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| RESEARCH ARTICLE

A Proposed Financial Feasibility Plan in Managing Wastewater among Selected Mixed-Use Establishments in Mandaluyong City

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| ABSTRACT

This study evaluated the effectiveness of wastewater management practices among selected mixed-use establishments in Barangay Wack Wack, Mandaluyong City, as a basis for proposing a financial feasibility plan. The research aimed to assess existing wastewater generation characteristics, treatment and maintenance practices, and the level of adoption of sustainable wastewater management measures. It also examined whether differences existed in wastewater management practices when establishments were grouped according to business or household size, type of operation, and water usage patterns.A descriptive-quantitative research design was employed. Data were gathered through survey questionnaires administered to residents and employees of selected establishments, supported by document review and basic financial analysis. Statistical tools were used to determine significant differences in wastewater management practices across establishment profiles. Financial feasibility indicators were applied to evaluate the practicality of implementing wastewater system improvements. The results showed that most establishments had existing wastewater treatment systems in place; however, gaps were identified in preventive maintenance, stakeholder awareness, and the consistent application of sustainable practices. Large commercial and large residential establishments demonstrated stronger capacity to support wastewater system improvements, while small and medium-sized establishments showed financial and operational constraints. Statistical analysis indicated no significant differences in wastewater management practices across most establishment profile variables, suggesting generally similar levels of implementation regardless of size or type of operation. Based on the findings, a proposed financial feasibility plan was developed to guide establishments in improving wastewater management practices. The plan integrates regulatory compliance, operational efficiency, financial sustainability, and stakeholder participation. The study concludes that effective wastewater management in mixed-use establishments can be achieved through financially viable strategies that balance environmental protection, economic practicality, and social responsibility

| KEYWORDS

Wastewater management; wastewater practices; sustainable development; water quality; regulatory framework; community involvement; financial feasibility; mixed-use establishments; sewage treatment systems; environmental sustainability

| ARTICLE INFORMATION

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I. Introduction

A. Urbanization and Environmental Challenges in the Philippines

Like many developing countries in the world, the Philippines is experiencing rapid population growth with an increased rates of urbanization that imposed environmental challenges. The primary environmental concerns were deterioration of ecosystems, pollution and climate change. Such environmental concerns have brought serious questions about the provision of water and sanitation (Abello et al., 2021). Surprisingly, almost 80% of the nation's sewage is released into environment untreated and this has led to severe health and environmental impacts. Sustainable development goal 6 of the United Nations seeks to ensure availability and sustainable management of water and sanitation for all, with a target that focuses on attaining universal and equitable access to safe and affordable drinking water for all by 2030. Additionally, SDG 13 (climate action) and SDG 14 (life below water) are linked to SDG 6. The SDGs are inter-related and achieving good water, sanitation and hygiene quality (SDG 6) is crucial for the achievement of other SDG targets (Ugo-Alum et al., 2024).

B. Importance of Water Resources and Sources of Wastewater

Water is a vital natural resource used for many different types of activities and plays a central role in everyday life for people Water is a vital natural resource used for many different types of activities and plays a central role in everyday life for people. At home, water is necessary for drinking, food preparation, bathing, and cleaning. Commercially, water is needed for hotel operations, office buildings, and restaurants. Water is also very important to industrial operations as it is utilized in manufacturing, cleaning, cooling and transporting materials (Lawrencia et al., 2023). Declining water quality severely compromises the sustainability of available water resources, thereby limiting the amount of usable water in areas impacted by declining water quality (Philippine Senate, 2024). All sectors produce wastewater. Wastewater can be produced from a wide variety of sources, such as human excrement, household laundry and excessive amounts of oils and cleaning products and pesticides. Storm water and surface runoff from streets, sidewalks and roof tops produces additional pollutants such as oil, manure from animals and residue from vehicles. In addition, highway drainage, storm water drainage systems, industrial discharges and waste from manufacturing, mining and energy production create even more complexity in managing water pollution as evidence of the complexity in managing wastewater exists (Bharat et al., 2022).

C. Impacts of Wastewater Mismanagement on Water Quality

The consequences of mismanagement of wastewater disposal and untreated water, coupled with a lack of infrastructure for wastewater disposal, significantly impacted the water bodies (Anonas et al., 2023). In the global context, as of 2021, approximately two billion people lacked access to safe drinking water (UN, 2021). In Metro Manila, the severe pollution in local rivers rendered them unsuitable as water sources, forcing the Metropolitan Waterworks and Sewerage System (MWSS) to heavily rely on Angat River, located in a different watershed from the outskirts of Metro Manila, to meet the region's water supply needs (Philippine Senate, 2024).

D. Wastewater Management Challenges in Highly Urbanized Cities

Managing wastewater effectively was was crucial to keeping cities clean, disease-free and sustainable, particularly in highly urbanized city like Mandaluyong City, where mixed-used establishments mingled residential with commercial or other uses. These kinds of changes resulted in other types of waste water that could cause problems for sewage treatment systems if not handled appropriately. Poor practices in managing waste water could be detrimental to public health, contribute to pollution of the environment and make it difficult to meet clean water and sanitation targets outlined by the Sustainable Development Goals (SGDs).

E. Purpose of the Study

This study assessed the level of awareness of the selected establishment with regards to the wastewater management among individuals in selected mixed-use establishments in Mandaluyong City. By examining their understanding, the study tried to identify areas for improvement specially in financial feasibility aspect and in the current practices of management to enhance the efficiency and sustainability of wastewater systems. The goal was to develop a financial feasibility plan that addressed existing challenges and promoted greater community participation. This effort was intended to ensure that the financial feasibility for wastewater systems met the needs of the environment and people who lived and worked within these establishments.

II. Statement of the Problem

This research assessed to determine the extent of effectiveness of wastewater management practices among selected mixed-use establishments in Barangay Wack Wack in order to propose a financial feasibility plan. More specifically, the following sub-problems were investigated in the study:

1. What is the profile of selected mixed-use establishments that contribute to water quality in terms of:
    - 1.1 Business or Household size;
    - 1.2 Type of business operations:
        - 1.2.1 Residential

1.2.2 Commercial
1.3 Water Usage Patterns?
2. What is the status or situation of wastewater management practices in terms of:
    2.1 Waste water Characteristics;
    2.2 Treatment Methods;
    2.3 Emerging Technologies;
    2.4 Resource Recovery;
    2.5 Regulatory Frameworks;
    2.6 Sustainable Practices; and
    2.7 Community Involvement and Education?
3. Is there a significant difference among the selected mixed-use establishment in terms of the wastewater management practices when grouped according to their profile:
4. Based on the findings of the study, what financial feasibility plan can be developed to the selected establishments' management?

III. Hypotheses

The study determined the contributory factors to water quality and wastewater management in selected mixed-used facilities of Mandaluyong City with particular attention to the financial viability of recommended upgrades. The research questions sought to determine whether the outlets were different in terms of how they allocated costs, capacity to invest and willingness to fund wastewater technology adoption toward sustainability.

H01: There is no significant difference between the selected mixed-use establishments in terms of financial capacity and practicality of implementing improvement measures when grouped according to their profile variables

IV. Scope and Limitations

In order to gain insight on wastewater management on a more localized level, Barangay Wack Wack Greenhills East in Mandaluyong City was chosen as the study area for several reasons. For one, the barangay is a major contributor to the San Juan River which runs out into Pasig River and Manila Bay. Second, it is now the most extensive barangay throughout the Mandaluyong City with its total land area of 288.50 hectares representing approximately one-fourth (1/4) of that particular city's entire land area.

V. Significance of the Study

The following areas may benefit from the results of the research which aimed at advancing wastewater management and water quality in Barangay Wack Wack:

Residents of Barangay Wack Wack and Neighboring Areas. The enhanced environmental and sanitary services resulting from better wastewater practices may benefit the overall welfare of both residents and the environment.

Condominium and Commercial Establishments of Barangay Wack Wack. Better practices for management of wastewater have the potential to reduce operational problems, provide compliance with laws and regulations governing our environment in a more cost-effective and efficient manner.

Local Government of Mandaluyong. The local government may gain environmentally sustainability, solid compliance with wastewater laws and regulations, with positive influence on environment and community health.

Department of Environment and Natural Resources (DENR). The DENR could use the data to inform its understanding of status of mixed-use devts wastewater management. These results could help in the implementation of environmental control, better monitoring and formulation of more targeted water quality policies.

Future Researchers. The research may provide a benchmark for future studies and breakthrough in development with regards to enhancement of wastewater management systems, quality control regimes and stability of environment.

Adamson University. As the proponents of this study is Adamson University could position itself as one of the best practices for wastewater management and make it known those bastions in to their academic expertise

V. Definition of Terms

This chapter described the operational definitions of certain concepts employed in this study. These definitions were included to ensure that the proper notion was consistently understood, such that Anglophone readers could understand the concepts in question in like fashion wherever these were referred to in the research.

Business Size. In this study, the size of the business, quantified as an establishment size—such as the number of employees, annual sales or total area worked—affecting its generation and management demand for waste water.

DENR Administrative Order (DAO) 2016-08, Also known as the Water Quality Effluent Standard, standards included in the analysis, used to describe the 2016 standards that established benchmark concentration limits for parameters battling wastewater released by business establishments.

Effluent. In this study, the term was used here by the researcher to describe effluent that was released back to the natural water bodies or for re-use after its discharge from wastewater treatment plant.

Emerging Technologies. In this study it was associated with the most recent achievements and novel technologies developed to improve efficiency, sustainability and resilience of wastewater treatment and contribute to resource recovery.

Establishments. Operationally, establishments in Barangay Wack Wack referred to individual residential houses, residential complexes such as condominiums and subdivisions, commercial facilities including offices, stores, and restaurants, and mixed-use properties that combined residential and commercial functions, such as condominiums with retail spaces

Fecal Coliform. In this study, this term referred to a group of bacteria commonly found in the intestines of warm-blooded animals, which served as indicators of water contamination from human or animal waste.

Harmful Substances in Effluents. This referred to chemical, biological, and physical contaminants present in wastewater discharged from mixed-use establishments. These substances were assessed through wastewater sampling and analysis to determine compliance with environmental regulations, such as DAO-2016-08. They served as key indicators of the environmental impact of effluents on water quality and public health.

Financial Feasibility Plan. referred to a structured improvement proposal designed to operations which promotes financial viability, sustainability and regulation adherence.
Influent In the present study, this term was used to describe raw or partially treated water that has just entered a treatment plant or system.

Mixed-use Establishment. Mixed-use facilities in the present report were any building or block that contained a combination of residential, commercial, and industrial uses such as not to be dominated by one particular source's discharging profile.

Public Health Improvement. In this work, improvement of public health corresponded to quantifiable decrease in waterborne diseases and other public health issues through improved treatment practices for wastewater.

Regulatory Frameworks. In this study, regulatory frameworks meant all legal and policy levels of guide for waste water management in line with the environmental protection standards.

Resource Recovery. Resource recovery from treated wastewater was defined as the recovery of reusable materials (e.g., clean water, energy and nutrients).

Screening. As used in this study, it referred to the preliminary stage of wastewater treatment in which large debris and solid materials, such as plastics, rags, and other non-biodegradable items, were physically removed from the wastewater.

Sewage Treatment Plant (STP). In this study, a sewage treatment plant (STP) was a facility used to treat wastewater by removing polluting components and then released or reused that water.

Sludge. In this study, sludge referred to the semi-solid residue generated during wastewater treatment, which required further handling, processing, or disposal.

Sustainable Practices. In this study, sustainable practices referred to environmentally friendly and resource-efficient methods of wastewater management used by mixed-use establishments

Treatment Methods. In this study, treatment methods referred to the physical, chemical, and biological processes used to treat wastewater and make it safe for disposal or reuse.

Wastewater. In this study, wastewater referred to used water from residential, commercial, and industrial sources that required treatment to remove contaminants.

Wastewater Characteristics. In this study, were defined as physical, chemical and biological properties of water, including pH, turbidity and pollutants concentration.

Wastewater Management Practices. Wastewater management practices in this study constituted the integrated or well-planned mechanisms, exercises, and regulations employed by the chosen entities to manage their wastewater efficiently.

Water Quality. In this analysis, this term was used to describe the general state of water including physical, chemical and biological aspects particularly quality effluents discharged from selected establishment wastewater treatment systems.

Water Quality Improvement. In this study, water quality improvement referred and as used in this study meant the quantifiable improvement in the physical, chemical and biological properties of water brought about by effective wastewater management practices

VI. Review of Related Literature and Studies

This chapter provided related literature and studies which became the basis for comprehension on the wastewater management practices of mixed-use establishments in Barangay Wack Wack, Mandaluyong City. The review relied on relevant peer-reviewed journals, books, articles, and academic theses. It covered the research area, water quality issues, wastewater characteristics, treatment processes, resource recovery, sustainable practices, emerging technologies, and regulatory frameworks. Overall, the review aimed to identify key factors influencing wastewater management and to serve as a guide for developing financial feasibility solutions.

A. Brief Description and General Data of the Location of the Study

The rapid growth in population and economic development, together with the effects of climate change, have aggravated problems addressed to clean water resource availability (Lee et al., 2023). Kumar (2020), citing a World Bank study conducted in 2015, took account that Metro Manila is the third largest urban area when compared in Asia excluding China. Furthermore, Maria Estrella (citing the DENR-ROV, 2014) observed that rivers found in the Philippines were commonly used by the residents for industrial and agricultural activities.

In the same report, it was also cited that the rivers were discharge points for residents living nearby (Estrella, 2021). With inadequate sewer coverage in many developing countrie including the Philippines, septic tanks and other on-site sanitation services have been heavily relied upon. Up to year 2030, it was anticipated that around 4.9 billion people globally would still rely on these decentralized means of sanitation (Kookana et al., 2020).

B. Water Quality Improvement Plan

The work of Hamel and Tan (2021) also demonstrated the urban water solutions type that are BGI, including forest, park etc. in their capacity to realizing the adaptive management of water systems. Yet, a large portion of the literature on BGI has been written in developed nations, resulting in limited understanding of its effectiveness in regions like Southeast Asia (Tan et al., 2021; Keeler et al., 2019; Nagendra et al., 2018; Song et al., 2017).
Addressing this research gap is important for Southeast Asia, where rapid urban growth and increasing risks of flooding and water pollution require more integrated water management approaches (UNEP-DHI Centre on Water and Environment, 2020).

Despite its potential, the real application of BGI has to deal with several hindering factors: institutional, financial and lack of knowledge based barriers (Sarabi et al., 2020; Wamsler et al., 2020). In Southeast Asia, these obstacles are further complicated by urban development patterns that have typically not resulted in well-harmonised water systems (Tan et al., 2021; Liu & Jensen, 2018). Sanitation coverage is also low in the region, with only 17.3%, excluding those of Singapore and Malaysia, connected to centralized sewer networks (World Health Organization & UNICEF, 2022).

Many Southeast Asian cities used open canals for both storm and wastewater were carried in open canals; frequently the untreated waste went straight into rivers. This indicated the demand for efficient water treatment systems. The situation was worse in informal settlements, where basic amenities like drainage, roads and sanitation were non-existent. Such conditions resulted in the poor water retention, restricted natural purification but facilitated the pollution of water particularly through improper waste disposal (Tan et al., 2021; Satterthwaite et al., 2020; Harriden, 2012).

