

Evaluation Of Sewage Systems and Wastewater Management Practices in Brgy. Sumacab Este, Cabanatuan City

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Abstract- This study evaluated the sewage systems and wastewater management practices in Barangay Sumacab Este, Cabanatuan City. It examined the current profile of sewage systems in terms of type of facility, age, structural integrity, and frequency of maintenance, and assessed how residents and commercial stakeholders managed wastewater, including domestic graywater, blackwater, and small-scale commercial sewage. A mixed-methods research design was utilized, integrating quantitative and qualitative approaches. Quantitative data were collected through a structured questionnaire administered to selected residents and establishment operators using stratified random sampling. The data were analyzed using descriptive statistics such as frequency, percentage, and mean through a Likert scale. Qualitative data were obtained from open-ended responses and were analyzed using thematic analysis to identify recurring issues and patterns. The findings revealed the condition and effectiveness of existing sewage systems and identified the wastewater management practices in the barangay. The study also identified issues such as inadequate maintenance, structural deficiencies, and improper disposal methods. The results served as a basis for proposing practical and sustainable improvements to enhance sanitation, environmental quality, and public health in the community.

Key Words — sewage systems, wastewater management, sanitation practices, structural integrity, wastewater disposal, environmental sanitation, public health, Barangay Sumacab Este, mixed-methods research, Cabanatuan City

I. INTRODUCTION

Water (H₂O) is an essential resource that supports human survival, hygiene, household activities, and

industrial operations. Although about 70% of the Earth's surface is covered by water, less than 1% is considered potable and suitable for human consumption (S. Zumdahl, 2025). The continuous use of water inevitably produces wastewater, which may contain pollutants from domestic and industrial sources. Domestic wastewater commonly includes graywater and blackwater from kitchens, laundry areas, and restrooms, while wastewater transported through sewer systems is referred to as sewage (C. Tuser, 2021). Effective wastewater management, which involves the collection, treatment, and disposal of wastewater, is essential to protect public health and environmental quality. In the Philippines, rapid urbanization and population growth have worsened wastewater problems, with around 80% of wastewater reportedly discharged without proper treatment (J.C. Dela Rosa, 2024).

Brgy. Sumacab Este in Cabanatuan City faces increasing pressure on its sanitation and wastewater systems due to residential and commercial growth, including dormitories and apartments. Improper wastewater disposal may lead to groundwater contamination and the spread of waterborne diseases, making effective wastewater management necessary for community health and environmental sustainability. This study aims to assess the existing sewage and wastewater management practices in the barangay by examining the types and conditions of sewage systems, wastewater disposal methods, and maintenance practices. It also seeks to evaluate the community's compliance with the Philippine Clean Water Act of 2004 and identify the major challenges

affecting effective wastewater management. Through surveys and technical observations, the study intends to provide recommendations that may help improve sanitation and environmental protection in the community.

1.1 Literature Review

Microbial contamination remains one of the leading causes of waterborne diseases worldwide. Recent studies have emphasized the growing importance of opportunistic premise plumbing pathogens (OPPPs), which thrive in drinking water systems under favorable conditions. LeChevallier et al. (2024) distinguished between traditional pathogens and opportunistic microorganisms that can persist in biofilms and resist disinfection processes. Similarly, Hayward et al. (2025) found that pathogens such as *Pseudomonas aeruginosa* and *Acinetobacter baumannii* can survive and proliferate within plumbing systems, which are commonly influenced by factors such as pipe age, temperature, flow rate, and storage conditions. Other studies have also shown that microbial communities in drinking water systems are shaped by environmental and infrastructural factors, further emphasizing the complexity of microbial contamination (Prest et al., 2016; Kristanti et al., 2022). These findings highlight the need to examine microbial presence in household water systems as an indicator of overall water quality.

Biofilm formation is widely recognized as the dominant mode of microbial growth in water distribution systems. Microorganisms attach to pipe surfaces and form biofilms embedded in extracellular polymeric substances, which enhance their resistance to disinfectants and environmental stress (Lin et al., 2025). Erdei-Tombor et al. (2024) identified biofilms as a primary contributor to microbial contamination, noting the consistent presence of microorganisms such as *Legionella*, *Pseudomonas*, and *Staphylococcus* within pipe surfaces. Earlier studies also support that biofilms act as reservoirs of microorganisms that can continuously release bacteria into flowing water (Fish et al., 2017; Neu & Hammes, 2020). These findings indicate that biofilm formation plays a crucial role in sustaining microbial contamination within plumbing systems.

In addition to biofilm formation, the age and condition of pipes significantly influence water quality. Pipe corrosion is an inevitable process resulting from continuous interaction between water and pipe materials, leading to structural degradation over time (Brossia, 2018). Aging pipes develop rough internal surfaces that promote microbial attachment and biofilm growth, increasing the likelihood of contamination (Douterelo et al., 2017). Furthermore, microbially induced corrosion has been shown to accelerate pipe deterioration while simultaneously supporting microbial communities within the system (Song et al., 2023). These findings suggest that prolonged pipe use contributes to both physical degradation and increased microbial activity, making pipe age a critical factor in assessing water quality in household systems.

