginalized communities with limited institutional support and poor sanitation access. Cluster 4, covering 12.70% of respondents, displayed very low organizational performance but high flexibility and neutrality in other aspects. This cluster was labeled "Flexible but Disorganized," representing communities that can adapt in day-to-day practices but lack structured organizational systems. Finally, Cluster 5, the smallest group at 3.17%, scored highly on organizational performance, agency, flexibility, and learning capacity but extremely poorly on access to facilities. This paradoxical profile was described as "Active but Underserved," a small yet active community segment with strong engagement but critical deficits in facility provision.

TABLE 2.
CLUSTER RESULTS OF HOUSEHOLD SANITATION GOVERNANCE AND RESILIENCE PROFILES

Factors	Cluster					Anova	
	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Mean square	p-value
Factor 1 – Organizational performance in sanitation management	-0.494	0.361	0.086	-1.495	0.514	6.407	< 0.001
Factor 2 – Sanitation agency and governance	-0.128	0.242	-2.662	0.143	1.759	11.066	< 0.001
Factor 3 – Sanitation access	0.628	0.152	-0.797	0.064	-3.810	9.081	< 0.001
Factor 4 – Sanitation flexibility	-0.900	-0.158	-0.055	1.595	0.515	7.097	< 0.001
Factor 5 – Sanitation learning capacity	1.669	-0.313	-0.334	-0.037	0.572	6.857	< 0.001
n (sample size)	8	40	5	8	2		
% of sample	12.70%	63.49%	7.94%	12.70%	3.17%		
Profile from Factor Scores	Low organizational performance, moderate access, very low flexibility, but very high learning capacity.	High organizational performance, positive agency and governance, positive access, relatively balanced across other dimensions.	Weak across nearly all factors, especially agency and access, with only slight organizational strength.	Very low organizational performance, but strong flexibility, neutral in other aspects.	High organizational performance, high agency, high flexibility, and strong learning capacity, but extremely poor access.		
Class Name	"Knowledge-Reliant but Rigid" → communities rely heavily on training and knowledge but lack flexibility and organizational support.	"Well-Organized and Supported" → majority group with strong institutions, governance, and access to sanitation.	"Disempowered and Isolated" → marginalized communities with little agency and poor sanitation access.	"Flexible but Disorganized" → communities adapt well day-to-day but lack structured organizational support.	"Active but Underserved" → small but active group with strong agency and learning yet critically underserved in access to facilities.		

Figure 2 illustrates the overall composition of the five household clusters identified in the study. The largest segment, accounting for 63.49% of respondents, was the "Well-Organized and Supported" group, reflecting the majority of households with strong organizational backing and access to sanitation services. Smaller but meaningful proportions included "Knowledge-Reliant but Rigid" (12.70%), "Flexible but Disorganized" (12.70%), and "Disempowered and Isolated" (7.94%), each highlighting specific vulnerabilities in governance or access. The smallest cluster, "Active but Underserved," represented only

3.17% of respondents, but signaled a critical group where strong community engagement is constrained by limited facility provision.