Globally, achieving Sustainable Development Goal 6.1 on safe and equitable access to drinking water remained difficult, hampered by climate change, other demands on water resources, lack of funding and deteriorating water quality (WHO, UNICEF, World Bank, 2022). Unsafe drinking water was still prevalent in many low- and middle-income countries. Fifty-seven percent of drinking water sources in the Philippines are at high risk from fecal contamination, emphasizing the immediate necessity to address water quality (WHO, UNICEF, World Bank, 2022).

C. Business/Household Size

Activities of human, most especially in residential areas, have contributed to the deterioration of water quality in the Philippines and brought about environmental and health issues (Encarnacion et al., 2024). Underlying some of these is the lack of efficient wastewater treatment, particularly sewage, stormwater and industrial waste which are discharged into rivers and lakes (Naidoo et al., 2013; Ntelekoa et al., 2021).

Businesses equally have their part to play in wastewater treatment, notably small and medium-sized enterprises (SMEs). Such businesses represent the majority of companies globally, they generate many jobs and economic activity (Martínez & Poveda, 2022). Yet many SMEs are short of money and technical resources to process their effluent as they should be doing. Larger and water dependent firms are likely to generate large volumes of wastewater hence necessitate superior systems for treatment that comply with environmental regulations (Patel et al., 2022).

D. Type of Business Operation

The type of business operating within mixed-use establishments affected how wastewater was managed and the level of environmental impact produced. Various sectors produced varying volumes and compositions of wastewater. Traditionally, production firms generated more water with higher toxic content that demanded advanced treatment to comply with environmental standards (Alfaro & Diaz, 2021).

Similar to industrial wastewater, even retail businesses and service-providing organizations had lower levels of pollution in their wastewater, although they added to the consumption and discharge of water for cleaning of facilities, cooling, and processing food (Hamann et al., 2017). Furthermore, higher water consumption was found to be associated with greater wastewater discharges and this suggests that better strategies for dealing with wastewater may be required in institutions using larger volumes of water (Zhang et al., 2023).Research has found that various types of businesses have required customized wastewater management strategies (Agyabeng-Mensah, 2021). Wastewater from food service establishments and health facilities required specific treatment methods due to grease, organic load, and hazardous substances (Woodard, 2020; Xiao et al., 2021).

E. Water Usage Patterns

Gremley (2020) provided insights on the use of water in Eastleigh, Nairobi and explained patterns of water use in densely populated areas such as mixed-use settlements in Mandaluyong City. The research indicated that cities in the midst of crowding have increasing water demands. But only 24% of homes used water-saving gadgets like dual-flush toilets and low-flow devices. Most of the households were non-users, and water continued to be excessively consumed even during a time of water scarcity.

The type of business also played a role in how much water was used and what kind of wastewater resulted (Khan et al., 2020; Lee & Park, 2022; Woodard, 2021). Public willingness to pay for improved sanitation systems emphasized the importance of both financing and community engagement (Brzusek et al., 2022).

F. Wastewater Characteristics

The Philippine Clean Water Act of 2004 (RA 9275) exists to safeguard the country's water bodies. This law is enforced by the DENR, which sets limits ensuring that water remains safe for us and for aquatic life. Most of the pollution in the Pasig River were domestic and industrial waste, a smaller fraction was soilage. Significant pollution also originated from major tributaries and esteros of the Pasig River such as the San Juan River. A study by Cadondon (2021) showed that despite many government cleanup efforts, Pasig River remained severely polluted (Cadondon, 2021). Like Laguna de Bay and Manila Bay, it suffered for decades from bad water quality.

Citing reports from the DENR, household sewage is one of the largest contributors to pollution in these water bodies and is being closely followed by agricultural and industrial waste. In the Philippines, wastewater treatment only reached a minimal fraction and few households were provided with sewer system connections (WEPA, p. 21).

Monitoring reports also indicated many areas along the Pasig River failed water quality standards. This is why it's important to study wastewater in this region—the Wack Wack Creek connects to these river systems. Clean the rivers that feed into it — including the Pasig River — and you'll start to improve the water quality of Manila Bay.While the aim was to restore the Pasig as a place safe for aquatic life and recreation, one study found that fish and river sediments were still highly contaminated. This meant that water-quality problems persist and highlighted the importance of getting a better handle on wastewater conditions in other nearby bodies like Wack Wack Creek.

Furthermore, Estrella (2021), citing Vanderlugt (2007), emphasised that river acidification was invariably anthropogenic in nature such that pollution from household waste and other sources including accidental spills, agricultural runoff and sewer overflows was a direct cause of human activities (Nkwocha et al., 2011). These pollutants also had a great impact in water quality as, especially when urban and commercial areas with common waste dumping were considered. Qualitative parameters such as colour, pH, temperature, dissolved oxygen content and presence of waste in the water were used for water measurement. Included among these were dissolved oxyget (DO) and Biological Oxygen Demand. DO revealed the amount of oxygen that could be used directly by fish and their fellow aquatic organisms, while BOD indicated how much organic waste was in the water. High BOD levels usually came from sewage and decaying waste, which depleted oxygen in the water and contaminated water quality. Other ingredients, like nitrate and phosphate, usually originate from detergents, human waste and seepage from surrounding terrain. The enormous number of wastes encountered in the Pasig River might indicate that water quality problems are also likely to be present in associated water bodies such as Wack Wack Creek.

G. Treatment Methods

Wastewater treatment is the process of cleaning dirty water before it is released to the environment. The main purpose is to to get rid of hazardous waste so it won't harm the environment or people's health. Treated water and living nutrients can also be utilized in plant growth and potting as well in some cases to prevent pollution and water wastage (Zinatizadeh, 2020). Wastewater treatment usually uses two basic methods: There are generally two approaches to wastewater treatment: chemical and biologic. The former involves the use of chemicals to remove dirt and contaminants, while microorganisms to digest waste is used in the latter. Chemical procedures are usually workable, but frequently they are costly, energy-intensive and hard to maintain. They also do not treat effectively all potentially harmful entities, which include heavy metals and nutrients (Jain, 2021; Kumar, 2014).

H. Emerging Technologies

Cleaned wastewater for disposal, but they typically were not able to clean water sufficiently to allow it to be reused. For this reason, newer treatment processes were developed to treat wastewater to the point that it could be reused in industry, agriculture and homes. These were processes like membrane technology which purged waste water of dirt and impurities. While membrane bioreactors (MBR) also had limitations, they offered improved treatment to older systems and were already being used in many wastewater facilities (Sweta, 2021).

Another approach was membrane separation that cleaned water with a thin filter, called a membrane. Tiny particles filtered through the membrane but larger, more harmful particles were blocked. The efficiency of this process was related to the particle size as well as pressure. The membrane separation in turn contributed to improving the quality of water despite energy needed for it (Sweta,2021).

Meanwhile, nanotechnology was beginning to find some practical applications in wastewater treatment. It was made up of very small materials for more efficient cleaning of water. Being porous, these materials had a large surface area and were fairly effective at trapping and eliminating pollutants. Nanotechnology can also be tuned according to the nature of the waste (Jain, 2021). Studies showed that nanomaterials were effective in removing harmful substances such as heavy metals, chemicals, dyes, and germs from wastewater. Due to these benefits, nanotechnology showed strong potential in producing cleaner and safer water and was considered a promising option for future wastewater treatment (Jain, 2021; Kumar, 2014).

I. Resource Recovery

In recent years, wastewater treatment focused efforts have concentrated on ensuring water is safe for people, animals and the environment post-treatment. Yet, due to population increases as well as an increase in water demand and consumption the time has come where we should conserve our precious water resources. From thenceforth the concept of sustainable and circular economy, i.e., waste reduction and resource's reuse came into existence (Yadav et al., 2021).

The biggest sources of waste water originate from household and industrial effluent. In the past, treatment plants mostly sanitized water before putting it back out. Today, reuse of valuable resources contained in wastewater like water, nutrients or energy receives greater attention. This is in line with the principles of a circular economy system, in which leftovers are upcycled rather than wasted (Yadav, 2021; Diaz-Elsayed et al., 2019).

Environmental projects also often get little funding, so public support needs to be there. Once they realize the advantages—clean water and happier, healthier home sites—people tend to have an easier time accepting the concept (Yan et al., 2023; Tunstall, 2000). For example, one of resources can be reclaimed from the wastewater is energy. Some technologies available, like microbial fuel cells, can clean wastewater at the same can produce electricity and recover nutrients (Yadav et al., 2020b; Lu et al., 2019).

J. Regulatory Frameworks

A study by Kallali (2021) conducted research to improve the management of wastewater by promoting peoples acceptation for reuse of treated wastewater. The aim was to minimize the use of fresh water and encourage sustainable water usage. It also underlined the value of receiving support from national, state and NGO. The study recommended switching to other sources that are available, such as recycled waste water for irrigation, agricultural drainage water and desalinated seawater. For a trial run, it conducted basic analysis in Tunisia, Lebanon and Spain to determine if an eco-friendly treatment system called APOC could do the job. The findings indicated that the cooperation and collaboration of communities, governments, and organizations were crucial for effective implementation of water reuse scheme.

Heavy water pollution has resulted from new residential, commercial and industrial developments. So many rivers and water bodies are already over the threshold for pollution. It is for this reason that there are requirements and tighter water quality standards to protect public health and environment (Okoro, 2023). Even in the Philippines, things were not looking up with programs like the Manila Bay and Boracay rehabilitation works still had low quality water bodies. High level of fecal coliform was revealed in drinking, food and recreational water sources. This was primarily due to inadequate wastewater treatment, and absence of adequate sewerage facility (Philippine Development Plan, 2023). Wastewater from homes, farms and businesses, including small and medium-sized enterprises, further contributed to water pollution when it was not treated appropriately.

According to government data, most of the pollution came from domestic sewage, followed by agricultural and industrial waste. There was limited waste water treatment and few households were connected to a sewer system (WEPA, 2021; PSA, 2023). Others found that drinking water was affected by contaminants like chemicals and metals from farming, factories and urban areas. The findings indicated the necessity of improving wastewater treatment to safeguard water quality and public health.

K. Sustainable Practices

Rapid population growth increased farming activities, which consumed the majority of the world's fresh water. As a result, water became scarce and more energy was used to produce fertilizers. To help do that, farmers had to have good and affordable alternatives. One such solution was the recycling of wastewater, which lessened water scarcity, and created value towards a circular economy.

The Lahlou (2021) study also highlighted the possibility of realising "sustainable agriculture" with farmers seeking to achieve a balance between their environmental, economic and social needs through the use of treated wastewater. Waste water carried nutrients that would replace part of the chemical fertilization. The research also indicated that the use of waste water in agriculture, particularly for animal feed production, was becoming increasingly popular among farmers. Another study by Pedrero et al. (2020) focused on the use of treated wastewater to help olive production in the Mediterranean area. The research found that all types of waste water could be used for irrigation without substantially compromising soil quality and crop yields. Poustie et al. (2020) investigated the impact of treated wastewater on food crops and soil. They considered nutrients and other compounds in wastewater. Chauhan, A., Kumar, P., 2020. was also discussed about the possible risk and recommendations for safe use of treated wastewater in agriculture.

L. Community Involvement and Education

A study by Estrella (2021) showed how households along the Naga River disposed of their solid waste. In about two-thirds (66%) of households the waste was put in garbage bags and taken away by city garbage trucks. Tinago had the most number of household users and Dayangdang, the least out of nine selected barangays. Both barangays were situated in the mid-section of the river. It also indicated, however, that improper waste disposal continued to be practiced in all barangays. Some families still disposed their rubbish into the river or elsewhere indiscriminately. In Sabang, this was most prevalent with 23% of inhabitants stating they disposed garbage directly into the river. The people in Peñafrancia made waste throwing a normal thing which all went to the river.

Another research of Ibanez (2020) was conducted among the agriculture students of DEBESMSCAT–Cawayan Campus. The research revealed that students had low information of environmental laws. Even so, numerous students continued to engage in ecologically-friendly behaviors. These ranged from recycling plastic bottles, conserving electricity by unplugging appliances and participating in clean-up drives to planting trees. Students also learnt on how to avoid polluting environment such as by not burning plastics and walking instead of using vehicles. For certain individuals, the titanic factor to blame was indolence; for a few others, they decided to purchase green products because of environmental concern.

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Liu et al. (2020) also studied how education affected waste sorting at the household level. The research revealed that while the students were not well-informed about environmental laws, many were nevertheless behaving in environmentally beneficial ways. The finding supported the notion that community involvement is crucial in waste and environmental Management since people's actions and attitudes are vital in promotion of positive changes towards bettering environmental practices (Ibanez et al., 2020; Kabito, 2021). In a parallel study, Wang et al. (2020) found that Chinese contractors with higher levels of waste sorting knowledge had lower construction waste generation. This indicated that education and training in respective sectors were necessary.

VII. Syntheses

The Philippines has water problems because of fast urban growth, increasing population, and poor sewer systemsUntreated wastewater frequently ends up in rivers, in part because many homes and businesses have septic tanks. This has implications in terms of public health and water quality. This issue is not isolated to Wack Wack but across most cities in Southeast Asia that face the same problem (Lee et al., 2023; Kookana et al., 2020).
A large number of surveys proved that water pollution is primarily caused by domestic sewage, industrial and solid wastes. Domestic wastes are among the major pollution loads in Pasig River, which is largely polluted despite rehabilitation efforts (Cadondon, 2021). It is cleaning smaller rivers, creeks and tributaries like the Wack Wack Creek because dirty water downstream will be addressed (Clemente, 2020).

Water quality is not good and we need to improve the way we manage wastewater. Some communities in other countries rely more on nature-based solutions like parks and green areas to help clean and manage their water. But such options are not frequently employed in Southeast Asia since they are expensive and the government does not sponsor them (Hamel & Tan, 2021; Tan et al., 2021). The quality of water is generally monitored through parameters such as BOD, DO and TSS. If BOD levels are high, there is an excessive amount of organic waste — often sewage — in the water. This demonstrates the importance of appropriate wastewater treatment.

Standard wastewater treatment techniques are still in general use. They are helpful in reducing waste but cannot extract all harmful substances. As a result of this, newer technologies had to be developed for the effective cleansing of wastewater. The latter are considered more efficient however due to their cost and complexity difficult to sustain (Jain, 2021). Taken together, results demonstrated that knowledege of wastewater and selection of appropriate technologies are significant contributors to improvements in water quality from both an enviornmental and financial sustainability perspectives.

