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Development of Multi-Criteria Assessment Tool on the Applicability of Trash Trap in Sto. Tomas Creek for Policy Improvement in Barangay Sto. Tomas, Lubao, Pampanga

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Abstract:

Solid waste management in the Philippines, especially in urban areas, was challenged by inadequate infrastructure and improper disposal practices, worsening the waste problem. The Ecological Solid Waste Management Act of 2000 promoted segregation and proper disposal as a potential solution. Innovative technologies like Trash Traps gained global attention to combat water pollution, but their effectiveness depended on solid policy frameworks. Plastic pollution posed significant threats to marine life, highlighting the importance of trash traps, which intercepted solid waste to improve water quality, capturing large and finer contaminants. To further assess the applicability of trash traps, the PESTLE framework was considered, encompassing political, environmental, social, legal, and economic hindrances. Barangay Sto. Tomas Lubao, Pampanga, was crucial for implementing effective remediation and preventive measures. Sto. Tomas Creek, situated near the inhabitants' houses, served as a natural absorber of floodwater. The study aimed to assess whether technology available and applicable to other locations regarding trash traps could be applied to Sto. Tomas Creek. The study focused on the technology's applicability to a water body and provided an official assessment tool to guide implementation decisions.The study revealed an average PESTLE score of 3.57, falling within the range of 3 - 3.99, signifying sufficient evidence to support the feasibility of using new technology like trash traps in the locale. Additionally, one-way ANOVA revealed that there is no significant difference in (MEAN SCORE) since the P-value (0.436) is more significant than the level of significance (0.05), which also means that researchers will not proceed to post-hoc analysis. It also showed that the critical value (1.526) is greater than F-computed (1.020). Since F < Fcrit, there is no significant difference in the scores among the respondents. This finding could significantly enhance government decision-making and overall performance, indicating the applicability of trash traps in the area.

Keywords **—Solid waste management, Trash Traps, Assessment tool**

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I. INTRODUCTION

Solid waste management in the Philippines is extremely difficult, especially in urban areas where most of the nation's waste is produced [1]. Solid waste management is recognized as a major global issue that calls for immediate action from both national and local governments. Waste in the Philippines has been increasing steadily and is predicted to do so in the years to come. There are not enough sanitary landfills, inadequate law enforcement, and inappropriate disposal practices in the nation, which increase the problems with managing solid waste. The implementation of the Ecological Solid Waste Management Act of 2000, which prioritize recycling of waste, segregation and proper disposal, is a potential solution to these challenges [2]. ISO (International Organization for Standardization) is a global coalition of national standards bodies that creates International Standards through technical committees, involving various organizations. ISO collaborates with the IEC on electro technical standardization. Balancing the environment, society, and the economy is crucial for current and future needs. The ISO 14001:2015(E) Standard provides a framework for organizations to protect the environment and address socio-economic needs, outlining requirements for their environmental management system. It excludes requisite specific to other ways of managing but allows for integration with them using a usual approach and safe thinking. Organizations can demonstrate conformity through self-declaration, external confirmation, or certification [3]. As the global community grapples with the escalating environmental crisis from water pollution, implementing innovative technologies has become imperative. One such solution gaining traction is the implementation of Trash Traps, designed to capture and remove floating debris from rivers, lakes, and oceans. As the global community recognizes the urgency of addressing environmental challenges, policymakers are actively seeking ways to enhance the efficiency and impact of these trash traps. However, the efficacy of these systems is intricately tied to the policy framework governing their deployment and operation [4]. Water pollution is becoming an ongoing worldwide issue, being the cause of illness and passing away of people. About 14,000 individuals perish from water contamination every day. Cleaning the trash by using manual processes would be ineffective as it often covers vast areas of work and effort [5]. It is a significant factor in the formation of eutrophication, which subsequently results in an increasing number of algae blooms. These algae blooms lower the oxygen levels, leading to oxygen deprivation of many marine life. Plastic bottles, bags, glass bottles, footwear, and packaging materials are identified as contributors to the contamination of water bodies [6]. Marine life frequently interprets plastic debris as a potential food source, which undergoes gradual decomposition. Various marine animals have been found to experience respiratory and digestive obstruction due to large amounts of plastic materials, with a particular focus on plastic bags [7].

The urgency of addressing plastic pollution is underscored by its far-reaching ecological consequences, affecting marine life, biodiversity, and human health. Trash Traps, designed to capture and remove debris from water bodies, have emerged as a tangible means to address this crisis. However, the success of these interventions is contingent upon the nuanced development and refinement of policies that guide their deployment, maintenance, and integration into broader environmental management strategies. An effective solid waste management system incorporates several operational components covering the on-site facility storage, collecting of trash, transportation, processing, resource recovery, characterization of garbage, and final step is the dumping of waste items. The 4Rs which means "refuse" "reduce," "reuse," and "recycle" concept have been adapted into a more usable and effective solid waste management strategy to establish sustainability [8].

Over the past few years, more reports of seabirds, marine mammals, turtles, fish, and invertebrates have been affected by marine debris [9]. In addition

to polluting natural water bodies, like rivers, lakes, and seas, trash has also damaged artificial water bodies, such as drainage systems. Numerous studies have proved that a significant portion of urban drainage systems are contaminated by residential and nondomestic waste materials [10]. Water bodies can become stagnant and have a higher water profile when debris is present in the drainage system.

A creek, sometimes called a creek channel, is a short, narrow body of water that usually flows through an urban or natural setting [11]. Streams are smaller than rivers and have a narrower width and relatively shallow depth. It contributes significantly to the hydrological cycle by acting as a drainage system for runoff and precipitation [12]. They can come from several places, including melting snow and ice, springs, and groundwater discharge. Creeks can empty into rivers, lakes, or the ocean, among other bigger bodies of water. In addition, it might differ significantly depending on local geology, climate, and geography. They support regional ecosystems by acting as habitats for various plants and animals [13].

Review of Related Literature

Solid waste is an integral aspect of human civilization, representing the diverse materials discarded in daily lives, industries, and construction activities. Broadly defined as non-liquid and non-gaseous waste, solid waste encompasses everything from household items and packaging to industrial byproducts and construction debris. Solid waste management is the most essential municipal service required to sustain other municipal activities, even if there are noticeable differences in service levels, costs, and environmental effects [14], [15].

In tropical Asia, there is a major and rising concern about solid waste. To effectively monitor and control waste management systems and make improvements, it is necessary to describe solid wastes based on their origins, rates of generation, types, and composition. Managing solid waste is critical because it has an important impact on the health of people, the environment, and quality of life. Effective management of solid waste can prevent the spread of diseases and reduce contamination. Inadequate waste disposal can lead to the proliferation of pests, such as rodents and insects that carry diseases harmful to humans [16].

Any solid substance, whether intentionally or unintentionally created, processed, disposed of, and abandoned in the maritime environment, is known as marine waste. Plastic waste dominates the ocean, making up eighty percent of all aquatic trash, ranging from surface to deep-sea dirt at various depths. Plastic contamination in coastal areas may easily interact with aquatic organisms, posing a hazard to species and their habitats. The study indicates that rivers and beaches contribute 80 percent of ocean plastic, with marine activities such as fishing nets, ropes, and fleets contributing the remaining 20 percent. According to 2017 research by the NGO Ocean Conservancy, China, Indonesia, the Philippines, Vietnam, and Thailand are the top countries for disposing of waste worldwide. Asian rivers contribute to 81 percent of the entire amount of rubbish found in the ocean, with the Philippines alone accounting for one-third of the world total. Researchers have identified the Philippines as a significant source of plastic pollution in the ocean, thereby requiring the implementation of stringent plastic regulation measures [17].

The main objectives of sustainable trash handling are to safeguard life and nature, as well as to save resources. Another objective is to prevent the transfer of trash-related issues to future generations, such as using sustainable waste management procedures that need little post-treatment and are socially acceptable. An essential prerequisite is the availability of cost-effective waste management services. In order to achieve these objectives, decision makers employ comprehensive strategies that encompass a variety of associated processes, including as disposal, reuse, treatment, and shipping. Consequently, decision makers anticipate the implementation of feasible waste management strategies that are cost-effective, while also considering the interplay of environmental,

economic, technological, regulatory, and societal variables [18].

Insufficient management of waste can result in nature pollution and hazards to health. Various hazardous substances are present in solid waste or produced via the incineration of solid trash, posing a risk to human health. Human exposure is influenced by a number of situations, it is essential to take into account the relationships between possible exposure sources to different solid waste treatment and disposal techniques, possible ecological pathways through which pollutants might be absorbed by humans, and potential harmful health effects. Straight contact of the skin with contaminated materials is a common method of exposure. Other major sources of contamination include trash, air pollution, and direct or indirect ingestion of contaminated water, soil, or plant matter. Additionally, pollutants can accumulate in the food chain. Pathogenic microorganisms present in dirt can also be transmitted by vectors, for example insects. In addition, inadequate selection of site and improper construction of the waterproof layer can result in leachate from landfills and dumpsites contaminating groundwater, hence providing significant health concerns to humans [19]. The act of engaging in open burning of rubbish can produce by-products, such as dioxins. Prolonged exposure to dioxins can lead to deleterious or cancer-causing consequences. The main way that humans are exposed to dioxins in this situation is by consuming contaminated animal-derived foods. Dioxins break down at a slow rate and can accumulate in the food chain [20].

Water Pollution

Nearly every local government provides solid waste management as a service to its citizens. Municipal solid waste (MSW) production is rising faster than the rate of urbanization. Just a decade ago, the total MSW produced by urban dwellers (2.9 billion) was 0.64 kg per person each day, or 0.68 billion tons yearly. Due to inadequate surface water quality protection and sanitation measures, river pollution has grown to be a serious problem [21]. Most of the time, waste is dumped into receiving water bodies without giving their assimilative capacities any thought. The ability of the major cities' rivers and lagoons to aerate runoff is endangered by the release of trash, raw sewage, and oil spills. Naturally occurring purification of contaminated waters takes time; substantially contaminated water may take days to reach a significant level of purification [22].

A chemical, physical, or biological component could be categorized as a pollutant in water if it negatively affects aquatic life and water users. However, substances that swim or stay suspended in water and generate unfavorable environmental responses make up the vast majority of water pollutants. Physical and biological components can both occasionally act as pollutants. Two significant physical forces that have an obvious effect on living things are heat and radiation. Microorganisms known as "bio pollutants" are present in water and can infect both humans and animals [23].

Municipalities and cities commonly produce waste from a range of areas wherein human involvement varies. Given their high variability and varying physical characteristics depending on their origin, it would be difficult to classify the debris from various sources. Its unpredictability is the main barrier to using generated waste as a starting point for recycling to make valuable products. Waste source segregation thereby significantly lowers the amount of money allotted for waste gathering and shipping, which are the most expensive aspects of overall waste management [24].

The unaddressed challenge of municipal solid waste management in other countries has led to exponential population development, industrialization, urbanization, and other related repercussions. Inadequate handling and disposal of MSW can result in all pollutant categories, including soil, water, and air. Undiscerning Waste disposal contaminates both the surface and the

ground. MSW clogs drains in cities, generating floods and stagnant water to breed insects during the wet season. Uncontrolled MSW burning and inappropriate incineration substantially contribute to air pollution in cities.

There are greenhouse gas emissions from the organic waste's breakdown in landfills, and untreated leachate contaminates the land around it—water features [25]. Concerns about health and safety also result from incorrect MSWM. Vectors of insects and rodents are drawn to the garbage and can potentially spread illnesses such as dengue fever and cholera. Utilizing water contaminated by MSW for drinking water, food irrigation, and bathing can expose people to pathogenic microorganisms and extra pollutants.

Flowing debris through the streams is considered a major contributing element to many problems for the engineered structures. Debris build-up can block the waterway entrance of intakes or bridges, negatively affect the structure operation, cause damage to boats, create navigation problems, increase the bed scour due to debris accumulation on a structure, and aggravate flooding [26]. Debris accumulation has the potential to change the structure of the ecosystem, lessen the penetration of light in the waters below, and lower oxygen levels. These changes can potentially negatively impact the capabilities of open water and marine habitats to sustain aquatic organisms [27].

Trash Trap

A trash trap is a device designed to prevent the passage of solid waste into waterways, hence enhancing the overall water quality. The trash trap primarily captures larger gross pollutants, but more microscopic contaminants including dirt, solvents, heavy metals, and microorganisms are not absorbed immediately. However, since the bigger gross pollutants may retain these smaller pollutants, it is possible to prevent them from reaching aquatic bodies indirectly. Stainless steel was utilized in the construction of the trash storage because of the sheet's natural corrosion resistance properties. Mesh wall trash traps demonstrate a significantly higher efficiency level, reaching 100%, compared to perforated wall rubbish traps. The latter, in contrast, demonstrates limited effectiveness, particularly in conditions of heavy flow [28]. It has been proven that the application of trash traps is a viable option for collecting floating garbage in water, particularly in rivers and it is advised to conduct additional research to improve the design of trash traps and the waste classification of marine wastes [29]. The floating material utilized is made up of HDPE, a type of material known for its resistance to exposure to sunlight. As a result, this material is expected to maintain its durability for a long time [30].

Trash Trap Design

An in-pit trash trap commonly implies a system or apparatus specifically engineered to apprehend and control refuse or debris inside a designated region, typically linked to mining or excavation operations. There are two categories of in-pit devices that serve the purpose of capturing gully pits and litter baskets. Gully pits are situated at a greater depth compared to regular pits in order to effectively capture and retain silt. Trap gully pits are only successful in stream systems with limited capacity, as their ability to collect silt and litter is hindered by the tendency of large flows to displace and carry away the gathered materials.

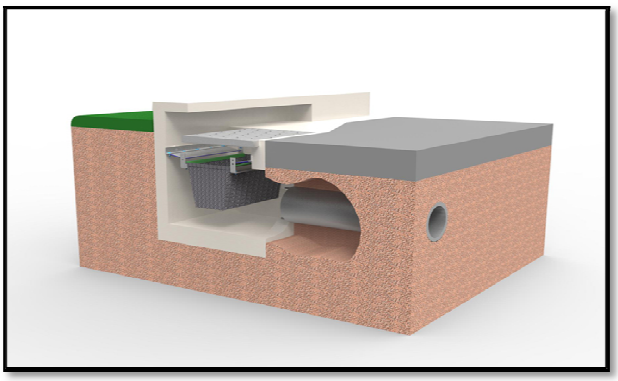

Fig.1 Example of an In-pit Trash Trap

The trash rack is a widely recognized apparatus, particularly in Australia. The Litter Control Device is a device that has been placed on waterways and pipe drain outlets in Australia. These devices, together with garbage racks, gather debris and might be referred to as "soft" trash racks

Fig. 2 Example of Trash Rack

SBTR is a hybrid system that integrates the features of a sedimentation basin and a fixed trash rack. The catchment was a large reservoir constructed with concrete lining, serving the dual purpose of capturing litter, debris, and coarse silt during storm flows, while also functioning as an effective retarding reservoir [31].

