Metro Cebu River Scan Challenge 2025

Black Soldier Fly Compost System for Community-Based Waste Management in Barangay Alang-Alang, Cebu

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PART A. RESEARCH REPORT

I. INTRODUCTION

The Butuanon river is a 23-kilometer water body that was a testament to life before the rapid urbanization of Metro Cebu. Today, 15 kilometers of the river's stretch pass through 11 barangays located in Mandaue City alone thus endlessly subjecting its waters to human and industrial activity. While discharging waste itself is non-issue, Architect Araceli Barlam, Officer-in-Charge of the Mandaue City Environment and Natural Resources Office, states that about 62 business and other establishments discard wastewater to the river. However, a much larger portion of the waste in the river can be attributed to the river's surrounding less-fortunate households and their negligence for proper waste disposal. With these considerations, the quality of Butuanon river has significantly deteriorated and the very households identified contributing to its decline have reported a considerably increased risk of flooding from blocked waterways.

One particular barangay located in Mandaue City downstream of the Butuanon river is Brgy. Alang-Alang, which had since known the river's pristineness in earlier years. Laundry, bathing, and leisure were once common everyday activities performed in the estimated 600 meters made available to their community. The recent reality is starkly different. On-site investigation has proven that the river has become a breeding ground of contamination with clusters of garbage flowing downstream alongside dark cloudiness characteristic of rotting organic material presumably from wrongfully discarded food waste and fallen tree branches and leaves. Threats of rising flood water levels due to congested waterways have prompted local government units (LGUs) to schedule clean-up drives, organize regular weekly garbage collection and segregation, and implement the construction of flood mitigation structures. Regardless the same issues persist, indicating the need for further observation and assessment of waste disposal habits at riverside.

1.1 Statement of the Problem

Barangay Alang-alang faces persistent challenges in managing household and organic wastes. Ineffective disposal methods result in environmental degradation and contamination of watercourses and create health hazards among its residents. Its existing waste management is inefficient and unsustainable to most poor villages. Decentralized and eco-friendly alternatives that will minimize organic trash generation at the source and involve the population in sustainable methods of disposal are needed. Black Soldier Fly (BSF) composting is a promising yet neglected method that has successfully turned organic trash into useful by-products such as protein-rich larvae and compost. Its applicability, efficiency, and public acceptance in a localized barangay-level setting remain untested.

1.2 Objectives

The objective of the study is to minimize garbage accumulation in the Butuanon river passing the group's assigned area of Barangay Alang-Alang to help revitalize the river's operability as a water source and lessen the immediate area's vulnerability to extreme flooding.

Specific Objectives:

1) To assess the extent of garbage accumulation along the Butuanon River.
2) To promote the use of compost bins as a sustainable solution in management of organic waste.
3) To evaluate the potential of composting in reducing waste and improving the community's resilience to flooding.

1.3 Significance of Study

This study is critically significant as it addresses the environmental degradation of the Butuanon River in Alang-alang, which has transitioned from a pristine community resource to a polluted waterway due to improper waste disposal and irregular garbage collection. By implementing compost bins to manage organic waste, the research aims to restore the river's ecological health, mitigate flood risks caused by waste blockages, and promote sustainable waste management practices. The project offers multiple benefits, including improved public health through reduced pollution, economic opportunities from compost production, and enhanced community engagement in environmental conservation. Furthermore, the findings can serve as a model for local governments to adopt cost-effective, community-based solutions for similar flood-prone and waste-affected areas, ultimately contributing to long-term environmental sustainability and resilience.

1.4 Research Questions

The study aims to answer the main research question and the following sub-questions below to accomplish the objectives mentioned earlier:

1. How effective are the ongoing government and community based efforts in reducing organic waste along the Butuanon river?
   1.1. What type of organic waste contributes most to the waste pollution in Butuanon?
   1.2. What are other waste mitigating procedures that could prove effective when in combination with the current waste management efforts?