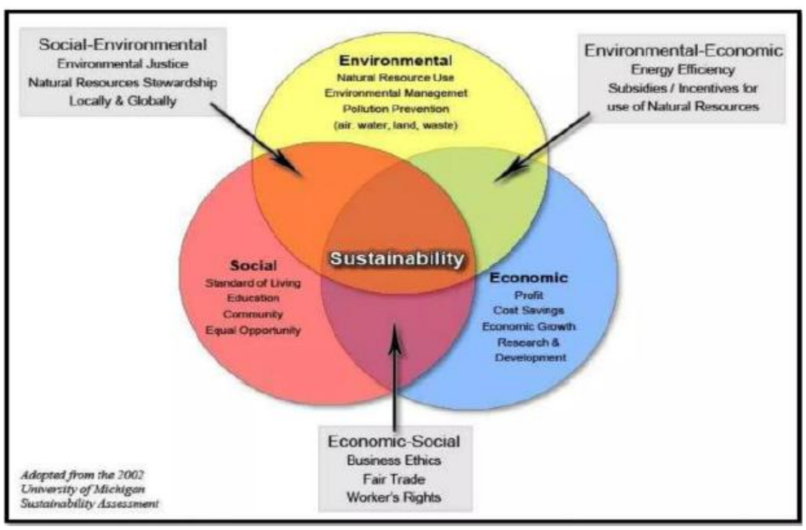
VIII. Theoretical Framework

The Sustainable Development Theory came from the Brundtland Report in 1987. This theory aimed at fulfilling the needs of the people of today without compromising the ability of future generations to fulfill their own needs. It stressed equilibrium among three dimensions: the environment, economy and society. All three had to capitalize off of each other for lasting growth. Environmental sustainability focused on pollutant reduction, resource saving and material recovery. Economics sustainable agreements based on economical and reasonable solutions. Human capital focused on the importance of peoples (education, communities involvement and collaboration among stakeholders.

In this research, the Sustainable Development Theory was applied to explore how mixed use facilities treated wastewaterFirm size, type of operation and water usage had been linked to wastewater treatment practices and legal compliance. These actions have been important in successful improvements of water quality. The theory also argued that good wastewater management was not just an environmental matter. It demanded inexpensive solutions, and community approach as well.

This framework was indispensable to the study since it guided both old and innovative wastewater management systems that can be made operational in Barangay Wack Wack, acceptable and sustainable. In was recommended that Southill develop a Water Quality Improvement Plan involving pollution control, resource recovery and public williningness in preventive early protective gauranteens to the environment long term benefits and community health on environmental socio-economic bases.

Figure 1. Sustainable Development Framework of Bruntland Report (1987)



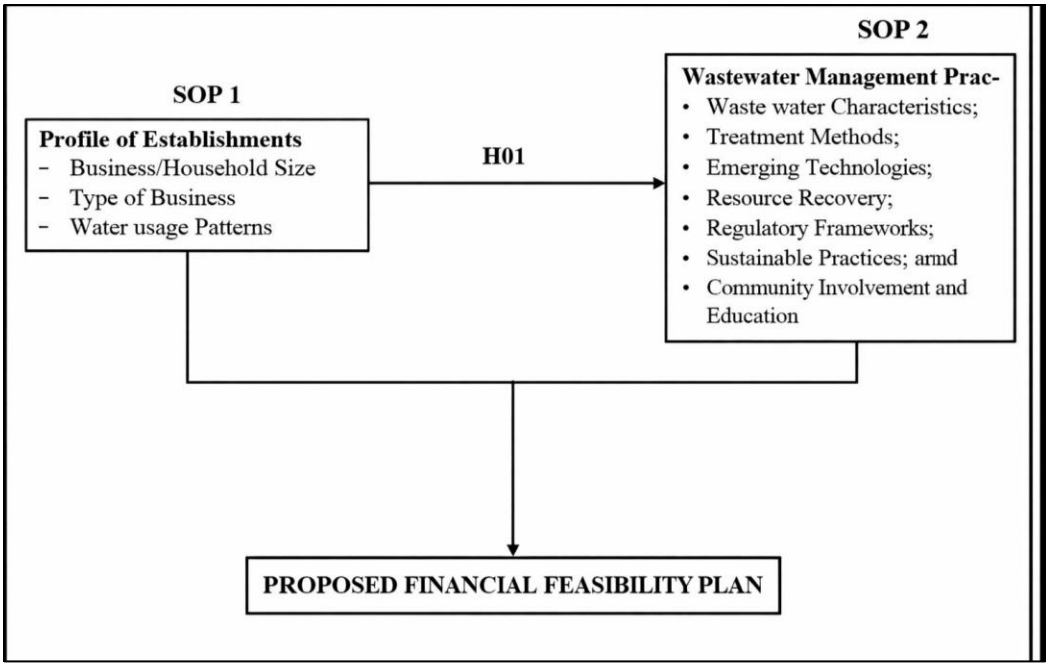
IX. Conceptual Framework

The study was underpinned by the Sustainable Development Theory, with the argument that environmental, economic and social elements are all interconnected which leads to sustainable success. The theory helped elucidate how facility characteristics led to facilities' wastewater-handling related practices contributing to water quality. Business profiles contained data such as the size of a business or residence, type of operation (e.g., residential, commercial or mixed-use) and water use patterns.

These factors influenced the amount of wastewater generated and its treatment. Waste management practices were investigated from these profiles, wastewater management practices were examined. These included wastewater characteristics, treatment methods, use of new technologies, resource recovery, compliance with regulations, and sustainable practices. These wastewater management practices were important in essential for the improvement of water quality and adherence to environmental legislation. The three dimensions of sustainability were also taken into consideration in the framework.

Environmental viability or reuse capability addressing the aspects of pollution reduction and useful product recovery from wastes. Economically anywhere you could make something realistic and affordable. Social sustainability focused on community involvement and education.

Figure 2. Malonzo's Conceptual Framework



X. Methods

This section explained the research design, data treatment, sampling technique applied and respondents' profile. It explained the data collection as well as the processing and analysis of the data using simple statistical methods. These procedures were followed in order to correctly interpret, describe and validate the findings.

A. Research Design

This study used a Descriptive-quantitative research design was used to determine the wastewater management activities of selected mixed-use establishments in Barangay Wack Wack, Mandaluyong City. The descriptive model was used to make description of the situation and existing processes in the establishments without any alterations. The quantitative part of the study used numbers and data to analyze the profile of the establishments, such as size, type of operation, and water use. That also examined how wastewater was handled, including treatment processes and whether regulations were followed. The environmental as well as economic and social factors affecting wastewater treatment were considered in the present work. The survey recommended a financial feasibility plan According to the findings number of statistical tools have been applied for checking out dimensionality and correspondence between the profile of establishments / units, wastewater-material management. This began to help account for how these activities were impacting the water quality. The effect of environmental, economic and social variables on wastewater treatment was also analyzed. The results of the study were used as the basis for proposing a financial feasibility plan.

B. Data Management

The data management process of this study followed simple and organized steps. Data were collected protect the privacy of records and adhere to Data Privacy Act of 2012. Instrument Data were gathered using survey questionnaires administered to randomly selected mixed-use establishments in Barangay Wack Wack. Responses of business owners, building managers and residents were recorded and digitized as a file for analysis. To protect the privacy of the respondent participants, their names and personal information were not reported. Rather, a code system was relied on. Data were stratified by business size, type of operation, water consumption and wastewater management behavior. Data generated from the survey using Google Forms were kept in a secured online server with password protection, and only authorized researchers had access to the data. The completeness and correctness of any information was verified before entering the data. The data was used primarily for research.

After the study concluded, all person-related data were irreversibly deleted. This method helped to guarantee secure, good quality and representative treatment of the data during the whole study.

B. Sampling Design

This section described the sampling strategy of the study and how respondents were identified, together with their characteristics. It also described the various research instruments and data analysis methods adopted in conducting empirical investigation to provide necessary information this study needs in testing its hypotheses. These activities bolstered the trustworthiness, applicability and dependability of data being collected in relation to overarching goals of the research.

C.1 Respondents

The research respondents from whom the data were collected for this study, consisted of members of the Board of Directors, building administrators (from Building Managers Assessment Office), maintenance personnel, residents from different establishments, technical group and officers in a local government unit (LGU) in Barangay Wack Wack.

Table 1 List of Selected Mixed-Use Establishments in Barangay Wack Wack for Wastewater Management Practices Assessment

No.	Establishment Name
1	Wack Wack Twin Towers
2	The Address Wack Wack
3	The Pinnacle
4	8-Wack Wack Condominium
5	Royal Mansion Wack Wack
6	Wack Wack Village
7	Shangri-La Mall and Residences
8	La Salle Greenhills
9	Wack Wack Golf and Country Club
10	Lee Gardens
11	The Summit Tower
12	Barangay. Wack Wack Barangay Hall

Source: Local Government of Mandaluyong City – Barangay. Wack Wack

Table 2 Estimated Population and Sample Size per Establishments

Institution	Sample Size	Percentage (%)
Wack Wack Twin Towers	55	25.82%
The Address Wack Wack	28	13.15%
8 Wack Wack Condominium	30	14.08%
Royal Mansion Wack Wack	10	4.69%
The Summit Tower	25	11.74%
The Pinnacle	25	11.74%
Barangay Wack Wack Barangay Hall	40	18.78%
Total	213	100%

Source: Local Government of Mandaluyong City – Barangay. Wack Wack

The barangay had a total voting population of 3,222. This calculated sample sized was used for the sample size estimation of this study. The stratified random sampling procedure was followed in such a way as to ensure adequate representation of residential and commercial sectors. All individuals in the population were equally likely to be drawn. The survey questionnaires adopted of previously conducted studies on wastewater management (Estrella, 2021). The questionnaires were applied to gauge the awareness, practices and adherence of rules about wastewater treatment and environment. A total of 213 were in total and approximately 20–25 respondents were from each sample source to have good picture on how waste water is managed.

Respondents were residents, household members (if they are not the residents) and building administrators/property or facility managers/maintenance personnel from selected mixed use establishments next to Barangay Wack Wack. Stratified random sampling was used to get a fair representation of establishment and respondents by type.

C.1.1 Vulnerability Considerations

The respondents in this study did not fall within vulnerable groups according to research ethics directives. However, response bias may have occurred because some respondents (e.g. inhabitants and maintenance staff) had possibly a poor knowledge of wastewater and because the situation where they lived or worked could reduce information provided. To address these concerns, the research was carefully explained to all participants by the investigator. They were assured that their answers would be kept secret and that participation was voluntary. Ethical research principles and the Data Privacy Act of 2012 were followed and informed consent was secured prior to data collection.

C.1.2 Right to Withdraw

The study was completely voluntary. Respondents were at liberty to discontinue study participation at any stage without having to justify their withdrawal. They also had the option of refusing to answer any questions that made them uncomfortable. These updates were made to meet the ethical standards, and respect self-determination and rights of all participants across all stages of research.

C.2 Research Instrument

The primary research instrument for data collection was a structured survey questionnaire to guide the objectives of the study. Two different sets of questionnaires were administered to residents and employees. The questionnaire was tailor-made for investigating wastewater management in the selected mixed-use facilities located in Mandaluyong City.
The residents were asked a total of 35 questions related to wastewater characteristics, treatment options, up-taking emerging technologies, resource recovery, regulation and sustainability; along with community engagement and involvement. Similarly, the employees' questionnaire also contained 35 items and focused on respondents' awareness, participation, and perceptions regarding wastewater management within their respective buildings. These structured instruments were intended to cover all relevant measurements in current clinical practice and assist with recognizing areas that in need of improvement.

C.2.1 Demographic Profile

The first section of the study focused to gather demographic and profile information of the respondents, such as their business' size, type of operation and water consumption pattern. These were meant to be used for the determination of important factors that can influence wastewater management in mixed-used facilities as well as for use as a basis with which to explore these impacts on water quality.
The survey tool used in the current study did not cover demographic profile as was done by Samiya (2024) on a sample of subjects in Durban, South Africa. The modified scale for use in the present study internal consistency and reliability of α-Cronbach of 0.75.

C.2.2 Wastewater Management Practices

The second section of the questionnaire were designed to cover management strategies adopted by the selected enterprises regarding wastewater. This part dealt with environmental laws, rating of treatment process efficiency and methods of pollution control being practised. It also investigated how respondents would rate the impact of such practices on water quality improvement and public health outcomes. It was designed as a quantitative tool to enable greater in-depth analysis of the relationships between establishment profile, WWMPs and water quality (Suryani et al., 2019).

The instrument was pre-tested to establish clarity, validity and reliability. a preliminary testing was done. The pre-test was validated with the assistance of three experts, one psychometrist and two professionals (property management expert inclusive). These validators made input on the instrument's contents, relevance and appropriateness. Following validation, the tool was pilot tested on 10–15 similar respondents with the targeted population.

Reliability was examined with Cronbach's Alpha, which is a measure of internal consistency without overlap or redundancy between the items in a scale. Test-retest reliability was assessed on their work as well using a Cronbach's Alpha (Malapane & Ndlovu, 2024; test of the internal consistency or homogeneity within the survey instrument). Rating scale and reliability A Cronbach Alpha coefficient score of 0.70 or higher indicates that items measure the same entity consistently (Malapane & Ndlovu, 2024). Consequently, the final questionnaire was considered to be valid and dependable for use in data collection on the basis of pre-test results after necessary modification in making the questions clearer and more accurate

C.3 Data Gathering Procedure

This study used a mix of Google Form and face-to-face data collection to achieve wider and respondent-friendly coverage. The selection and hiring of respondents required personal arrangement with the administrators, management's body, and occupants' association in the chosen mixed-use establishments of Mandaluyong City. Flyers and invitations were shared via e-mails, social media groups, and building bulletin boards to introduce potential participants to our study and encourage their involvement in this research.

For respondents who completed the survey through Google Forms, the Informed Consent Form (ICF) was integrated into the online questionnaire. The ICF was presented before starting the survey, where respondents read through and understood the study purpose, were assured of compliance to data privacy standards under Republic Act No 10173 (Data Privacy Act of 2012), voluntariness to participate in the study and their right to withdraw at any time during the process. There was a compulsory "I Agree" box to be checked in order that the participant provided informed consent before they could advance to the questionnaire.

For face-to-face data collection, printed copies of the ICF were distributed prior to the administration of the survey. The researcher explained the details of the study, addressed any questions or concerns raised by the participants, and obtained their signed consent before proceeding with the questionnaire. Upon obtaining the approval, a written request letter was forwarded to the management of all finally identified enterprises to inquire about their consent to participate in the research. Once approved, the investigator worked with facilities managers or operations staff to arrange for data collection activities to be scheduled.

All participants were well briefed about the study, relevance of their participation and safety of their data. The survey was conducted in person on scheduled visits or on-line via secure link and depending on respondents' availability and preference. For in-person meetings, the investigator followed local government guidelines on health and safety. Responses from both online and offline modes for the men were collated into a secure password-protected database before analysis was carried out.

XI. Statistical Treatment

The following statistical tools were used to analyze the data that were gathered through the survey instrument distributed to the respondents of selected establishments and to test the hypotheses formulated in the study:

1. Frequency and Percentage. These were used to examine demographic and profile variables of the respondents such as type of establishment, water use pattern and level, and size of wastewater treatment system.
2. Mean. The means were computed to evaluate the responses to survey questions related to wastewater management practices, compliance measures, and the use of technology. These aspects were measured using a four-point Likert scale (1:strongly disagree 4:strongly agree). The calculated means of all the variables gave an overall picture, thereby fulfilling research objectives 2 and 3.
3. Standard Deviation. This was done to examine the range of responses for each item on the survey. It indicated the uniformity of responses among establishments according to categories of wastewater maangement practices and approval. This measure made it easier to identify any potential outliers or bias that would have influenced the ultimate conclusions.
4. Pearson's Correlation Coefficient. This statistical analysis was also used to evaluate the correlation between sanitation practices and meeting water quality goals. In this regard, it centered on RQ5 and helped to guide the recognition of reports where current experiences within legislative contexts I mean had attracted previous studies.

