WATER WARRIOR

MovaBin : A Proposed Solution for Midstream Butuanon River

Easing the Lives of the Residents of Barangay Tingub, Mandaue City

Proponents:

Ala, Sheena
Amit, Norma
Aquino, Rod
Avila, Xyzel
Bebita, Ira
Bontilao, Taneza
Caballero, Jerald
Cang, Stacey
Capondag, Uriel
Dumas, Lisandra
Gonzales, Judd
Jadulco, Kiara
Jager, Sven
Mahinay, Alezandra
Montuya, Denzel
Robb, Jennifer
Roda, Lucky
Russel, Nathan
Sacmar, Ritche
Saco, Dby
Son, Karl
Tan, Oscar
Van der Meer, Ischa
Villamor, Trixie

CEBU LEADS FOUNDATION, INC.

UNIVERSITY of SAN CARLOS

ROTTERDAM UNIVERSITY

Hanzehogeschool Groningen
University of Applied Sciences

TABLE OF CONTENTS

CHAPTER 1
RESEARCH REPORT

INTRODUCTION

Background of the Study

Butuanon River is a 23-kilometer water body stretching from the mountain barangays of Cebu City down to the urbanized barangays of Mandaue City. The upstream stretch of the river runs through barangays Pulangbato, Pit-os and Bacayan of Cebu City, while the midstream and downstream segments of this river cut through several barangays in Mandaue City.

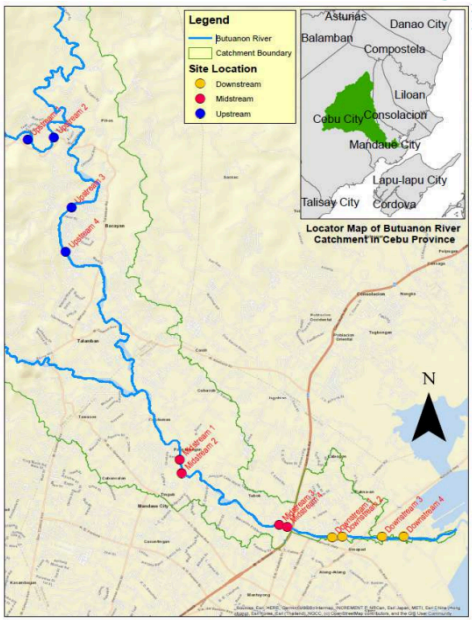

Figure 1. Location Map of Butuanon River

In the past two decades, the rate of urbanization has risen significantly in Mandaue City and Cebu City. As a result, more infrastructures were built, replacing lands that were once covered with vegetation into impermeable pavements. These changes increase the risk of flooding during heavy rains due to the water being unable to infiltrate into the soil. And because of the increasing population, improper management of domestic wastewater and solid waste also became a huge problem. Therefore, the pollution of these water bodies becomes inevitable.

As of July 31, 2023, through the second State of the City Address (SOCA) of Mayor Jonas Cortes of Mandaue City, the Butuanon River is reclassified to Class C by the Environmental Bureau Region VII office. In the midstream portion of the river, which is the main focus of the project, the identified sources of pollutants were commercial businesses and industries that illegally release untreated wastewater into the river. Informal settlers and certain establishments along the river also release septic wastes and contribute to the improper disposal of solid wastes into the river.

The problems caused by the widespread pollution in the Butuanon River have raised environmental and health concerns. Proposals have been planned, pitched, and considered in the hopes of revitalizing the river. This body of water is essential and any changes that occur in it will highly affect the ecosystem and the lives of the communities around it. The students from both the Netherlands and the Philippines are participating in order to help resolve and determine solutions for these environmental concerns and issues. However, due to the scope and complexity of this project, the chosen river, Butuanon River, was then divided into multiple areas for each team to survey and study. The team is given the task to address the issues concerning pollution, particularly, in the midstream area of the Butuanon River in the barangay of Tingub, Mandaue specifically. This project will help provide solutions for the rehabilitation and rejuvenation of the rivers and creeks of Cebu City and Mandaue City. This is a collaboration of

students from the Rotterdam University of Applied Sciences, Hanze University, and from the University of San Carlos. It is also conducted in collaboration with the Cebu City Environment and Natural Resources Office (CENRO) and other participating LGUs in Cebu City and Mandaue City.

Statement of the Problem

The Butuanon River is facing severe pollution due to several activities, such as untreated wastewater discharge from nearby commercial and industrial establishments, solid waste disposal, and domestic wastewater disposal. This pollution greatly affects the water quality of the river, which poses risks to the health and safety of the communities. Overall, the accumulation of garbage in the river and in the community acts as the main problem as a result of insufficient planning of garbage collection.