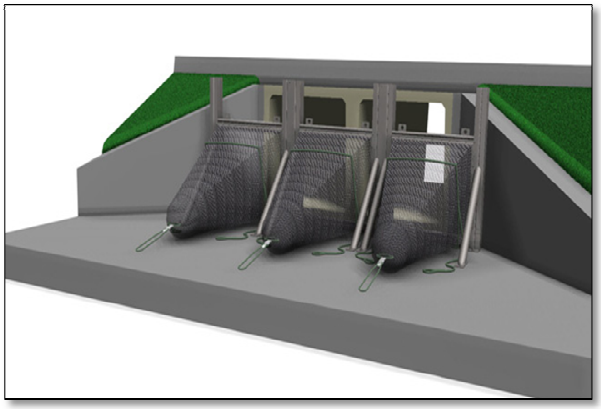

Fig. 3Example of SBTR Trash Trap

A Bandalong Litter Trap is being widely recommended by engineering firms and governments for effectively capturing and controlling rubbish in streams. The Bandalong Litter Trap, a modern solution, is built utilizing corrosion-resistant materials and the provider's extensive knowledge in plastic and aluminum welding technology. It is commonly used in the urban waterways, rivers, streams and lakes [32].

Fig. 4 Example of Bandalong Litter Trap

The initiative of Provincial Environment and Natural Resources Office of DENR (PENRO PAMPANGA) to conceptualize the design of trash trap for coastline of the Manila Bay.

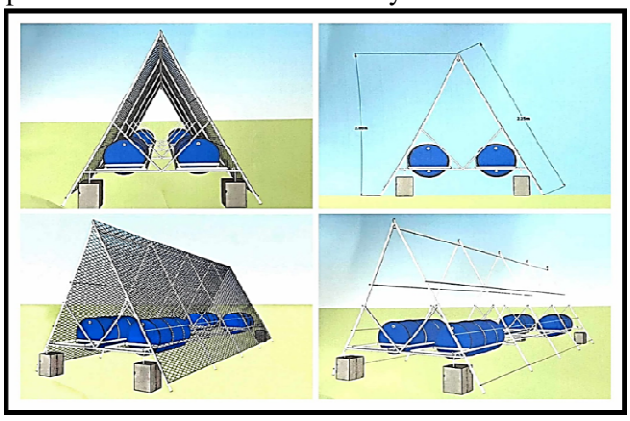

Fig. 5 PENRO Pampanga Trash trap design

Policy Implementation

Local Government Units (LGUs) are primarily in charge of implementing and enforcing the requirements of this Act within their respective jurisdictions, as per RA 7160, the Local Government Code of 1991. Additionally, the law requires that solid waste be gathered and separated at the level of the barangay. On the other hand, the city or municipality is responsible for collecting non-recyclable materials and specific garbage. Hence, since segregation speeds up trash processing

and drastically lowers the amount of waste dumped in landfills, local government units (LGUs) should be implementing it [33].

To address these issues, a comprehensive plan is required, and laws like RA 9003 require Local Government Units (LGUs) to put solid waste management procedures into place and enforce them. The heterogeneity of waste generated from various sources poses a significant hurdle to recycling efforts, emphasizing the importance of waste source segregation. This practice not only facilitates waste processing but also reduces the financial burden associated with waste collection and transport, as highlighted in RA 9003. Debris buildup in bodies of water presents a significant problem that affects both artificial structures and aquatic environments [34]. Trash traps are a viable solution because they are made to catch solid waste and improve the quality of the water. It has been shown that trash traps, especially ones with mesh walls, are excellent at keeping larger, filthy contaminants from passing through. To maximize trash trap effectiveness, waste classification and design research and development are essential [35].

Determining Factors for the Policy Improvement on the Implementation of Trash Trap

Although a trash trap offers advantages, it is not sufficient for a place to just implement on it for their solid waste management. Various issues need to be taken into account, which will be examined through the following relevant literature:

Political Factor

Throughout the course of time, Ghanaian government have allocated large financial resources towards projects and programs aimed at enhancing socioeconomic growth and ultimately improving the quality of life of their people. Yet, the execution of the majority of these plans and projects has been unsuccessful and subsequently terminated. There is insufficient research that investigates this issue and the precise cause-and-effect relationship between politics, culture, and the failures of these implementations and project cancellations. Political involvement is an essential factor that would help with the policy improvement in implementing trash traps in the Philippines. Applying these technological methods is important for enhancing and maintaining our waterways. Absence of governmental support, the realization of this execution will be unattainable since there no organization which can supply the requisite assistance for this project. Programs, projects, and implementation can fail due to premature termination by the government or important stakeholders, either before completion or if they fail to meet their stated goals [37].

Economic Factor

Many economic factors can exert an effect on the implementation of programs. The major criteria of the PESTLE Framework will be derived from factual data and research, which will be used to thoroughly assess the parameters and limitations of the topic area in order to achieve the intended output for this research [38]. The sustainability of a project is a widely used strategy for managing projects, programs, businesses, and other companies. It focuses on achieving efficient and effective manufacturing, advertising, distribution, and transportation of items and services. In order to ensure the long-term success of projects, it is necessary to establish specific metrics and standards at every stage of the project, starting from project identification and continuing via feasibility assessments, composition, layout, financing, implementation, observing, and evaluation [39]. Several factors affecting the economy, including growth in the economy, intense competition, and quick evolution of the building sector, influence the execution of construction projects [40].

Social Factor

Injunctive norms represent society's widely recognized standards of behavior and serve as the appropriate guidelines for conduct. On the other hand, descriptive norms depict the behaviors often demonstrated by others, which can either align with or deviate from the injunctive norms. Descriptive

norms encompass both favorable and unfavorable orientations. Positive descriptive norms refer to situations when the majority of group members behave in a way that aligns with the expected standards, without any conflicts in norms. On the other hand, harmful descriptive norms indicate that most group members behave in a manner that contradicts the expected standards. Adverse public sentiment or perceptions of the object or project might give rise to resistance and impediments. Put simply, people can preserve their sense of self-worth by offsetting their deficiencies in certain domains with their aptitudes in other matters. During this phase, once the individual's self-worth is firmly established, the individual can analyze and embrace threatening information in a more receptive, equitable, and unbiased manner [41].

Moreover, the absence of community engagement and active participation might result in opposition and impede the effective execution of initiatives. Suppose the local community is unaware of the benefits of the proposed item. In that case, it may result in the neglect of information within the area and a lack of support for its implementation. This phenomenon may arise due to insufficient knowledge, dissemination of incorrect information, or adherence to cultural beliefs that hinder the acceptance of novel concepts. Some of these ideas encompass objects that may be seen as culturally insensitive or incompatible with local customs and values. This can result in opposition from locals who perceive the object as a menace to their cultural heritage [42].

In summary, the conflict between proposed objects or projects and established social norms, values, and beliefs can hinder their acceptance and implementation. Negative public opinion, cultural disparities, and insufficient community engagement can generate resistance and barriers. If the local population needs to gain awareness of the advantages or be misinformed regarding the proposed object, their support for its implementation may be lacking, resulting in obstacles to practical implementation. To successfully integrate new products or projects, it is essential to consider cultural sensitivity and community participation, as these aspects play a critical role in overcoming social barriers.

Technological Factor

In addition to being efficient at collecting garbage, floating trash traps must also be sustainable, flexible, and resource-efficient due to technological considerations. By incorporating modern technologies, they operate better overall and help create a waste management system that is more thorough and applicable. Water conditions cover the chemical, physical, and biological properties of water that might impact its suitability for different purposes, such as drinking, sustaining aquatic organisms, and participating in recreational activities [43].

Booms were shown to be the most effective at eliminating small objects that can be driven through screens, such as grass clippings and polystyrene objects less than 50mm, or floating objects, such as cans and plastic bottles. As a result, a greater percentage of partially or completely submerged litter, including bags, sheets of paper, and plastic, was collected by the garbage rack. While these materials slide under booms with the flow and escape, the trash rack bars intercept them. Field investigations revealed that the hydraulic features had a greater impact on the effectiveness of trash retention by floating devices compared to the performance of trash racks. The floating trash traps were efficient in controlling dry weather flows, however, they were ineffective in preventing trash from escaping when dealing with higher flows, since trash was able to pass underneath the device [44]. In deploying a TCD, it is essential to identify the optimal trap type, ideal location, and appropriate timing for deployment. Effectively positioning a device in a location that optimizes its effectiveness involves considering key routes for litter and areas of high accumulation of debris. [45].

Throughout the conduct of the study, the most optimal design of the trash trap will be determined by a thorough site analysis and consultation that will lead to policy improvement, given that it could be a basis for the LGU to have additional ordinances for the management of the location, such as the Municipal Environment and Natural Resources (MENRO).

Legal Factor

The use of a trash trap, alternatively referred to as a litter trap or waste collector, may be contingent upon diverse legal considerations contingent of the jurisdiction and unique circumstances in which it is employed. The Ecological Solid Waste Management Act (Republic Act No. 9003) establishes the structure for managing solid waste in the Philippines. It places emphasis on trash segregation, recycling, and disposal procedures. The implementation of trash traps might be seen as a measure that is in line with the objectives of this act [46]. In the Philippines, acquiring the required licenses and ensuring respect to environmental laws and regulations are essential steps in installing and operating a trash trap. This process usually entails coordinating with various government authorities.

Republic Act No. 9275, also referred to as the "Philippine Clean Water Act of 2004," is a law in the Philippines that focuses on the governance, safeguarding, and conservation of the nation's water resources. The text underscores the significance of community engagement, regulatory actions, and the implementation of water quality benchmarks and surveillance systems [47].

Environmental Factor

Environmental factors are essential in determining the effectiveness and influence of trash traps. Trash traps use water flow to direct and capture waste. Comprehending the regional currents and flow patterns is crucial for accurate positioning and effectiveness. The primary objective of the floating trash trap's design should be to protect and preserve the indigenous biodiversity in the area. It is crucial to reduce interference with water habitats and migration pathways.

A system or device specifically engineered to collect and control trash or debris, specifically in bodies of water. Environmental considerations significantly influence the efficacy and consequences of trash traps. There is a mutually beneficial connection between the environment and drainage systems. To recognize the harmful effects of drainage systems and effectively deal with them, many developed and developing countries have taken steps to regulate their drainage water and establish evaluation criteria [48]. The urban environment is more vulnerable due to increasing impervious surfaces and the growing risk of drainage network overflow. This trend is expected to worsen as metropolitan areas continue to expand. The potential damage caused by urban floods is exacerbated by the rising occurrence and magnitude of expected intense precipitation events due to climate change. An Environmental Impact Assessment (EIA) is used to quantify a project's social and environmental consequences, enabling stakeholders to make well-informed decisions. Most governments worldwide acknowledge and employ Environmental Impact Assessment (EIA) procedures while developing new systems and buildings [49].

It affecting the deployment of trash traps are varied and dependent on the particular location. A comprehensive strategy that considers the local ecosystem, community interactions, and environmental circumstances is crucial for the effectiveness of trash trap efforts. Trash traps are particularly essential in urban or densely populated regions where human activities significantly contribute to the accumulation of litter. Comprehending land utilization and the degree of urbanization is crucial for strategic positioning. Hence, it is imperative to consider the environmental aspect when designing and executing such a system in all communities, as demonstrated in the subsequent research. Disposing municipal

solid garbage can incur significant expenses and cause detrimental environmental impacts [50].

Factors in selecting water body for trash traps

Successful implementation of trash traps in a water body needs thorough investigation and examination to attain the intended positive result for the community and impacted organizations. By compiling these data, the researcher utilization would like to establish a basis for creating a reliable assessment tool for implementing trash traps in the relevant area.

Determining a suitable location for a trash trap requires careful consideration of multiple elements to guarantee its applicability in capturing and controlling floating debris in waterways.

TABLE I
DECISIVE FACTOR IN THE SELECTIVE WATER BODY FOR THE TRASH TRAPS [29].

Factors	High Preference	Low Preference
Location	• Around Locale Areas • Easy Access	• Secluded Area
Weather	• Wind or Storm • Moderate Water Flow	• Areas with freezing water • Strong winds of natural disasters • Periodic Flood • The event of dryness that induce to expose the water bed
Type of Water Body	• River and Stream • Artificial path for water flow • Industrial water • Irrigation	• Stable or stagnantwater • Tourist or recreational sites
Water Characteristics	• Wide opening toward north or south	• Presence of islands/obstacle that hinders the flow of water
Water Body Ownership	• Single Owner • Legal-entity owner	• Multiple owners • Individual private owners
Water Condition	• Fresh or saltwater	• Dirty/corrosive water • Water prone to bio fouling

The validation of Brgy. Sto Tomas creek was conducted utilizing the relevant variables. An on-site inspection of various areas has been done to see if the river meets the desired criteria.

Solid waste is a vital aspect of human civilization, encompassing materials from daily life, industries, and construction. Local Govertment Unit (LGU) prioritize the Solid Waste Management (SWM) that is crucial for the public health and environment. In tropical Asia, the issue is escalating, requiring effective monitoring prompting the need for stringent regulations. The sustainable waste management plan protects the environment, human health, resources, and emphasizing cost-effective services and comprehensive strategies covering collection, transportation, treatment, recycling, and disposal. The inadequate solid waste management (SWM) shows health and environmental risks, along with hazardous substances and pollutants. River pollution arises from inadequate water quality protection and sanitation measures, endangering major cities' water bodies. Water pollutants encompass physical, chemical, and biological elements impacting aquatic life and human health. City and municipal wastes, originating from diverse human activities, pose a challenge in waste management due to their heterogeneous nature. Inefficient MSW handling leads to soil, water, and air pollution, contributing to floods, stagnant water, and air pollution. A trash trap serves to enhance the condition of water by preventing the passage of solid waste into waterways, primarily capturing larger gross pollutants. While it may not directly retain finer pollutants like dirt and chemicals, the trap indirectly prevents their entry by trapping larger debris.