XII. Ethical Considerations

Strict ethical standards were observed throughout the process of data collection. Formal written approval was secured from the appropriate authorities prior to conducting the study. All participants received an explanation regarding the aim of the study, its procedure, and further details on data acquisition/processing/storage.

Consent was obtained from all those who participated. Confidentiality of the study participants' information was also kept always protected. Ethics approval was performed in accordance with Republic Act No. 10173, also referred to as the Data Privacy Act of 2012, providing assurance for data privacy and participant safety during the research process.

A. Conflict of Interest

The researcher has ensured here, too, that the objectivity of this study cannot be abated by neither a conflict of interest. All possible conflicts of interest were declared and managed in favor of the research any connections, relationships or involvement with stakeholders that may have affected the results in a presumable way have been declared. These rigorous checks and additional procedures were applied to ensure impartiality and protect the integrity of the study at all stages.

B. Privacy and Confidentiality

All received information was treated with the strictest confidence and sensitivity, as per institutional protocols. Anonymizations of individual-level and institution-level data has been ensured through the use of distinct random codes; the access to delicate information was limited exclusively to authorized personnel. The study complied with the mandate of Republic Act No. 10173 known as Data Privacy Act of 2012 by strictly following the policy guidelines, rules, and regulations set forth to guide research in compliance with Philippine data sharing practices advocacy for full implementation of national standards on data protection.

C. Informed Consent Procedure

Participants were informed of the purpose and method, and possible risks and benefits of this study in detail before the study commenced. Signed consent was obtained, indicating that participants had voluntarily agreed to participate to in the study and acknowledged their rights through the volunteers.

D. Vulnerability

Participants who could be regarded as vulnerable, such as those with impaired ability to make decisions themselves, received special attention to protect autonomy and stimulate informed participation. The researcher neither engaged in any compulsion nor a coercion and participants fully understood their rights, purpose of the study along with its voluntary participation.

E. Recruitment

Recruitment was conducted transparently and in accordance with ethical standards. Prior to data collection, the researcher secured clearances from Barangay Wack Wack administration and the Local City Government of Mandaluyong. Study participation was fully voluntary and recruitment procedures were intended to minimize coercion or duress. Study information was available and sufficient for participants to make an informed decision.

F. Assent

Assent will be sought for minors, from subjects not capable of giving legal consent and from those that are blind, deaf or unable to write. The instructions and goals of the study were explained using language appropriate for their age and they provided informed assent. To maintain ethical guidelines and protect the welfare of underage subjects, this 2-stage consent process was developed.

G. Risks

All potential risks, such as psychological discomfort during interviews, potential harm on the privateness of information, were clearly explained to participants before they took part in the study. All participants were informed about the voluntary nature of their participation and could withdraw from study at any time without adverse consequences. Furthermore, very stringent means of maintaining confidentiality and integrity of the collected data was employed in keeping with the ethical standards in research and considerations for privacy.

H. Benefits

The anticipated benefits of the studies (e.g., better ways to manage wastewater and improved health outcomes) were described to participants. But the dealing was transacted free of any quid pro quo, to keep things clean and communicate expectations. This ensured an informed, intentional, voluntary action, without any coercion or misunderstanding about benefits.

I. Community Considerations

The studies were based in partnership with the community leaders so that the research direction and emphasis would be responsive to what Barangay Wack Wack has identified as its needs and priorities. Efforts were made to make the research work applicable and usable to local actors. The results were communicated to promote good practices, especially for the management of wastewater and upgrading public health, as well as to make a contribution towards informed decision-making and an integrated community development.

J. Incentive or Compensation

No financial compensation was offered for the sake of maintaining a voluntary nature of participation, but participants were compensated in non-monetary form. In-kind rewards provided to those completing the surveys. These included educational brochures on waste water management measures designed to raise public awareness and promote eco-friendly behavior among the well-disposed.

K. Collaborative Study Terms of Reference

The terms of reference provided the researcher with specific direction relating to the roles and responsibilities of all stakeholders involved in the agreement, i.e. Adamson University, LGUs and Barangay Wack Wack. This framework was developed to facilitate collaborator, open and ethical forms of research based on trust and concern between a range of key constituencies.

XIII. Results

The researcher adhered to the terms-of-reference, which stipulated lines of duty – not only for Adamson University but also for the local government offices and Barangay Wack Wack administration. This was a mechanism to promote cooperation, transparency and ethics in how research is done across all stakeholders who worked together in good respect and accountability.

Table 1.1
Profile of Selected mixed- used establishment in terms of Business/Household Size

Business/Household Size	Residential		Commercial		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Large (more than 200 occupants)	149	78.8	18	69.2	167	77.7
Medium (50-200 occupants)	39	20.6	3	11.5	42	19.5
Small (less than 50 occupants)	1	.5	5	19.2	6	2.8
Total	189	100.0	26	100.0	215	100.0

Based on Table 1.1, large percentage of participants were members of large establishments with more than 200 occupants. Out of the 215 respondents, 167 (77.7%) belonged to large establishments, 42 (19.5%) came from medium-sized establishments with 50–200 occupants, and only 6 (2.8%) were from small establishments with fewer than 50 occupants. This showed that most respondents lived or worked in large, high-occupancy places.

In the residential group, most respondents (78.8% or 149 out of 189) lived in large residential units. Around 20.6% lived in medium-sized residences or establishment, while only one respondent came from a small household. This suggested that high-density housing, such as condominiums or apartment buildings, was common in the area.

In commercial group, the data were as follows; large establishments being still more at 69.2% (18/26). But small and medium businesses outnumbered the residential sector. Medium-sized, small enterprises Medium businesses represented 11.5%, and small business comprised 19.2% of respondents. Overall, large establishments were the most common in both residential and commercial areas. But there was greater variety in the size of commercial premises. These findings were significant for planning and policies, in particular for the development of services and infrastructure coverage in high population density areas.

Table 1.2
Profile of Selected mixed- used establishment in terms of Type of Business Operations

Type of Business Operations	RESIDENTIAL		COMMERCIAL		TOTAL	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Mix Residential	178	94.2	11	42.3	189	87.9
Mix Commercial	11	5.8	15	87.7	26	12.1
Total	189	100.0	26	100.0	215	100.0

Table 1.2 shows the distribution of respondents based on the type of business operation. The participants were classified into residential mixed and commercial mixed respectively. A total of 189 (87.9%) out of 215 respondents were from residential establishment and 26 (12.1%) from commercial establishment.

majority (94.2%) of the residential respondents were characterized as mixed residential, with 5.8% falling under mixed commercial. Conversely, of the work commercial respondents' 57.7 percent were mixed commercial use and 42.3 percent where residential units are being used commercially or have a commercial zoning. Overall, the results showed that residential establishments made up most of the respondents. The data also highlighted that mixed-use building functions were common, especially in commercial establishments.

Table 1.3
Profile of Selected mixed-use establishment in terms of Water Usage Patterns – Monthly Consumption in cubic meters

Water Usage Patterns – Monthly consumption in cubic meters	Frequency	Percent
51-100 cu.m.	7	26.9
101-200 cu.m.	1	3.8
More than 200 cu.m.	18	69.2
Total	26	100.0

Table 1.3 shows the monthly commercial hydrant usage of 26 businesses. Most of the facilities, 18 out of 26 (69.2%), consumed more than 200 cubic meters equally or more per month. This meant that most companies were the heavy water users. In the meantime, seven (7) institutions (26.9%) had moderate consumption of water which falls between 51-100cum /month. There was a small number of establishments (3.8%) using water between 101and 200 cm 3, indicating that very few belong to the medium-sized category.

Overall, the results demonstrated that most commercial dwellings were using large quantities of water. This, in turn, indicated the need for improved water management and increased supervision along with measures of conservation particularly among facilities imparting extensive use of water.

Table 1.3.1
Profile of Selected mixed-use establishment in terms of Water Usage Patterns – Peak water usage time

Water Usage Patterns - Peak water usage time	Frequency	Percent
Morning (6 am-12 noon)	7	26.9
Evening (6 pm-12 pm)	16	61.5
No peak time	3	11.5
Total	26	100.0

Table 1.3.1 The major purposes of water use in 26 business offices are presented in Table.1. Most premises 23/26 (88.5%) used water only for cleaning and hygiene purposes. This involved sweeping the floors, the equipment, and toilets for hygiene.

Only three (11.5%) places said that the water they poured was for cooling systems, such as air conditioners or refrigeration units. It showed that only a small number of projects needed cooling water. Water was generally most utilized for cleaning and sanitation in commercial buildings. This just goes to show the need for a consistent water supply which is more than suitable for your daily living and good health in commercial premises.

Table 1.3.2
Profile of Selected mixed-use establishment in terms of Water Usage Patterns – Primary use of water

Water Usage Patterns – Primary uses of water	Frequency	Percent
Cleaning and sanitation	23	88.5
Cooling systems (e.g., AC, refrigeration)	3	11.5
Total	26	100.0

The primary uses of water in 26 commercial establishments are presented in Table 1.3.2. The majority of the facilities, or 23 of 26 (88.5%), wash water was primarily directed to cleaning and sanitation. -This involved washing floors, equipment and toilets to ensure appropriate sanitation.

Just three establishments (11.5%) used water mainly for cooling systems such as air conditioning or refrigeration. This showed that only a few businesses depended on water for cooling purposes. Overall, the findings indicated that water was used to maintain hygiene in commercial sectors. This emphasized the necessity of an uninterrupted water provision line for both commercial and health related activities in businesses.

Table 1.3.3
Profile of Selected mixed-use establishment in terms of Water Usage Patterns – Saving device or system

Water Usage Patterns – saving device or system	Frequency	Percent
Yes	3	11.5
No	23	88.5
Total	26	100.0

Table 1.3.3 shows the use of water-saving devices or systems among 26 commercial establishments. Just three establishments (11.5%) reported using water-saving devices, while most establishments, or 23 (88.5%), did not use any.

This indicated that most industry were not aware of or equipped with water-saving technologies. Low utilization of these devices may also have led to high levels of water use cited above, because most water was used for cleaning and sanitation.

In general, it was shown that water-saving technologies in commercial buildings have to be promoted. Long-term water regulations, the creation of awareness programs, and incentives or policies would be useful to enhance water conservation and lower operating costs by cutting down water use.

Table 1.3.4
Profile of Selected mixed-use establishment in terms of Water Usage Patterns – Water consumption for the past 12 months

Water Usage Patterns – Water consumption for the past 12 months	Frequency	Percent
Increasing	9	34.6
Decreasing	17	65.4
Total	26	100.0

Table 1.3.4 presented the changes in water consumption patterns among 26 commercial establishments over the past 12 months. The data indicated that most respondents, 17 establishments or 65.4%, reported decreased water consumption during the past year. In contrast, nine establishments, or 34.6%, experienced increased water usage.

The decrease in water use at most facilities could be due to operational changes that include operating hours, the implementation of more efficient cleaning practices or external considerations such as regulatory actions and higher water prices. However, this idea seemed to be in contrast to data from Table 1.3.3 that indicated a small percentage of establishments (11.5%) as those having installed water-saving devices. This implied that some shift in behavior or administration, rather than structural interventions, had led to declines in water use. However, the 34.6% of facilities indicating that water use had increased may have resulted from growth in operations or demands for production, or less focus on efficiency measures. Taken together, these results indicated that drivers of both increasing and decreasing water use should be investigated further and sustainable water practices encouraged among commercial premises.

Table 2.1
Wastewater Management Practices in terms of Wastewater Characteristics - RESIDENTS

Water Characteristics	Mean	Interpretation
I have smelled a foul odor from the building's drains, sinks, or toilets.	3.26	Strongly Agree
I have seen water from sinks, toilets, or drains that looks dirty, yellowish, or cloudy.	2.80	Agree
I have noticed grease, oil, or floating substances in the water from sinks or drains.	3.02	Agree
I have seen or heard about checks to test wastewater quality (e.g., for dirt, chemicals, or bacteria) before it goes to the drainage.	2.98	Agree
I have not experienced drainage problems like slow-draining water, clogged pipes, or Wastewater backing up in the building.	2.93	Agree
Water Characteristics Weighted Mean	3.00	Agree

Table 2.1 shows the respondents' opinions about water condition and drainage problems in their buildings. The bad odour from drains, sinks or toilet is the most frequent issue withthe highest mean score (3.26). This suggested that many buildings had odour problems that were potentially linked to wastewater or not enough ventilation.

Other problems reported were the presence of grease or floating substances in drains (mean = 3.02), awareness of wastewater quality checks (mean = 2.98), and slow drainage or clogging (mean = 2.93). The least common problem was dirty or cloudy water, but it was still observed by some respondents (mean = 2.80).

The overall weighted mean of 3.00 indicated on the average revealed that majority of the respondents believed that water and drainage problems were present in their buildings. This demonstrated the necessity of better maintenance as well as more effective wastewater management.

Table 2.2
Wastewater Management Practices in terms of Treatment Method – RESIDENTS

Treatment Method	Mean	Interpretation
The building has a wastewater treatment system that appears to be working.	3.16	Agree
The wastewater treatment system seems to remove dirt, odor, and other pollutants	3.06	Agree
The Wastewater appears to be treated before going into the drainage.	3.08	Agree
The wastewater treatment system is regularly checked and maintained.	3.12	Agree
The wastewater treatment system can handle the amount of Wastewater produced in this building.	3.05	Agree
Treatment Method Weighted Mean	3.09	Agree

Table 2.2 shows the responses to the question on types of building wastewater treatment facilities are presented in table 2.2 above. Total weighted mean was 3.09 to indicate that respondents generally agreed that the wastewater treatment systems were functioning properly.

All of the items fell into "Agree." The highest mean score was for having a functional wastewater treatment system (mean = 3.16). Respondents also expressed agreement that systems were regularly inspected and maintained (mean = 3.12), and wastewater was treated before releasing to environment (mean = 3.08).

Removal of pollutants (mean = 3.06) and capacity to treat the volume of wastewater (mean = 3.05), were likewise critically considered but not ranked as high. Generally, the results indicated that WTSs were successful to a reasonable extent, although better monitoring and performance practices could achieve increased certainty in these systems.

Table 2.3
Wastewater Management Practices in terms of Emerging Technologies – RESIDENTS

Emerging Technologies	Mean	Interpretation
The management is considering new ways to improve wastewater treatment.	3.03	Agree
The wastewater system works well even when more water is used in the building	3.08	Agree
Advanced or modern wastewater treatment methods are used here.	2.98	Agree
The wastewater system has been improved or upgraded in the past three years.	2.98	Agree
Smart sensors or automatic systems are used to monitor wastewater quality.	2.91	Agree
Emerging Technologies Weighted Mean	3.00	Agree

Table 2.3 shows the respondents' views on the use of new technologies in wastewater treatment in their buildings. The overall weighted mean was 3.00, which meant that respondents generally agreed that some new practices were being used, but only to a limited extent.

The system's capacity to function properly in periods of peak water demand (mean = 3.08) received the highest rating. This indicated that people assumed the system could cope with more demand. Respondents also commonly perceived willingness of management to experiment with newer technologies for effective treatment of wastewater (mean = 3.03).