Objectives of the Study

One of the major problems of bodies of water is water pollution, which affects water quality, and the Butuanon River in Barangay Tingub, Mandaue City, is no exception. This project aims to identify measures to restore and improve the Butuanon River's water quality with the help of the community. Specifically, the project aims to:

- Identify and analyze the source of water pollution, whether it is from industrial discharges, agricultural runoff, household wastes, urban wastes, human activities, or other potential sources.
- Involve the community members in Barangay Tingub, Mandaue City through an interview to identify problems that they have experienced from the deterioration of the river's water quality.
- Identify the effects of the river's pollution on human, terrestrial, and animal life near the river, and other possible effects it causes.
- Create feasible and cost-effective solutions to mitigate water pollution and improve the river's water quality.
- Involve the community nearby to raise awareness and think of possible solutions which in turn will help in maintaining and improving the water quality of the river.

Research Question

Main Research Question:

How to resolve the accumulation of garbage in the river and in the community?

Sub-Questions:

The following sub-questions presented are to be answered to solve the main problem of this project.

1. What are the main contributing factors to the accumulation of garbage in the river and in the community?
2. What is the approximate volume of garbage produced in a one week period?
3. What feasible solution can help solve the community's problem in regard to the accumulated garbage?
4. What is the difference between the current situation of the community and the ideal outcome of the project?
5. How committed and motivated are the community members in cleaning and improving the river?

DATA GATHERING AND METHODS

The data gathering and methods section describes the procedures used to acquire and evaluate relevant data on the environmental issues encountered by Tingub Purok 2 along the Butuanon River. The study was primarily concerned with determining the level of garbage accumulation and pollution, as well as examining the community's perspectives and experiences with these concerns.

Community Walk

During the community walk, researchers conducted visual evaluations of Tingub Purok 2's surroundings, with an emphasis on the Butuanon River. This entailed examining the existence of fish species such as *pantat* (catfish) and tilapia, as well as vegetation such as kangkong. In addition, researchers conducted interviews with residents to collect qualitative data on their experiences and perceptions of environmental concerns such as rubbish accumulation, pollution

sources, and the impact on their daily activities. These interviews gave vital insights into the community's perspective on the issues affecting the river.

Measurement of Flood Heights

Researchers measured flood heights in the area, with a particular emphasis on the community's most significant flood event, which happened two years after Typhoon Odette. Researchers applied a measuring stick to identify and record the greatest flood height reported by the residents of the area. This quantitative data was implemented to analyze the severity of floods and its impact on the community, giving useful information for understanding the repercussions of environmental deterioration.

Community Meeting

A community meeting was held to promote interaction and discussions among the residents of Tingub's Puroks 1 and 2. During this discussion, community members discussed many issues impacting their immediate surroundings, such as rubbish accumulation, pollution sources, floods during the rainy season, and a lack of government aid. The community highlighted the accumulation of rubbish as the primary concern, which was exacerbated by the ineffective garbage collection system and the lack of garbage containers. This qualitative data acquired during the community meeting assisted in prioritizing the study's major emphasis and informing the recommended strategy for enhancing garbage collection in the surrounding community.

Gathering of Online References

The researchers reviewed different articles from online sources in order to reinforce and verify the data gathered from the community meeting and community walk. Additionally, the researchers also reviewed articles related to solid waste management, statistics on solid waste generation, and various practical solutions for river-related problems to have references for proposing an innovative solution for the community of Brgy. Tingub. The prices of the standardized materials proposed in this research were based on reliable online sources.

RESULTS AND DISCUSSION

This section presents and discusses the data collected through the various data-gathering methods that were implemented.

Community Walk and Community Meeting

The data gathered by the researchers in this section is mostly qualitative data because it was mainly obtained from the answers of the community members during the community walk and community meeting. Moreover, the community expressed several concerns related to the Butuanon River. To summarize and analyze the relationship between the relevant problems identified by the community, a tree diagram is presented below.