In the Philippines, many residential plumbing systems are used for extended periods without regular monitoring or replacement, increasing the risk of water quality deterioration at the household level. While previous studies have examined water quality, microbial contamination, and plumbing conditions, there remains limited research focusing specifically on the relationship between pipe age and microbial contamination in residential settings. This gap highlights the need for localized studies that consider actual household conditions and infrastructure practices.

The present study focuses on assessing the correlation between pipe age and microbial contamination in household water systems. By examining selected residential households, this study aims to determine how pipe age, along with factors such as pipe material and maintenance practices, influences microbial presence in water. The findings are expected to provide insights into water quality risks and contribute to the development of safer and more effective household water management practices.

1.2 Conceptual Framework

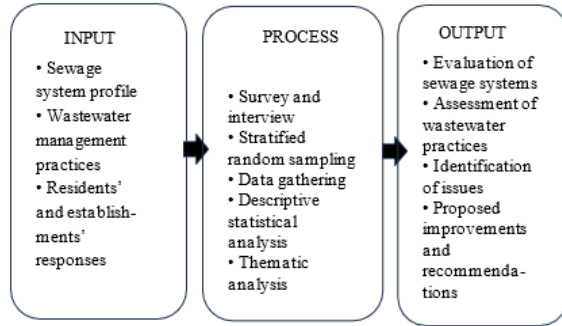


Fig. 1. Conceptual Framework

The research paradigm of this study illustrates the flow of the research process using the Input–Process–Output (IPO) model. The inputs consist of the profile and condition of existing sewage systems and the wastewater management practices of residents and commercial establishments in Barangay Sumacab Este, Cabanatuan City. The process involves the collection of quantitative and qualitative data through surveys and interviews, followed by statistical and thematic analyses. The outputs of the study include the evaluation of sewage systems, assessment of wastewater management practices, identification of existing issues and deficiencies, and the formulation of practical and sustainable recommendations to improve sanitation, environmental quality, and public health in the community.

1.3 Statement of the Problem

1.3.1. What is the current profile of the sewage systems used by the residents and establishments in Brgy. Sumacab Este in terms of:

- type of facility,
- age,
- structural integrity of the system; and
- frequency of maintenance?

1.3.2. How do the residents and commercial stakeholders in the barangay manage their wastewater disposal across different sources, specifically:

- domestic graywater
- blackwater (human excreta), and
- Commercial/Small-scale industrial sewage (dormitories and apartments)?

1.3.3. What common problems caused by poor wastewater management are experienced by residents?

1.3.4. What improvements can be proposed to enhance the existing systems and practices in terms of:

- infrastructure development,
- maintenance programs, and
- community participation?

1.4 Significance of the Study

This study on the evaluation of sewage systems and wastewater management practices in Barangay Sumacab Este, Cabanatuan City provides relevant insights for key stakeholders. For local government units, it may serve as a basis for improving sanitation policies, programs, and wastewater management strategies. For community residents, it can increase awareness of proper wastewater practices and encourage behaviors that promote better sanitation, public health, and environmental protection. For environmental and public health sectors, the findings may help identify risks such as water contamination and disease spread, supporting the development of preventive measures. For engineering students and researchers, it may serve as a reference for future studies on sewage systems and urban sanitation. Overall, this study supports improved wastewater management and contributes to sustainable community development and environmental preservation.

II. METHODS

2.1 Research Design

This study employed a mixed-method research design, specifically utilizing both quantitative and qualitative approaches, to evaluate the sewage systems and wastewater management practices in Barangay Sumacab Este. The quantitative aspect of the study involved the use of survey questionnaires to gather numerical data regarding the residents' sewage disposal methods, wastewater management practices, sanitation conditions, and level of awareness. The qualitative aspect, on the other hand, involved conducting interviews with selected respondents to obtain deeper insights, opinions, and experiences

related to the existing sewage systems and wastewater management practices within the barangay.

The mixed-method design was considered appropriate for the study because it enabled the researchers to collect comprehensive data by combining statistical information with detailed personal responses from the participants. Through the survey, the researchers were able to identify trends and patterns, while the interviews provided additional explanations and contextual understanding of the issues encountered by the community regarding wastewater management.

According to Creswell et al. (2018), mixed-method research combines quantitative and qualitative approaches to provide a more complete understanding of a research problem. Creswell emphasized that integrating numerical data with participants' experiences allows researchers to strengthen the validity and depth of the findings. This supports the suitability of the mixed-method design in evaluating both the measurable conditions and lived experiences related to sewage systems and wastewater management practices in the study area.