In correspondence of the Local Government with RA 7160 or the Local Governement Code of 1991, stand the primary responsibility for implementing and enforcing solid waste management provisions. RA 9003 dictates the collection of solid waste and segregation at the level of barangay, emphasizing

waste separation importance in facilitating processing and reducing landfill disposal.
In order to further assess the applicability of the trash traps that will be varied throughout the study, the PESTLE framework will be considered, encompassing the hindrances regarding the political, environmental, social, legal, and economic aspects. Trash traps are a viable solution because they are made to catch solid waste and improve the condition of the water. To maximize trash trap effectiveness, design research and development are essential, which could then be a basis for the local implementation of policies as a guide for the management of MENRO (Municipal Environmental and Natural Resources).

Background of the Study

Plastic contamination in oceans and waterways has reached concerning levels in recent years. The environmental and ecological consequences of poorly disposed of or abandoned plastic garbage have been well documented. As plastic garbage accumulates in bodies of water, it endangers marine life, disturbs ecosystems, and even enters the food chain, eventually affecting human health. Various projects aimed at minimizing single-use plastics and promoting recycling have been launched to address plastic pollution. Despite these efforts, a large number of plastic debris continues to enter rivers, lakes, and oceans.

One of the most important resources for maintaining ecosystems and life is water. However, a lot of regions have seen increasing industrialization and urbanization, which has increased water body pollution and posed serious risks to the environment and human health. To keep the earth sustainable, it is important to protect the ecosystem from many sources of pollution. Since contaminated water and poor sanitation are associated with the spread of diseases, water pollution poses a threat to both the health and well-being of living things as well as the surrounding water quality.

The Barangay Sto. Tomas Lubao, Pampanga is crucial for implementing effective remediation and preventive measures. Potential hazards arise from accumulated trash in water bodies, such as habitat degradation, deterioration of the water quality, and harm to aquatic life through ingestion and entanglement, contaminated water posing a threat to human health, adverse effects on visual appeal and recreational activities, and global environmental consequences. It may also result in flooding, problems with managing stormwater, and the production of micro plastics.

As a potential solution to this ongoing issue, the concept of “trash traps” has gained attention. Trash traps are ingenious devices that capture and collect floating waste, particularly plastics, before it can migrate downstream and reach larger bodies of water. To intercept and control the flow of plastic debris, these traps can be strategically put in rivers, canals, or other water channels

Study Area

Located in the Barangay Sto. Tomas Lubao, Pampanga, the Sto. Tomas creek is situated near the houses of the inhabitants in the barangay. It serves as a natural absorber of floodwater from the small canals in the area. The figures below show the study location.

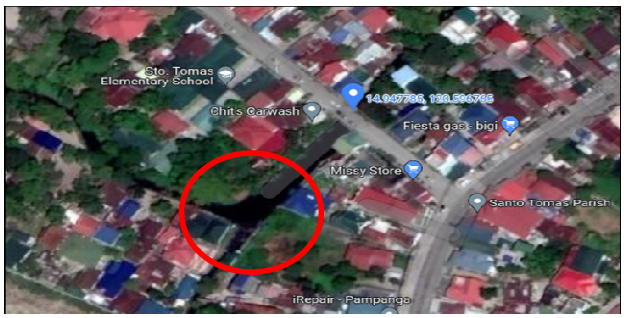

Fig. 6 Location of Sto. Tomas Creek

Fig. 7 Brgy. Sto. Tomas Creek

According to the Local Disaster Risk Reduction Management Office (LDRRMO), the said location is highly susceptible to flooding. In addition to this, the District Chairman, Pacia Pillar, highlighted that the condition is highly compromised by the blockage of trash to the connecting canals leading to the said creek.

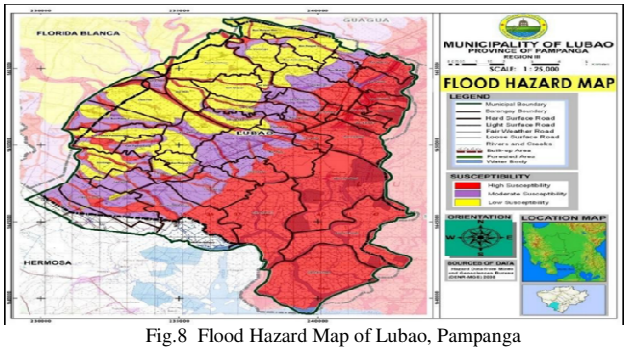

Fig.8 Flood Hazard Map of Lubao, Pampanga

Upon conducting a comprehensive site analysis, the researchers have discovered the presence of a trash trap in the area. However, it is constructed using a scrap material made from bamboo used to create a fence like trash trap that is ineffective during high water levels. The local community took the initiative to build this trash trap after recognizing that the accumulation of garbage in the creek was causing flooding in their area.

Statement of the Problem

This study aims to propose a recommendation for policy improvement regarding implementation of trash traps in Barangay Sto. Tomas creek. The research will focus on the policies introduced mandating the use of trash traps in water bodies and increase public awareness caused by waste pollution. By doing so, a coordination with the Local Government Unit of the specified area will be observed, addressing the mandate of trash trap usage in the given channel.

Specifically, this study will provide answers to the following questions:

- What are the possible assessment tools that can evaluate the applicability of trash traps in Sto. Tomas Creek?
- What are the possible factors that hinder the implementation of the trash trap in the locale using the following parameters?
- What are the recommendations for the improvement of applicability of trash traps?

Objectives

General Objective

The goal of this study is to develop a multi-criteria assessment tool for the applicability of trash trap in Sto. Tomas creek for policy improvement in Barangay Sto. Tomas, Lubao, Pampanga

Specific Objectives

In pursuit of a more specified set of objectives, the researchers aim to:

- Develop a validated assessment tool in the determination of the applicability of trash traps in Sto. Tomas Creek.
- Evaluate the applicability of trash trap through an assessment tool using the PESTLE framework in Barangay Sto. Tomas and Municipality of Lubao Pampanga
- Provide evidence-based recommendations for improving policies regarding the applicability of trash traps in Barangay Sto. Tomas, based on the results derived from the multi-criteria assessment tool.

Significance of the Study

The study will provide significant benefits for various stakeholders:

Households. The findings of the study will be useful to the people of Barangay Sto Tomas,

especially the community near the creek. This information will embed learning about the cause and effect of throwing garbage in the creek, to the community.

Local Government. The findings of the study will provide vital insights to local government officials, supporting them in prioritizing resource allocation and executing policies in ecological solid waste management and trash traps application. The research will aid the government's decision-making process for sustainable ecological solid waste management by identifying regions in Barangay Sto Tomas that require this type of equipment.

Future Researchers. The research will be useful for scholars interested in ecological solid waste management. The research will be beneficial to academic literature by increasing the current state of knowledge, allowing future researchers to build on these results and investigate comparable topics in more depth.

Environment. The results of the study will help prevent or lessen floods, prevent potential harm to the area's freshwater ecosystems, and lessen the risk of water contamination, which can lead to illnesses and diseases.

Scope and Delimitation

This study is mainly focused on the development of multi-criteria assessment tool on the applicability of trash trap in the said locale for policy improvement. The field of study that has been selected is Brgy. Sto. Tomas Creek, Lubao, Pampanga.

The Sto. Tomas, Lubao Creek will only be utilized as a test subject when the assessment tool is being pilot tested. The design of the said trash trap will be deviated from an existing literature and will exclusively emphasize the utilization and applicability of the given technology. The effect of severe weather on trash trap performance will not be extensively studied in this study.

The Waste Analysis and Characterization Study as well as the quality of water will not be utilized in the study, as it is not necessary in the collection of solid waste. The researchers will not be responsible for the segregation of the generated litter. This study will have a five-month timeframe, starting from data collection process and finishing the suggested mitigation strategies.

Overall, the purpose of this study is to offer a thorough and targeted evaluation of the deployment and effects of trash traps in the designated geographic area.

Conceptual Framework

The researchers used the IPO (Input-Process-Output) model as a schematic representation in their study as it breaks down a system into three components: Input (data entered into the system), Process (operations performed on the input), and Output (result produced by the system).

Phase 1 ➡	Phase 2 ➡	Phase 3
Formulation of Multi-Criteria Assessment Tool using PESTLE Framework for the Applicability of Trash trap In Sto. Tomas Creek for Policy Improvement In Barangay Sto. Tomas, Lubao, Pampanga	Assessment of Applicability of Trash Trap for Sto. Tomas Creek	Proposal of Recommendations for the Policy Improvement of the area in terms of its Applicability of Trash trap.

Fig. 9 Conceptual Framework

The diagram shows interconnected boxes that each represent different types of data within particular processes. In Box A, it shows the Formulation of Multi-Criteria Assessment Tool using PESTLE Framework for the Applicability of Trash trap In Sto. Tomas Creek for Policy Improvement in Barangay Sto. Tomas, Lubao, Pampanga. Box B represents the process which involves the gathering of data, sources of debris, and assessment of the applicability of trash traps. Box C is the Proposal of Recommendations for the Policy Improvement of the area in terms of its Applicability of Trash traps.

II. METHODOLOGY

Research Design

This study applies a Mixed Method, a combination of Qualitative and Quantitative design. To determine the applicability of trash traps for implementing it in the creek of barangay Sto. Tomas, Lubao, Pampanga.

Embedded Design by Mixed Method

In mixed methods research, embedded design is a strategy in which one methodology—qualitative or quantitative—is employed as the main approach, with the other being added to supplement or improve it. This approach is particularly useful when the research question requires the strengths of both methods to provide a comprehensive understanding of the problem.

For example, a predominantly quantitative study might embed qualitative elements to explore unexpected results in greater depth, or a qualitative study might include quantitative elements to measure the prevalence of observed phenomena [51].

Research Locale

The study will be conducted in Sto. Tomas, a barangay in the urban area of Lubao, a municipality in the province of Pampanga, located 91.1 kilometers from Manila. The locale area has a history of flooding, and it will provide the necessary data for evaluating the applicability of trash traps. All the gathered data will be fundamental for the criteria based in decision making assessment tool.

Methodological Framework

Phase 1 – formulation of Multi-Criteria Assessment Tool using PESTLE Framework

The data to be used in the study were assessed using an evaluation tool.

A standardized tool used to assess a certain item or attribute is called an assessment tool. It provides a methodical strategy to gathering data, allowing for unbiased analyses and encouraging uniformity all the way through the assessment procedure.

Because of the complex nature of this instrument, expertise and knowledge are necessary to guarantee precise and methodical outcomes. As a result, the following credentials and qualifications are among the suggested principal users:

1. Water Resources Engineer
2. Land Use Planners
3. Forester
4. Forest Ranger
5. Forest Technician
6. Technical Support Specialist
7. Environmental Engineer
8. Solid Waste and Manila Bay Focal Person
9. MPDC or Acting MENRO
10. Municipal Engineer of Lubao
11. Barangay Committee Chair on Environment
12. Project Development officer
13. Monitoring and Evaluation council
14. Environmental Specialist

As the research paper's introductory sections imply, a comprehensive selection procedure for data collection will consider political, economic, social, technological, legal, and environmental considerations. The specifications and extent of each segment's requirements will be outlined in order to implement the trash trap.

Political Factor

Political factors pertain to the manner and degree of government involvement in the economy. The factors that influence the business environment include government policy, as policy, corruption, labor laws, and the environmental law. Government Policy relate to set of principles and guidelines that aim to achieve positive results for the public or specific group. Positive outcomes for the community or a specific group. Prior to implementing a trash trap, it is necessary to delegate official duty to the government authorities and organizations that are accountable for the specific policy area. The presence of political uncertainty might significantly hinder the

installation of trash traps, leading to hesitancy in investing new cash. Hence, in order to adequately meet the criteria of this aspect, the following data must be obtained for this study:

The role of Municipal Government in promoting Solid Waste Management

A geohazard map is a functional instrument employed for identifying regions that are prone to environmental threats such as flooding, landslides, and earthquakes. Geohazard maps can effectively contribute to sustainable solid waste management by reducing the likelihood of flooding and erosion. These methods can enhance the development of urban areas that are more durable and environmentally friendly.

Local government actions to promote environmental sustainability in terms of organizational freedom in application policies

Social welfare, demographic concerns, and integrated protected areas are actions that local governments may take to encourage durability. These actions can assist local governments in selecting trash trap technologies that are sustainable and efficient.

Economical Factor

Regarding the economic aspect, the main focus will be on what the government has allocated budget for these programs. In order to effectively manage the budget, it is crucial to take into account the expenses related to development, operating expenditures, and maintenance. This would also involve the principles related to employment. To have sufficient comprehension of this factor, the subsequent data is necessary:

Current allocation of funds for the construction projects of solid waste management systems in flood-prone areas

The budget allocation for flood control building projects in flood-prone areas, namely for the implementation of solid waste management systems, pertains to the designated amount of cash allocated for the construction of trash traps. Additional flood mitigation strategies in regions prone to substantial flooding. This budget can be allocated to facilitate the procurement and execution of a waste containment device known as a trash trap. This can facilitate the advancement of long-term sustainability [52].

Financial resources allotted for implementing sustainability ideas for improving the current trash trap

Yearly budget, also known as an annual investment plan, is a financial plan that shows anticipated revenue and expenses for a given time frame, typically a year. Budgets set aside for trashtrap implementation can aid in the selection of environmentally friendly trash trap systems by supplying the resources required for trashtrap design, construction, and maintenance.

Social Factor

This significant environment component represents the customs, habits, and ideals of people that the organization works with. It covers aging, population increase, and distribution, career views, economic distribution, emphasis on safety, and health awareness, cultural barriers and views about lifestyle. These standards are essential for evaluating the insight of the neighborhood as a whole toward trash traps. This factor requires the following information:

Cognitive Foundation if community residing in the locale

Environmental knowledge is based on a cognitive foundation of environmental understanding. People who possess an enhanced comprehension of ecological systems, environmental concerns, and the consequences of human actions are more capable of making well-informed choices. The cognitive framework needed to understand the complex interactions between human behavior and environmental health is provided by this knowledge [53].

Sustainable development in rapidly urbanized areas

An environmentally friendly solution to the garbage problem in quickly urbanizing areas is the use of trash traps. Based on empirical evidence, these actions are clearly associated with sustainable development principles, provide measurable environmental benefits, and enhance socioeconomic well-being [54]. But for implementation to be successful, a comprehensive strategy that include support for policies, community involvement, and continuous upkeep is needed. It is essential to weave such sustainable solutions into urban design as urbanization continues its unstoppable march in order to promote healthier, cleaner, and more resilient communities. Trash traps have been incorporated, which is evidence of the possibility of creative, green solutions to create a sustainable future for rapidly urbanizing places [55].

Technological Factor

In addition to being efficient at collecting garbage, floating trash traps must also be sustainable, flexible, and resource-efficient due to technological considerations. By incorporating modern technologies, they operate better overall and help create a waste management system that is more thorough and applicable. The water quality covers the chemical, biological factors and physical.