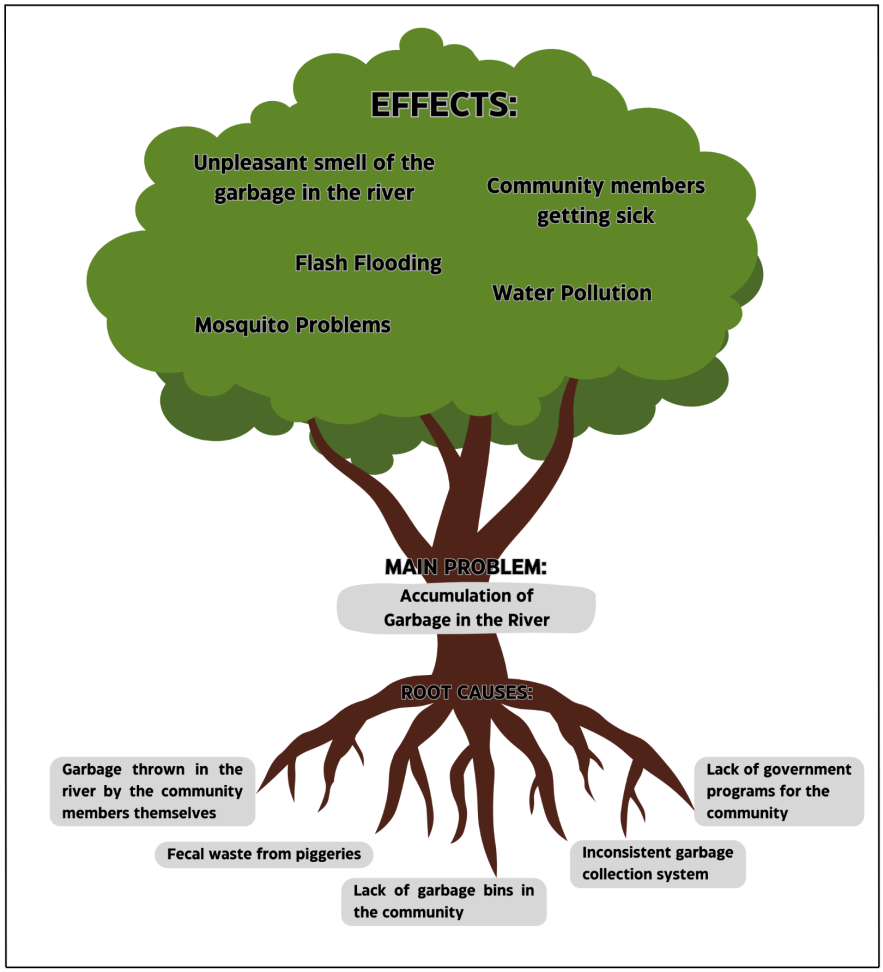

Figure 2. Tree Diagram Of The Root Causes & Main Problem Purok 2 Brgy. Tingub

The researchers mainly focused on Purok 2 of Brgy. Tingub and determined the effects experienced by the community. During the community walk and meetings, the researchers obtained information about the situation of Purok 2 and its community members. The community does monthly clean-up drives in the river with the support of business companies in the area. However, even with the monthly clean-up drives and support of the local business companies, the main problem of the community continues to deteriorate, and this is because the root causes were not resolved. The accumulation of garbage in the river is the main problem that poses dangerous risks to the community of Purok 2 Brgy. Tingub and there are several root causes of the problem. First, the lack of garbage bins in the community causes citizens to carelessly dispose of their garbage into the river, and some are indolent towards bringing their garbage to the mainroad due to the inconsistent garbage collection system and the bad pathway, which results in the accumulation of garbage in the Butuan River. Additionally, due to the lack of government planning, the community severely suffers from the effects of the garbage accumulation in the river.

The water pollution in the river causes the stagnation of water to become the breeding ground for mosquitoes, and the unpleasant smell emitted by the river causes the residents of the area to be afflicted with diseases. The most common symptoms are coughing, and the common cold and the symptoms are mainly seen in children due to them playing in the stagnant river.

In addition, the recent changes in climate, particularly the increased rainfall, exacerbate the poor living conditions of the residents. On September 9, 2022, a flash flood occurred at the Butuanon River and devastated Metro Cebu, sweeping away at least 20 barangays, including Brgy. Tingub, the area of study. The risk of flash floods during the rainy season endangers the residents of the area. If another flash flood were to occur, the community could collapse, depending on the severity of the damage.

Finally, the tree diagram fully represents the root cause and main problems of the community and the detrimental effects experienced by Brgy. Tingub. Thus, solutions to the problem are developed and proposed by the researchers to support the community in improving their living conditions.