II. METHODOLOGY

2.1 Research Design

The study utilized both a qualitative and quantitative approach. It includes descriptive research of the site, interviews among members of the community and collection of maximum flood heights of the area in order to determine the problem and possible ways to resolve it.

2.2 Research Respondents

The respondents of the survey are community members of Barangay Alang-Alang, Mandaue City who are located near the Butuanon River. There are 19 respondents in total and the range of years the respondents live in the area is 16 to 44 years. While all residents own the house they currently live in the area, the land is owned by a private owner. Most of the respondents are female and the source of incomes and the value of income vary among the residents interviewed.

AGE IN YEARS	NO. OF RESPONDENTS	PERCENTAGE (%)
Below 18	0	0
18 - 25	2	10.53
26 - 60	15	78.95
61 and above	2	10.53
TOTAL	19	100

Figure A1. Age Range of Surveyed Residents in Barangay Alang-Alang

2.3 Research Environment

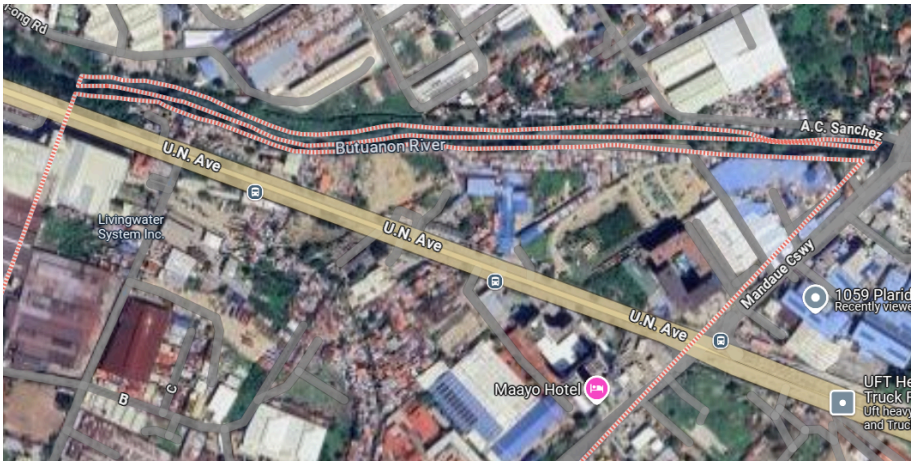

Figure A2. *Satellite Image of the Site Located Nearby Butuanon River in Barangay Alang-alang, Mandue*

Figure A3. Satellite Image of Research Area Boundaries, Barangay Alang-alang

The study is conducted in Barangay Alang-alang, Mandaue City in areas near the Butuanon River. The area can be accessed by an alleyway or narrow pathway right across GEF Incorporated. Vehicles are able to pass the narrow pathway heading the community but it would be difficult due to the narrow roads and once it passes through the narrow road, there is only a small area facing the river where parking of the car is possible. The households are cramped and can only be accessed by walking or motorcycles as the alleyway is way narrower than the entryway. Noticeable upon arriving are trucks working on river projects in the area, the amount of trash present both in the river and near the households and the foul odor.