2.2 Research Instrument

This study employed a combination of quantitative and qualitative research instruments, specifically a structured survey questionnaire utilizing a Likert scale and a semi-structured interview guide, to comprehensively evaluate the sewage systems and wastewater management practices in Brgy. Sumacab Este, Cabanatuan City.

The primary instrument used in this study was a self-administered survey questionnaire designed to gather quantitative data from selected household respondents. The questionnaire was divided into several sections, including: (1) demographic profile of respondents, (2) condition and type of sewage system, (3) wastewater disposal practices, and (4) level of awareness and perception regarding proper wastewater management. The survey utilized a four-point Likert scale to measure the degree of agreement of respondents with specific statements, with the following scale: (5) Strongly Agree, (4) Agree, (3) Neutral, (2) Disagree, and (1) Strongly Disagree.

This scaling technique allowed for a more systematic and objective analysis of attitudes, behaviors, and perceptions related to sewage and wastewater management.

A semi-structured interview guide was also used to gather qualitative data from key informants and chosen locals in order to supplement the quantitative data. In order to learn more about participants' experiences with sewage-related issues, such as overflow occurrences, drainage problems, and sanitation concerns, the interview included open-ended questions. Additionally, it aimed to get their opinions on present procedures, difficulties faced, and suggestions for enhancing the system. This method gave the survey results more context and a deeper understanding.

The research instruments underwent content validation prior to data collection to guarantee that the questions were suitable, pertinent, and clear. Based on comments, necessary changes were made to improve efficacy and dependability. Overall, the researchers were able to gather thorough, precise, and balanced data for the assessment of sewage systems and wastewater management techniques in the study area by using both Likert-scale questionnaires and interviews.

2.3 Data Gathering Procedure

According to J. Hecker and N. Kalpocas (2023), mixed-method research, both interviews and surveys function as complementary tools. Interviews facilitate the exploration of personal narratives in real-time situations, whereas qualitative surveys provide the necessary to distinguish trends across a more extensive demographic.

The researchers employed a combination of survey questionnaires and face-to-face interviews to gather relevant data regarding wastewater management practices in Brgy. Sumacab Este, Cabanatuan City, Nueva Ecija.

A structured survey questionnaire was developed and distributed to selected residents and commercial establishment owners within the barangay. The questionnaire will consist of both closed-ended and open-ended questions designed to collect data.

A purposive sampling was utilized to ensure representation of households and establishments within different areas of the barangay. The researchers personally administered the surveys or distribute them digitally, depending on the accessibility and convenience of respondents.

Face-to-Face Interviews was conducted with selected local officials and personnel, such as barangay officials, health officers, and representatives from the local government unit (LGU). These interviews will aim to gather in-depth information regarding the community's compliance with environmental regulations, existing wastewater management programs, and the common challenges encountered in implementation and monitoring. An interview guide will be prepared to ensure consistency while allowing flexibility for probing questions.

Prior to data collection, permission was asked from the barangay officials, and informed consent was obtained from all participants. The researchers will ensure confidentiality and ethical handling of all gathered data. Finally, all collected data was compiled, organized, and prepared for analysis to address the research questions.

2.4 Data Analysis and Technique

The researchers employed both quantitative and qualitative data analysis techniques to ensure a comprehensive evaluation of sewage systems and wastewater management practices. The integration of these methods allows for a more reliable interpretation of results by combining numerical data with contextual insights.

Quantitative data was analyzed through survey questionnaires and was measured using a Likert scale and interpreted through the computation of the mean to determine patterns and levels of effectiveness in sewage system performance and wastewater management. Meanwhile, qualitative data obtained from interviews and field observations was examined using thematic analysis to identify recurring issues, challenges, and management insights.

To strengthen the validity of the findings, both quantitative and qualitative results was integrated

through triangulation, enabling a comprehensive and well-supported interpretation of the data.

III. RESULTS AND DISCUSSIONS

Respondent Profile and Sewage System Profile

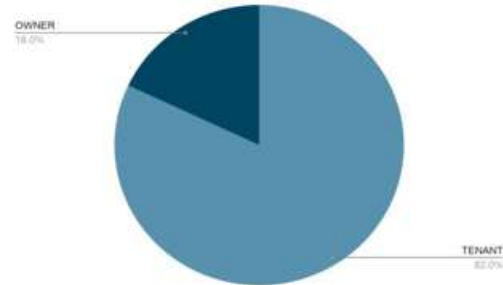


Fig. 2. Type of Respondent

The figure illustrates the composition of the respondents in Brgy. Sumacab Este, revealing a significant majority of Tenants, who account for 82% (41 out of 50) of the total sample. In contrast, Owners represent a much smaller segment of the population at 18% (9 out of 50).