Maximum Flood Height

The researchers interviewed and asked the local residents about the river's water level in an extreme flood event. The height measured by the researchers was indicated and recorded to be 3.28 meters from the river bed. Additionally, this flood height indicated by the local residents was based on their experience when the Butuanon River overflowed due to heavy rainfall last September 9, 2022, sweeping away at least 20 barangays in Metro Cebu.

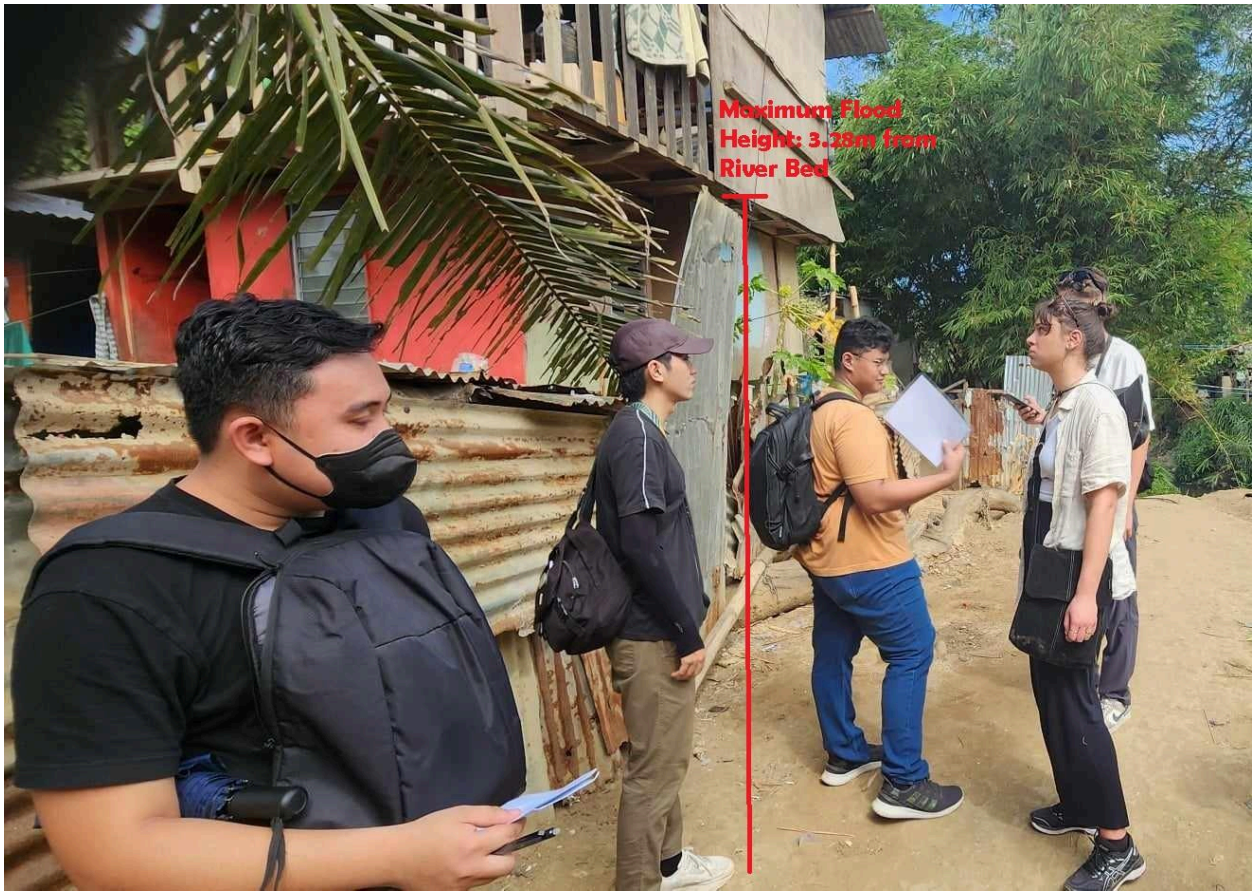

Figure 3. Illustration of Flood Height

As seen in the picture above, the estimated flood height by the community members of Purok 2 is above the normal height of the person, and it can reach the second floor of the household. This phenomenon increases the risk of the community members residing within the three-meter easement zone.

Figure 4. Washed Out Column

The picture shown is one of the structures that was destroyed by the Mandaue City flash flood that occurred two years ago. The purok's vice president shared with the researchers the event of the building that was swept away by the flash flood. According to her, the intensifying effect of the floods experienced by the community implies that the river is under a serious condition that requires collaborative action of the people for the river's rehabilitation.