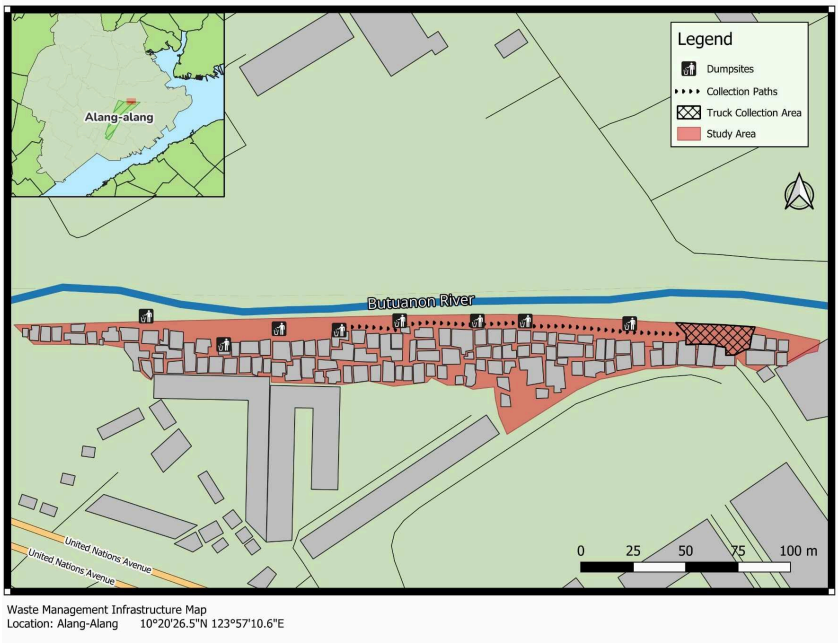

Figure A4. GIS Map of Brgy. Alang-Alang featuring Households and Waste Management System Areas

2.4 Research Procedure

Figure A5. Order of Procedures Followed during the Study

The descriptive method of the qualitative research starts with the site profiling where the group visited the area near Butuanon River in Barangay Alang-Alang, Mandaue City. The group took documentation on the current state of the area and the river. Observations on the cleanliness, smell and water condition of the area were taken note of together with the current state of living of the residents. A survey was then conducted in different households to gather information regarding the waste management system of their area, the problems faced by the community and their satisfaction towards the local government unit's initiatives to help them. Simultaneously, the maximum flood heights of different areas near the river were quantitatively investigated and collected in order to determine the areas most affected by the flood.

The gathered data were then analyzed to identify the relevant waste streams. The problem was identified given all the responses of the residents and different solutions were proposed in order to mitigate or even solve the problem. The chosen solution was then identified and the planning and designing followed. Considered in planning and designing is the area where the product will be placed, maintenance and how it will affect the community. The Cost-Benefit Analysis of the proposed project is then identified to make sure that this will be of help to the community ultimately.

III. RESULTS

Most residents expressed satisfaction with the existing garbage collection system; however, they acknowledged its inability to address the accumulated waste contaminating the Butuanon River. Several respondents reported a visible deterioration in water quality, citing increased turbidity and darkening of the river due to improper disposal of biodegradable waste. Additionally, residents noted that the maximum recorded flood height reached approximately 5.32 meters, significantly exceeding the natural riverbank height of 3.6 meters during the dry season.

To mitigate flooding, the Department of Public Works and Highways (DPWH), in collaboration with Quirante Construction Corporation, initiated the construction of riprap walls on June 11, 2024. Although the project has surpassed its original completion date (April 22, 2025), preliminary observations suggest a reduction in flood levels by approximately 1 meter during the wet season. However no major flood events comparable to September 2022's Typhoon Noru (Karding), the maximum flood water height event, have occurred since construction began, limiting a comprehensive assessment of the structure's effectiveness under extreme conditions.

This section highlights both community concerns regarding river pollution and the ongoing efforts to mitigate flood risks, emphasizing the need for integrated waste management and infrastructure solutions.

IV. CONCLUSION AND RECOMMENDATIONS

While waste disposal is thorough in its weekly collection of garbage in the sitio, waste left adorning the riverbanks persist despite the residents' and LGU's efforts. It also proved difficult for waste to be mitigated downstream due to a collection of waste from previous passing barangays and the irresponsible dumping of industrial waste. To remedy at least the quality of the river downstream, compost bins are proposed as a means of reducing the number of organic waste in the river.

Current efforts made by the government that were made known during investigation proved difficult work alongside as any structural means of providing solutions such as additional catch nets or footbridges were to impede work for increased embankment height. While valiant, a solution involving mainly the government would not ensure that the residents interested in improving their own waste management habits could cooperate in their own meaningful endeavors. Furthermore, the lack of ample space in between and across housing limits the opportunities for larger scale solutions. Leading the group to promote compact compost bins that do not hinder but alleviate the issue of organic waste contamination from the ongoing operations implemented in the barangay.