Water conditions cover the chemical, physical, and biological properties of water that might impact its suitability for different purposes, such as drinking, sustaining aquatic organisms, and participating in recreational activities [56].

Field investigations revealed that the hydraulic features had a greater impact on the effectiveness of trash retention by floating devices compared to the performance of trash racks. The floating trash traps were efficient in controlling dry weather flows, however, they were ineffective in preventing trash from escaping when dealing with higher flows, since trash was able to pass underneath the device [57].

Litter hotspots can be identified by offering an accessible site development map

In deploying a TCD, it is essential to identify the optimal trap type, ideal location, and appropriate timing for deployment. Effectively positioning a device in a location that optimizes its effectiveness involves considering key routes for litter and areas of high accumulation of debris [58].

Legal Factor

Legal issues can affect politics as well, but they are typically more specialized and focused on laws and regulations. The application of a trash traps can be impacted by the laws and regulations of a government. Communities' adoption of specific political and legislative objectives regarding the use of flood protection their quality has resulted in the legal element. It refers to guidelines controlling cooperation between local government agencies, corporations, and educational institutions. This factor requires the following information:

The directives of the policies for the use of trash traps

Designing, building, and maintaining trash traps in a way that maximizes resource efficiency and maintains ecological health over time is essential to sustainability [59].

Government Policies Modification

The government policy modifications regarding trash traps aim to bolster environmental protection by mandating stricter installation and maintenance protocols for waste interception systems in water bodies [60].

Environmental Factor

This part will be centered on the topic environmental state of area. This will cover the topography of the locale, the biodiversity that corresponds with it, the resources that surround it, and much more. In regard to this, the following information is needed to satisfy the criteria in this factor:

The flood susceptibility of the locale in management planning for Trash Trap

A flood hazard map refers to a geographic representation that illustrates the areas prone to flooding within a particular locale. When designing and implementing trash traps in areas susceptible to flooding, a flood hazard map becomes an essential tool for planning and risk assessment [61]. Flood hazard maps are useful communication tools to convey flood risks to relevant stakeholders, including the local community, environmental agencies, and those involved in trash trap management [62].

The topographic layout of the locale in management planning for Trash Trap

The topographic layout of a locale plays a crucial role in the management planning for Trash Traps, as it influences the design, placement, and overall effectiveness of these systems in capturing and managing plastic and debris in water bodies [63]. Taking the topographic layout of the locale into account in Trash Trap management planning ensures a comprehensive and site-specific approach, optimizing the efficiency of the system and minimizing potential environmental impacts [64].

The rate of vegetation over the total area of the locale

A vegetation map is a specialized map that illustrates the distribution and types of vegetation in the vicinity of the trash trap installation. Such a map is valuable for understanding the surrounding environment, potential sources of debris, and the ecological context in which the trash trap operates. The map may include information about other land cover types, such as water bodies, urban areas, bare soil, or agricultural land. This helps visualize the trap in relation to the surrounding vegetation and land cover, facilitating an understanding of its ecological context [65].

Research Instrument

Survey questionnaires are based on the PESTLE framework and will be administered to twenty-five (25) respondents who possess sufficient expertise in waste management and policy implementation in order to collect data. The proponents will utilize the survey questionnaires to determine the applicability of the trash trap.

Once the researchers established the specific scopes and requirements of the necessary indicators, the developed comprehensive assessment instrument that will contain all of the specified indications. These indicators or components will function as a reference to acquire a precise comprehension of each feature. The collection of all the data is essential for ensuring that each aspect fulfils the relevant concepts and principles for the implementation of trash traps. In order to assess the gathered data, each factor will be assigned a numerical rating ranging from one (1) to five (5), which will be determined by the level at which valuable information can be derived from it. The scores of all items will be examined to identify the appropriate approach for handling each data during analysis. Kindly check the table provided below for the specific criteria used to assign grades to each item.

TABLE III
CRITERIA FOR GRADING OF THE ASSESSMENT TOOL

Rating	Interpretation	Description
5.00	**Totally Applicable**	The gathered information or document included all the necessary details about the item in question and went above and beyond what was expected in terms of further utility in augmenting the overall comprehension of the tool.
4.00 – 4.99	**Highly Applicable**	The gathered information or document offers insightful information for a range of circumstances. It makes a major contribution to the trash trap's applicability in the area.
3.00 – 3.99	**Applicable**	The gathered information and document provide enough evidence that the new technology such as trash trap is applicable in the locale.
2.00 –	**Less Applicable**	The gathered information and

2.99		document are somewhat relevant, but their applicability is limited. It might provide some proof that the new technology, such as trash traps, is appropriate for the specified area.
1.00 – 1.99	**Not Applicable**	The gathered information or document does not offer sufficient proof that the new technology such as trash traps is appropriate for the specified area.

Table 2 describes the criteria used to assess the gathered information in this research. The first column presents a range of values for the grading that were used for the assessment instrument. The qualitative interpretation is shown in the adjacent column, while the last column presents a detailed description of the conditions needed to achieve the desired grading.

After creating the initial assessment tool, the researchers will then validate its reliability and appropriateness in practical scenarios. The scientists will first create the basic assessment instrument for this study, and then they will test its appropriateness and security in real-world circumstances. In order to validate the procedure, a variety of experts in the field as well as the local government unit will be consulted about their views. During the consultation process, if any expert finds a specification or parameter that needs to be adjusted, the researchers will update the evaluation tool. It will continue the iteration procedure until the assessment instrument is reliable enough for practical use.

Data Gathering

The design of the trash trap system will be determined following a thorough site analysis and consultation with municipal authorities and other pertinent organizations. The objective of the visit is to gather data and specifics regarding the present circumstances, encompassing details on water flow, flood-related damages, and their underlying causes. The design and planning stages of the construction project will be based on this information and data.

The researchers will obtain 25 respondents with sufficient expertise in waste management and policy implementation to collect data, namely:

1. Forester
2. Forest Ranger
3. Forest Technician
4. Technical Support Specialist
5. Environmental Engineer
6. Solid Waste and Manila Bay Focal Person
7. MPDC or Acting MENRO
8. Municipal Engineer of Lubao
9. Barangay Committee Chair on Environment
10. Project Development officer
11. Monitoring and Evaluation council
12. Environmental Specialist

The researchers will utilize purposive sampling technique, where the respondents are purposefully selected according to the pertinent inquiry at hand, it involves selecting participants who are deemed to be most informative, or representative of the population being studied. In this study, engineers and LGU officials are the focused strata. In Quota Sampling, the researchers are free to choose from the population the calculated number of units in each stratum, and they can choose anyone as long as they match the conditions of the stratum, in order to produce the same (or at least fairly comparable) proportion for each stratum in the sample.

An initial site visitation was conducted in Sto. Tomas Creek during the research process. This was vital in gathering preliminary information about the condition of the said locale. Regarding the technical data, the researchers will also conduct survey to the engineers and local government officials of the Municipal Environment and Natural Resources of Lubao, Pampanga. This data will be analyzed to gain insights into the applicability of trash traps in the locale.

Data Analysis

To assess the internal consistency and reliability of the assessment tool, it is essential to apply Cronbach's alpha and One-way ANOVA.

Initially, the researchers will provide a preliminary sample to the respondents in order to ascertain whether the questionnaire is satisfactory and reliable. If the questionnaire attains a score of 0.7, it indicates that it is feasible to utilize. However, if it fails to achieve this threshold, the questionnaire requires adjustments to certain questions. Upon reevaluation by the researchers, if determined satisfactory, the study will proceed to conduct a One-way ANOVA analysis. Internal consistency indicates a level at which every item in a test evaluates same notion or construct and is, therefore, related to the interconnectedness of the items inside the test [66].

Conversely, one-way ANOVA examines the mean scores of participants to determine if there are significant differences among the responses of users of the evaluation instrument. If there are no changes, it indicates that the questions are consistent and can be used to measure and evaluate the applicability of the trash trap. The One-way ANOVA, short for analysis of variance, is a statistical approach utilized to evaluate means. This paper provides a conceptual picture of how the difference in means might be explained by comparing the variances rather than solely focusing on the means themselves. The significance measurement relies on a significant probability value (P value). To calculate this value, it is necessary to have information on the statistic and its position within the corresponding distribution. But there must be a distribution that acts as the benchmark, referred to as the F distribution [67]. Once the researchers have developed the comprehensive assessment tool that contains the specified indicators and components. The results based on the respondents' answers will aid in the application of trash traps that can help the management of ordinances in the policy development aspect of the MENRO and LGUs in Sto. Tomas, Lubao, Pampanga in terms of cleaning or removing pollution.

III. RESULTS AND DISCUSSIONS

Phase 1 - Formulation of Assessment Tool

The table below contains the formal evaluation tool that will help determine if a trash trap should be placed in the area. The table lists a number of parameters that the study determined to be crucial in determining whether or not to use a trash trap. The table also lists the necessary data along with the location for collection. The criteria listed in this Chapter II Table 2 of the study will be used to evaluate the data that has been gathered.

TABLE IIII
MULTI-CRITERIA ASSESSMENT TOOL

FRAMEWORK	DETERMINING FACTOR		DOCUMENT [EVIDENCE/S]	SITE / AGENCY FOR GATHERING OF DATA	GRADING	REMARKS
Political Factor	1.1	The initiative of Municipality to create a certain program regarding the implementation of solid waste management	Created project on solid waste management under the political task force on waste management. • Municipal Ordinance No. 2 Series of 2001, Article III Sect. 2	Municipal Environment and Natural Resources Office		
	1.2	The initiative of Barangay Officials of the Locale in implementing solid waste management	Programs and memorandum related to Solid waste management made by the Barangay officials: • Adaptation of DILG MC No. 2000-117 provides the creation of Ecological Solid Waste Management Committee (ESWMC) at barangay level.	Barangay Office of Locale		
	1.3	The management, conservation, preservation, and protection of the municipality's natural resources and environment will fall under the responsibility of MENRO.	Memorandum mandating the creation of MENRO • Section 484 of the Local Government Code of 1991 • There is no Memorandum on the creation of MENRO, but they have an office that acts as MENRO	Municipality of the Locale		
	1.4	The initiative of Municipal Government in promoting Solid Waste Management by seminar, workshop and campaigns.	Environmental program, workshop or campaign made by the Municipal Government • Implementing Rules and Regulations made by the Municipal level	Municipality of the Locale - MENRO		Note: Data for 1.4 is inclusive in the Municipal Ordinance No. 2 Series of 2001 in 1.1.
	1.5	The initiative of Barangay Officials in promoting Solid Waste Management by seminar, workshop and campaigns.	Environmental program, workshop or campaign made by the Barangay Office • E.O. NO. 14 Series of 2024 BESWMC	Barangay Office of Local		
	1.6	Updated penalties made by the Municipal for laws mandating waste segregation, recycling programs, landfill regulations, and penalties for illegal dumping.	Updated ordinances made by the Municipal about providing penalty for improper disposal of garbage and other forms of uncleanliness • Mun. Ordinance No.2 Series of 2001	Municipality of the Locale - MENRO		
	1.7	Updated fines for violations of laws requiring trash segregation, recycling initiatives, landfill rules, and unlawful dumping, as determined by the barangay office.	Adaptation of ordinances from the municipal and national level regarding the imposition of fines for inappropriate trash disposal and other forms of uncleanliness	Barangay Office of Local		
	1.8	The presence of Municipal regulation and policies regarding the implementation of clean-up drive to manage solid waste in the water body of the Locale.	Programs that improve the cleanliness of the water body • Quarterly Manila Bay Clean Up, Rehabilitation and Preservation Program	MENRO - Barangay Office of Locale		
	1.9	Laws or ordinances made by the LGU for the environmental protection, including those pertaining to waste management.	Ordinances for environmental protection and waste management	MENRO - Barangay Office of Locale		Note: Data for 1.9 is inclusive in the Municipal Ordinance No. 2 Series of 2001 in 1.1.
	1.10	Involvement of Public-Private Partnerships (PPPs) in managing solid waste	Memorandum of Agreement about coordination with public-private partnerships in solid waste management • Agreement with Metro Clark Waste Management (MCWM) for disposal of residual solid waste into its landfill facility	Municipal Environment and Natural Resources Office		
Economic Factor	2.1	The Local Government Unit budget for solid waste management.	Budget allocation for the Solid Waste Management (SWM) Ten-Year Plan	Municipality of the Locale		
	2.2	Annual performance plan (APP) showing the budgeted amount for the required funds regarding the construction of Green Infrastructure (SLR, MRF, etc.) in the field of solid waste management	Ten-Year Plan for Solid Waste Management (SWM) funding allocation	Municipality of the Locale		Note: Data for 2.2 is inclusive in the Budget allocation for the Solid Waste Management (SWM) Ten-Year Plan in 2.1.
	2.3	Existing budget for the clean-up drive in a water body for solid waste management	Determine the breakdown of waste management allocation budget issued by the Barangay Officials and Municipal Engineering Office • Solid Waste Management (SWM) Ten-Year Plan • AIP Services of Barangay	Municipality of the Locale - Barangay office of the Locale		
	2.4	The Barangay budget for managing solid waste and installing garbage collection equipment in the body of water	Budget for the solid waste management services number • AIP Reference Code 8000-002-006-002 • AIP Reference Code 8000-002-006-003 • AIP Reference Code 8000-002-006-004 • AIP Reference Code 8000-002-006-008	Barangay office of the Locale		
	2.5	The Barangay budget for managing solid waste and maintenance of garbage collection equipment in the body of water	Funding requirements for implementation of sustainability concepts to the solid waste management • AIP Reference Code 8000-002-006-002 • AIP Reference Code 8000-002-006-003	Barangay office of the Locale		Note: Data for 2.5 is inclusive in the data in 2.4.