This demographic distribution is crucial for the study as it suggests that a large portion of the stakeholders managing wastewater in the area may have different levels of control over permanent infrastructure (like septic tank construction) compared to property owners. The high number of tenants highlights the need for effective communication between renters and landlords regarding the maintenance and upgrading of household sanitation facilities to ensure compliance with the Philippine Clean Water Act.

Type of Sewage Facility

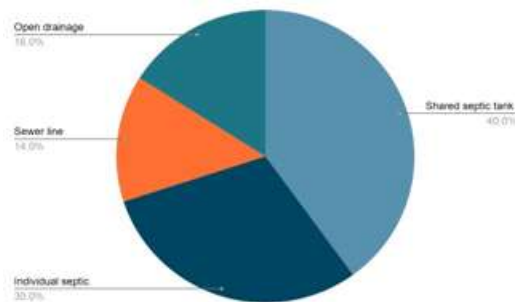


Fig. 3. Type of Sewage Facility

The data reveals that the most common method of wastewater disposal in the community is the Shared Septic Tank, utilized by 40% of the respondents. This is closely followed by Individual Septic Tanks at 30%. Together, these onsite containment systems represent the vast majority (70%) of the barangay's sanitation infrastructure.

However, a concerning 16% of respondents still rely on Open Drainage Systems for disposal, which correlates with the previously noted "Significant Problems" regarding foul odors and environmental degradation. The minority of the population (14%) is connected to a formal Sewer Line. This distribution underscores the necessity for the proposed "Shared Septic Tank Desludging Programs" and highlights why many residents feel the current infrastructure is outdated, as a significant portion of the community still lacks access to modern, closed-loop sewer connections.

Structural Integrity of the System

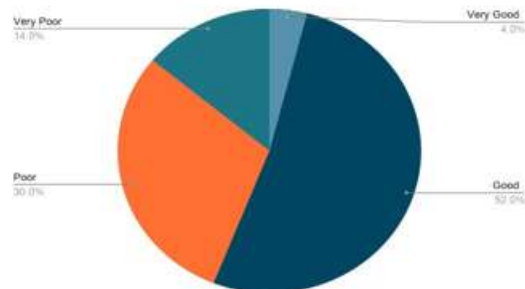


Figure 4: Structural Integrity of the System

The figure demonstrates a polarized view regarding the state of the local sewage infrastructure. A slight majority of the respondents (52%) rate the system as Good, suggesting that more than half of the community finds their current disposal setup functional for their daily needs. Only a very small fraction (4%) considers the system to be in Very Good condition.

Conversely, a substantial 44% of the population views the sewage system negatively, with 30% rating it as Poor and 14% as Very Poor. This significant dissatisfied minority aligns with the previous findings in Part III, where stagnant water and frequent overflows were identified as frequent problems. The

data suggests that while the system may be operational for the majority, it is nearing a point of critical failure for nearly half of the residents, reinforcing the community's call for urgent government intervention and infrastructure upgrades.

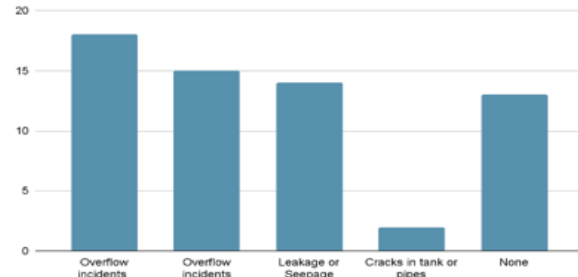


Figure 5: Technical failure of the system

The figure highlights the specific technical failures within the barangay's wastewater system. The most prevalent issue is Blockage or Clogging, reported by 36% of the respondents, followed closely by Overflow Incidents (30%) and Leakage or Seepage (28%). These findings suggest that the system suffers from a lack of regular maintenance and insufficient capacity to move waste efficiently, likely due to the accumulation of solid waste or silt in the lines.

While 26% of the residents reported experiencing None of these issues, the majority of the community (74%) is affected by at least one significant technical problem. The presence of Cracks in tanks or pipes (4%), though low, represents a high-risk factor for groundwater contamination. Collectively, these results validate the residents' earlier calls for a "Sanitation Task Force" and a monthly desilting schedule to address the recurring clogs and overflows that disrupt daily life in Brgy. Sumacab Este.