Compost bins utilizing black soldier flies in particular are suggested as the type of composting to be implemented. Black soldier flies (BSF) or *Hermatia illucens* are popular insects recognized for their ability to act as "bioconversors" capable of processing biodegradable waste (food residue) and other by-products. BSF larvae themselves are also mainly eyed as ideal resources for feeds for livestock due to the quality of nutrients present in mature specimens. Roughly 60% of its dry weight is identified as protein and 40% is attributable to lipids. Important biological phenomena are also supported by the larvae's unique atypical fatty acid profile akin to that of coconut oil, which is rich in saturated fatty acid and lauric acid. The species was originally native to South America and thrive in the tropical, subtropical, and temperate climates of the region. However, it is now present in multiple other warm and temperate regions such as Europe, Africa, and Asia.

There are local precedents that support the notion of BSF composting. The Kaharian Farms in Lipa City, Batangas had held a conference on January 23, 2020 that discussed the production technology used in BSF farming and launched products created from the harvested BSF larvae to various media outlets, stakeholders, and local government units (LGUs). They had researched and actively tested the feasibility and appropriateness of BSF larvae in poultry, fish, and, eventually, pig feeds. Additionally, the University of the Philippines Cebu (UPC) had also conducted a feasibility study on the adaptation of BSFs to repurpose animal manure into *frass* (organic fertilizer promoting fertility and growth in plants). The UPC's partner industry, Chesed Farm, found that harvested 14-day old larvae added to poultry feeds reduced feeding expenses by 10% and experienced a significant reduction in housefly infestation since implementation of the study. Moreover, frass generated from BSF larvae composting had supplemented income to the farm via sale. These reinforce the opportunities presented to stimulate revenue and increase productivity for areas in need of hasted waste management at lower operating costs.

As a species, the BSFs are non-invasive and are improbable carriers of disease. Although resembling wasps, BSFs do not carry a stinger and are not keen on devouring decaying matter as mature flies. With a lifespan of roughly 45 days (4 days as eggs, 14-23 days as larvae, 15 days as pupa, and 5-9 days as flies), the species is solely focused on reproducing by the time of its maturity. A female BSF may lay 500 to 900 eggs once suitable food sources are identified.

PART B. PRACTICAL SOLUTION

I. DESIGN OF SOLUTION

Backyard BSF larvae farms may typically be made from large plastic bins to wooden trays or sheds that house mature flies. The study adopts a combination of a system utilizing the *biopod* (a ventilated large plastic container) and a miniature BSF farm shed. The plastic bin shall be first layered with coffee grounds as means of substrate for food waste. PVC pipe openings along the lid of the bin allow BSFs to find the decaying matter and have them lay eggs in layers of cardboard hanging underneath the lid. The species is fond of securing their clutches in tight spaces near food sources. Once the eggs hatch, the larvae fall into the compost and convert the waste into frass. Fully matured larvae seek to separate themselves from the food source in search of soil, where they pupate and eventually become flies. They larvae then walk up the guided wooden ramp and drop into the collection bucket. As the larvae cannot reach maturity within the compost system, residents or persons in charge of the maintenance must select several larvae and allow their growth to adulthood for a complete cycle as reproducing flies die within a week or so. These larvae may be separated from the system and placed within trays of soil on wooden shelves still inside the recycled shed.