CONCLUSION AND RECOMMENDATIONS

The study was done in Purok 2, Barangay Tingub, Mandaue City, within the Butuanon River, and identified various critical environmental challenges that have a substantial influence on the community's well-being. The primary issue highlighted is the accumulation of rubbish in the river and adjoining areas as a result of an insufficient garbage collection system and a lack of appropriate waste management equipment. The excessive accumulation puts residents' health and safety at risk, worsening issues like pollution, floods, and disease transmission.

According to the study's research objectives, the primary contributing evidence to waste accumulation was found as to be lack of garbage containers, inconsistent garbage collection, and poor government planning. Community members expressed discontent with the existing situation and stated a readiness to help establish solutions. The volume of waste produced throughout the week was calculated based on community feedback, revealing a significant quantity that exacerbates the pollution problem.

In response to these problems, the study suggests a cost-effective and feasible solution: strategically placing large, portable garbage containers in inaccessible places in the area. These bins would be labeled for biodegradable, non-biodegradable, and recyclable garbage to aid in correct waste sorting. Community members would take turns delivering the gathered trash to specified garbage collection zones, guaranteeing effective waste management. This method tackles the underlying reasons for garbage accumulation while empowering the community to actively contribute to preserving a clean environment.

Moving forward, stakeholders such as local governments, community leaders, and people will need to work together to execute this solution. Proper planning, resource allocation, and continual monitoring are required to ensure the planned intervention's long-term viability and efficacy. By addressing the core causes of waste accumulation and encouraging community participation, the project hopes to contribute to the restoration and preservation of the Butuanon River surroundings for the benefit of current and future generations.

The following recommendations are proposed by the researchers to ensure that future research on the Butuanon River's environmental issues are comprehensive and effective. Hence, the future researchers should:

1. **Increase the number of respondents.** By expanding the sample size to include more respondents from the area will enhance the representativeness and credibility of the study's findings. Consequently, more diverse voices from the different parts of the community can provide a better understanding of the environmental issues brought upon by the river and its impact on the locals of Bray. Tingub.
2. **Allocate more manpower in the field work.** By designating more manpower to the field will facilitate a more thorough and swift data collection. Through this the fieldwork's scope will be enhanced as it can cover a greater area, conduct the interviews more effectively, and gather data efficiently, thus ensuring that the assessment would be more detailed and comprehensive.
3. **Improve the program organization and planning.** By making a more structured and well-organized plan and executing the research program will minimize the disruptions and changes during the project proper. Hence a clear, detailed plan with set deadlines/timelines and specific roles assigned to team members will help in smoother execution and better outcomes.
4. **Employ well-structured and well-designed surveys.** By conducting rigorous surveys that can be compared to anecdotal evidence can be helpful in collecting accurate data. This will also aid in verifying the reliability of the community members' responses and as a result provide a clearer picture of the community's environmental situation. Additionally, utilizing statistical analysis on the data collected will provide a solid foundation in interpreting results and in making informed decisions, as it helps in identifying patterns, trends, and correlations
5. **Ensure proper information and instruction dissemination.** By establishing effective communication channels to disseminate information to all participants and stakeholders will prevent confusion and conflicting instructions. Thus, providing clear, consistent, and regular updates will help maintain transparency and promote a working environment that is inclusive and more participative.

CHAPTER 2
PRACTICAL SOLUTION

Design of the Solution:

Protecting the Butuanon River from various sources of pollution is imperative to ensuring its sustainability. The untreated wastewater and solid waste lead to problems concerning water quality, health, and flooding along the riverbanks, where informal settlers are most seriously affected. The qualitative data gathered from the community walk and community meeting reveals that the accumulation of garbage in the river and in the community was the primary concern of the residents. It was found that the residents of Tingub's Purok 2 have an inefficient garbage collection system and lack garbage containers.

The acquired data became the major basis for the researchers to develop a practical and easy-to-implement solution to enhance garbage collection in the surrounding community. Additionally, it was also a concern for the community that the garbage truck collection area is far from their location, forcing them to dispose of their garbage into the river for their convenience.

Hence, the researchers developed a practical solution called the "MovaBin." The design of the movable garbage bin considers the narrow passageway from the main road to the community instead of individually bringing their trash to the collection area, the garbage will be collected and transported as one for the entire community.

Moreover, the researchers made a consensus on the number of households and the number of people per household. Based on the community members that participated in the meeting and an inquiry from the Purok Vice-President, there are approximately 40 households for Purok 2 alone and more or less 4 people per household. According to Eileen Bernardo in their study on the solid waste management practices of households in the Philippines, based on the data gathered through an interview with household members as well as garbage collectors and

scavengers, households generated an average of 3.2 kg of solid waste per day or 0.50 kg/capita/day.