			• AIP Reference Code 8000-002-006-004 • AIP Reference Code 8000-002-006-008			
	2.6	The budget of the Barangay Office for solid waste management and installation of waste-collecting technology for the open channel	Solid waste management services budget allocation of the barangay	Barangay Office of the Locale		Note: Data for 2.6 is inclusive in the data in 2.4.
	2.7	The budget of the Barangay Office for solid waste management and maintenance of waste-collecting technology for the open channel	AIP Budget for the other environmental management projects	Barangay Office of the Locale		
	2.8	Budgetary allocation for the implementation of sustainability concepts to the solid waste management of the water body.	Funding requirements for implementation of sustainability concepts to the solid waste management	Barangay Office of the Locale		
	2.9	Financial support of Public-Private Partnerships (PPPs) in managing solid waste	Memorandum of Agreement about financial assistance with public-private partnerships in solid waste management	Barangay Office of the Locale		
	2.10	Adequate funding and budget allocation from government sources are essential for establishing and maintaining solid waste management infrastructure and services.	Funding requirements for SWM PLAN - Ten -Year Plan	Municipality of the Locale		Note: Data for 2.10 is inclusive in the Budget allocation for the Solid Waste Management (SWM) Ten-Year Plan in 2.1.
	2.11	The budget of the Barangay for the clean-up drive campaign or other campaign pertaining to solid waste management	• Manila Bay Clean Up, Rehabilitation and Preservation Program • Weekly Clean-Up drive	Barangay Office of the Locale		
	2.12	Budget of the barangay office in the information dissemination for solid waste management	• Barangay Weekly Clean-Up drive	Barangay Office of the Locale		Note: Data for 2.12 is inclusive Weekly Clean-up Drive in 2.11.
Social Factor	3.1	The residents' waste segregation practice on their respective household.	Manila Bayanihan Form 2.2 Barangay DCF (Sto. Tomas, Lubao) • MANDATORY SEGREGATION OF WASTES AT SOURCE REPORT	Barangay Office of the Locale		
	3.2	The communal management practice of the residents in terms of disposal solid waste.	Manila Bayanihan Form 2.2 Barangay DCF (Sto. Tomas, Lubao) • FUNCTIONAL MATERIALS RECOVERY FACILITY REPORT	Barangay Office of the Locale		
	3.3	The social inclusivity and participation of the public in terms of solid waste management program such as clean-up drive in the locale's body of water.	Manila Bay Clean up, Rehabilitation, and Preservation Program • Weekly Clean-up Drive Report	Barangay Office of the Locale		
	3.4	The public perception on the impact of solid waste accumulation in the locale's body of water.	Residential complaints regarding the solid waste management system of the locale.	Barangay Office of the Locale		
	3.5	The development and adoption of environmentally responsible approaches to sustainable solid waste management practice in the area.	NSWMC Resolution No. 1088 series of 2018 • RESOLUTION APPROVING THE TEN-YEAR SOLID WASTE MANAGEMENT PLAN OF MUNICIPALITY OF LUBAO PROVINCE OF PAMPANGA	Municipal Hall of the Locale		
	3.6	The awareness of the residing community by means of seminar or educational campaigns about Solid Waste Management.	Manila Bay Clean Up, Rehabilitation, and Preservation Program • WEEKLY CLEAN UP DRIVE ATTENDANCE SHEET	Barangay Office of the Locale		
	3.7	The influence of media coverage in the portrayal of situation's information to the public.	https://www.facebook.com/barangay.stotomas.1/about	Barangay Office of the Locale		
	3.8	The interpersonal influence of the residents in terms of the contribution to the continuity of responsible solid waste management practices.	https://www.facebook.com/barangay.stotomas.1/about	Barangay Office of the Locale		
	3.9	The level of communal solidarity of the community in terms of social responsibility regarding the collective action on sustaining an organized solid waste management disposal effort.	Manila Bay Clean Up, Rehabilitation, and Preservation Program • WEEKLY CLEAN UP DRIVE REPORT	Barangay Office of the Locale		
Technological Factor	4.1	Number of solid waste management filtering technology for bodies of water in the community being utilized.	Program of solid waste management in the community that used technology.	Local Government Unit of the Locale		
	4.2	The level of technology used by the community in filtering solid waste.	On-site evidence on the locale	Local Government Unit of the Locale		
	4.3	The interplay between the water level and the applicability of the solid waste management device on the said locale.	DISASTER RISK REDUCTION AND MANAGEMENT (DRRM)AND CLIMATE CHANGE ADAPTATION (CCA) PLAN, 2012-2016	Local Government Unit of the Locale - Department of Public Works and Highways		
	4.4	The spatial visualization and analysis of geospatial data on a specific location if it affects the installation of trash trap.	DISASTER RISK REDUCTION AND MANAGEMENT (DRRM)AND CLIMATE CHANGE ADAPTATION (CCA) PLAN, 2012-2016	Department of Public Works and Highways		
	4.5	Readiness of the local government of Lubao in operating trash traps technology.	Seminar or certificate of government employee in operation of trash trap technology	Department of Environment and Natural Resources Pampanga		
	4.6	Access for the after-sales phase of the technology for its maintenance.	On site evidence on the locale			
Legal Factor	5.1	The adherence to Solid waste disposal regulations under Republic Act No. 9003	The Certificate of Acceptance of Residual Waste of the Municipality from Geocycle	MENRO		
	5.2	Compliance with environmental protection laws particularly in protection of public health and environment in relation to waste management in the site locale	Manila Bayanihan Form 2.2 Barangay DCF of Sto. Tomas	Barangay Office of Locale - MENRO		
	5.3	The adherence to transportation laws governing waste movement and collection.	MEMORANDUM OF AGREEMENT between the Municipal Government and a sanitary landfill facility	MENRO		
	5.4	Compliance with laws requiring ongoing monitoring and reporting of environmental indicators, waste management practices, and any incidents that may occur during the project.	NSWMC Resolution No. 1088 series of 2018 RESOLUTION APPROVING THE TEN-YEAR SOLID WASTE MANAGEMENT PLAN OF MUNICIPALITY OF LUBAO PROVING OF PAMPANGA	MENRO		
	5.5	Embracing legal compliance regarding public nuisance regulations, with a focus on actively responding to community concerns regarding the potential adverse impacts of waste management practices.	JOINT MEETING OF SOLID WASTE MANAGEMENT BOARD & MBTF/IIMT	MENRO		
	5.6	The trash traps' alignment with local zoning laws for waste management project locations	CLUP GUIDEBOOK VOLUME 3 Article V Section 12.4 Regulations in Municipal Waters Zone	MENRO		
	5.7	Existing policy for solid waste management in the area that may hinder the operation of trash trap	MUNICIPAL ORDINANCE NO. 02 2001 - AN ORDINANCE ENACTING THE COMPREHENSIVE SOLID WASTE MANAGEMENT OF THE MUNICIPALITY	MENRO		
	5.8	Adherence to legal standards regulating noise and odor emissions from waste management operations	Letter complaints from nearby residents, businesses, or community members	Barangay Office of Locale		
Environmental Factor	6.1	The variations in vegetation density and species composition influence the selection and design of trash traps for effective waste interception.	Through vegetation maps from the Department of Environment and Natural Resources (DENR) or a manual survey on the land a. Vegetation Type/Map	Municipal Environment and Natural Resources Office		
	6.2	The diverse forms of waste commonly found in water bodies necessitate the implementation of trash traps.	The Solid Waste Management - Records of Waste Diversion	MENRO		
	6.3	The volume of debris in water bodies of the locale area.	The Certificate of Acceptance of Residual Waste of the Municipality and the record of clean-up drive from Barangay Sto. Tomas.	MENRO - Barangay Office of Locale		
	6.4	The type of Aquatic environment ecosystems impacts the overall health and survival of marine and freshwater species.	On-site evidences from Barangay Sto. Tomas and Reports for environmental NGOs	City Disaster Risk Reduction Management Office		
	6.5	The flood susceptibility of the locale in management planning for Trash Trap.	Review the flood hazard map from LiPAD FMC website of the area to identify the vulnerability of the areas from flood acclamation a. Flood Hazard Mapping	City Disaster Risk Reduction Management Office		
	6.6	The current state of the local environment in terms of pollution and waste accumulation	Through conducting Field Observations and On-site evidences from Barangay Sto. Tomas.	Local Government Unit of the Locale		
	6.7	The water body or waterway condition of the local area.	Consider conducting a Field Observation and a check with local community groups or municipal websites.	Local Government Unit of the Locale		
	6.8	The waste barrier made by those in the local area effectively mitigates waste pollution and protects the environment.	Executive order No. 14, An order organizing the Barangay Ecological Solid Waste Management Committee (BESWEMC) from Barangay Sto. Tomas.	MENRO - Barangay Office of Locale		
	6.9	The effectiveness of the trash collection frequency by the equipment in maintaining the quality of the water body.	The Solid Waste Management Schedule Collection - The LGU implements segregated collection system	Municipal Environment and Natural Resources Office		

Table 3 comprises the subsequent elements: particular parameters, which define a specific aspect in the application of trash trap in the locale; determining factors, as previously discussed in the preceding chapter; data collection, which enumerates the actual data required to satisfy the corresponding factor; site data collection, specifying where the data can be gathered from; grading, which shows of the compliance level of each data item required for analysis and determination; and remarks, which consist of notes that must be considered during data collection.

Phase 2 –Assessment of Applicability of Trash Trap for Sto Tomas Creek

In order to assess if the trash trap is applicable in the area, the researchers conducted a survey with the objective of gathering information from individuals who have significant knowledge in waste management and policy implementation. In order for the researchers to achieve this objective, they gathered all of the essential data, which included information regarding the management of solid waste, environmental and any local policies or regulations that were pertinent to the situation.

After collecting all of the necessary data, the researchers were able to conduct an analysis of it by utilizing the assessment tool that they had developed.

This tool will utilize the PESTLE Framework as a foundation to identify the key elements that are crucial in establishing the suitability of implementing a trash trap in the area. Through meticulous examination of various elements and thorough analysis of the acquired data, the researchers can get a comprehensive comprehension of the applicability of the trash trap. Using the existing findings, the researchers can provide recommendations for any areas where the interpretation of the computational analysis is insufficient. In order to meet the assessment criteria, the researchers gathered various information from the documents listed below:

- **Municipal Ordinance No. 2 Series of 2001 –** an ordinance enacting the comprehensive solid waste management of the Municipality.
- **Lubao Ten Year – Solid Waste Management Plan 2017 – 2026** - An extensive procedure that encompasses multiple stages to guarantee efficient and enduring waste management methodologies.
- **Barangay Executive Ordinance No. 14 Series of 2024** – an order organizing the barangay ecological solid waste management committee
- **Barangay Annual Investment Program 2024 -** The Barangay budget for managing solid waste and installing garbage collection equipment in the body of water.
- **Manila Bay Clean Up, Rehabilitation and Preservation Program (Conduct Weekly Clean-up drive -** regulation and policies regarding the implementation of clean-up drive to manage solid waste in the water body of the Locale.
- **Memorandum of Agreement about involvement of Public-Private Partnerships (PPPs)**
- **NSCWM Resolution No. 1088 series of 2018** – resolution approving the Ten-Year Solid Waste Management Plan of Municipality of Lubao Province of Pampanga
- **Flood Hazard Map of Lubao -** Determine the specific regions that are impacted by floods of varying likelihoods. They offer significant data regarding the anticipated flood depth and flow velocity.
- **Disaster Risk Reduction Management and Climate Change Adaptation (DRRMCCA PLAN) -** The fundamental component of disaster management comprises prevention, mitigation, and preparedness. In order for development operations to be sustainable, it is imperative that communities possess a comprehensive understanding of the risks present in their surroundings and acquire the necessary knowledge and skills to mitigate their risk of disasters.
- **Comprehensive Land Use Plan (CLUP) -** This document serves as a tool utilized by local government units to distribute their land resources across various sectors under their jurisdiction. It is a tangible manifestation of the local government's vision for the territory's land resources.

The specified documents were essential requirements for using the built evaluation tool in this study. The collected data was subjected to grading analysis, following the criteria outlined in Table 2, as considered suitable and essential. Every data point was evaluated for its relevance and examined to identify its corresponding information related to the given determining factors. The researchers determined the level of applicability for each item and calculated the average for each element. The calculated mean offered valuable information regarding the degree of application for each particular facet of suitability.

After calculating the average score for each factor, the researchers determined the overall average score, which indicated the overall level of compliance of the obtained data. This provides an assessment of the level of preparedness of the area for the implementation of the trash trap. The grading analysis yielded an applicability score,

which was utilized to assess the readiness of the area in terms of its suitability of a waste management device. The researchers can assess the overall applicability score in relation to the stated criteria to see whether any enhancements or modifications are necessary to meet the requisite requirements. This can facilitate the identification of the strengths and weaknesses of the current solid waste management procedures in the area, as well as identify areas that require additional improvement or investment.

Based on the results of the analysis, the researchers can assess the possibility of implementing a trash trap in the local area. If the overall compliance score is high, it indicates that the location is adequately prepared for the implementation of the trash trap. In contrast, a low score indicates that further efforts are required to enhance the preparedness of the area for solid waste management. In such instances, suggestions can be provided to rectify the detected deficiencies with the aim of enhancing sustainability and safeguarding the well-being and security of the local environment.

Statistical Analysis

To determine the internal consistency, reliability and means between respondent, the following statistical measures are used:

Cronbach Alpha

According to this statistical metric, each of the twelve items in the assessment tool will undergo an internal consistency test. To validate the internal consistency of every item, the yielded α needs to be higher than 0.70. The value of Alpha across the twelve (12) items in the created assessment tool is displayed in the table below:

TABLE IV
CRONBACH'S ALPHA

Reliability Statistics	
Cronbach's Alpha (α)	**N of terms**
0.964	12

The tool had a Cronbach's alpha value of 0.964, according to the results. Showing that the acceptable range of internal consistency was met by all 12 items. This result implies that the assessment instrument is trustworthy and suitable for confidently measuring the appropriate concept.

One-way ANOVA

In order to test One-way ANOVA, a set of twenty-five (25) responses which includes the evaluation of the collected data, grading and supporting evidence have been gathered in addition to the responses of the researchers. The responses were compared for One-way ANOVA, which required indication that there was no significant distinction between any of the parameters.
The calculations made by the respondents for each item in the assessment tool are displayed in the tables below.

TABLE V
ONE-WAY ANOVA – STANDARD DEVIATIONS

Groups	Count	Average (Mean)	Standard Deviation
Respondent 1	54	3.39	0.66
Respondent 2	54	3.56	0.88
Respondent 3	54	3.65	0.91
Respondent 4	54	3.65	0.91
Respondent 5	54	3.65	0.91
Respondent 6	54	3.65	0.91
Respondent 7	54	3.89	0.72
Respondent 8	54	3.74	0.76
Respondent 9	54	3.69	0.75
Respondent 10	54	3.59	0.84
Respondent 11	54	3.61	0.83
Respondent 12	54	3.63	0.83
Respondent 13	54	3.56	0.77
Respondent 14	54	3.48	0.69
Respondent 15	54	3.48	0.82
Respondent 16	54	3.50	0.80
Respondent 17	54	3.52	0.82
Respondent 18	54	3.41	0.86
Respondent 19	54	3.54	0.69
Respondent 20	54	3.44	0.79

Respondent 21	54	3.52	0.84
Respondent 22	54	3.54	0.77
Respondent 23	54	3.59	0.77
Respondent 24	54	3.46	0.82
Respondent 25	54	3.50	0.72

Table 5 includes the sample sizes, means, respondents, variables and standard deviation needed for evaluating the implementation of a trash trap in a selected locale area. The factors column lists political, economic, social, technological, legal, and environmental components. The average/mean column shows the calculated average scores, at the same time the count column showed the number of survey questionnaires. The Standard Deviation column represents the mean deviation of each answer.