Fully Rendered Model of a Compact Black Soldier Fly Larvae Farm

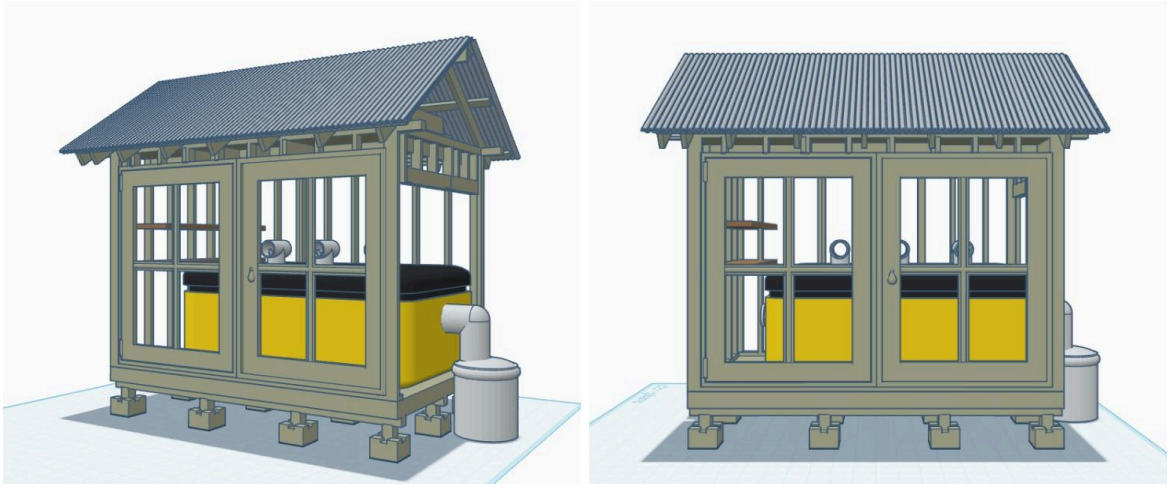

Figure B1. Completed render of design made from TinkerCAD by Autodesk (left) and the model's front view (right) with doors.

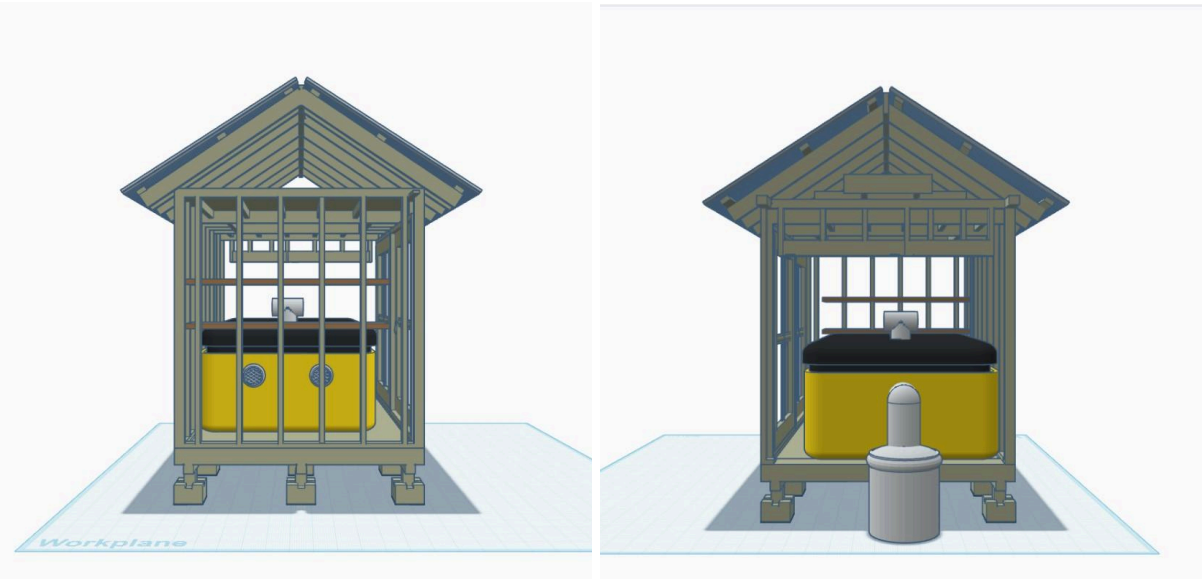

Figure B2. Side view of the Black Soldier Fly (BSF) composting and farming system.