Lastly, for the capacity and the number of garbage bins required for the community, the researchers first computed the average solid waste generated by the entire community per 4 days, which is about 320 kgs. The researchers decided to propose the utilization of three 55-gallon plastic barrels as the main component of the garbage bin design. The three barrels can hold up to 690 kg, but with the assumption of an allowance factor of 30% for the air pockets, since the garbage inside the MovaBins are not always compressed, the three barrels will have an effective capacity of 480 kg, which is more than the solid waste generated by the community every four days.

Design Specifications

The **"*MovaBin*"** is designed in a way that can face the challenges of collecting the garbage found in the Butuanon River. The bin is made out of lightweight materials primarily made out of plastic to handle the wastes that were soaked in water and is placed in a lightweight steel frame with wheels for it to be portable, to transfer garbage from the river. Presented below are 2D and 3D representations of the design of the proposed MovaBin.

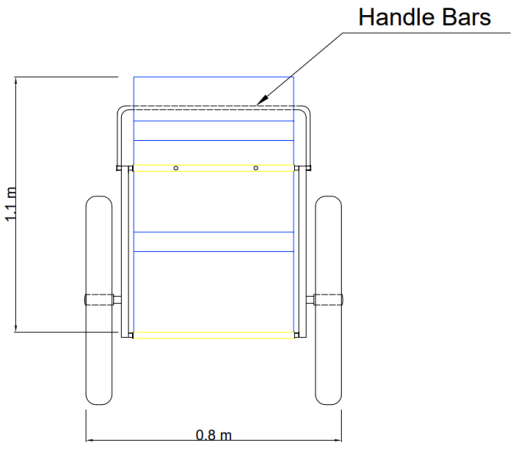

Figure 5. Front View of MovaBin

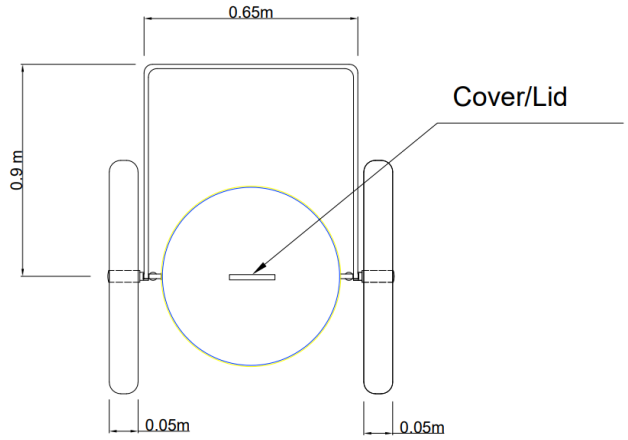

Figure 6. Top View Of MovaBin

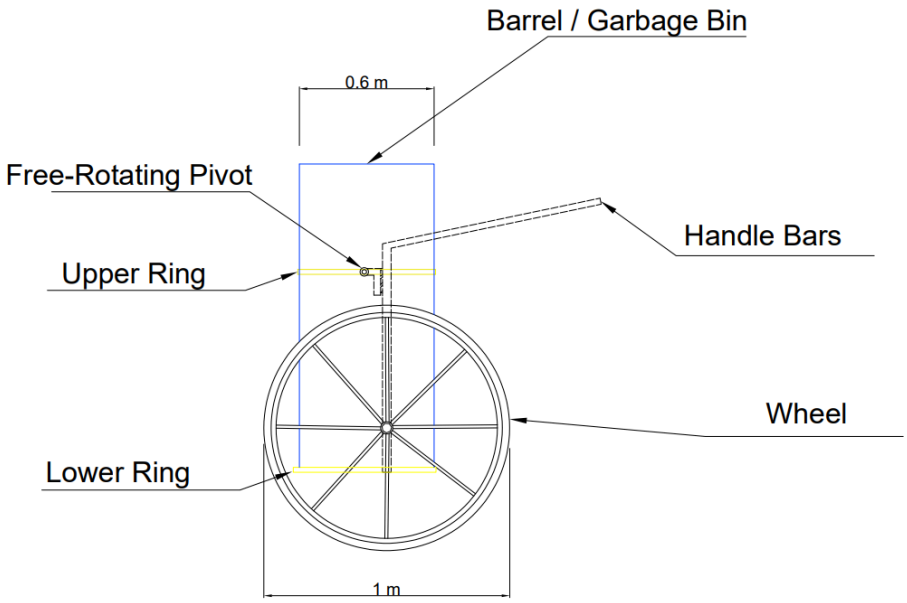

Figure 7. Side View of The MovaBin

Figure 8. 3D Render of the MovaBin

Locational Analysis

This segment of the study examines how the site of the garbage bins to be placed was selected. Based on the proposed solution which is aimed at improving the problematic garbage collection system, it will be of importance to choose an accessible open area for the garbage bins to be placed. The image shown below is the proposed location for the garbage bins because according to the field researchers who went to the community, it is the only suitable open area for the garbage bins.