Other factors such as advanced treatment applications and system recent upgrades (mean = 2.98) received intermediate scores, suggesting they were not widely implemented or very apparent to respondents. Lowest rated was the use of smart sensors and/or automated measurement systems (M = 2.91), suggesting there seems not to have been much use in these technologies or are not represented in the building yet.

In general, the results suggested that although some novel water technologies had been used or considered systems approaches to their application and use were in evidence pi; adoption of advanced and smart technologies was limited. This underscored the need for additional investments in new technologies and higher awareness to improve—and ensure long-term sustainability of—wastewater treatment.

Table 2.4
Wastewater Management Practices in terms of Resource Recovery – RESIDENTS

Resource Recovery	Mean	Interpretation
Some treated wastewater is reused for cleaning, watering plants, or flushing toilets.	3.12	Agree
The wastewater system helps reduce the use of fresh water.	2.99	Agree
Waste materials like grease or sludge are collected and reused instead of thrown away.	2.97	Agree
The management encourages saving water and reusing treated Wastewater.	3.08	Agree
The building has programs to reduce the amount of Wastewater produced.	3.10	Agree
Resource Recovery Weighted Mean	3.05	Agree

The responses to resource recovery issues relevant to wastewater reuse and conservation by the respondents in their buildings are summarized in Table 2.4. The overall weighted mean was 3.05 or moderate, indicating that respondents generally agreed that some sustainable practices were implemented.

The most accepted reuse practice (use of treated wastewater to clean, water plants or flush toilets) had an average score of 3.12. That showed that water reuse was already occurring to some extent, in a few buildings for non-drinking purposes. For all respondents, it was also agreed that there is encouragement for the reduction of wastewater (mean = 3.10) and management has encouraged the saving and reuse of treated water (mean = 3.08).

Reuse of waste products as grease or sludge (mean = 2.97) and consumptive use of freshwaters being reduced (mean = 2.99) were rated among the least practiced practices. This suggested that these app uses were either rare or less visible. In general, it was demonstrated that fundamental/chemical principles of pulp mill disintegration were accurate. Water reuse and conservation practices were present. However, more advanced resource recovery methods needed more support and awareness to be widely adopted.

Table 2.5
Wastewater Management Practices in terms of Regulatory Frameworks – RESIDENTS

Regulatory Frameworks	Mean	Interpretation
The building follows government rules on wastewater disposal.	3.10	Agree
Regular water quality tests are done to follow government regulations.	3.07	Agree
Government authorities inspect the wastewater system in this building	3.08	Agree
The management is aware of wastewater disposal rules, such as DAO-2016-08.	3.10	Agree
The building has not received penalties for wastewater violations.	3.13	Agree
Regulatory Frameworks Weighted Mean	3.10	Agree

Table 2.5 presents the respondents' perceptions regarding their buildings' adherence to regulatory frameworks in wastewater management. The mean (95%CI) overall weighted was 3.10, Agree indicating broad recognition that regulatory standards and guidelines were observed. For the specific indicators, means were between 3.13 (building not penalized for wastewater violations) and 1.88 (building had won environmental awards). This spoke to a pattern of obedience and absence of major infractions, adding up in the optics sense.

Two significant factors contributed to the mean rating 3.10: compliance of management with government requirements on wastewater discharge and awareness level of management 352 Outcomes for wastewater discharges towards specific legislation such as including DAO-2016-08 that set criteria for water quality and effluent standards into the nature. These ratings indicated that respondents provided substantial acknowledgment to the institutional adherence as well as administrative responsibility, addressing environmental regulatory obligations.

A lower but still acceptable mean rating was reported for government's regularly testing water quality (mean = 3.07) and government inspections of wastewater systems (mean = 3.08). These remarks suggested that even if testing and external scrutiny had occurred, it might not have been as formalised or open to stakeholders or known to some respondents.

In general, the analyzed buildings could be shown to comply with the applicable laws and standards concerning wastewater. Yet equally moderate Agree ratings in relation to each indicator indicated room for enhancing compliance efforts through increased transparency, supporting stakeholder knowledge and systematically documenting both inspections and water quality testing.

Table 2.6
Wastewater Management Practices in terms of Sustainable Practices – RESIDENTS

Sustainable Practice	Mean	Interpretation
The building takes steps to reduce water use and wastewater production.	3.13	Agree
Water-saving devices (e.g., low-flow faucets, water-efficient toilets) are installed here.	3.04	Agree
Tenants and employees are encouraged to save water.	3.13	Agree
The wastewater treatment system is designed to use less energy and be environmentally friendly.	3.11	Agree
The management promotes sustainability in wastewater management.	3.10	Agree
Sustainable Practice Weighted Mean	3.10	Agree

Table 2.6 indicated the respondents' attitude on the application of sustainable wastewater management practices in their buildings. The aggregated weighted mean was 3.10 indicating that statement is a total agreed among the respondents as having an implementation of environment friendly only had less implementation with not so high level.

The most highly rated strategies included efforts to reduce water consumption and wastewater (mean, 3.13) and promoting water saving among tenants and owners (mean, 3.13).

This demonstrated that conservation and awareness were actively being practiced. Respondents also supported that the wastewater treatment plant was energy-saving (mean = 3.11).

Management's promotion of sustainability (mean = 3.10) and the use of water-saving appliances such as low-flush fixtures (mean = 3.04) also received relatively low scores. This served to indicate that actions taking place with respect to behaviour and policy were more obviously on display than any physical improvements to the facilities themselves. Generally, the findings revealed that sustainable wastewater management measures were lowly practiced. But more would be achieved by better technology and infrastructure.

Table 2.7
Wastewater Management Practices in terms of Community Involvement and Education – RESIDENTS

Community Involvement and Education	Mean	Interpretation
Residents, tenants, and workers receive information about proper wastewater disposal.	3.14	Agree
There are signs or reminders about saving water in the building.	3.06	Agree
The management provides training or information about wastewater management	3.04	Agree
People in this building report leaks, clogged drains, or plumbing problems to the management	3.11	Agree
Residents are encouraged to take part in improving wastewater management.	3.24	Agree
Community Involvement and Education Weighted Mean	3.12	Agree

Table 2.7 presents the respondents' perceptions regarding community involvement and education on wastewater management. The overall weighted mean was 3.12, as Agree, and this means a relatively good opinion that actions of awareness and involvement are practiced within their building.

The most highly endorsed item was 'Residents are encouraged to be involved in improving the way that wastewater is managed' (mean score = 3.24). This indicated a high level of support for participatory action and implied that the attempt to engage building occupants in environmental activities was acknowledged and appreciated.

Respondents also indicated that residents, tenants, and workers got information on how to dispose of wastewater correctly (mean = 3.14) and reported leaks, clog drains or plumbing leaks to management (mean = 3.11). These results suggested that functional communication and feedback existed between management and caretakers.

On the attainment of signs or indications about saving water and training on sewage procedure issues by management, though still high they recorded lower agreement averaged scores (mean = 3.06 and mean = 3.04). This finding indicated that passive informational resources and planned training activities were under-represented or less emphasized than hands-on experience and informal communication.

In general, the results showed that community education and participation were included in wastewater management measures with participatory methods and communication as focus points. Nevertheless, there were openings to enhance formal training and awareness of educational materials to encourage continued engagement and development of a stronger environmental ethic.

Table 2.1.1
Wastewater Management Practices in terms of Wastewater Characteristics – EMPLOYEES

Water Characteristics	Mean	Interpretation
I am aware of the wastewater management system used in this building.	3.38	Strongly Agree
I have received training or information on how to manage Wastewater properly	2.88	Agree
There is a designated team responsible for wastewater management in this building.	3.35	Strongly Agree
I am familiar with how Wastewater is treated before it is discharged.	3.23	Agree
I know the procedures to report or address wastewater issues in the building.	3.15	Agree
Water Characteristics Weighted Mean	3.30	Agree

Table 2.1.1 shows the respondents' level of awareness about wastewater management practices in their buildings. The total weighted mean was 3.30 indicating that respondents agreed aware of wastewater management in their buildings.

The awareness of wastewater management system utilized in the building had the highest mean value of 3.38. Respondents similarly indicated a strong agreement that wastewater management was the responsibility of a specific formal group (mean = 3.35). This suggested to the scientists that there were already wastewater systems and personnel in place in many buildings, and their occupants knew about them.

A couple of other items received somewhat lower evaluations, but were still within the Agree range. An average of respondents knew treatment process and how to report problems related with wastewater were 3.23 and 3.15, respectively. The least rating was for provision a training or information on sanitary waste handling (mean = 2.88).

On the whole, as it is seen that the respondents were aware of how waste water was being managed in their buildings. But the results also indicated that a little more training and some information would certainly improve on doing things right with waste waters.

Table 2.2.1
Wastewater Management Practices in terms of Treatment Method – EMPLOYEES

Treatment Method	Mean	Interpretation
The building has a functional wastewater treatment system.	3.15	Agree
The wastewater treatment system is regularly checked and maintained.	3.31	Strongly Agree
The wastewater treatment system effectively removes pollutants.	3.23	Agree
The Wastewater is properly treated before it is discharged into the drainage.	3.19	Agree
The wastewater treatment system can handle the volume of Wastewater generated in this building.	3.08	Agree
Treatment Method Weighted Mean	3.19	Agree

Table 2.2.1 shows the respondents' evaluation of wastewater treatment methods in their buildings. The emphasis was placed on the degree of operation of the system, its servicing and how effectively it treated wastewater. The mean weighted was 3.19, which indicated the respondents felt a general satisfaction regarding the performance of wastewater treatment system.

The best items were that the wastewater treatment system was inspected and maintained (mean 3.31). This indicated that those surveyed felt the gear got appropriate care and maintenance attention.

Other items were also endorsed by Agree. The system was perceived to do the job of taking up pollutants and aesthetic contaminants removed (mean = 3.23); treating wastewater before its discharge generally in effective manner (mean =3.19), was operational (mean= 3.15) and having its capacity to handle wastewater produce by them (mean 3.08).

Altogether, the results indicated that respondents were content with their building's wastewater treatment facility. Although the performance and perception of the system were sufficient and satisfying other potential enhancements could be further developed residents' understanding of it.

Table 2.3.1
Wastewater Management Practices in terms of Emerging Technologies – EMPLOYEES

Emerging Technologies	Mean	Interpretation
The management is considering or has invested in newer wastewater treatment technologies.	3.19	Agree
The wastewater system can handle increased water usage over time.	3.31	Strongly Agree
Modern wastewater treatment methods (e.g., Sequencing Batch Reactor) are used in the building.	3.15	Agree
The wastewater system has undergone upgrades or improvements in the past three years.	3.00	Agree
Smart sensors or automated systems are used to monitor wastewater quality.	3.04	Agree
Emerging Technologies Weighted Mean	3.14	Agree

Table 2.3.1 highlights how respondents perceived the adoption of new wastewater technologies by their building. The average for this statement was 3.14, indicating that in general respondents agreed that some steps were being taken to accomplish this goal.

The item-total correlation showed that the wastewater system has capacity to withstand more water in the long run (mean = 3.31). This indicated that participants perceive the system to be capable of accommodating higher water use in the future.

Respondents also agreed that management was exploring new technologies, that treatment used at present is of modern design, that some monitoring systems had been installed and upgraded in recent years.

Overall, the findings indicated that many of the buildings were beginning to upgrade wastewater systems and while there was limited penetration of advanced or smart technology, it could be further developed.

Table 2.4.1
Wastewater Management Practices in terms of Resource Recovery – EMPLOYEES

Resource Recovery	Mean	Interpretation
Some treated wastewater is reused for cleaning, watering plants, or flushing toilets.	2.73	Agree
The wastewater treatment system contributes to water conservation efforts.	3.00	Agree
Waste materials (e.g., grease, sludge) are collected and repurposed instead of discarded.	3.12	Agree
Management encourages water conservation and wastewater reuse practices.	3.19	Agree
The building has initiatives to reduce the amount of Wastewater produced.	3.19	Agree
Resource Recovery Weighted Mean	3.05	Agree

Table 2.4.1 shows how respondents viewed resource recovery and water-saving practices in their buildings. The overall mean was 3.05, which showed that respondents indicating respondents agreed to some extent that conserving water was taking place.

The highest-rated items indicated that water saving, and wastewater reuse were encouraged by management, and initiatives to reduce the wastewater. This served as a promotional tool of sorts for building management to advocate water conservation. Respondents also concurred that wastes, such as grease and sludge were recycled in one form or another. They believed that the wastewater treatment system could partially contribute to decreased water use.

The reuse of treated wastewater for cleaning, irrigation, or flushing toilets was the least popular item. This indicated that direct reuse of used water was not prevalent or not perceptible in many buildings. In general, it was possible to note that there were basic water-saving measures predominating in the company, especially those promoted by management. But in fact practice of recycled water consumption would deserve some better development, promotion, and information.

Table 2.5.1
Wastewater Management Practices in terms of Regulatory Frameworks - EMPLOYEES

Regulatory Frameworks	Mean	Interpretation
The building follows government regulations on wastewater disposal.	3.35	Strongly Agree
Regular water quality tests are conducted to comply with environmental laws.	3.23	Agree
Government authorities inspect the wastewater system in this building.	3.19	Agree
The management is informed about wastewater disposal regulations, such as DAO-2016-08.	3.42	Strongly Agree
The establishment has not received penalties for violations related to improper wastewater management.	3.04	Agree
Regulatory Frameworks Weighted Mean	3.25	Strongly Agree

Table 2.5.1 shows the respondents' perception of how much their buildings complied with government regulations pertaining to wastewater management. The grand total mean score was 3.25, indicating that respondents agreed strongly that their buildings were complying with these regulations.

The most knowledge was among the questions regarding management's knowledge of wastewater rules like DAO-2016-08 (mean = 3.42). This made it so that building management would have known what the government required and had helped assure that they were followed. Respondents were also highly confident that the rules and regulations for disposal of wastewater were followed in people's buildings (mean = 3.35).

Consistent and favorable ratings were also reported for other items. Participants had the perception that regular water quality testing was carried out (mean = 3.23), while government inspections occurred (mean = 3.19). These sorts of practices have been there but not everyone is aware of them. The lowest-rated item was related to no penalties for wastewater violations (mean = 3.04). This indicated but didn't prove that violations never occurred but penalties were infrequent.

Generally, most buildings complied with the wastewater regulations and management emerged as an important factor influencing this relationship. But inspections and water testing could be more overt to bolster confidence in compliance.

Table 2.6.1
Wastewater Management Practices in terms of Sustainable Practices – EMPLOYEES

Sustainable Practice	Mean	Interpretation
The management takes steps to reduce water consumption and wastewater production.	3.15	Agree
Water-saving devices (e.g., low-flow faucets, water-efficient toilets) are installed.	3.23	Agree
Employees and tenants are encouraged to participate in water conservation programs.	3.27	Agree
The wastewater treatment system is designed to be energy-efficient and eco-friendly	3.15	Agree
The management actively promotes sustainability in wastewater management.	3.23	Agree
Sustainable Practice Weighted Mean	3.21	Agree

Table 2.6.1 indicates what the respondents think about sustainable wastewater management options in their buildings. The mean was 3.21, which suggests that most people agreed that it is done and sustainable.