Figure B3. Rear view of composting and farming system.

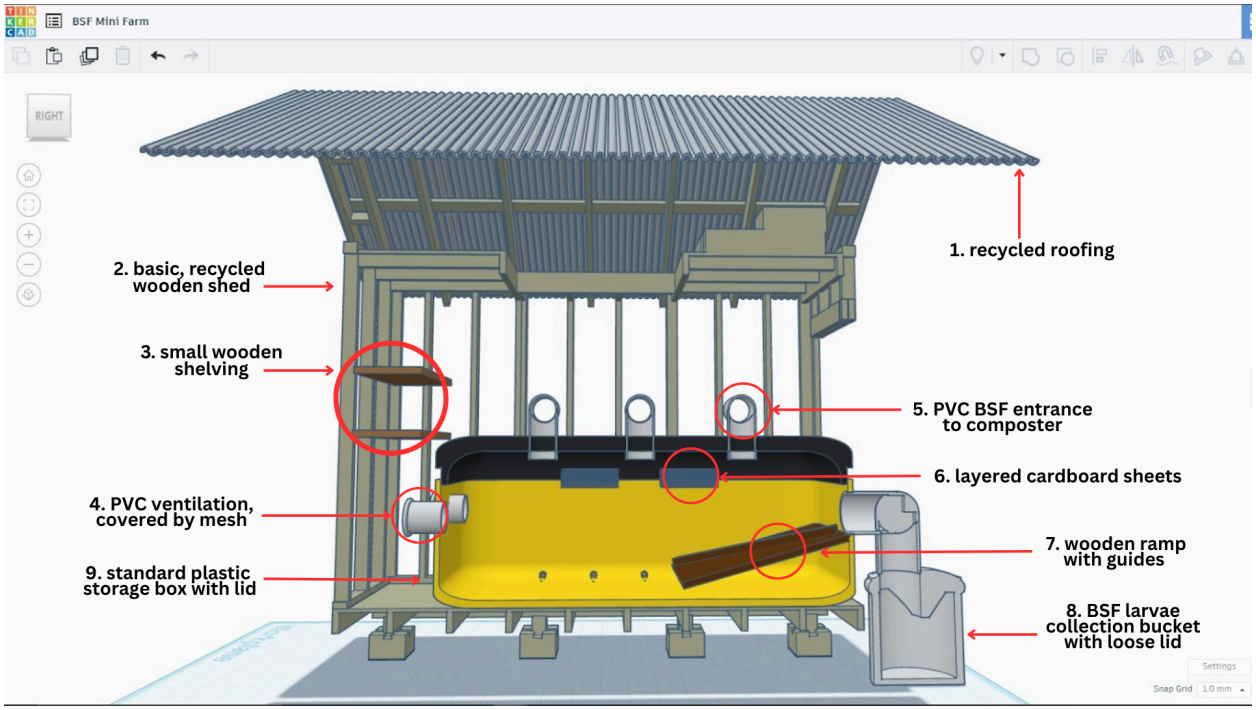

Figure B4. Labelled front section view of the composting system.