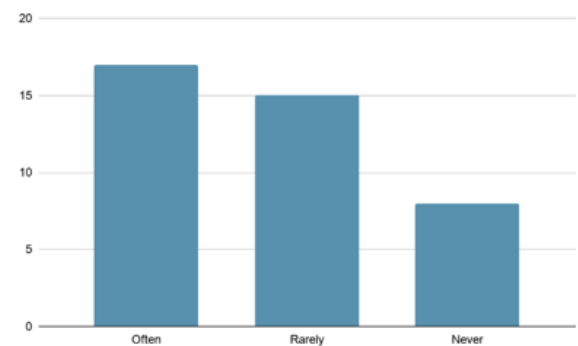


Figure 6: Regularity with Which Residents Encounter Wastewater-Related Problems

The figure illustrates the regularity with which residents encounter wastewater-related problems. Half of the respondents (50%) indicate that these issues occur rarely, suggesting that for a large portion of the community, system failures like clogs or overflows are intermittent rather than constant. Combined with the 16% who have Never experienced such issues, a total of 66% of the households live in relatively stable sanitary conditions. However, a significant 34% of the population reports that these problems occur Often. This indicates that more than one-third of the barangay deals with chronic wastewater malfunctions. This "high-frequency" group likely represents residents living in low-lying areas or near high-density commercial zones where the infrastructure is most strained. The consistency of these disruptions for a third of the community reinforces the "Urgent" verbal interpretation found in Part III, as chronic exposure to stagnant water and overflows poses a sustained risk to both public health and environmental hygiene.

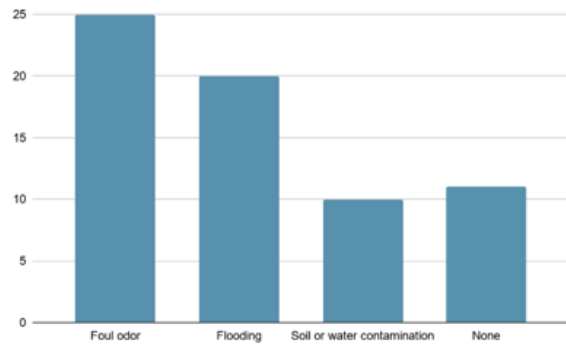


Figure 7: Sensory And Environmental Consequences of Poor Wastewater Management within the Barangay

The figure highlights the sensory and environmental consequences of poor wastewater management within the barangay. The most pervasive issue is Foul Odor, affecting 50% of the respondents. This indicates that even when wastewater is contained, the lack of proper ventilation or the presence of stagnant graywater creates a significant atmospheric nuisance for half of the community.

Additionally, 40% of residents report that their systems contribute to Flooding. This aligns with

previous data suggesting that the drainage infrastructure is either undersized or severely blocked, causing backflows during usage or rainfall. While 22% of the community reports None of these impacts, a notable 20% are aware of Soil or Water Contamination. Though this is the least selected option, it represents the most severe long-term risk to the community's natural resources. Collectively, these results suggest that the "Significant Problems" identified earlier are manifest most clearly through air quality issues and localized flooding, directly impacting the daily comfort and hygiene of the residents.

Frequency of Maintenance

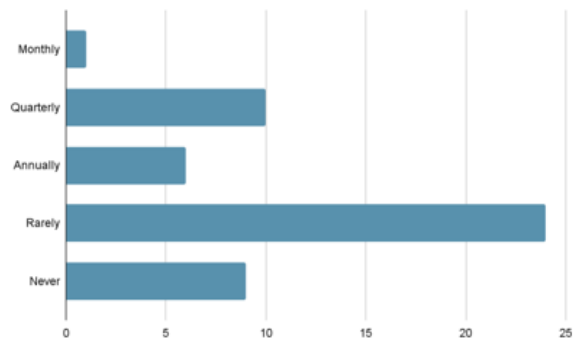


Figure 8: Frequency of Maintenance

The figure reveals a significant gap in proactive maintenance within the barangay. A combined 66% of respondents report that their sewage systems are inspected either Rarely (48%) or Never (18%). This lack of regular oversight is a primary driver for the high incidence of clogs and overflows identified in earlier sections of the study, as issues are likely only addressed once a total system failure occurs.

In contrast, only a small portion of the community follows a consistent maintenance schedule, with 20% conducting Quarterly checks and a mere 2% performing Monthly inspections. The 12% who conduct Annual checks represent a minimum standard of care, but they remain a minority. These results strongly support the residents' proposal for a "Sanitation Task Force" and a mandated desludging schedule, as the current data indicates that the majority of the community relies on reactive rather than preventive maintenance practices.

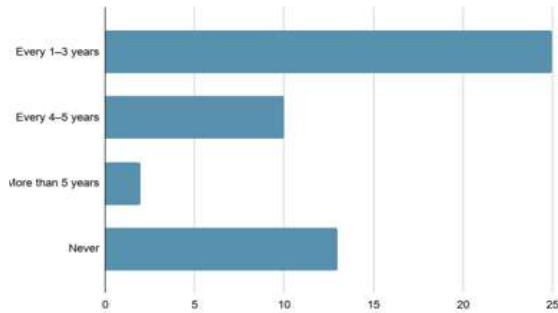


Figure 9: Frequency of Performing Desludging/Cleaning

The figure highlights the maintenance habits of the residents regarding the long-term functionality of their wastewater systems. Exactly 50% of the respondents perform desludging Every 1-3 years, which aligns with proactive sanitation standards and likely accounts for the high level of "Operational Compliance" noted in Part V. Another 20% perform this task Every 4-5 years, suggesting a consistent, albeit less frequent, maintenance schedule for a significant portion of the population.