The top article was that personnel and residents were asked to conserve water (mean = 3.27). That meant there were others in the building constantly reminding each other to save water.

Respondents also agreed on water saving devices and management of safe keepers with 3.23 means each. This suggested a mix of physical improvements in buildings, such as low-flow faucets, and some kind of management being good for environmental practices. Overall, the results showed that sustainable wastewater practices were present in the buildings, especially through water-saving efforts and management support.

Respondents also agreed that management took steps to limit water use and wastewater generated, the wastewater treatment system was energy efficient and environmentally friendly (= 3.15). This indicated that the respondents were confident about the management's efforts and system design.

In general, responses indicated that most of the respondents shared the same opinion regarding adopting sustainable practices in their buildings. None of the lowest items were even in the "Strongly Agree" range, though they were close to it. This indicated that sustainable work practices were continuously followed. The trial revealed that buildings already met a strong base in environmental responsibility, but was far from as good as it could be with the use of better technology, control and communication.

Table 2.7.1
Wastewater Management Practices in terms of Community Involvement and Education – EMPLOYEES

Community Involvement and Education	Mean	Interpretation
Employees and tenants receive information about proper wastewater disposal.	3.31	Strongly Agree
Signs and reminders about water conservation are placed around the building.	3.27	Strongly Agree
The management provides training or awareness programs on wastewater management.	3.12	Agree
There are clear procedures for reporting leaks, blockages, or wastewater issues.	3.27	Strongly Agree
The community is encouraged to participate in improving wastewater management practices.	3.35	Strongly Agree
Community Involvement and Education Weighted Mean	3.26	Strongly Agree

Table 2.7.1 details of the respondents' opinion on community participation and education related to wastewater treatment, (Table 2.7.1.) The mean overall score was 3.26, meaning respondents strongly agreed that people in the building were informed as well as involved. It also meant that the communication and involvement work was working.

The most rated statement indicates that the community was motivated to contribute in improving wastewater management (mean = 3.35). This indicated that tenants, workers and others had felt a part of these efforts.

Respondents also most strongly agreed with that mobilized the information of suitable way to dispose of wastewater was provided (mean = 3.31), visibility‚Äôs of signs and reminders with water conservation attitude mean = 3.27, clear procedures for reporting leaks or drainage problems mean = 3.27. That indicated that communication and reporting systems were functioning properly. The weakest rated item was the management to conduct formal training or awareness programs (mean = 3.12). This indicated that this rating could be improved even though it was still scored as Agree. In general, the responses indicated that the community was informed and engaged. Issuing more formal training, though, may even amplify visibility and engagement.

Table 2.7.2
Comparison of Residents' and Employees' Perceptions on Wastewater Management Practices

Dimension	Residents – General Perception	Employees – General Perception	Key Comparison Insight
Wastewater Characteristics	Agree (WM ≈ 3.00); issues such as foul odor and drainage problems were commonly experienced	Agree to Strongly Agree (WM ≈ 3.30); high awareness of systems and procedures	Employees showed higher awareness and system familiarity, while residents reported more direct experiential issues
Treatment Methods	Agree (WM ≈ 3.09); systems perceived as functional and maintained	Agree (WM ≈ 3.19); stronger confidence in maintenance and pollutant removal	Employees rated treatment effectiveness and maintenance slightly higher
Emerging Technologies	Agree (WM ≈ 3.00); technologies perceived as present but limited	Agree (WM ≈ 3.14); higher confidence in system capacity and modernization	Employees perceived stronger adoption and readiness for future demand
Resource Recovery	Agree (WM ≈ 3.05); visible reuse of treated wastewater for non-potable purposes	Agree (WM ≈ 3.05); stronger emphasis on management-led conservation programs	Both groups agreed on practices, but employees emphasized institutional initiatives
Regulatory Frameworks	Agree (WM ≈ 3.10); compliance acknowledged but moderately rated	Strongly Agree (WM ≈ 3.25); strong confidence in regulatory adherence	Employees showed greater confidence in compliance and regulatory awareness
Sustainable Practices	Agree (WM ≈ 3.10); focus on conservation behavior	Agree (WM ≈ 3.21); stronger recognition of infrastructure and management actions	Employees perceived sustainability efforts as more embedded
Community Involvement & Education	Agree (WM ≈ 3.12); participation encouraged but training less visible	Strongly Agree (WM ≈ 3.26); strong communication and participatory engagement	

Table 3.1
ANOVA Results of Waste Management Practices when grouped according to Water Characteristics- RESIDENTS

Water Characteristics – RESIDENTS	F	Sig.	Interpretation	Null Hypothesis Decision
Business/Household Size	2.026	.135	Not Significant	Accept the Null Hypothesis
Type of Business Operations	.461	.631	Not Significant	Accept the Null Hypothesis

The analysis of variance for whether the waste management practices of respondents living in residential areas differed by household size and operation type was formulated as table 3.1 below reflects. Results: RM-ANOVAs revealed no differences.

Household size had a calculated F-value of 2.026 and p-value of 0.135. The null hypothesis was not rejected because the p-value was greater than 0.05. This implied that small, medium and large households had similar waste disposal behavior.
For type of operation, the F-value is 0.461 (p = 0.631) where no differences were also noted. In general, there was little variation in (* P < 0.05) how residential respondents disposed of waste between household size and operation type.

Table 3.1.1
ANOVA Results of Waste Management Practices when grouped according to Treatment Methods – RESIDENTS

Treatment Methods – RESIDENTS	F	Sig.	Interpretation	Null Hypothesis Decision
Business/Household Size	.514	.599	Not Significant	Accept the Null Hypothesis
Type of Business Operations	.095	.910	Not Significant	Accept the Null Hypothesis

Table 3.1.1 shows the ANOVA results on whether waste treatment practices of residential respondents differed based on household size and type of operation. The results showed no significant differences.

The results regarding the household size was F = 0.514, p=0.599. Because p-value was greater than0.05 the null hypothesis approved. This implied that the treatment for small, medium and large is small.

In type of operation, the F-value was 0.095 with a p-value of 0.910 indicating no significant difference as well. In general, these findings indicated that the residential waste treatment practices were uniform in all the clusters irrespective of farm size or type.

Table 3.1.2
ANOVA Results of Waste Management Practices when grouped according to Emerging Technologies – RESIDENTS

Emerging Technologies – RESIDENTS	F	Sig.	Interpretation	Null Hypothesis Decision
Business/Household Size	1.591	.206	Not Significant	Accept the Null Hypothesis
Type of Business Operations	.636	.530	Not Significant	Accept the Null Hypothesis

Table 3.1.2 showed the ANOVA results on whether the use of new or emerging waste management technologies among residential respondents differed based on household size and type of operation. The results showed no significant differences.

For household size, the F-value was 1.591 and the p-value was 0.206. Since the p-value was higher than 0.05, the null hypothesis was accepted. This meant that the use of new technologies was similar for small, medium, and large households. Type of operation had an F-value of 0.636, a p-value =0.530 (also showed no difference). In general, the results indicated that differences in perception and practice bars regarding scans for new waste management technologies were slight among the residential respondents of different family size and agriculture operation types.

Table 3.1.3
ANOVA Results of Waste Management Practices when grouped according to Resource Recovery – RESIDENTS

Resource Recovery – RESIDENTS	F	Sig.	Interpretation	Null Hypothesis Decision
Business/Household Size	.670	.513	Not Significant	Accept the Null Hypothesis
Type of Business Operations	4.732	.010	Significant	Reject the Null Hypothesis

Multiple Comparisons							
Tukey HSD							
Dependent Variable	(I) Resource Recovery Weighted Mean	(J) Resource Recovery Weighted Mean	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Business/Household Size	Disagree	Agree	.009	.078	.993	-.18	.19
		Strongly Agree	-.073	.086	.674	-.28	.13
	Agree	Disagree	-.009	.078	.993	-.19	.18
		Strongly Agree	-.082	.073	.505	-.25	.09
	Strongly Agree	Disagree	.073	.086	.674	-.13	.28
		Agree	.082	.073	.505	-.09	.25
Type of Business Operations	Disagree	Agree	-.112*	.042	.022	-.21	-.01
		Strongly Agree	-.018	.046	.918	-.13	.09
	Agree	Disagree	.112*	.042	.022	.01	.21
		Strongly Agree	.094*	.039	.047	.00	.19
	Strongly Agree	Disagree	.018	.046	.918	-.09	.13
		Agree	-.094*	.039	.047	-.19	.00
*. The mean difference is significant at the 0.05 level.							

Table 3.1.3 presents the ANOVA results examined whether resource recovery behaviour between residential respondents was different in terms of Business / Household Size and the Type of Business Operations Table 3-15 Nagler: Get Copyright Permission RTWF Screen View I41 ii from BUSINESS PEOPLE? Business/Household Size was not found to be a significant factor according the ANOVA results (F = 0.670, p = 0.513) which meant that the null hypothesis was accepted and confirmed that small, medium and large households participated equally in resource recovery practices.

Type of Business Operations, on the other hand, recorded a significant F-value (F = 4.732; p = < 0.010), then null hypothesis was rejected. Tukey HSD post hoc comparisons indicated that the modality of agreement was different between disagree and agree (mean difference = 0.112, p = 0.022) as well as strongly agree (mean difference = 0.094, p = 0.019). These observations indicated the lower activities of resource recovery among participants in mixed commercial types relative to those in mixed residential ones. Overall, the findings indicated that while household size did not influence resource recovery practices, operational classification played a significant role, emphasizing the need for more targeted sustainability initiatives in mixed commercial environments.

Table 3.1.4
ANOVA Results of Waste Management Practices when grouped according to Regulatory Frameworks – RESIDENTS

Regulatory Frameworks – RESIDENTS	F	Sig.	Interpretation	Null Hypothesis Decision
Business/Household Size	1.139	.322	Not Significant	Accept the Null Hypothesis
Type of Business Operations	.055	.947	Not Significant	Accept the Null Hypothesis

Table 3.1.4 presents the ANOVA results examining if the regulatory environment in the waste management activities of household respondents varied by Business/Household Size and Type of Business Operations. For both factors the difference was found to be statistically non-significant in the present study.

In the case of Business/Household Size, F-value was 1.139 with a p-value as 0.322, which in turn is found to be greater than significance level (0.05) and hence null hypothesis is accepted. It meant that the small, medium and large domestic consumers had not very different regulatory environments. Similarly, the Type of Business Operations yielded an F-value of 0.055 with a p-value of 0.947, also indicating no significant difference. Overall, the findings suggested that regulatory frameworks among residential respondents was consistent regardless of household size or operational classification, likely reflecting standardized regulatory requirements and shared enforcement practices across residential settings.

Table 3.1.5
ANOVA Results of Waste Management Practices when grouped according to Sustainable Practices – RESIDENTS

Sustainable Practices – RESIDENTS	F	Sig.	Interpretation	Null Hypothesis Decision
Business/Household Size	1.184	.308	Not Significant	Accept the Null Hypothesis
Type of Business Operations	.570	.567	Not Significant	Accept the Null Hypothesis

Table 3.1.5 presents the ANOVA findings in the total composite waste management practices between foundation respondents by Business/Household Size and Type of Business Operations. It can be said from the study that Business/Household Size was not a statistically significant factor, and therefore general waste management practice is constant in small, medium and large households.

Type of Business Operations, however, had a significant difference in Total Waste Management performance. The findings of the study also showed that mixed commercial residential respondents have significantly lower waste management performance than their primarily residential counterparts, the implication being that operational context plays a role in predicting waste behavior.

In general, the study established that household size had no role in determining waste management practices but operational category had a big influence. This suggested that multi commercial residential properties may need more tailored interventions and policies to address specific circumstances influencing their effectiveness at waste management.

Table 3.1.6
ANOVA Results of Waste Management Practices when grouped according to Community Involvement and Education – RESIDENTS

Community Involvement and Education – RESIDENTS	F	Sig.	Interpretation	Null Hypothesis Decision
Business/Household Size	.754	.472	Not Significant	Accept the Null Hypothesis
Type of Business Operations	.371	.691	Not Significant	Accept the Null Hypothesis

The ANNOVA Table 3.1.6 presents whether the mediating role of community participation and education on waste management were significantly different among residential respondents based on the size of a household and type operation. It was found that no significant differences existed.

For family size, the F-value was 0.754; p= 0.472. Regarding the type of operation, F-value was 0.371, p = 0.691. Since both of the p-values were more than 0.05, the null hypotheses were retained.

In summary, community involvement, and access to waste management education among residential respondents were similar, regardless of household size or type of operation. It indicated that education and promotion were offered uniformly within residential areas.

Table 3.2
ANOVA Results of Waste Management Practices when grouped according to Water Characteristics – EMPLOYEES

Water Characteristics – EMPLOYEES	F	Sig.	Interpretation	Null Hypothesis Decision
Business/Household Size	1.954	.164	Not Significant	Accept the Null Hypothesis
Type of Business Operations	2.496	.104	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - Monthly consumption in cubic meters	.016	.984	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - peak water usage time	.111	.896	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - primary uses of water	.224	.801	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - saving device or system	.224	.801	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - water consumption for the past 12 months	.277	.760	Not Significant	Accept the Null Hypothesis

Table 3.2 presents The ANOVA test is shown in Table 3.2 comparing waste management practices by employees, apart and when grouped according to Business/Household Size, Type of Business Operations and water usage characteristics. The comparison results indicated no statistically different outcomes in all variables.

Business/ Household size: The F-value is 1.954, p<0.05 Type of Business Operations: The calculated F value is 2.496 with a probability value of 0.104 both greater than 0.05 significance level respectively. So also in the w ater usage-related variables none of them was significant as we obtained p-values : 0.984 for monthly water consumption, 0.896 for peak usage time, 0.801 for primary purpose fo r using water, 0.801 for presence of devices to sa ve water and 0.760 for changes in consumpti on during the past year.

In general, our results showed that there was similar waste management practices for employees between process environment and water conservation using patterns in the plant, implying the impact of standardized workplace regulations and common operation.

Table 3.2.1
ANOVA Results of Waste Management Practices when grouped according to Treatment Methods – EMPLOYEES

Treatment Methods – EMPLOYEES	F	Sig.	Interpretation	Null Hypothesis Decision
Business/Household Size	.141	.666	Not Significant	Accept the Null Hypothesis
Type of Business Operations	.608	.553	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - Monthly consumption in cubic meters	.183	.834	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - peak water usage time	.044	.957	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - primary uses of water	.533	.594	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - saving device or system	.533	.594	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - water consumption for the past 12 months	.845	.442	Not Significant	Accept the Null Hypothesis

Table 3.2.1 presents the ANOVA results examining whether waste management practices related to treatment methods among employees differed when grouped by Business/Household Size, Type of Business Operations, and various water usage characteristics. The analysis showed no statistically significant differences across all variables.

In case of Business/Household Size, F-value computed was 0.141 with p-0.666 and Type of Business Operations the F-value calculated was 0.608 along with a p- value at 0.553 (Table 3) which are above the significance level of percentage i.e., 5 %.