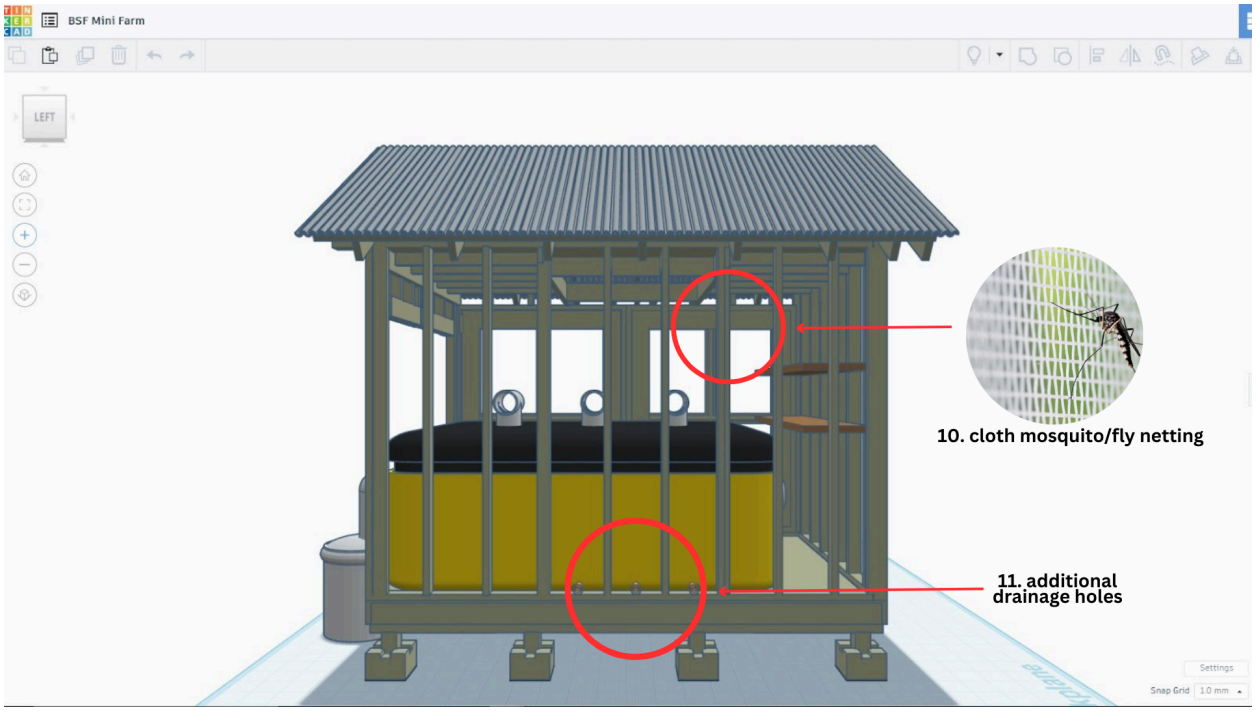

Figure B5. Labelled rear section view of the composting system.

II. LOCATION ANALYSIS

The recycled compost bins are to be installed within the Barangay Alang-alang area. The proposed area is near the riprap as seen in the picture below.

Figure B6. Possible Installation Area of Recycled Compost Beam

The vicinity of the mentioned place is shaded due to the trees present but it also is exposed to temperatures needed for a compost bin to thrive. The surface of the land is also leveled due to recent construction which makes it a good area to place the compost bin, lessening the risk of it tipping over and spilling its contents.

Figure B7a. Visualization of the composting system relative to prospective areas along Alang-Alang.

Figure B7b. Visualization of composting system in prospective area.

III. SOCIAL COST-BENEFIT ANALYSIS

The costs involved in implementing the composting project can be divided into initial investment costs, operational & maintenance costs, and social & environmental costs. The initial investment includes material costs for procuring recycled materials like plastic drums, mesh covers, and aeration pipes, as well as labor costs for assembling and installing compost bins. Additionally, the project requires purchasing Black Soldier Fly Larvae (BSFL) to speed up decomposition and covering transportation expenses for delivering materials to the site. Operational and maintenance costs encompass community training and seminars to educate residents on proper composting techniques, weekly monitoring and evaluation by local officials or environmental experts, labor for organic waste collection and segregation, and long-term replacement and repair of compost bins. Social and environmental costs may include temporary inconvenience for residents adjusting to new waste disposal habits, as well as potential short-term odor and pest issues if composting is not properly managed.