Figure 8. Proposed Area of The Garbage Bins Placement

Social Cost-Benefit Analysis with Explanation

The proposed design in this project uses affordable and widely available components with good functionality. The dimensions of the materials utilized in this project are also standardized. Below shows the breakdown of the cost per part of the design as well as the labor.

Table 1. Total Cost of one MovaBin.

Parts	Component Details	Size/Length	Pieces	Unit Price	Total Price
Barrel/ Garbage Bin	Plastic Drum	55- Gallon	1	₱1,000.00	₱1,000.00
Wheels	Rim with Rubber Tire	20" by 2.125"	2	₱900.00	₱1,800.00
Axle	Bearing Connector	180mm	2	₱84.00	₱168.00
Handlebar	Steel Round Pipe	(2" DIA) - 2.45 m	1	₱438.00	₱1,073.10
Frame (including Lower Ring)	Steel Round Pipe	(2" DIA) - 3.6 m	1	₱438.00	₱1,576.80
Upper Ring	Flat Steel Bars (Bolted)	40mmx3mmx1.9 m	1	₱47.00	₱89.30
Bolts	Bolt, Nut, and Washer	1" by 1/2"	10	₱20.00	₱200.00
Welding Labor			1	₱1,000.00	₱1,000.00
Total Cost					₱6,907.20

The total cost computed on the table is good for one barrel but since the researchers are proposing to create three MovaBins to meet the generated waste of the community every four days, the total capital required for this project is more or less ₱ 20, 721.6. Since the budget required to manufacture a single MovaBin didn't cross the ₱ 10,000 mark, we assume that the

LGUs and barangays will find this solution cost-effective and feasible for the community. Furthermore, using recyclable materials can also be an alternative in reducing the total cost for the MovaBins.

Planning

This solution plans that the LGU should encourage and coordinate with the community, especially in the creation or funding of the design and the placement of the design. The community must discuss with themselves and assign the community members who will then take turns taking the design into the designated garbage collection area. With this, the LGU should allocate funds for the procurement of materials needed for the construction of garbage collectors or MovaBins.

Including conducting community awareness campaigns to educate residents about the importance of proper waste management and the benefits of the proposed design. They must also identify suitable locations for placing the garbage collectors based on accessibility and proximity of the river in order to ensure the availability of necessary resources such as manpower, transportation, and tools to monitor progress regularly and address any challenges or issues that arise during the implementation. Lastly, the community should have a concrete scheduling plan among themselves for the people who will be in-charge for the twice-a-week transportation of the MovaBins to the garbage collection area along the highway to ensure that the MovaBins will be cleaned or emptied regularly to maximize its effectivity.

Stakeholders Involved

The stakeholders that are involved in the implementation of the proposed *MovaBin* solution for the restoration of the Midstream Butuanon River in the areas of Brgy. Tingub, Mandaue City are the following:

1.) **Brgy. Tingub Officials -** The involvement of the community members of Brgy. Tingub officials in its planning, evaluation processes and decision-making in the *"MovaBin"*

solution are needed, so that they can work with the project team in order to guarantee that the project aligns with the needs of the residents in Barangay Tingub Mandaue City.

2.) **Local Government Unit In Mandaue City -** The Local Government Unit (LGU) of Mandaue City is now leading the implementation of the rehabilitation and development of the Butuanon River, with the established partnership with the Cebu City government through the "Beyond Borders Initiative." This helps to ensure the safety and well-being of the residents in Brgy. Tingub. Additionally, the local government unit can enforce strict regulations on the disposal of waste materials, environmental protection, and establish partnerships with private sectors to aid flood mitigation.

3.) **Non-Governmental Organizations -** The involvement of non-governmental organizations (NGOs) in the implementation of the proposed *"MovaBin"* solution for the restoration of the Midstream Butuanon River in the areas of Brgy. Tingub of Mandaue City can work with other stakeholders to conduct a comprehensive assessment of the current flood mitigation in the area, and prioritize infrastructure projects that can address the issue about the domestic wastewater and solid waste in Barangay Tingub Mandaue City.