It was the same for all water usage–related variables – no significant impact as well, whether this concerned monthly water consumption ($F = 0.183$, $p = 0.834$), peak hour of consumption ($F = 0.044$, $p = 0.957$), primary use and the existence of water-saving devices at home (both $F = 0.533$, $p = 0.594$) or changes in water consumption over past year ($F = 0.845$, $p=442$).

In general, the results suggested that employees had consistent wastewater treatment practices regardless of their work classification or water use behavior, implicating the impacts of prevalent systems, collective behaviors and institutional regulations in influencing workplace wastewater treatment behavior.

Table 3.2.2
ANOVA Results of Waste Management Practices when grouped according to Emerging Technologies – EMPLOYEES

Emerging Technologies – EMPLOYEES	F	Sig.	Interpretation	Null Hypothesis Decision
Business/Household Size	.405	.672	Not Significant	Accept the Null Hypothesis
Type of Business Operations	.013	.987	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - Monthly consumption in cubic meters	1.340	.281	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - peak water usage time	.512	.606	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - primary uses of water	.442	.648	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - saving device or system	.442	.648	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - water consumption for the past 12 months	2.342	.119	Not Significant	Accept the Null Hypothesis

Table 3.2 shows the ANOVA results on whether waste management practices of employees differed based on business size, type of operation, and water usage. The results showed no significant differences.

For company size or household size, the p-value was greater than 0.05 indicating that worker practices did not differ according to company size of small, medium and large enterprises. A similar finding was observed on the type of business activities in that there is no significant difference. None of the water usage factors were significantly different. This included the participant's monthly water consumption level, the peak time they used water, their major use of water, whether and how much they had used water-saving devices (if not: reasons), and any change in their use of water over the past year.

In general, it was found that the staff adopted almost identical waste management methods irrespective of business size, nature of operation and water utilisation. This indicated that general working norms and routine affected how waste is handled by employees.

Table 3.2.3
ANOVA Results of Waste Management Practices when grouped according to Resource Recovery – EMPLOYEES

Resource Recovery – EMPLOYEES	F	Sig.	Interpretation	Null Hypothesis Decision
Business/Household Size	.189	.829	Not Significant	Accept the Null Hypothesis
Type of Business Operations	.484	.634	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - Monthly consumption in cubic meters	2.025	.155	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - peak water usage time	.867	.434	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - primary uses of water	.708	.503	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - saving device or system	.708	.503	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - water consumption for the past 12 months	2.311	.122	Not Significant	Accept the Null Hypothesis

Table 3.2.3 presents the ANOVA results evaluating whether employee resource recovery practices varied significantly when grouped according to Business/Household Size, Type of Business Operations, and various water usage patterns.

The result shows none of the variables were able to make any statistically significant difference, since all listed in p-values of greater than 0.05 which is threshold for significance.

The findings revealed that the Business/Household Size had an F value of 0.189 with a (p-value) of 0.829 and Type of Business Operations given F= 0.484 and p=0.634. These results further revealed that there was no significant difference in employee engagement in resource recovery based on scale of household as well as the type of business operations, thereby leading to acceptance of null hypotheses for both the variables.

Similar non-significant results were also observed when considering the two subgroups based on use of water. Monthly water consumption got F-value of 2.025 with P-value of 0.155, peak water usage time had an F-value equal to 0.867 whose P-value was = 0.434 and finally primary use of water obtained an F-value =.708 and its associated P-value below is shown in table1. Likewise, the use of water saving appliances and changes in consumption over 12 months did not have significant results having p-values of 0.503 and 0.122, respectively.

In general, the results indicated that participants behaved in a consistent manner toward resource recovery despite individual demographic differences or water use behaviors. The above consistency did not suggest to us that organizational measures of workplace resources were neither differentially applied to workplace settings nor emphasized among employee groups. The even spread of awareness and action illustrated a possible necessity to develop more focused approaches for the event of material discrimination or resource recovery upcycling with employees.

Table 3.2.4
ANOVA Results of Waste Management Practices when grouped according to Regulatory Frameworks – EMPLOYEES

Regulatory Frameworks – EMPLOYEES	F	Sig.	Interpretation	Null Hypothesis Decision
Business/Household Size	.268	.766	Not Significant	Accept the Null Hypothesis
Type of Business Operations	2.133	.141	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - Monthly consumption in cubic meters	.424	.659	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - peak water usage time	.172	.843	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - primary uses of water	.232	.795	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - saving device or system	.232	.795	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - water consumption for the past 12 months	.812	.456	Not Significant	Accept the Null Hypothesis

Table 3.2.4 shows the ANOVA results on whether employees' compliance with waste management regulations differed based on business size, type of operation, and water usage. The results showed no significant differences in all categories.
Among business or household size and type of operation, the p-values exceeded 0.05. That is, workers adhered to the same waste management policies regardless of company sizes/industries.

A similar pattern was observed for all water use characteristics (monthly water use, peak hour usage period, primary use of water, if a high efficiency device was used, and changes in behavior relative to control). No differences between these were found.
In general, the results indicated that all groups of workers followed waste management instructions with a high level of compliance. This implied that a common policy, clear guidelines and consistent implementation contributed to relatively consistent compliance amongst staff.

Table 3.2.5
ANOVA Results of Waste Management Practices when grouped according to Sustainable Practices – EMPLOYEES

Sustainable Practices – EMPLOYEES	F	Sig.	Interpretation	Null Hypothesis Decision
Business/Household Size	.285	.755	Not Significant	Accept the Null Hypothesis
Type of Business Operations	1.120	.343	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - Monthly consumption in cubic meters	.140	.870	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - peak water usage time	.028	.973	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - primary uses of water	2.110	.144	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - saving device or system	2.110	.144	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - water consumption for the past 12 months	.550	.550	Not Significant	Accept the Null Hypothesis

Table 3.2.5 shows whether sustainable waste management practices of employees were different based on business size, type of operation, and water usage. The results showed that there were no significant differences. This was possible because we

made every worker employ your same sustainable waste management plan, regardless of being a small, medium or large business -or being the type of business that you are.

The findings also revealed that water-use factors (i.e., how much water used, when peak consumption hours, the most frequently consuming activity, use of water-saving devices and whether there had been a change in using behaviors over past year) did not influence employee's sustainability practices.

In general, it was found that staff awareness and conduct regarding sustainability measures were of a similar nature. This hint that common work rules, training and policy guaranteed all employees reported a similar level sustainable practices across establishments.

Table 3.2.6
ANOVA Results of Waste Management Practices when grouped according to Community Involvement and Education – EMPLOYEES

Community Involvement and Education – EMPLOYEES	F	Sig.	Interpretation	Null Hypothesis Decision
Business/Household Size	.285	.755	Not Significant	Accept the Null Hypothesis
Type of Business Operations	1.120	.343	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - Monthly consumption in cubic meters	.140	.870	.973Not Significant	Accept the Null Hypothesis
Water Usage Patterns - peak water usage time	.028	.973	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - primary uses of water	2.110	.144	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - saving device or system	2.110	.144	Not Significant	Accept the Null Hypothesis
Water Usage Patterns - water consumption for the past 12 months	.550	.550	Not Significant	Accept the Null Hypothesis

Table 3.2.6 shows whether community involvement and education on waste management among employees were different based on business size, type of operation, and water usage. The results showed no significant differences. This is because no matter its size or variety of business, each enterprise has employees that have similar experiences and perceptions of involvement with the community and education – regardless how much water you use. In all cases, waste management education and community interventions were implemented similarly among the groups. Generally, community engagement and education programs reached employees equally.

XIV. Discussions

This chapter discussed the summary, conclusions and recommendations of the study on wastewater management practices of selected mixed-use establishments in Mandaluyong City. Attention at the analysis stage was given to interpreting findings, discerning trends and making sense of challenges and opportunities within existing practices. In addition, this section sought to make inferences from the collected information and offer recommendations appropriately. These findings were hoped to provide information that could be used through local stakeholders to develop better management of wastewater systems, improve compliance with environmental regulations, and contribute overall towards sustainability within the study area.

A. Summary of Findings, Conclusions, and Recommendations

This chapter discussed the summary, conclusions and recommendations of the study on wastewater management practices of selected mixed-use establishments in Mandaluyong City. Attention at the analysis stage was given to interpreting findings, discerning trends and making sense of challenges and opportunities within existing practices. In addition, this section sought to make inferences from the collected information and offer recommendations appropriately. These findings were hoped to provide information that could be used through local stakeholders to develop better management of wastewater systems, improve compliance with environmental regulations, and contribute overall towards sustainability within the study area.

B. Conclusions

One big finding of the study was how much water the commercial operations were consuming. Most of the buildings used more than 200 cubic meters of water per month, especially during nighttime. Just as the utilization mostly didn't go beyond washing and cleaning. But very few locations had any water-saving devices at all. Despite that, most respondents said that their water consumption had diminished in recent years — probably better habits or operations.
To maintain these gains, the study recommended adding water-saving appliances, such as low-flow faucets and dual flush toilets. This encouragement might be on a governmental level, such as through incentives or even building requirements, it was also suggested. Information campaigns and reminders that water savings had increased could nudge people to save water over the long term.

The study also found that the vast majority of buildings had wastewater treatment systems, and that those systems were functional. Workers were also more willing to trust the systems than residents, probably because employees did so much of the maintenance. This showed us that better communication – posting maintenance schedule, outcomes from inspections, updates to a system for residents.

Knowledge on new wastewater technologies was still low. Some buildings were employing classic systems such as SBRs, but many participants did not know if were installed. Awareness of smart surveillance systems was also poor. And it's not difficult to think of simple improvements that could be made, such as installing flow meters or leak alarms and training building property managers in how to do their jobs better than they have been.

A handful of buildings already recycled treated wastewater for cleaning or flushing, most commonly in residential areas. But commercial buildings were less active in reusing water. Policies promoting graywater systems and better management of grease and sludge could increase water conservation in such buildings.
Awareness on wastewater regulations like DAO 2016-08 was significantly higher among employees than residents. This was possibly due to employees being more engaged in compliance activities. To solve this, simplified orientations, posters and the visualization of test results and permits in public were suggested to ensure that residents stayed informed.
Sustainability was evident in the majority of buildings, but this was more about behaviours rather than technology. Workers saw other changes more directly, including water-saving fixtures and sustainability programs. The study suggested the introduction of systems such as rainwater harvesting, energy-efficient treatment technologies, supported or incentivized by local government units.

Community participation and education were higher on the side of employees than among residents. Employees were more likely to be aware of reporting procedures and see information resources. Training was less available to residents. Consistent orientations, posters and surveys may improve resident involvement.
Over all, the study found that good practices were already in place, including operating wastewater systems and some reuse efforts as well as public awareness of regulations. But it wasn't enough, as communication, infrastructure and activating the community remained improvements that needed to be made. This report formed the foundation of a more stringent and enhanced Water Quality Improvement Plan for city mixed-use structures.

C. Proposed Water Quality Improvement Plan

The proposed water quality improvement framework was thus introduced in this section, and arranged gradually from low investment–low yielding solutions to high cost–high impact plans. It emphasized actions that are low cost and result in immediate benefits, leading to high-cost programs and regulatory regimes. Recommendations were developed for addressing selected wastewater management deficiencies, taking into consideration financial achievability, anticipated ecological merit and transferability of implementation in different categories of facilities.

D. Information Dissemination, Capacity Building, and Community Feedback

The promotion of information flow and capacity building at the local level has been an important first stage to enhance wastewater management practices. It was hoped that this would alert stakeholders to their plight and lead to behavior change, especially among tenants, inhabitants, and property management.
Among the project activities were four quarterly orientation sessions, posting of visual aids in general areas such as inside elevators and on bulletin boards, and a series of publicly presented educational videos about basic wastewater handling practices. These

were developed in-house with administrative staff and resources or borrowed from existing environmental education kits offered by other government organizations. Securing a strong relationship with barangay captains and LGUs helped in successful implementation.

A year's supply of materials cost an average ₱3,000 to ₱5,000. This utilized already existing infrastructure and manpower and involved no capital investment, resulting in a ₱0.00 per sq.m./month cost. The intervention was initiated one month after planning and activities were repeated quarterly.

Following initial awareness generation, formal channels to interact and provide feedback were suggested. These included online surveys, QR codes, hotlines, and feedback drop boxes. These systems promoted transparency, accountability, and responsiveness. Implementation costs ranged from ₱2,000 to ₱4,000 with no capital investment required.

E. Enhancement of Wastewater Treatment Facilities

Strengthening the sewage treatment plants (STPs) was crucial to long-term wastewater management and regulatory compliance. Costs varied by building size and type. Large commercial buildings required approximately ₱9 million, large residential condominiums ₱6 million, and small to medium residential buildings ₱2.5 million. Savings, avoided penalties, and reuse opportunities differed by category, with larger buildings achieving faster payback periods. While small to medium residential buildings faced longer payback periods, joint funding or LGU support could improve feasibility. Overall, STP upgrades were shown to be a viable long-term investment for environmental compliance and sustainability.

F. Proposed Financial Feasibility Plan and Cost–Benefit Analysis

This section provided capital budgeting analysis using NPV, IRR, and payback period to assess economic feasibility across building types. Results showed positive NPVs and acceptable IRRs for large commercial and residential buildings, while small to medium residential buildings required additional CAPEX to become viable. Cost–benefit analysis further supported these findings, with benefit–cost ratios above 1.0 for large developments and below 1.0 for small to medium buildings. The comparative summary table consolidated financial indicators and decision bases, reinforcing the need for shared or subsidized funding models for smaller facilities.

4.3.1 For Large Commercial Establishment (15,000 sqm)

Year	Cash Flow (₱)	PV Factor @8%	Present Value (₱)	Cumulative CF (₱)
0	-9,000,000	1.00000	-9,000,000.00	-9,000,000
1	1,300,000	0.92593	1,203,703.70	-7,700,000
2	1,300,000	0.85734	1,114,540.47	-6,400,000
3	1,300,000	0.79383	1,032,002.01	-5,100,000
4	1,300,000	0.73503	955,538.81	-3,800,000
5	1,300,000	0.68058	884,758.16	-2,500,000
6	1,300,000	0.63017	819,220.52	-1,200,000
7	1,300,000	0.58349	758,537.51	100,000
8	1,300,000	0.54027	702,349.54	1,400,000
9	1,300,000	0.50025	650,324.84	2,700,000
10	1,300,000	0.46319	602,152.63	4,000,000
11	1,300,000	0.42888	557,548.73	5,300,000

12	1,300,000	0.39711	516,248.82	6,600,000
13	1,300,000	0.36770	477,998.17	7,900,000
14	1,300,000	0.34046	442,600.14	9,200,000
15	1,300,000	0.31524	409,815.05	10,500,000

The section provides an economic analysis of the proposed upgrade of sewage treatment plant (STP) in selected mixed-use facility at Barangay Wack Wack, Mandaluyong City. The objective of this analysis is to assess the economic impact of improving wastewater treatment plants using traditional capital budgeting tools, including Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period. These were used to evaluate whether the potential financial returns of planned interventions would cover the initial capital outlay and electronic/electrical upgrades for the remaining useful lifetime of a plant.