On the other hand, the benefits of the project are substantial. Environmentally, it reduces river pollution by decreasing organic waste dumped into the Butuanon River, lowers flood risks by preventing waste blockages in waterways, and enriches soil through the production of compost for urban gardening and agriculture. Economically, the project reduces waste collection costs due to less frequent garbage pickups, decreases flood-related damages by improving water flow, and generates potential income from selling excess compost to local farmers. Socially, it fosters community engagement by encouraging cooperation in waste management, improves public health by reducing pollution and disease risks, and provides educational value by raising awareness about sustainable waste practices.

When comparing costs and benefits, the short-term (1-2 years) involves initial setup expenses, training programs, and maintenance labor, but it also brings immediate benefits such as reduced organic waste in the river, increased community participation, and flood mitigation. In the long-term (3+ years), upkeep costs are minimal, with only occasional repairs needed, while the benefits grow more significant, leading to a sustainable waste solution, improved river cleanliness, and economic savings from compost use. Overall, the project presents a strong case for environmental, economic, and social improvement despite the initial investments required.

IV. PLANNING

The compost bin project will roll out in three phases. First, we'll spend two months preparing through community consultations, securing permits, training leaders, and finalizing designs using local materials. Next comes the four-month implementation phase where we'll install bins, launch education campaigns, establish waste collection systems, and begin monitoring. After launch, we'll maintain weekly inspections, monthly meetings, and regular training refreshers to ensure long-term success.

Using a community-based approach, we'll measure success through waste reduction data, river quality improvements, and resident feedback. The plan balances structure with flexibility, focusing on reducing pollution while adapting to local needs. Key to success will be strong barangay support and clear roles for all participants.

V. STAKEHOLDERS INVOLVED

The success of the project is co-dependent on the different stakeholders involved. The following are the involved parties and their roles and contributions for the project:

Local Government Officials. The local barangays play a big role in the project. Before the project is implemented, thorough planning, budgeting and role delegations are done to ensure that the project would go as smoothly as possible. During the implementation of the project, they will be in charge of guiding the other stakeholders in the area, making sure that the transportation and installation of the compost bin to the site will be done effectively. They will also be the people in charge to gather the community for meetings about the project. After the implementation, the officials will also be responsible in doing weekly or monthly check ups on the situation of the project to make sure that the compost bins are properly maintained.

Government Organizations. Environmental organizations are present to guide the officials on the implementing process as they are knowledgeable about the steps to start a compost bin. They will also hold community meetings for the introduction of the project and seminars to educate and inform the community on their role in maintaining the compost bin making sure that it will be used properly. They are also responsible in making sure that health protocols and precautions are done to ensure that the project will not just be safe for the environment but also the entire community.

Business Partners. The collaboration of the LGUs and the private business owners in the Agriculture field is essential to continue to maintain the compost. Products of the compost bins which are the fertilizers for the crops and larvae or pupae as feeds for the animals will be sold to the business owners in exchange for monetary value to continue to maintain the compost and to help the community. The presence of the partners are of value so that the products will be put to good use.

Communities. The community determines the success of the project. They are responsible for the proper usage and maintenance of the compost bins provided by the local government in order to produce healthy and usable compost.

VI. OPERATION MAINTENANCE

The ones responsible for the operation and maintenance of this solution are both the LGUs and the community involved. The LGUs are to fund the making of the compost bins and procuring the black soldier flies needed in order to start this project as well as educate the community as to how its maintenance should be done. The community is required to follow the needed procedures in maintaining the compost bins so as not to reduce its efficiency and reduce risks of further contamination of the environment.

Weekly check ups of the compost bins should be done in order to ensure that the compost is still thriving and it still follows the health measures mandated. During the weekly checkups, an expert hired by the LGUs should assess the condition of the compost and decide on whether or not the compost should be collected. Weekly reports should also be done to monitor the project's progress and evaluate what can be done to improve the project.

The processing of the product which is the compost should also be maintained making sure that they will be put to good use. It may be sold to individuals needing fertilizers for their personal use or business. It can also be used by the local government to start a community garden in open areas owned by the government. This way the land will be put to good use and the produce will benefit the community also.

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