TABLE VI
ONE-WAY ANOVA – OVERALL SIGNIFICANCE

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	15.908	24	0.663	1.020	0.436	1.526
Within Groups	861.185	1325	0.650			
Total	877.093	1349				

Table 6 offered a range of statistical metrics to illustrate the variations among the assessed management approaches or options. It showed degrees of freedom (df), variances within and between groups, and data dispersion. A comparison of three management produced "Mean Square" values that were computed for both "Between Groups" and "Within Groups." A one-way ANOVA revealed that there is no significant difference in (MEAN SCORE) since the P-value (0.436) is greater than the level of significance (0.05) which also means that researchers will not proceed to post-hoc analysis. It also showed that the critical value (1.526) is greater than F-computed (1.020). Since F < Fcrit, that means, there is no significant difference on the scores among your respondents

TABLE VII
ONE-WAY ANOVA – SIGNIFICANCE PER FACTOR

Factor	*Source of Variation*	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Political	Between Groups	48.96	9	5.44	0.78	0.749	1.56
	Within Groups	77.12	240	0.321			
	Total	126.1	249				
Economic	Between Groups	15.18	11	1.38	0.90	0.590	1.55
	Within Groups	70.8	288	0.24			
	Total	85.98	299				
Social	BetweenGroups	55.52	8	6.94	0.46	0.986	1.57
	Within Groups	51.92	216	0.24			
	Total	107.4	224				
Technological	Between Groups	24.11	5	4.82	0.81	0.716	1.60
	Within Groups	32.72	144	0.22			
	Total	56.83	149				
Legal	Between Groups	28.24	7	4.03	0.75	0.789	1.58
	Within Groups	35.76	192	0.18			
	Total	64	199				
Environmental	Between Groups	152.0	8	19.0	0.47	0.982	1.5
	Within Groups	87.44	216	0.40			
	Total	239.	224				

Table 7 displays the important values that have been determined among the elements that determine outcomes within the prescribed boundaries. It is important to mention that this only allows a margin of error of 5%, therefore the significance value should not be less than 0.05. Each observed value in this investigation surpassed the specified margin of error for the respective parameters.

Applicability Assessment of Trash trap in Brgy. Sto Tomas

The next portion of this proposal includes the use of the assessment tool that was formulated in understanding the collected data in regard to the applicability of trash trap in the locale. The researchers assessed each data relating into its applicability level in Table 2 based on the gathered

data. Every item was individually analyzed and assigned an applicability level according to its degree of adherence to the criteria established by the researchers. The criteria used to analyze the collected data were specifically specialized to determine the level of applicability of trash trap in the study area. The table below presents the grading that each item acquired and its corresponding sum per factor and overall grading.

TABLE VIII
GRADING FOR THE ASSESSMENT TOOL BASED ON BRGY. STO TOMAS, DENR PENRO PAMPANGA AND MUNICIPALITY OF THE LOCALE.

Parameter	Determining Factor		Grading
Political	1.1	The initiative of Municipality to create a certain program regarding the implementation of solid waste management	4.52
	1.2	The initiative of Barangay Officials of the Locale in implementing solid waste management	4.00
	1.3	The management, conservation, preservation, and protection of the municipality's natural resources and environment will fall under the responsibility of MENRO.	4.48
	1.4	The initiative of Municipal Government in promoting Solid Waste Management by seminar, workshop and campaigns.	4.52
	1.5	The initiative of Barangay Officials in promoting Solid Waste Management by seminar, workshop and campaigns.	3.44
	1.6	Updated penalties made by the Municipal for laws mandating waste segregation, recycling programs, landfill regulations, and penalties for illegal dumping.	3.60
	1.7	Updated fines for violations of laws requiring trash segregation, recycling initiatives, landfill rules, and unlawful dumping, as determined by the barangay office.	3.20
	1.8	The presence of Municipal rgulation and policies regarding the implementation of clean-up drive to manage solid waste in the water body of the Locale.	4.00
	1.9	Laws or ordinances made by the LGU for environmental protection, including those pertaining to waste management.	3.68
	1.10	Involvement of Public-Private Partnerships (PPPs) in managing solid waste	3.68
		Subtotal	**39.12**
Economic	2.1	The Local Government Unit budget for solid waste management.	3.28
	2.2	Annual performance plan (APP) showing the budgeted amount for the required funds regarding the construction of Green Infrastructure (SLR, MRF, etc.) in the field of solid waste management	3.76
	2.3	Existing budget for the clean-up drive in a water body for solid waste management	3.68
	2.4	The Barangay budget for managing solid waste and installing garbage collection equipment in the body of water	3.56
	2.5	The Barangay budget for managing solid waste and maintenance of garbage collection equipment in the body of water	3.84
	2.6	The budget of the Barangay Office for solid waste management and installation of waste-collecting technology for the open channel	3.76
	2.7	The budget of the Barangay Office for solid waste management and maintenance of waste-collecting technology for the open channel	3.48
	2.8	Budgetary allocation for the implementation of sustainability concepts to the solid waste management of the water body.	4.00
	2.9	Financial support of Public-Private Partnerships (PPPs) in managing solid waste	3.52
	2.10	Adequate funding and budget allocation from government sources are essential for establishing and maintaining solid waste management infrastructure and services.	4.04
	2.11	The budget of the Barangay for the clean-up drive campaign or other campaign pertaining to solid waste management	3.76
	2.12	Budget of the barangay office in the information dissemination for solid waste management	3.56
		Subtotal	**44.24**
Social	3.1	The residents' waste segregation practice on their respective household.	4.92
	3.2	The communal management practice of the residents in terms of disposal solid waste.	3.60
	3.3	The social inclusivity and participation of the public in terms of solid waste management program such as clean-up drive in the locale's body of water.	3.28
	3.4	The public perception on the impact of solid waste accumulation in the locale's body of water.	3.32
	3.5	The development and adoption of environmentally responsible approaches to sustainable solid waste management practice in the	4.00

		area.	
	3.6	The awareness of the residing community by means of seminar or educational campaigns about Solid Waste Management.	4.12
	3.7	The influence of media coverage in the portrayal of situation's information to the public.	3.88
	3.8	The interpersonal influence of the residents in terms of the contribution to the continuity of responsible solid waste management practices.	4.36
	3.9	The level of communal solidarity of the community in terms of social responsibility regarding the collective action on sustaining an organized solid waste management disposal effort.	3.60
		Subtotal	**35.08**
Technological	4.1	Number of solid waste management filtering technology for bodies of water in the community being utilized.	3.28
	4.2	The level of technology used by the community in filtering solid waste.	3.08
	4.3	The interplay between the water level and the applicability of the solid waste management device on the said locale.	2.40
	4.4	The spatial visualization and analysis of geospatial data on a specific location if it affects the installation of trash trap.	3.08
	4.5	Readiness of the local government of Lubao in operating trash traps technology.	3.52
	4.6	Access for the after-sales phase of the technology for its maintenance.	3.68
		Subtotal	**19.04**
Legal	5.1	The adherence to Solid waste disposal regulations under Republic Act No. 9003	4.00
	5.2	Compliance with environmental protection laws particularly in protection of public health and environment in relation to waste management in the site locale	3.48
	5.3	The adherence to transportation laws governing waste movement and collection.	3.44
	5.4	Compliance with laws requiring ongoing monitoring and reporting of environmental indicators, waste management practices, and any incidents that may occur during the project.	4.00
	5.5	Embracing legal compliance regarding public nuisance regulations, with a focus on actively responding to community concerns regarding the potential verse impacts of waste mnagement practices.	3.00
	5.6	The trash traps' alignment with loca zoning laws for waste maagement project locations	3.60
	5.7	Existing policy for solid waste management in the area that may hinder the operation of trash trap	4.28
	5.8	Adherence to legal standards regulating noise and odor emissions from waste management operations	3.76
		Subtotal	**29.56**
Environmental	6.1	The variations in vegetation density and species composition influence the selection and design of trash traps for effective waste interception.	4.00
	6.2	The diverse forms of waste commonly found in water bodies necessitate the implementation of trash traps.	3.56
	6.3	The volume of debris in water bodies of the locale area.	2.68
	6.4	The type of Aquatic environment ecosystems impacts the overall health and survival of marine and freshwater species.	1.80
	6.5	The flood susceptibility of the locale in management planning for Trash Trap.	2.44
	6.6	The current state of the local environment in terms of pollution and waste accumulation	1.68
	6.7	The water body or waterway condition of the local area.	2.24
	6.8	The waste barrier made by those in the local area effectively mitigates waste pollution and protects the environment.	3.72
	6.9	The effectiveness of the trash collection frequency by the equipment in maintaining the quality of the water body.	3.56
		Subtotal	**25.68**
		TOTAL	**192.72**

Table 8 outlined a framework for evaluating the suitability of a trash trap in a selected locale, taking into account a number of factors grouped into six categories: Political, Economic, Social, Technological, Legal and Environmental. The significance of each parameter in determining trash trap applicability was assigned a number, and sub-factors were rated from 1 to 5 with 193 as the total score. Analyzing these variables might have made it easier to pinpoint the system's advantages and disadvantages, which would have allowed for the creation of plans to improve applicability efforts.

The researchers will compute the mean score for every component and a comprehensive assessment to ascertain the suitability of the trash trap in the region. Certain standards that have been specified will serve as the foundation for the examination. The researchers will determine the extent to which each aspect applies to identify areas that require more work. Every factor's degree of application will be considered in the calculation of the average score for each component and the overall assessment. The computed applicability levels will be used to assess the garbage trap's applicability as well as the acceptability of the data gathered. The following table displays the mean score for every component as well as the overall evaluation.
Formula for computing the average of each score:

$$\overline{X} = \frac{\sum_{i=1}^{n} Xi}{n}$$

Where: $\overline{X}$ = Average of Score

Xi = Value of Score

n = Number of Items

TABLE IVX
COMPUTATION OF AVERAGE RATING PER FACTOR

Parameter	Average	Interpretation
Political	3.91	Applicable
Economic	3.69	Applicable
Social	3.90	Applicable
Technological	3.17	Applicable
Legal	3.70	Applicable
Environmental	2.85	Less Applicable
Overall	**3.54**	**Applicable**

Table 9 presents the computed total and related average for each assessed parameter. The average value of the political parameter is 3.91, and its sum is 39.12. The average value of the economic parameter is 3.69, and its sum is 44.24. The average of the social parameter is 3.90, and its sum is 35.08. The technological parameter's average is 3.17 and its sum is 19.04. The average of the legal parameter is 3.70, and its total is 29.56. The average value of the environmental parameter is 3.70, with a sum of 25.68. The examination of the 54 elements produced an average score of 3.54 and a total sum of 192.72.

Interpretation

The associated statements presented each value in the table and explained any patterns or trends identified in the data.

Political Factor

A score of five (5) was found for Political Factors 1.1, 1.2, 1.3, and 1.4, indicating a very high level of initiation and great responsibility. There are hints that data was gathered for the four particular things under consideration. A score of four (4) was awarded to items 1.5, 1.8, 1.9, and 1.10, indicating a high level of commencement, extensive regulation, and liberal legislation. Nonetheless, it was found that items 1.6 and 1.7 scored three (3), indicating a phased-in approach. All the necessary information was collected for these items, in addition to extra data that enhanced the instrument's comprehension. Therefore, it can be concluded that a large amount of comprehensive data was gathered, which significantly improved the accuracy of the assessment. With a mean score of 4.2, this criterion demonstrated a good level of application. Consequently, sufficient information and details have been supplied by the political parameter for the complete evaluation method.

Economic Factor

Economic factors 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.9, 2.10, 2.11, and 2.12 were shown to have average scores, falling between 3.00 and 3.99. Evidence points to the collection of data for the ten (11) particular items under consideration. Nonetheless, it was found that item 2.8 had a score of four (4), indicating a larger budget. All the necessary information was collected for these items, in addition to extra data that enhanced the instrument's comprehension. Therefore, it can be concluded that the data that was gathered was both

substantial and plentiful, which significantly improved the evaluation's accuracy. A mean score of 3.69 was obtained for the criterion, indicating a modest level of application. As a result, the economical element has given the entire assessment instrument a wealth of information and precise details.

Social Factor

Social Factors 3.1 and 3.8 were found to have a five-(5) score, suggesting outstanding participation and waste segregation practices. The scores of four (4) for items 3.2, 3.5, 3.6, and 3.7 indicated an established word, considerable development, moderate awareness, and major influence. However, a score of three (3) was assigned to items 3.3, 3.4, and 3.9, suggesting a developing level of inclusion and engagement, moderate dissatisfaction, and moderate attendance. All the necessary information was collected for these items, in addition to extra data that enhanced the instrument's comprehension. Therefore, it can be concluded that the data that was gathered was both substantial and plentiful, which significantly improved the evaluation's accuracy. A mean score of 3.89 was obtained for the criterion, indicating a modest level of application. As a result, the social element has given the entire assessment tool a wealth of information and precise details.

Technological Factor

It was concluded that the responses to Items 4.5 and 4.6, which had scores of four (4), were reasonably accessible and well-prepared. The document or collected data contained all of the pertinent information required for the current task. A score of three (3) was obtained for Items 4.1, 4.2, and 4.4, showing the existence of technology that is currently in use and neither simple nor complex to use. The gathered material or document contained all the necessary facts for the assigned item in addition to additional information that enhanced the overall understanding of the tool. However, Item 4.3 was given a score of 2, indicating that the technological component was not followed. The document or data that was obtained only matched the necessary data. With an average score of 3.17, which falls within the allowed range for a grade 3, it can be concluded that the papers and data gathered met the requirements for the particular item on technological elements. These findings suggest that the technological issue has been sufficiently addressed and can be taken into account in light of the evaluation as a whole.

Legal Factor

According to the analysis's findings, Items 5.1, 5.4, and 5.7 all scored between 4 and 4.99, indicating high compliance with the legal factor. The collected data or document included all the pertinent details required for the item in question, in addition to additional information that enhanced the tool's overall comprehension. However, the compliance score for Items 5.2, 5.3, 5.5, 5.6, and 5.8 ranged from 3.00 to 3.99. Thus, it can be concluded that the data collected was both plentiful and thorough, which greatly improved the assessment's correctness. With an average score of 3.70, the criterion was implemented to a moderate extent.