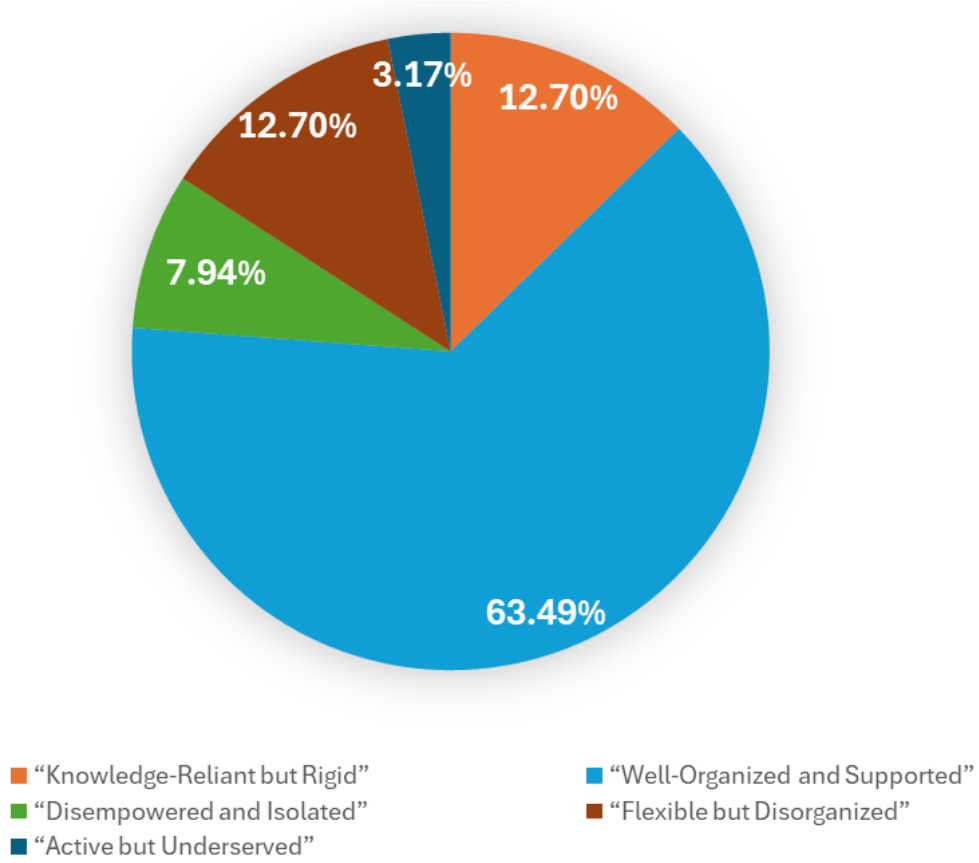

Figure 2. Composition of household sanitation governance clusters

Table 3 presents the segmentation of the five household clusters according to socio-demographic characteristics, including gender, age, education, occupation, household expenditure, and household income. The cross-tabulation highlights how different profiles of governance and resilience capacity intersect with household characteristics, while the chi-square tests provide statistical evidence of whether these relationships are significant. The results indicate that most socio-demographic factors were not significantly associated with cluster membership, suggesting that governance and resilience capacities cut across social and economic backgrounds. Gender distribution across clusters was relatively balanced and showed no significant effect ($\chi^2 = 3.955$, $p = 0.412$). Age differences were more pronounced, with younger respondents more concentrated in Cluster 2, though the association did not reach significance ($\chi^2 = 19.246$, $p = 0.083$). Education levels also showed a spread across clusters, with diploma and senior high school graduates dominating, but again the chi-square test indicated no significant relationship ($\chi^2 = 8.572$, $p = 0.739$). Occupation, however, revealed a statistically significant difference ($\chi^2 = 27.686$, $p = 0.034$), marking it as the only socio-demographic factor clearly associated with cluster membership. This finding suggests that occupational roles influence how households experience governance support, access, and resilience in sanitation management. Household expenditure ($\chi^2 = 23.529$, $p = 0.100$) and household income ($\chi^2 = 12.455$, $p = 0.712$) did not demonstrate significant associations with cluster profiles, underscoring that economic capacity alone does not fully determine governance and resilience outcomes.