However, a critical 26% of the respondents reported that they have Never performed desludging. This lack of maintenance among more than a quarter of the households is a primary risk factor for septic tank overflow, groundwater leaching, and system blockages. The small percentage of those waiting More than 5 years (4%) further indicates that for nearly one-third of the community, septic tanks are left to operate until a malfunction occurs. These findings underscore the necessity for the proposed "Standardized Desludging Program," as a significant segment of the barangay currently lacks a routine schedule for waste removal.

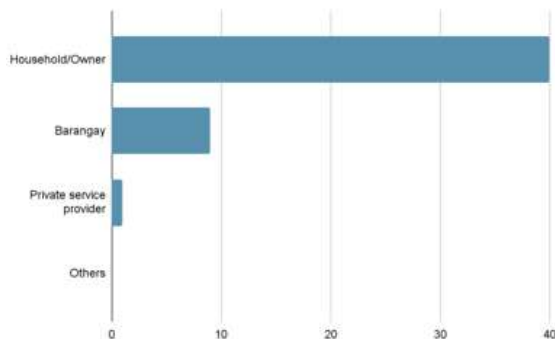


Figure 10: Responsibility for Maintenance

The figure clearly indicates that the vast majority of residents (80%) view wastewater maintenance as a private responsibility, falling on the Household or Property Owner. This aligns with the high percentage of tenants and owners who manage their own septic tanks and plumbing. It suggests a strong culture of individual accountability for onsite sanitation within the community.

In contrast, 18% of the respondents identify the Barangay as the responsible party. This group likely represents households connected to public drainage lines or those living near communal facilities where maintenance issues (such as street canal clogs) require local government intervention. Only 2% of the respondents currently utilize a Private service provider, highlighting a potential gap in the market for professional sanitation services. These results emphasize that while residents accept personal responsibility for their homes, there is a clear distinction between private upkeep and the public maintenance required for the larger community drainage network.

The data are organized into four key thematic sections: (1) current management practices across different wastewater sources, (2) common problems and their impacts on health and daily life, (3) proposed improvements for infrastructure and maintenance, and (4) the level of community compliance with local and national environmental mandates.

By applying a 4-point Likert Scale and qualitative verbal interpretations, this analysis aims to bridge the gap between numerical findings and the lived experiences of the residents. Through this systematic presentation, the study identifies the strengths of existing domestic habits while highlighting critical areas where infrastructure and commercial oversight require urgent intervention to align with the standards set by the Philippine Clean Water Act (RA 9275).

Managing Wastewater Disposal Across Different Sources Specifically in Domestic Graywater, Black Water (Human Excreta), and Commercial/Small Scale water.

Based on the data, the management of wastewater in the barangay shows a clear disparity between domestic practices and commercial oversight. Residents exhibit a Good/Satisfactory level of management regarding Domestic Graywater (2.59) and Blackwater (2.84). This indicates that most households have functional septic systems and basic plumbing that directs water toward drainage lines. However, a significant concern is noted in the environmental impact of graywater, which received a Fair/Inadequate (2.12) rating. This suggests that while residents are successfully moving wastewater away from their immediate homes, the chemicals or detergents used are perceived to be damaging the local ecosystem, or the drainage eventually leads to untreated discharge into natural water bodies.

In contrast, the management of Commercial and Small-Scale Wastewater is rated as Fair/Inadequate (2.48), representing the weakest link in the barangay's sanitation profile. While general commercial management is borderline satisfactory, specific infrastructure for high-density dwellings like apartments and dormitories is lacking. The data reveals that commercial establishments often discharge directly into open drainage, which negatively impacts nearby residents. This suggests that commercial growth in the area has outpaced the development of specialized sewage infrastructure, such as grease traps or large-capacity treatment tanks, necessitating stricter enforcement of disposal standards for business owners and landlords to prevent localized health and environmental degradation.

Residents Poor Wastewater Management Experienced in Health and Sanitation, Environmental and Hygiene, and Socio-Economic and Daily Life Impact.

The data for Brgy. Sumacab Este reveals that poor wastewater management has become a Significant/Frequent Problem across all measured dimensions, with the socio-economic and environmental impacts weighing most heavily on the residents. In terms of Health and Sanitation (2.75), the community is particularly troubled by the physical safety risks posed to children by open sewers and a significant increase in pests like

mosquitoes and rodents. While direct medical issues like skin rashes and waterborne illnesses are currently rated as "Moderate," there is a high level of underlying anxiety regarding the long-term contamination of local water sources, such as dug wells and rivers.