Environmental Factor

Items 6.1, 6.2, 6.8, and 6.9 all received a score of four (4), indicating minimal impact and high effectiveness, according to the analysis results. The gathered information or record included all the details needed for the specified item in addition to extras that improved the instrument's overall understanding. Items 6.3, 6.5, and 6.7 received a score of two (2), signifying a considerable quantity of debris, a comparatively elevated susceptibility, and a low caliber of the aquatic environment. On the other hand, items 6.4 and 6.6 scored 1, indicating a remarkably low degree of compliance. The average score for the environmental factor was 2.66, indicating that it was not very relevant in providing the necessary environmental data. The scores and associated compliance levels led to this result. It was observed that whereas some things showed low levels of compliance, others achieved great levels of compliance. Consequently, the

Environmental Factor's compliance score was reduced.

Overall Consideration

Based on the study, the PESTLE elements had an average score of 3.57, which is between 3 and 3.99. This rating shows that there is enough data and supporting documentation to show that implementing new technology—like a trash trap—in the area is feasible. This might greatly improve the government's performance in general and decision-making in particular. Consequently, the statistical data indicates that the trash trap is appropriate for the area.

Results

After evaluating the Barangay Sto. Tomas Creek, it was determined that most of the criteria in the obtained data have achieved a high degree of application. However, the only criterion that fell below the satisfactory level was the environmental component. This suggests that the trash trap meets the required criteria for implementation based on the specified parameters.

When certain standards have already been met or surpassed, it suggests that there is sufficient information within those limits to establish the suitability of trash traps in the area. The data pertaining to the parameter will function as an outline for the implementation of the solid waste management device. Consequently, it is crucial to regularly monitor and evaluate the selected indicators in order to uphold compliance and achieve ongoing enhancement.

The study reveals both strengths and areas for improvement within each aspect through careful investigation. Within the field of politics, a strong regulatory framework is indicated by significant levels of initiative and responsibility, while certain areas may need attention due to a slow pace of implementation process. From an economic standpoint, a primarily increased allocation of funds suggests a positive financial condition. However, there are certain variables that show only moderate levels of implementation, which suggests that there is room for improvement in specific areas. Social dynamics encompass a wide range of established behaviors and new trends, which reveal both strengths and places for improvement in societal interaction. Although there are worries regarding the readiness of technology, the overall assessment shows that there is sufficient technological support, although there is still space for development in terms of accessibility and preparedness. The general level of legal compliance is strong, nevertheless, it would be advisable to closely examine areas with limited implementation to guarantee complete adherence to regulatory standards. From an environmental perspective, the lack of evidence in certain sections of the assessment tool resulted in significantly low scores. Nonetheless, this issue could be effectively addressed by implementing a WACS (Waste Analysis and Characterization Study) analysis, which would generate the necessary evidence to support and potentially improve the scores of the low-graded questions.

The evaluation of Barangay Sto. Tomas Creek indicated a satisfactory degree of execution. This reflects the sufficiency of the available data regarding the area's capacity to accommodate trash traps. This extensive research provides vital information for stakeholders interested in the local area. The study provides practical insights to guide decision-making and facilitate positive change in the solid waste management of the community.

Phase 3 - Proposal of recommendations for the policy improvement of the area in terms of its applicability of trash trap

In order to utilize the assessment tool, herewith is the assessment of trash trap for policy improvement. This will be approved after being submitted to the local government unit. The policy improvement has the following contents.

After assessing each factor's degree of compliance and acquiring a thorough understanding, the researchers will propose a recommendation. The proposed approach involves using the formulated

assessment tool to examine the location in terms of its suitability for a trash trap.

Moreover, the proposal functioned as a standard for future assessments of the locale's suitability for trash traps. It will also serve as a tool to determine which further actions might be required in the future to improve the trash trap's adoption in the area.

In conclusion, the development of this assessment tool allowed for a thorough and systematic analysis of the area's suitability for trash traps. The proposal will serve as a guide for determining future actions to enhance the area's capabilities to consistently adapt trash traps. The proposal for recommendations will comprise multiple components designed to ensure the improvement of the assessment tool.

These required recommendations are presented for items that garnered an average of below 3:

- **Item 4.3: The interplay between the water level and the applicability of the solid waste management device on the said locale.**

Consistent surveillance of water level in the area will help in determining the installation of trash trap as it identify the optimal placement where the trash trap can effectively capture debris while ensuring uninterrupted water flow.

- **Item 6.3: The volume of debris in water bodies of the locale area.**

A waste analysis and characterization study (WACS) of the locale should provide essential data on the types of quantities of debris present in the water body, aiding in the design and placement of the trash trap to effectively intercept debris.

- **Item 6.5: The flood susceptibility of the locale in management planning for Trash Trap**.

A detailed flood susceptibility map of the locale can help determine the most vulnerable areas to flooding, guiding the strategic placement of trash traps to effectively capture and mitigate debris accumulation during flood events.

- **Item 6.6: The current state of the local environment in terms of pollution and waste accumulation**

Water quality testing results can help determine the effectiveness and necessity of implementing a trash trap by revealing the presence and concentration of pollutants and debris in the water, thereby highlighting areas where a trash trap would be most beneficial in mitigating environmental contamination.

- **Item 6.7: The water body or waterway condition of the local area.**

To help with the design and location of the trash trap to ensure, a waste analysis and characterization study (WACS) of the area should supply crucial information on the condition of the water body.

The following recommendations are presented for items that garnered an average of 3 and above:

1. Formulated Assessment Tool: The assessment tool that the researchers developed to determine the applicability of trash traps in the area will be strictly detailed in the proposal. It will emphasize the exact criteria utilized to measure compliance as well as the determining elements for the assessment process that were identified in this study.
2. Trash Trap Design: a detailed set of criteria and design principles that may be used as a guide to choose the most suitable trash trap design for the area in relation to its installation. The specific characteristics of the locale will be taken into consideration when determining which trash trap designs are acceptable for the area, using these criteria and basis as a reference.
3. Accessibility: To ensure Trash Trap's accessibility, a design software or an application with a user-friendly interface, allowing all users to easily navigate and submit data. This includes implementing intuitive controls, clear instructions, and

straightforward data entry fields for efficient use by all individuals.

Executive Summary

This formulated assessment tool evaluates the applicability of trash trap for Sto. Tomas creek. The main objective of this tool is to determine whether the locale is suitable for policy improvement through the application of trash trap.

Environmental, technological, and legal concerns are among the assessment criteria; each is filled with a collection of information and evidence. A compliance rating system with a low to high range is used to evaluate the criteria. The evaluation results are examined, analyzed, and presented in a thorough report that highlights areas that are compliant and those that require improvement.

The assessment tool offers the barangay of Sto. Tomas and policymakers, many benefits, because it provides them with precise information about the availability and suitability of trash trap installation in their community. Policymakers can promote better decisions based on data by modifying implementation plans as needed with the support of dependable data.

The main objective of the tool is to evaluate the creek's state and gather information required for the installation of trash traps. As a result, the tool is essential for assessing the accuracy and completeness of the technical, legal, and environmental data needed for trash trap installation. Local planners and other policymakers that are interested in implementing solid waste management project into action will find the tool beneficial.

Goals and Objectives

To develop an assessment tool that evaluates the availability and quality of data required to implement trash traps in a selected locale and to determine whether a given locality has sufficient data to utilize Trash Traps.

In order to achieve this, the following must be considered:

1. To identify the political, economic, social, technological, legal, and environmental data required to implement Trash Trap.
2. To provide recommendations for improving the quality and completeness of data needed for the Trash Trap applicability.
3. To create a simple interface for the assessment tool that aids policymakers and planners in analyzing the data of their respective areas.
4. To facilitate the use of data in decision-making by helping the Local Government Unit make informed decisions using precise and dependable data.
5. To raise awareness among the community about the importance of waste management and pollution prevention through the visible presence and impact of trash traps.

IV. CONCLUSIONS AND RECOMMENDATIONS

Conclusion

This study has developed a tool for assessment that includes several determining factors necessary for assessing the suitability of a solid waste management device in the said locale. Subsequently, this method was employed to assess the collected data concerning Barangay Sto. Tomas, Lubao, Pampanga. After an in-depth evaluation of all relevant parameters, it is evident that there is enough and appropriate data to support the implementation of trash traps in Barangay Sto. Tomas, Lubao, Pampanga. Moreover, these data underwent a grading analysis to assess the amount of applicability for each element and overall considerations. Based on the study's findings, it can be concluded that trash traps are suitable for use in Barangay Sto. Tomas Creek in Lubao, Pampanga. Moreover, the study indicates that trash traps are a feasible approach for efficiently controlling and capturing waste in nearby water systems. The

collected information supports the idea that trash traps can successfully reduce the number of suspended debris, therefore improving environmental health. Implementing a solid waste management device in the locale is a promising strategy for mitigating water pollution and preserving a healthy marine environment. With this, it is crucial for both residents and local authorities to acknowledge this issue and collaborate in developing solutions to address the gap in the implementation of the said trash traps.

After considering all relevant criteria, it is evident that there is adequate, appropriate data about implementing trash traps in Barangay Sto. Tomas, Lubao, Pampanga. The study suggests that implementing trash traps has been adequately incorporated into the plan. The statement suggests that while the factors associated with trash traps, such as technological, social, political, economic, legal, and environmental factors, may have been considered, the connections between these factors to establish implementing trash trap practices have been sufficiently developed.

Recommendation

The researchers suggest implementing the following recommendations to improve the assessment tool used to evaluate the characteristics of the area in relation to solid waste management, based on the findings of the study:

1. In order to provide more detailed information on the data collected from the local area, it is crucial to create specific criteria for each item in the assessment tool that has been created. The criteria will facilitate a more intricate assessment of each parameter, therefore yielding a more thorough comprehension of the compliance levels of the area. By formulating customized criteria, it will be more convenient to pinpoint areas that want enhancement and ascertain the requisite measures that need to be implemented to ameliorate them.
2. Create an established set of standards and criteria for trash traps that can be used as a baseline to assess the environmentally friendly aspects of the area in relation to solid waste management. The decision-making process for selecting suitable trash traps for the given area will be guided by these criteria and rationale, while also considering the distinctive characteristics of the locale.
3. In accordance with the earlier suggestion, it is necessary to create an application or software that can be used to implement the evaluation instrument. This software should enable main users to submit their respective grade of the obtained data, which the computer will then present in its appropriate qualitative interpretation.

In conclusion, the developed assessment tool can be used by other locales in a view of the fact that the parameter and key indications of the study are made general. As a result of this study, other researchers might have further proposition on improving the analysis of the assessment tool. By using various procedures, the assessment tool will be enhanced in terms of its accuracy and precision in evaluating the sustainable aspects of the location in relation to solid waste management. It will assist in identifying suitable and relevant garbage traps that may effectively reduce flood hazards and handle solid waste management.

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REFERENCES

[1] A. A. Magalang, "Municipal Solid Waste Management in the Philippines," 2014. https://www.semanticscholar.org/paper/Municipal-Solid-Waste-Management-in-the-Philippines-Magalang.

[2] Ericson Esquibel Coracero, R. Gallego, K. Joy, and J. R. Gonzales, "A Long-Standing Problem: A Review on the Solid Waste Management in the Philippines," *Indonesian Journal of Social and Environmental Issues (IJSEI)*, 2021. https://www.semanticscholar.org/paper/A-Long-Standing-Problem%3A-A-Review-on-the-Solid-in-Coracero-Gallego.

[3] O. for, "ISO 14001:2015," ISO, 2015. https://www.iso.org/standard/60857.html (accessed May 28, 2024).

[4] S. Vlase, M. Marin, M. L. Scutaru, D. D. Scarlatescu, and C. Csatlos, "Study on the mechanical responses of plastic pipes made of high density polyethylene (HDPE) in water supply network," Applied Sciences (Switzerland), vol. 10, no. 5, Mar. 2020, doi: 10.3390/app10051658.

[5] G. K. Singh, K. Gupta, and S. Chaudhary, "Solid Waste Management: Its Sources, Collection, Transportation and Recycling," International Journal of Environmental Science and Development, vol. 5, no. 4, pp. 347–351, 2014, doi: 10.7763/ijesd.2014.v5.507.

[6] S. Das, S. H. Lee, P. Kumar, K. H. Kim, S. S. Lee, and S. S. Bhattacharya, "Solid waste management: Scope and the challenge of sustainability," J Clean Prod, vol. 228, pp. 658–678, Aug. 2019, doi: 10.1016/J.JCLEPRO.2019.04.323.

[7] M. F. Mukhtar et al., "DEVELOPMENT of RIVER TRASH COLLECTOR SYSTEM," in Journal of Physics: Conference Series, Institute of Physics Publishing, Jun. 2020. doi: 10.1088/1742-6596/1529/4/042029.

[8] L. G. A. Barboza, A. Cózar, B. C. G. Gimenez, T. L. Barros, P. J. Kershaw, and L. Guilhermino, "Microplastics pollution in the marine environment," in World Seas: An Environmental Evaluation Volume III: Ecological Issues and Environmental Impacts, Elsevier, 2018, pp. 305–328. doi: 10.1016/B978-0- 12-805052-1.00019-X.

[9] D. Sulaeman, S. S. Arif, and Sudarmadji, "Trash-polluted irrigation: Characteristics and impact on agriculture," in IOP Conference Series: Earth and Environmental Science, Institute of Physics Publishing, May 2018. doi: 10.1088/1755-1315/148/1/012028.

[10] "The Design and Analysis of Self-Cleansing Trash Trap for Capturing Floating Debris at the Drainage System."

[11] A. Rahman et al., "'Application of GFRP Rubbish Trap In Open Channel System', 6 th Seminar on Water Management (JSPS-VCC) July 2008 (Sabah) STUDY OF EFFECTIVENESS FOR RUBBISH TRAPS IN OPEN CHANNEL FLOW."

[12] M. Zayed, A. El Molla, and M. Sallah, "An experimental study on angled trash screen in open channels," Alexandria Engineering Journal, vol. 57, no. 4, pp. 3067–3074, Dec. 2018, doi: 10.1016/j.aej.2018.05.005.

[13] M. Khairul et al., "THE EFFECTIVENESS OF PROPOSED DESIGN RUBBISH TRAP SYSTEM."

[14] P. B.-T. D. Hoornweg, "What a Waste : A Global Review of Solid Waste Management cb," *World Bank*, vol. 15, no. November, 2014.