TABLE 3.
SEGMENTATION OF HOUSEHOLD CLUSTERS BY SOCIO-DEMOGRAPHIC CHARACTERISTICS

Variables	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Chi-Square (p-value)
Gender						3.955 (p = 0.412)
Male	2 (3.17%)	11 (17.46%)	3 (4.76%)	1 (1.59%)	1 (1.59%)	
Female	6 (9.52%)	29 (46.03%)	2 (3.17%)	7 (11.11%)	1 (1.59%)	
Age						19.246 (p = 0.083)
18–29 years	6 (9.52%)	31 (49.21%)	3 (4.76%)	4 (6.35%)	0 (0.00%)	
30–39 years	1 (1.59%)	5 (7.94%)	2 (3.17%)	2 (3.17%)	2 (3.17%)	
40–49 years	1 (1.59%)	4 (6.35%)	0 (0.00%)	1 (1.59%)	0 (0.00%)	
≥ 50 years	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (1.59%)	0 (0.00%)	
Education						8.572 (p = 0.739)
Postgraduate	0 (0.00%)	1 (1.59%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	
Diploma/Bachelor	1 (1.59%)	20 (31.75%)	4 (6.35%)	4 (6.35%)	1 (1.59%)	
Senior High	2 (3.17%)	19 (30.16%)	2 (3.17%)	4 (6.35%)	1 (1.59%)	
Junior High	1 (1.59%)	0 (0.00%)	0 (0.00%)	1 (1.59%)	0 (0.00%)	
Main Occupation						27.686 (p = 0.034)
Laborer	0 (0.00%)	1 (1.59%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	
Others	0 (0.00%)	9 (14.29%)	3 (4.76%)	2 (3.17%)	1 (1.59%)	
Trader	2 (3.17%)	3 (4.76%)	2 (3.17%)	3 (4.76%)	0 (0.00%)	
Government Employee	3 (4.76%)	15 (23.81%)	2 (3.17%)	4 (6.35%)	0 (0.00%)	
Student	3 (4.76%)	12 (19.05%)	0 (0.00%)	1 (1.59%)	0 (0.00%)	
Farmer/Fisher	0 (0.00%)	1 (1.59%)	0 (0.00%)	1 (1.59%)	0 (0.00%)	
Household Expenditure (per month)						23.529 (p = 0.100)
< Rp 1 million	1 (1.59%)	14 (22.22%)	0 (0.00%)	4 (6.35%)	2 (3.17%)	
Rp 1–2 million	1 (1.59%)	13 (20.63%)	1 (1.59%)	2 (3.17%)	0 (0.00%)	
Rp 2–3 million	0 (0.00%)	6 (9.52%)	0 (0.00%)	2 (3.17%)	0 (0.00%)	
Rp 3–5 million	2 (3.17%)	4 (6.35%)	1 (1.59%)	2 (3.17%)	0 (0.00%)	
> Rp 5 million	1 (1.59%)	3 (4.76%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	
Household Income (per month)						12.455 (p = 0.712)
< Rp 1 million	1 (1.59%)	9 (14.29%)	0 (0.00%)	4 (6.35%)	0 (0.00%)	
Rp 1–2 million	3 (3.17%)	10 (15.87%)	1 (1.59%)	2 (3.17%)	0 (0.00%)	
Rp 2–3 million	2 (3.17%)	7 (11.11%)	1 (1.59%)	2 (3.17%)	1 (1.59%)	
Rp 3–5 million	2 (3.17%)	9 (14.29%)	1 (1.59%)	1 (1.59%)	1 (1.59%)	
> Rp 5 million	1 (1.59%)	5 (7.94%)	1 (1.59%)	0 (0.00%)	0 (0.00%)	

Table 4 reports the results of the binary logistic regression analysis examining the determinants of household willingness to participate in community-based sanitation initiatives in Gorontalo Province. The model demonstrates strong explanatory capacity, with a classification accuracy of 81%, a -2 Log Likelihood of 54.904, and pseudo-R^2 values of 0.384 (Cox & Snell) and 0.517 (Nagelkerke), indicating a moderate-to-strong fit for social science models. The analysis shows that most sociodemographic variables, including gender, age, education, and occupation, were not statistically significant predictors of participation, suggesting that willingness is not strongly differentiated by these individual characteristics. However, within household expenditure categories, those with monthly spending between Rp 1–2 million displayed significantly higher willingness to participate ($p = 0.032$), indicating that lower-middle expenditure households may be more responsive to sanitation initiatives. Household income levels did not significantly affect participation across categories. Among governance and resilience-related factor scores, sanitation access emerged as a significant predictor ($p = 0.01$), highlighting the central importance of facility availability and adequacy in motivating household engagement. Sanitation flexibility also showed marginal significance ($p = 0.098$), suggesting that households are more likely to participate when systems demonstrate adaptability to changing needs and conditions. Organizational performance, agency and governance, and learning capacity did not reach statistical significance in this model, although their

directional effects remain relevant for broader policy considerations.