Assumptions:

Initial Investment (Year 0): ₱9,000,000

Annual Net Cash Inflow (Years 1–15): ₱1,300,000

Discount Rate: 8%

Remaining Useful Life: 15 years

Solutions

PV factor (8%, 15 yrs):

PV each year:

$$\boldsymbol{PV_t} = \frac{\boldsymbol{CF_t}}{(\mathbf{1}+\boldsymbol{r})^{\boldsymbol{t}}}$$

$$\frac{1-(1.08)^{-15}}{0.08} = 8.559$$

Present Value of Inflows:

$$PV = 1{,}300{,}000 \times 8.559 = ₱11{,}126{,}700$$

Net Present Value:

$$NPV = 11{,}126{,}700 - 9{,}000{,}000 = ₱2{,}126{,}700$$

$$IRR = r_1 + \left(\frac{PV - 9}{PV1 - PV2}\right)(r_2 - r_1)$$

Substitute:

Internal Rate of Return (IRR):

$$IRR \approx 10.6\%$$

Payback Period:

$$\text{Payback Period} = \frac{\text{Initial Investment}}{\text{Annual Net Cash Inflow}}$$

Payback Period: 9,000,000÷1,300,000 = 6.9 years

NPV of annual net cash in-flow has been calculated on the basis of annuity measure, with an assumption that cash inflows are uniform over a period of 15 years. At a discount rate of 8%, the annuity factor for present value of 8.559 was used to multiply adjusted annual net cash inflow to yield total present value of future benefits greater than initial investment. As a result, the NPV of the project was positive which means that discounted costs associated with benefits are enough to utilize the Planned project cost and for creating extra economic value.

The IRR, estimated by interpolation was greater than the assumed discount rate of 8%, indicating that the project has performed satisfactorily under traditional financial evaluation criterion. This establishes that the proposed STP upgrade would be financially feasible when realistic water reuse quantities and avoided regulatory expenses for large-scale Philippine developments are also factored into account.

The Payback Period was computed to be within the remaining fifteen-year useful life of the upgraded facility, indicating timely recovery of the initial investment. Based on the positive NPV, acceptable IRR, and reasonable payback period, the project satisfies standard capital budgeting acceptance criteria.

Altogether, the results show that the STP upgradation for large industries is economically viable and socially acceptable in Philippines. In addition to direct financial payback, the project continues long-term commitment toward regulatory compliance (EM), environmental protection and resource conservation, lending credence to its status as a sound infrastructure investment.

4.3.1 For Large Residential Establishment (10,000 sqm)

Assumptions :Initial Investment (Year 0): ₱6,000,000
Annual Net Cash Inflow (Years 1–15): ₱800,000
Discount Rate: 8%
Remaining Useful Life: 15 years

Year	Cash Flow (₱)	PV Factor @8%	Present Value (₱)	Cumulative CF (₱)
0	-6,000,000	1	-6,000,000.00	-6,000,000
1	800,000	0.92593	740,740.74	-5,200,000
2	800,000	0.85734	685,871.06	-4,400,000
3	800,000	0.79383	635,065.79	-3,600,000
4	800,000	0.73503	588,023.88	-2,800,000
5	800,000	0.68058	544,466.56	-2,000,000
6	800,000	0.63017	504,135.70	-1,200,000
7	800,000	0.58349	466,792.31	-400,000
8	800,000	0.54027	432,215.10	400,000
9	800,000	0.50025	400,199.90	1,200,000
10	800,000	0.46319	370,555.46	2,000,000
11	800,000	0.42888	343,106.91	2,800,000
12	800,000	0.39711	317,691.58	3,600,000
13	800,000	0.3677	294,158.88	4,400,000
14	800,000	0.34046	272,369.32	5,200,000
15	800,000	0.31524	252,193.82	6,000,000

Financial Indicators

PV Factor (8%, 15 yrs):

$$\frac{1-(1.08)^{-15}}{0.08} = 8.559$$

Present Value of Inflows:

$PV = 1{,}300{,}000 \times 8.559 = ₱11{,}126{,}700$
Net Present Value:

$NPV = 11{,}126{,}700 - 9{,}000{,}000 = ₱2{,}126{,}700$
Internal Rate of Return (IRR):

$IRR \approx 10.6\%$
Payback Period:

$9{,}000{,}000 \div 1{,}300{,}000 \approx 6.9$ years

The annual net cash inflow was discounted to present value based on the annuity method with equal periodic payment, over a fifteen-year analysis period. Using an 8% discount factor, the present value of ₱800,000 was multiplied by factor (annuity) of 8.559 to compute for the total present value of future benefits or ₱6,847,200. Substracting the initial investment of ₱6,000,000 generated a positive NPV of ₱847,200 (shown in the last row) which means that the discounted future benefits were sufficient to pay for cost of capital and provided incremental economic value.

The financial IRR is about 9.4% which is more than the discount rate of 8%, as assumed in this case. This means that the project is economically viable at its hurdle rate of return (that is, using standard capital budgeting criteria) and that feasible water reuse applications and avoided regulatory costs as in actual for large residential condominiums in the Philippine context are simply embedded.

The Payback Period was estimated at about 7.5 years which is far lower than the remaining fifteen-year useful life of the modified plant. On the basis of the project having a positive NPV, IRR greater than the discounting rate and an acceptable payback period, the project meets all major financial acceptance criteria. Together, all of these findings support the feasibility and acceptability of the above-mentioned proposed upgrade for big residential condominiums in the Philippines.

4.3.3 For Small to Medium Residential Buildings (5,000 sqm)

Assumptions

Initial Investment (Year 0): ₱2,500,000

Annual Net Cash Inflow (Years 1–15): ₱185,000

Discount Rate: 8%

Remaining Useful Life: 15 years

Year	Cash Flow (₱)	PV Factor @8%	Present Value (₱)	Cumulative CF (₱)
0	-2,500,000	1	-2,500,000.00	-2,500,000
1	185,000	0.92593	171,296.30	-2,315,000
2	185,000	0.85734	158,108.23	-2,130,000
3	185,000	0.79383	146,358.47	-1,945,000
4	185,000	0.73503	135,980.52	-1,760,000
5	185,000	0.68058	125,908.65	-1,575,000
6	185,000	0.63017	116,581.38	-1,390,000
7	185,000	0.58349	107,945.72	-1,205,000
8	185,000	0.54027	99,949.74	-1,020,000
9	185,000	0.50025	92,546.23	-835,000
10	185,000	0.46319	85,690.95	-650,000

11	185,000	0.42888	79,343.47	-465,000
12	185,000	0.39711	73,467.18	-280,000
13	185,000	0.3677	68,026.44	-95,000
14	185,000	0.34046	62,987.41	90,000
15	185,000	0.31524	58,319.39	275,000

Financial Indicators

PV Factor (8%, 15 yrs):

$$\frac{1-(1.08)^{-15}}{0.08}=8.559$$

Present Value of Inflows:

$$PV=185{,}000\times 8.559=₱1{,}583{,}415$$

Net Present Value:

$$NPV=1{,}583{,}415-2{,}500{,}000=(\mathbf{₱916,585})$$

Internal Rate of Return (IRR):

$$IRR\approx 3.9\%$$

Payback Period:

$$2{,}500{,}000\div 185{,}000\approx \mathbf{13.5\ years}$$

Additional Fund to cover the expenses and for acceptable NPV

Compute NPV (current situation)

$$NPV=PV\ of\ inflows-Initial\ Investment$$
$$NPV=1{,}583{,}415-2{,}500{,}000=(916{,}585)$$

NPV = (₱916,585) (negative)

Additional CAPEX=Initial Investment−PV of inflows

Additional CAPEX=2,500,000−1,583,415=916,585

Required Additional CAPEX = ₱916,585

Interpretation and Investment Decision (with CAPEX Requirement)

The financial evaluation indicated that the recommended STP expansion for small to medium residential facilities was not sustainable in economic terms individually. The NPV of the project was -₱916,585 and yielded an IRR less than the discounting rate of 8%, indicating that the expected savings would not be able to recoup the cost of investment under prevailing conditions.

Even though the payback period was 13.5years, which was close to the STP's useful life of 15years. That meant the building would not recoup the cost until near the end of the system's life, with virtually no financial upside.

And in order to make the project fiscally acceptable, additional financing was being sought. The study noted this would necessitate an additional contribution of ₱916,585 from residents, either through a larger CAPEX fund or special assessment. Combined with this additional source of, the equivalent project cost could be cut down to ₱1,583,415 and would result into a negative NPV value.

Any amount of additional contribution is tantamount to a positive NPV already, which would imply that the project at this point is financially feasible.

In general, the findings indicated that STP conversion on small to medium residential buildings was not financially feasible without joint sponsorship. This could be from the residents, support from the local government or a cost share with other developments close by. The results emphasized the difficulty of financing wastewater projects in small buildings and the need for group support to implement a successful project.

4.4 Cost–Benefit Analysis of Sewage Treatment Plant Upgrade Projects

A cost–benefit analysis (CBA) was also performed to evaluate the economic feasibility of the proposed STP up-gradations by comparing present value total benefits with present value total costs over a 15 years period. Compared with NPV, which looks at net value, CBA has the advantage of presenting an intuitive measure of economic efficiency: benefits relative to costs.

An 8% discount rate is assumed, and the present value annuity (PVA) of an 8.559 factor has been delivered for continuing annual benefits.

4.4.1 Large Commercial Establishment (15,000 sqm)

Costs (PV of Costs)

- Initial capital cost: ₱9,000,000
- Present Value of Costs (PVC): ₱9,000,000
- Annual net benefit: ₱1,300,000
- PV of Benefits = ₱1,300,000 × 8.559 = ₱11,126,700

Indicator	Value
PV of Benefits (PVB)	₱11,126,700
PV of Costs (PVC)	₱9,000,000
Net Benefit (PVB − PVC)	₱2,126,700
Benefit–Cost Ratio (BCR)	1.24

Interpretation

Since a BCR of greater than 1.00 then the discounted economic benefits of the project exceed its costs. This significant STP upgrade offers a return of investment (ROI) of around ₱1.24:1 and represents high economic viability in favor of the project which further validates its full-fledged approval.

4.4.2 Large Residential Condominiums (15,000 sqm)

Cost–Benefit Components

Costs (PV of Costs)

Initial capital cost: ₱6,000,000

Present Value of Costs (PVC): ₱6,000,000

Benefits (PV of Benefits)

Annual net benefit: ₱800,000

PV of Benefits = ₱800,000 × 8.559 = ₱6,847,200

Indicator	Value
Indicator	Value
PV of Benefits (PVB)	₱6,847,200
PV of Costs (PVC)	₱6,000,000
Net Benefit (PVB − PVC)	₱847,200

Interpretation

The B/C ratio is greater than 1, which means the project returns more benefits than costs during its life-time. Though the profit margin is smaller than for commercial facilities, results demonstrate that STP renewal in large scale of resident condominium can be cost-justifiable and operationally feasible even without external sublicense.

4.4.3 Small to Medium Residential Buildings (5,000 sqm)

Cost–Benefit Components

Costs (PV of Costs)

Initial capital cost: ₱2,500,000

Present Value of Costs (PVC): ₱2,500,000

Benefits (PV of Benefits)

Annual net benefit: ₱185,000

PV of Benefits = ₱185,000 × 8.559 = ₱1,583,415

PV of Benefits (PVB)	₱1,583,415
PV of Costs (PVC)	₱2,500,000
Net Benefit (PVB − PVC)	-₱916,585
Benefit–Cost Ratio (BCR)	0.63

Interpretation

If BCR is less than 1.00, costs of the project are more than the benefits generated by the same. This reinforces the finding above that an STP up-gradation for small to medium residential complexes is not financially feasible as a single investment. Actual roll out would likely become possible only with the introduction of alternative means of financing, such as residents' CAPEX contributions or LGU cofunding, CAs or both.

Table 4.1 Comparative Summary of STP Upgrade Scenarios for Mixed-Use Establishments by Building Type

Category	Large Commercial Establishments (15,000 sqm)	Large Residential Condominiums (10,000 sqm)	Small to Medium Residential Buildings (5,000 sqm)
Capital Cost	₱9,000,000	₱6,000,000	₱2,500,000
Implementation Timeline	6 months planning; 12–18 months construction	6 months planning; 12 months construction	3–6 months planning; 9–12 months construction
Dues Collection Efficiency	85–90%	90%	85%
Cost Allocation (₱/sqm/month)	₱10.00	₱10.00	₱8.33
Adjusted Annual Net Cash Inflow (Used in Feasibility)	₱1,300,000 / year	₱800,000 / year	₱185,000 / year
Analysis Horizon	15 years	15 years	15 years
Discount Rate	8%	8%	8%
Present Value of Benefits (PVB)	₱11,126,700	₱6,847,200	₱1,583,415
Net Present Value (NPV)	₱2,126,700	₱847,200	-₱916,585
Internal Rate of Return (IRR)	≈ 10.6%	≈ 9.4%	≈ 3.9%
Payback Period	≈ 6.9 years	≈ 7.5 years	≈ 13.5 years
Benefit–Cost Ratio	1.24	1.14	0.63

Financial Feasibility Result	Feasible – Accept	Feasible – Accept	Not feasible (standalone)
Best Application	High-usage sites	Vertical residential developments	clustered/shared wastewater systems
Funding Implication	Can be implemented without external subsidy	Can be implemented without external subsidy	Requires additional CAPEX ≈ ₱916,585,
Decision Basis	Positive NPV, IRR > discount rate, BCR > 1	Positive NPV, IRR > discount rate, BCR > 1	Negative NPV, IRR < discount rate, BCR < 1

XV. Implications of the Study

The results of this research study indicate that the practice of wastewater management in mixed used buildings at Mandaluyong City is still inadequate. Though many buildings have sewage treatment systems already, issues remain of awareness, coordination and carbon-consuming water-saving practices. This indicates that some environmental requirements, such as DAO 2016-08, are not well defined or hardly implemented at the building level. Consequently, clearer instruction and greater periodic oversight from local government units (LGUs) are necessary.

The findings also highlight the importance of building administrators and property managers in maintaining wastewater systems. While this may sound like motherhood, easy orientation and clear instructions — not to mention regular updates for residents and staff — appears to result in a deeper knowledge of how the system works and greater adherence to its care. It also helps to avoid problems in system and minimize possible environmental risks.

When it comes to money, the study indicates that size of building is a very big deal. In the general case, commercial buildings and/or highrise residential condominiums may upgrade to a sewage treatment facility. The financial analysis was favorable, meaning these buildings can fund upgrades without relying on additional funding. Small- and medium-sized residential buildings, however, are a bit more cash-strapped. In the case of these structures, additional intervention house-to-house or LGU-aided or a communal wastewater facility may be necessary before upgrading is feasible. This in turn suggests that the same rules and requirements may not be feasible for all buildings, which would mean a different response based on size/capacity of building.

The report also contends there are real, on-the-ground things that can be done to build in the sustainability such as recycling gray water and rainwater, incorporating performance measurement systems — and upgrading antiquated treatment facilities now in operation. These are more affordable options when costs can be shared in larger developments and your grey water recycling is up.Such measures not only reduce pollution and protect nearby water bodies.
This analysis indicates that successful water management is not just a matter of equipment. It also requires clear rules, good budgeting, periodic maintenance and willing cooperation by everyone in the building. By calculating the size of the building itself and how built-in and available in local situation, LGUs or property management can adapt wastewater systems that are feasible yet sustainable; particularly fast-growing cities like Mandaluyong City.

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