[15] S. Das, S. H. Lee, P. Kumar, K. H. Kim, S. S. Lee, and S. S. Bhattacharya, "Solid waste management: Scope and the challenge of sustainability," *J Clean Prod*, vol. 228, 2019, doi: 10.1016/j.jclepro.2019.04.323.

[16] R. Chandrappa and D. B. Das, "Waste Quantities and Characteristics," in *Environmental Science and Engineering*, 2012. doi: 10.1007/978-3-642-28681-0_2.

[17] J. G. Gacu, "Design of River Floating Trash Traps Using Recycled Plastic Bottles and Characterization of Waste Collected in Odiongan, Romblon Philippines," 2022.

[18] A. Allesch and P. H. Brunner, "Assessment methods for solid waste management: A literature review," *Waste Management and Research*, vol. 32, no. 6. 2014. doi: 10.1177/0734242X14535653.

[19] G. Vinti, V. Bauza, T. Clasen, T. Tudor, C. Zurbrügg, and M. Vaccari, "Health risks of solid waste management practices in rural Ghana: A semi-quantitative approach toward a solid waste safety plan," *Environ Res*, vol. 216, 2023, doi: 10.1016/j.envres.2022.114728.

[20] P. Alam and K. Ahmade, "Impact of Solid Waste on Health and the Environment," *International Journal of Sustainable Development and …*, vol. 2, no. 1, 2013.

[21] W. A. Khan, S. Ali, and S. A. Shah, "Water Pollution: Sources and Its Impact on Human Health, Control and Managing," *Journal of International Cooperation and Development*, vol. 5, no. 1, 2022, doi: 10.36941/jicd-2022-0005.

[22] J. Halder and N. Islam, "Water Pollution and its Impact on the Human Health," *Journal of Environment and Human*, vol. 2, no. 1, pp. 36–46, Jan. 2015, doi: https://doi.org/10.15764/eh.2015.01005.

[23] S. Dwivedi and D. Shikha, "Water pollution: Causes, effects and control," *Biochem Cell Arch*, vol. 16, 2016.

[24] Waste Analysis and Characterization Study (WACS): Measures Towards Effective Municipal Waste Management in Batad, Iloilo, Philippines," *FFTC Agricultural Policy Platform (FFTC-AP)*, Dec. 06, 2019.https://ap.fftc.org.tw/article/1650?fbclid=IwAR0sjUY3MiBXLsVF6ZflXkhRuA8_9iOpTxUXg-pQyzWO79TinDJHItdcWk4 (accessed Nov. 14, 2023).

[25] A. Soni, P. K. Das, and P. Kumar, "A review on the municipal solid waste management status, challenges and potential for the future Indian cities," *Environment, Development and Sustainability*, vol. 25, no. 12. 2023. doi: 10.1007/s10668-022-02688-7.

[26] M. Zayed, A. El Molla, and M. Sallah, "An experimental study on angled trash screen in open channels," Alexandria Engineering Journal, vol. 57, no. 4, pp. 3067–3074, Dec. 2018, doi: 10.1016/j.aej.2018.05.005.

[27] K. D. Ganvir, P. R. Nerkar, L. W. Ghate, and H. H. Bhagat, "THE IMPACT OF WATER POLLUTION AND PRELIMINARY STUDY ON RIVER TRASH COLLECTING MECHANISM." [Online]. Available: www.ijtra.com

[28] K. D. Ganvir, P. R. Nerkar, L. W. Ghate, and H. H. Bhagat, "THE IMPACT OF WATER POLLUTION AND PRELIMINARY STUDY ON RIVER TRASH COLLECTING MECHANISM." [Online]. Available: www.ijtra.com

[29] J. G. Gacu, "Design of River Floating Trash Traps Using Recycled Plastic Bottles and Characterization of Waste Collected in Odiongan, Romblon Philippines," 2022.

[30] T. Harianto, A. B. Muhiddin, and U. Zahra, "Stability of Trash Trap Design in Various River Estuary," IALT.

[31] Mohd *et al.*, "Design and development of trash trap of stream for mini hydro," *Materials Today: Proceedings*, vol. 46, pp. 2105–2111, Jan. 2021, doi: https://doi.org/10.1016/j.matpr.2021.05.435

[32] G. R. Hopkins, "A journey to capture marine debris—Before it reaches the oceans," *Marine Technology Society Journal*, vol. 53, no. 4. 2019. doi: 10.4031/MTSJ.53.4.7.

[33] L. Bangani, H. M. Kabiti, O. Amoo, M. D. V. Nakin, and Z. Magayiyana, "Impacts of illegal solid waste dumping on the water quality of the Mthatha River," *Water Pract Technol*, vol. 18, no. 5, pp. 1011–1021, May 2023, doi: 10.2166/wpt.2023.053.

[34] "Republic Act No. 7160 | GOVPH," *Official Gazette of the Republic of the Philippines*, Oct. 10, 1991. https://www.officialgazette.gov.ph/1991/10/10/republic-act-no-7160/ (accessed Nov. 25, 2023).

[35] "Republic Act No. 9275," *Lawphil.net*, 2023. https://lawphil.net/statutes/repacts/ra2004/ra_9275_2004.html?fbclid=IwAR3Kx0Ew-hcYl_AN_vF3q4KCliaUo6Ph-hAPRgwQBRp3UI1br2sh3H4Pwpc (accessed Nov. 25, 2023).

[36] "Republic Act No. 9003 | GOVPH," *Official Gazette of the Republic of the Philippines*, Jan. 26, 2001. https://www.officialgazette.gov.ph/2001/01/26/republic-act-no-9003-s-2001/?fbclid=IwAR2LxntGtWFB-KudaeLfnCXnXk2r4-rIlcquAMEVJ9PQPHxP-DlrxYC2pYk (accessed Nov. 25, 2023).

[37] C. Akwei, Isaac Sakyi Damoah, and J. Amankwah□Amoah, "The Effects of Politics on the Implementation of Government Programs/Projects: Insights from a Developing Economy," Politics & Policy, vol. 48, no. 6, pp. 1161–1201, Dec. 2020, doi: https://doi.org/10.1111/polp.12384

[38] L. E. Chapman, "Clinical Xenotransplantation," *JAMA*, vol. 285, no. 18, p. 2304, May 2001, doi: https://doi.org/10.1001/jama.285.18.2304

[39] L. B. Pollans, "Trapped in trash: 'Modes of governing' and barriers to transitioning to sustainable waste management," *Environ Plan A*, vol. 49, no. 10, 2017, doi: 10.1177/0308518X17719461.

[40] Juhaidie Zamani Jamaludin, "Research of Innovation Smart Sensor Floating Trash Trap," *Borneo Engineering & Advanced Multidisciplinary International Journal*, vol. 2, no. 2, 2023, Accessed: Dec. 02, 2023. [Online]. Available: https://beam.pmu.edu.my/index.php/beam/article/view/111

[41] A. Paris, A. Kwaoga, and Chinthaka Hewavitharane, "An assessment of floating marine debris within the breakwaters of the University of the South Pacific, Marine Studies Campus at Laucala Bay," *Marine Pollution Bulletin*, vol. 174, pp. 113290–113290, Jan. 2022, doi: https://doi.org/10.1016/j.marpolbul.2021.113290

[42] Smith, J. R., Louis, W. R., Terry, D. J., Greenaway, K. H., Clarke, M. R., & Cheng, X. (2012). Congruent or conflicted? The impact of injunctive and descriptive norms on environmental intentions. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0272494412000412

[43] Chen, Y. Y., & Hong, Y. Y. (2015). Different ways to resolve discrepancy between descriptive and injunctive norms across cultures https://journals.sagepub.com/doi/abs/10.1177/0022022115600265?journalCode=jcca

[44] B. D. Neville Nacpil et al., "Development of Multi-Criteria Assessment Tool for The Management Planning of Sustainable Urban Drainage: The Case Study of Bulaon Resettlement, City of San Fernando, Pampanga Indexed Terms-Flood Mitigation Management, PESTLE Framework, Sustainable Urban Drainage Systems I. THE PROBLEM AND ITS REVIEW OF RELATED LITERATURE AND STUDIES," 2023.

[45] M. G. Carleton and J. S. Nielsen, "A STUDY OF TRASH AND TRASH INTERCEPTION DEVICES," 1990. [Online]. Available: http://iwaponline.com/wst/article-pdf/22/10-11/287/100940/287.pdf

[46] C. Sherlock, R. F. Gutierrez, M. David, and C. M. Rochman, "A methodology for quantifying and characterizing litter from trash capture devices (TCDs) to measure impact and inform upstream solutions," Facets, vol. 8, pp. 1–12, 2023, doi: 10.1139/facets-2022-0034.

[47] "REPUBLIC OF THE PHILIPPINES CONGRESS OF THE PHILIPPINES Metro Manila TWELFTH CONGRESS OF THE REPUBLIC) OF THE PHILIPPINES) Third Regular Session) REPUBLIC ACT 9275 AN ACT PROVIDING FOR A COMPREHENSIVE WATER QUALITY MANAGEMENT AND FOR OTHER PURPOSES."

[48] "Congress of the Philippines Metro Manila Eleventh Congress Third Regular Session [REPUBLIC ACT NO. 9003] AN ACT PROVIDING FOR AN ECOLOGICAL SOLID WASTE MANAGEMENT PROGRAM, CREATING THE NECESSARY INSTITUTIONAL MECHANISMS AND INCENTIVES, DECLARING CERTAIN ACTS PROHIBITED AND PROVIDING PENALTIES, APPROPRIATING FUNDS THEREFOR, AND FOR OTHER PURPOSES."

[49] J. Morfaw, "Fundamentals of Project Sustainability," Pmi.org, Oct. 26, 2014. https://www.pmi.org/learning/library/fundamentals-project-sustainability-9369

[50] Mustafa Can Canoğlu, H. Aksoy, and Murat Ercanoğlu, "Integrated approach for determining spatio-temporal variations in the hydrodynamic factors as a contributing parameter in landslide susceptibility assessments," *Bulletin of Engineering Geology and the Environment*, vol. 78, no. 5, pp. 3159–3174, Jul. 2018

[51] J. Creswell, "CHOOSING A MIXED METHODS DESIGN," 2006. Available: https://www.sagepub.com/sites/default/files/upm-binaries/10982_Chapter_4.pdf

[52] "WATER ENVIRONMENT FEDERATION. ANNUAL TECHNICAL EXHIBITION AND CONFERENCE. 88TH 2015. (WEFTEC 2015) (11 VOLS)," proceedings.com, 2015. https://www.proceedings.com/41060.html (accessed Jan. 02, 2024).

[53] "The London Plan 2021," London City Hall, Jun. 27, 2023. https://www.london.gov.uk/programmes-strategies/planning/london-plan/new-london-plan/london-plan-2021 (accessed Jan. 02, 2024).

[54] H. Tian & X. Liu. (2022). Pro-Environmental Behavior Research: Theoretical Progress and Future Directions. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9180624/

[55] United Nations. (2018). Addressing the Sustainable Urbanization Challenge. Retrieved from https://www.un.org/en/chronicle/article/addressing-sustainable-urbanization-challenge

[56] R. K. Adom et al. (2023). Assessing the social and economic implications on water security. Retrieved from https://iwaponline.com/jwh/article/21/7/939/95919/Assessing-the-social-and-economic-implications-on

[57] B. D. Neville Nacpil *et al.*, "Development of Multi-Criteria Assessment Tool for The Management Planning of Sustainable Urban Drainage: The Case Study of Bulaon Resettlement, City of San Fernando, Pampanga Indexed Terms-Flood Mitigation Management, PESTLE Framework, Sustainable Urban Drainage Systems I. THE

PROBLEM AND ITS REVIEW OF RELATED LITERATURE AND STUDIES," 2023.

[58] M. G. Carleton and J. S. Nielsen, "A STUDY OF TRASH AND TRASH INTERCEPTION DEVICES," 1990. [Online]. Available: http://iwaponline.com/wst/article-pdf/22/10-11/287/100940/287.pdf

[59] C. Sherlock, R. F. Gutierrez, M. David, and C. M. Rochman, "A methodology for quantifying and characterizing litter from trash capture devices (TCDs) to measure impact and inform upstream solutions," *Facets*, vol. 8, pp. 1–12, 2023, doi: 10.1139/facets-2022-0034.

[60] C. G. da Rocha and M. A. Sattler, "A discussion on the reuse of building components in Brazil: An analysis of major social, economical and legal factors," Resour Conserv Recycl, vol. 54, no. 2, pp. 104–112, Dec. 2009, doi: 10.1016/j.resconrec.2009.07.004.

[61] [2] M. D. Anas Wajid Aasim Zafar Nagarajan M Talea Nagarajan M Lathamaheswari et al., "PESTEL Analysis to Identify Key Barriers to Smart Cities Development in India,"

[62] Man Ho Park, M. Ju, Y.-H. Cho, and Jae Young Kim, "Data stratification toward advanced flood waste estimation," *Waste Management*, vol. 114, pp. 215–224, Aug. 2020

[63] "Final Technical Report Appropriate Solid Waste Management towards Flood Risk ReductionAvailable:https://www.apngcr.org/wpcontent/uploads/2020/09/8b0f05d8c890d1b8281b92258d0d27aa.pdf

[64] Geoscience Australia, "What is a Topographic Map?," *Geoscience Australia*, Apr. 28, 2016. https://www.ga.gov.au/scientific-topics/national-location-information/topographic-maps-data/basics/what-is-a-topographic map#:~:text=Topographic%20maps%20are%20detailed%2C%20accurate,state%20and%20international%20borders%2C%20reserves (accessed Jan. 02, 2024).

[65] "What is a topographic map? | U.S. Geological Survey," *Usgs.gov*, Jun. 23, 2017. https://www.usgs.gov/faqs/what-a-topographic-map (accessed Jan. 02, 2024).

[66] "Vegetation Map - Yosemite National Park (U.S. National Park Service)," *Nps.gov*, 2023. https://www.nps.gov/yose/learn/nature/vegetation-map.htm#:~:text=What%20Is%20a%20Vegetation%20Map,land%20manager%20has%20to%20face. (accessed Jan. 02, 2024).

[67] Shabir Hussain Khahro, Aftab Hameed Memon, N. Memon, Zubair Ahmed Memon, and Rawal Naresh, "Influence of Socialand Economic Factorson Construction Project Performance in Pakistan," Sustainability, vol. 15, no. 3, pp. 2469–2469, Jan. 2023, doi: https://doi.org/10.3390/su15032469.

[68] Tavakol M, Dennick R. Making sense of Cronbach's alpha. Vol. 2, International journal of medical education. 2011. p. 53–5.