The Environmental and Hygiene (3.06) and Socio-Economic (3.13) scores indicate a community experiencing a tangible decline in their quality of life. Residents are frequently subjected to foul odors and unsightly stagnant water, with the problem escalating into street overflows even during light rainfall. This suggests that the infrastructure is no longer capable of handling the current population density. Consequently, there is a strong consensus that these conditions are devaluing local properties and hindering daily social activities. The high score for the lack of regular maintenance (3.24) and the call for urgent local government intervention (3.22) underscore a clear public demand for improved governance and a modernized sewage system to restore the barangay's sanitary and economic integrity.

Enhancing the Existing Systems and Practices in Infrastructure Development, Maintenance Programs, and Community Participation

The survey results for proposed improvements in Brgy. Sumacab Este reflect a community that is highly supportive of a multifaceted approach to wastewater reform, with all categories reaching a level of High Priority / Necessary. In the realm of Infrastructure Development (3.41), residents strongly advocate for physical upgrades, such as covering open canals and installing trash traps to mitigate clogs. Notably, there is a clear demand for policy-driven engineering, specifically through the separation of sewage from stormwater and the requirement of wastewater management plans for new developments to ensure sustainable growth.

Regarding Maintenance Programs (3.40), the data highlights an Urgent need for a monthly desilting schedule (3.52), which is the highest-rated item in this section. This suggests that residents view consistent, scheduled cleaning as the most immediate solution to current drainage failures. Furthermore, the high scores for public budget transparency and the

creation of a "Sanitation Task Force" indicate that the community values administrative accountability and specialized oversight as much as the physical repairs themselves.

Finally, Community Participation (3.35) scores demonstrate a strong willingness among residents to take ownership of their environment. There is significant support for community-led initiatives, such as "Clean-up Days" and "Bantay Estero" programs, as well as the adoption of individual household grease traps. While still highly rated, the slightly lower scores for voluntary effort and the imposition of fines suggest that while residents are ready to help, they believe the foundation of success lies in the combination of personal responsibility and strict, fair local ordinances.

Community compliance with the wastewater management practices: Infrastructure & Facility Compliance, Waste Disposal Practices (Operational Compliance), and Legal Awareness and Civic Responsibility

The results indicate that residents of Brgy. Sumacab Este maintains a High Compliance / Consistent level of adherence to wastewater management practices, with an overall sentiment that favors following both legal mandates and operational safety. In the area of Infrastructure & Facility Compliance (2.82), there is a strong consensus on the separation of blackwater and graywater (3.12). However, the lowest score in this category is the installation of grease traps (2.50), suggesting that while primary plumbing is consistent, secondary filtration devices are less common and represent a key area for facility improvement.

Regarding Waste Disposal Practices (3.00), the community shows its highest level of compliance, particularly in avoiding the disposal of solid waste and hazardous chemicals into drains (3.24 and 3.20, respectively). This demonstrates a strong sense of Operational Compliance and a clear understanding of how domestic habits affect the local drainage system. While residents are consistent in their habits, the slightly lower scores for regular pipe inspections (2.70) indicate that maintenance remains more reactive—waiting for a problem to occur rather than proactive.

Finally, Legal Awareness and Civic Responsibility (2.84) reflects a community that is ethically aligned with the Philippine Clean Water Act (RA 9275). Residents are highly willing to report illegal dumping (3.02) and follow regulations specifically to avoid legal penalties (3.04). While familiarity with specific Cabanatuan City ordinances and participation in seminars are slightly lower, the overall data suggests that residents are socially responsible and legally conscious. The "gap" between established laws and actual behavior is relatively narrow in Sumacab Este, as residents show a genuine commitment to maintaining community sanitation standards.

In summary, the data reveals that while the residents of Brgy. Sumacab Este maintains a satisfactory level of domestic compliance and a strong sense of civic responsibility, these individual efforts are significantly undermined by an outdated and overburdened infrastructure. The prevalence of street overflows, stagnant water, and unregulated commercial discharge indicates that the current system has reached its capacity, necessitating a transition from reactive habits to a proactive, dual-track management strategy. Achieving an exemplary sanitation profile will require the local government to prioritize the modernization of physical infrastructure, specifically through reinforced drainage and separated sewage systems: alongside the institutionalization of regular, transparent maintenance programs. Ultimately, the high level of resident willingness to participate in community-led initiatives and support stricter sanitary ordinances provides a robust social foundation for these urgent interventions, ensuring the long-term health, environmental integrity, and socio-economic stability of the barangay.

For the interview questionnaire, the study used three open-ended questions to collect the participants' answers. These questions were used as the main tool for gathering information about wastewater problems, their causes, and possible solutions.

These questions helped the participants share their own experiences and ideas about wastewater issues in their community. The first question focuses on the problems they usually see. The second question asks about the reasons behind these problems. The third

question asks for their suggestions to improve the situation.