4.) **Residents of the Barangay Tingub** - The Residents of Barangay Tingub are also involved as stakeholders in the implementation of the proposed *MovaBin* solution for the rehabilitation of the Midstream Butuanon River in Mandaue City. Their active participation in any community project to address water pollution involves all environmental activities aligned with the project.

Operation and Maintenance

The operation and maintenance of the solution shall primarily be headed by the Brgy. Tingub officials and the Purok 2 Community, with the support of the Local Government Unit (LGU) of Mandaue City for the funding. The role of barangay officials in the implementation of the solution is crucial because this enduring solution already requires a thorough monitoring and spearheading by the mandated leaders that are elected by the constituents themselves. Given that the *MovaBin* solution is already low-cost and feasible for the real-life situation of the Brgy.

Tingub residents, the officials are highly likely to not have a hard time managing this implementation as it is also their responsibility.

Some of the roles that the Barangay Tingub officials may undertake are (a) designating residents to their "area of responsibility"; (b) distributing the *MovaBin*s to such areas; (c) formulating the rules and procedures of the operations or garbage collection; (d) imposing sanctions, if any, to those that do not abide by the rules and procedures of the operations; and (e) providing maintenance activities for the continued operation of the solution.

Moreover, the cooperation of the purok leaders, residents, and the community as a whole is also of utmost importance. The purok leaders, in this case the leaders of Purok 2, may be responsible for the assigning of roles and responsibilities among the residents and management of the implementation in the focus areas. The residents, on the other hand, are also responsible for abiding by the collection rules and schedule in order for the solution to be genuinely effective. They are also responsible for keeping the garbage collection area clean, as well as their overall surroundings such as the river, the riverbanks, and their residences. With the cooperation of all members of the community, a true positive and productive effect of the solution may be seen.

Furthermore, maintaining the quality of the *MovaBin* design also goes hand in hand with the implementation. Thus, ensuring that maintenance activities are carried out is also part of the responsibility of the concerned officials and residents. Some of these may be:

a. Ensuring the cleanliness of the garbage collection area and regularly deep cleaning the design to avoid a foul smell;
b. Monitoring the strength and integrity of the design by immediately replacing parts that are damaged and replacing it as soon as it is already unrepairable;
c. Ensuring that the design is not used beyond its weight capacity or being misused;
d. Regular emptying of the trash bin design by following the agreed collection schedule;

e. Using appropriate garbage bags as a protective layer between the trash and the design for the ease of emptying trash; and
f. Continued education and awareness among the residents by providing information drives and reminders of how to properly segregate wastes by its kind (i.e., biodegradable, non-biodegradable, and recyclable waste).

REFERENCES:

[1] Bernardo E. C. (2008). Solid-waste management practices of households in Manila, Philippines. *Annals of the New York Academy of Sciences*, *1140*, 420–424. https://doi.org/10.1196/annals.1454.016

[2] EMB-7, strengthens alliance with Butuanon River Rehabilitation Partners | Environmental Management Bureau Region 7. (n.d.). https://r7.emb.gov.ph/emb-7-strengthens-bond-with-butuanon-river-rehabilitation-partners-in-a-recognition-ceremony/

[3] *Floods prompt evacuation of some individuals in Mandaue*. INQUIRER.net.(2023, September 12).https://cebudailynews.inquirer.net/527044/floods-prompt-evacuation-of-some-individuals-in-mandaue

[4] *GI pipe price list: Material price list*. TheProjectEstimate.com. (2023, July 29). https://www.theprojectestimate.com/gi-pipe-price-list/

[5] Larisma, A. M. (n.d.). *Cebu City to relocate 6,000 residents as it partners with Mandaue LGU in Butuanon River Rehab effort*. SunStar Publishing Inc. https://www.sunstar.com.ph/cebu/local-news/cebu-city-to-relocate-6000-residents-as-it-partners-with-mandaue-lgu-in-butuanon-river-rehab-effort

[6] Sitchon, J. (2022, September 20). *Explainer: Mandaue Butuanon River Flood*. RAPPLER. https://www.rappler.com/newsbreak/explainers/explainer-mandaue-butuanon-river-flood-cebu/

[7] *Urgency of land use act*. INQUIRER.net. (2023b, September 17). https://opinion.inquirer.net/166370/urgency-of-land-use-act