TABLE 4.
BINARY LOGISTIC REGRESSION RESULTS FOR HOUSEHOLD WILLINGNESS TO PARTICIPATE IN COMMUNITY-BASED SANITATION

Variables	B	S.E.	Wald	df	p-value	Interpretation
Gender (Male=1)	0.071	0.965	0.005	1	0.941	Not significant
Age (ref = 40–49 years)						
18–29 years	-0.214	1.876	0.013	1	0.909	Not significant
30–39 years	-0.966	1.877	0.265	1	0.607	Not significant
≥ 50 years	-20.427	40192.970	0.000	1	1	Not significant
Education (ref = Junior High)						Not significant
Diploma/Bachelor	21.671	40193.030	0.000	1	1	Not significant
Postgraduate	-2.210	56841.490	0.000	1	1	Not significant
Senior High	21.582	40193.030	0.000	1	1	Not significant
Occupation (ref = Student)						
Laborer	-1.658	2.637	0.395	1	0.53	Not significant
Others	2.401	1.267	3.590	1	0.058	**Significant**
Trader	0.889	1.608	0.306	1	0.58	Not significant
Government employee	0.771	1.088	0.502	1	0.479	Not significant
Household Expenditure (ref = Rp 3–5 million)						
< Rp 1 million	3.145	2.213	2.019	1	0.155	Not significant
> Rp 5 million	-1.305	2.400	0.296	1	0.587	Not significant
Rp 1–2 million	4.185	1.950	4.607	1	0.032	**Significant**
Rp 2–3 million	2.333	1.694	1.897	1	0.168	Not significant
Household Income (ref = Rp 3–5 million)						
< Rp 1 million	-1.199	2.088	0.330	1	0.566	Not significant
> Rp 5 million	3.867	2.596	2.219	1	0.136	Not significant
Rp 1–2 million	-0.414	1.528	0.073	1	0.786	Not significant
Rp 2–3 million	-1.472	1.384	1.132	1	0.287	Not significant
Factor Scores						
Factor 1 – Organizational performance	0.076	0.649	0.014	1	0.905	Not significant
Factor 2 – Agency & governance	-0.294	0.414	0.505	1	0.477	Not significant
Factor 3 – Sanitation access	-1.091	0.667	2.671	1	0.1	**Significant**
Factor 4 – Sanitation flexibility	0.856	0.566	2.284	1	0.098	**Significant**
Factor 5 – Learning capacity	0.226	0.452	0.250	1	0.617	Not significant
Cluster Membership Constant	-1.649	0.988	2.784	1	0.095	**Significant**
Model fit						
Percentage Correct Classification	0.81					
-2 Log likelihood	54.904					
Cox & Snell R Square	0.384					
Nagelkerke R Square	0.517					

IV. DICUSSION

The findings of this study provide important insights into the governance and resilience factors that influence household willingness to participate in community-based sanitation in Gorontalo Province. The results highlight the interplay between socio-demographic characteristics, governance structures, and institutional capacities, showing that while individual-level attributes matter in certain respects, systemic governance dimensions remain central to explaining participation outcomes. The first set of hypotheses (H1–H6) concerned the role of socio-demographic characteristics. Gender (H1) was not found to be a significant predictor, suggesting that willingness to participate in sanitation governance is shared across male and female respondents. This finding resonates with earlier studies that point to the increasing recognition of

sanitation as a collective household responsibility rather than one defined by gendered divisions of labor [32,49,50]. Age (H2) similarly showed no significant influence, indicating that willingness is relatively consistent across generational groups, which contrasts with research in other contexts that has found younger respondents to be more environmentally engaged [51]. Education (H3) was also not statistically significant in this study, a surprising result given the evidence that higher education often enhances environmental awareness and the adoption of hygienic practices [52,53]. One explanation may be that sanitation concerns in Gorontalo are experienced so directly and urgently that they cut across educational levels, with lived experience outweighing formal knowledge.

Occupation (H4), however, was found to significantly differentiate cluster membership, suggesting that employment status shapes participation profiles even if it does not directly predict willingness in the binary model. This aligns with findings that informal workers or laborers often face constraints in engaging with governance initiatives due to time scarcity and income precarity (Haque et al., 2021). Household expenditure (H5) showed significance, with those in the Rp 1–2 million category more willing to participate. This suggests that lower-middle expenditure households are especially responsive to sanitation programs, perhaps because they balance vulnerability with sufficient resources to act. Household income (H6) was not significant, reflecting a broader pattern observed in environmental willingness-to-pay studies [40,54,55], where income often moderates the ability to contribute financially but does not consistently predict willingness to participate.

The second set of hypotheses (H7–H11) related to governance and resilience dimensions revealed more consistent and robust patterns. Organizational performance (H7) was not a significant predictor, despite being strongly emphasized in sanitation governance frameworks. This may suggest that while institutional presence is necessary, households in Gorontalo base their willingness more on visible outcomes such as access and service flexibility than on organizational processes. Agency and governance (H8) similarly did not reach significance, although descriptive results showed that clusters with stronger agency tended to be better organized and supported. This finding points to the possibility that agency, while essential in long-term governance sustainability, may not be immediately perceived by households as directly shaping their willingness. Sanitation access (H9) emerged as one of the most decisive factors, with a highly significant effect on willingness to participate ($p = 0.01$). This confirms that access to adequate toilets, drainage, and wastewater treatment plants remains the cornerstone of sanitation governance. Where facilities are present and equitably distributed, households are far more likely to engage, echoing global research that underscores access as the most basic determinant of sanitation behavior [56,57]. Sanitation flexibility (H10) also demonstrated a marginally significant effect ($p = 0.098$), suggesting that households value systems that can adapt and upgrade in response to changing needs, even if this dimension is less visible on a daily basis. Flexibility has been identified in resilience literature as a critical property of adaptive governance, allowing institutions to respond to shocks or surges in demand [58,59], and the Gorontalo findings support this perspective.