The answers were then grouped and analyzed using thematic analysis to identify common patterns and ideas. Thematic

Analysis is a widely used approach for identifying, analyzing, and reporting patterns of meaning within qualitative data, offering a structured yet flexible framework for interpretation (Sandhiya & Bhuvanewari, 2024). Through this method, recurring ideas and patterns were systematically coded and organized into key themes related to wastewater management.

The first theme identified is poor waste disposal practices, where participants commonly reported improper handling and disposal of wastewater and solid waste. This reflects how everyday sanitation behaviors contribute to environmental concerns. With the lack of resources and facilities, the supervision of wastewater disposal needs more attention and strict compliance affecting the practices of the residents within the area to be considered improper. Which is the same from study of Oluseyi and Nweke (2020), that resulted in water pollution where the findings included the presence of extremely contaminated bacteria, including *Saccharomyces*, *Klebsiella*, *Pseudomonas*, and *E. coli*, causing the water unsafe for human use. Both of which the study suggests in active insinuation of proper sewage disposal and responsibilities regarding it that makes up to the percentage of threats in public health.

The second theme is inadequate drainage and infrastructure, as several responses highlighted poorly maintained canals and drainage systems. This indicates existing structural and maintenance issues within the community's wastewater management system. According to the study from University of Lagos in Nigeria, Oluseyi and Nweke (2020), stated in their study that their findings with the same concern in this study with the main concern where there is also lack of resources and consistent inspection and maintenance. It was discovered that the majority of the homes in the research area lacked toilets, and open defecation or underground toilets were the common practices in the area. The

restrooms of some other homes were situated very next to the body of water without any septic tanks to handle water disposal. Observed data resulted in the development of algae blooms that emerge as scum on the surface of waterways can worsen by open defecation and other contamination, which disrupts aquatic ecosystems and kills aquatic creatures in the impacted water bodies.

The third theme is community-based improvement strategies, where participants emphasized actions such as proper waste segregation, regular cleaning of drainage systems, and increased discipline in waste management practices. This shows awareness of collective efforts needed to address wastewater-related problems.

In which, the major problems are directly related to infrastructure defects where Hendricks and Rosenberg (2025) discussed in their study about an overflow could result from any heavy rainfall event, combined sewer systems are more commonly linked to sewer overflows. Flooded weather events can cause sewer overflows in both separated and mixed sewer systems. Because they expose residents to untreated sewage through outfall releases into nearby waterways, sewage overflows in public areas, and basement backups in individual homes and buildings, sewer overflows are detrimental to the health of people and ecosystems directly proportional to other affected situations such as public health, sustainability, and management practices.

Overall, the findings suggest that wastewater management issues are influenced by both behavioral and system-related factors. At the same time, participants demonstrated awareness of feasible solutions that may help improve current environmental conditions.

IV. CONCLUSION

First, in terms of the profile of sewage systems, the study reveals that Brgy. Sumacab Este predominantly relies on onsite sanitation facilities, particularly shared and individual septic tanks. While many systems are still functional, a significant portion shows signs of structural deterioration and insufficient maintenance. The limited presence of

formal sewer connections and the continued use of open drainage systems indicate that the existing infrastructure is outdated and inadequate to support the growing population.

Second, regarding wastewater management practices, residents generally demonstrate satisfactory handling of domestic graywater and blackwater, indicating basic compliance with sanitation practices. However, commercial and small-scale wastewater management is found to be inadequate, particularly in apartments and dormitories, where improper disposal and insufficient facilities are evident. This reflects an imbalance between residential responsibility and commercial accountability.

Third, in relation to the common problems experienced, the study confirms that wastewater-related issues such as clogging, overflow, foul odor, stagnant water, and flooding are significant and frequently occurring. These problems negatively affect environmental conditions, public health, and the daily lives of residents, indicating that the current system is already operating beyond its capacity.

Fourth, with respect to the proposed improvements, the findings establish that there is a strong need for infrastructure development, particularly the upgrading of drainage systems, covering of open canals, and implementation of waste filtration mechanisms. Additionally, the institutionalization of regular maintenance programs and the promotion of community participation are identified as essential strategies to improve overall wastewater management.

Lastly, in terms of community compliance with environmental laws, the study concludes that residents exhibit a generally high level of compliance and awareness of the Philippine Clean Water Act (RA 9275) and local ordinances. However, compliance remains inconsistent in certain aspects, particularly in preventive maintenance practices and the adoption of additional facilities such as grease traps. This suggests that while awareness exists, full implementation is still lacking.

Overall, the study concludes that although the community demonstrates responsible wastewater

practices at the individual level, these efforts are not sufficient to compensate for the deficiencies in infrastructure and system management. Therefore, achieving effective and sustainable wastewater management in Brgy. Sumacab Este requires a comprehensive and coordinated approach involving infrastructure modernization, strengthened policy enforcement, regular maintenance, and active community engagement.

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