Learning capacity (H11) did not significantly predict willingness, despite its conceptual importance. This may indicate that while education and community-based training are important in shaping long-term behavior, their immediate influence on willingness to participate is less direct compared to tangible service access. Previous work has noted similar results in sanitation contexts, where knowledge provision alone does not translate into behavior without concurrent improvements in service delivery and institutional support [60,61]. However, the cluster analysis showed that groups with higher learning capacity, but weak organizational performance existed ("Knowledge-Reliant but Rigid"), highlighting the need to integrate learning with structural reforms rather than treating it as a standalone driver. Taken together, the hypothesis testing reveals several critical dynamics. Socio-demographic variables did not exert strong direct effects on willingness, with the notable exception of occupation and expenditure. This suggests that sanitation governance interventions should not assume that demographic categories such as gender or education inherently drive participation but should instead pay closer attention to the economic thresholds that influence household capacity to act. At the same time, governance dimensions, especially access and flexibility, proved to be decisive. This reinforces the central claim in resilience and adaptive governance theory that household willingness emerges most strongly when governance delivers tangible, equitable, and adaptable services [62,63].

The cluster analysis further enriched this picture by identifying groups that are well organized and supported, alongside others that are disempowered, rigid, or underserved. The "Well-Organized and Supported" cluster, which accounted for more than 60% of respondents, underscores the effectiveness of governance structures where institutional strength, access, and agency converge. In contrast, the existence of clusters such as "Disempowered and Isolated" and "Active but Underserved" points to serious inequities in governance distribution, with some communities left behind despite their willingness. These findings echo broader debates in sanitation governance, which argue that inequities in access and governance capacities are often more decisive than individual-level willingness [64–66], particularly in marginalized or peri-urban communities. Policy implications flow directly from these findings. Efforts to strengthen sanitation governance in Gorontalo should prioritize improving access and ensuring that facilities are equitably distributed, as this was the strongest predictor of participation. Enhancing flexibility in systems, such as through adaptive planning and facility upgrading, should also be prioritized to build resilience against future challenges, including floods and population growth. While learning and agency did not

emerge as direct predictors in the models, they remain crucial in shaping long-term sustainability and should be embedded within broader governance reforms. Targeted attention to occupationally vulnerable groups, such as informal workers, and to households within specific expenditure ranges will help ensure that interventions are inclusive.

V. Conclusion

This study set out to examine the determinants of household willingness to participate in community-based sanitation governance in Gorontalo Province, focusing on both socio-demographic attributes and governance-related dimensions. The findings demonstrate that while demographic characteristics such as gender, age, and education did not significantly predict participation, economic thresholds and occupational roles had an influence, with lower-middle expenditure households and certain occupational groups showing greater responsiveness. More importantly, governance-related factors emerged as decisive, with sanitation access strongly shaping willingness, while flexibility of services also played a supporting role. Organizational performance, agency, and learning capacity did not directly predict willingness in the regression model, though cluster analysis revealed their relevance in distinguishing community profiles. The segmentation of households into five clusters underscored the uneven distribution of governance benefits. The majority of respondents fell into the "Well-Organized and Supported" cluster, but other groups such as "Disempowered and Isolated" and "Active but Underserved" highlight critical gaps where communities remain excluded despite their potential willingness to participate. These findings suggest that participation in sanitation governance is most effectively fostered where tangible service delivery especially access is combined with institutional strength and adaptive flexibility. Addressing inequities in governance capacity is therefore central to building sustainable and inclusive sanitation systems in Gorontalo.

A. Limitations and Future Research

Despite providing valuable insights, this study has several limitations. The sample size of 63 respondents, while consistent with standards for preliminary exploratory studies, restricts the generalizability of findings across the wider population of Gorontalo. The reliance on cross-sectional data also limits the ability to capture changes in willingness over time or in response to specific policy interventions. In addition, while the survey design provided robust quantitative data, qualitative insights into household motivations, perceptions of governance fairness, and cultural dynamics were not included, leaving some contextual factors unexplored. Future research should expand the sample to ensure representation across Gorontalo's districts and rural–urban divides, enhancing external validity. Longitudinal studies would provide deeper understanding of how willingness evolves as sanitation systems improve or as external pressures such as flooding intensify. Comparative studies across provinces in Indonesia, or across border regions with similar socio-ecological conditions, would also strengthen the relevance of findings for national and international audiences. Finally, integrating qualitative approaches, such as interviews or participatory observation, would enrich the quantitative results by capturing the social and cultural dimensions of sanitation governance that statistical models may overlook.

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