



UNIVERSITY of SAN CARLOS
SCIENTIA • VIRTUS • DEVOTIO



METRO CEBU RIVER SCAN CHALLENGE 2025

RESEARCH REPORT AND INNOVATIVE SOLUTION PROPOSAL



**"Find Your Peace, Find Your Green, Seek your Place,
and create your Space, Ou-vert"**

Submitted by:

Alicaway, Bryan Kim

Arago, Ian Gabriel

Arguillas, Rechelle

Bakker, Niels

Bucud, Joshua Cain

Castillo, Trisha Allison

Coja Jr., Dennis

Colipapa, Franz Yhecil

Dadia, Katherine

Dawaton, Roxanne

Esguerra, Eizen Lance

Flores, Kyla

Genegabuas, Mary Jerielyn

Gonzales, Alphard

Israel, Anthony Joel

Kiseo, Kane Joshua

Labastida, Bernadino

Lamanilao, Katrina Louise

Loyola, Dominic

Mirafuentes, John Marl

Noel, Earlsteen

Parena, Aldin Carlo

Presas, Joachim Ray

Quizeo, Andreah Jobelle

Sigue, Evita Valeska

CHAPTER 1

RESEARCH REPORT

I. INTRODUCTION

Urban rivers in developing countries often bear the brunt of rapid population growth, industrial expansion, and inadequate environmental management. The Butuanon River in Cebu, Philippines, is a clear example of a waterway under increasing ecological stress. Once considered a valuable natural asset for local communities, the river now suffers from a range of environmental problems, most notably pollution from domestic waste, untreated sewage, and industrial effluents. These pollutants have led to a drastic decline in water quality, rendering the river hazardous for both human use and aquatic life.

Compounding the river's environmental degradation is the issue of informal settlements along its banks, particularly within the designated three-meter easement zone intended to protect waterways and mitigate flooding. The communities, often lacking access to basic services, such as sanitation and waste disposal, contribute to the river's pollution while facing the greatest health and safety risks from environmental hazards like flooding and contaminated water.

Efforts have been made by government agencies, environmental organizations, and local stakeholders to rehabilitate the Butuanon River, including cleanup drives, public awareness campaigns, and policy initiatives. However, the persistence of ecological degradation and socio-economic vulnerabilities around the river highlights the need for a more integrated and sustainable approach. By investigating the root causes and consequences of the river's decline, this study aims to provide a comprehensive understanding of the situation and to recommend viable solutions that align environmental restoration with community development.

While various efforts have been made to rehabilitate the river, the lack of a coordinated, multi-stakeholder approach has limited the effectiveness and sustainability of these initiatives. As a result, the challenges facing the Butuanon River remain unresolved, with serious implications for both environmental integrity and community well-being.

Statement of the Problem

The Butuanon River has undergone significant environmental degradation due to increasing levels of pollution, unregulated urban development, and the presence of informal settlements along its banks. Despite its importance as a natural resource and its proximity to urban centers, the river continues to suffer from poor water quality, frequent flooding, and diminished ecological function. Informal settlers living within the river's three-meter easement zone are especially vulnerable, facing ongoing threats to their health, safety, and quality of life.

Objectives

The objectives of this study are the following:

- To assess the living conditions of the residents within the 3m easement zone of the river.
- To determine the primary contributor/s to the pollution of the Butuanon River
- To provide feasible solutions to address the environmental problem/s faced by the community.

Research Questions

The study aims to examine the environmental challenges affecting the Butuanon River and to propose sustainable solutions that support ecological restoration and community well-being. The questions needed to be addressed in line with the objectives:

1. What environmental and social interventions are needed to rehabilitate the Butuanon River?
 - 1.1. What are the primary sources or contributors of pollution to the Butuanon River?
 - 1.2. What feasible and sustainable solution can be made to address the environmental concern of the community?

II. PROCEDURES

The researchers conducted fieldwork in the Sitio Common, Barangay Bacayan, Cebu City. The fieldwork consists of three tasks: to conduct a survey, to record the coordinates of the location/s of waste bins and the collection point of all the garbage from the barangay, and to measure the maximum flood height of the study area.

The target demographic of the survey was the residents situated within the river's 3-meter easement zone, which aims to collect data regarding the environmental problems of the community, health risks, sources of pollution, and efforts from the barangay to address these issues. The survey is crucial in determining the common environmental problems of the community.



Fig 1. Researchers interviewed the residents within the 3m easement zone

Household Socio-Economic and Waste Management Survey

Google Forms - forms-recaptha-nomph@gmail.com
To: 22103633@uc.edu.ph Wed, Apr 23, 2023 at 11:08 AM

Google Forms

Thanks for filling out Household Socio-Economic and Waste Management Survey

Here's what was received.

Edit response

Household Socio-Economic and Waste Management Survey

Maayung buntaghapon. Ako si (Name of enumerator), interviewer sa University of San Carlos. Aduna kami paghuhungod sa mga komunidad nga anaa nahimutang sa duol sa mga sapin. Ang among paghuhungod gibito aron malibaw-an namo ang balanting sa pagguyo sa mga lumulupyo. Ang mga resulta niini nga paghuhungod among gamiton para pagrekomendar ng mga aksyon aron matubag ang among mga problema ug aron mas mapalibutan pa ang mga komunidad.

Good morning! I am (Name of Enumerator), an interviewer from the University of San Carlos. We are conducting a study about communities located near rivers. This study aims to understand the living conditions of residents. The results of this study will be used to recommend actions to address identified issues and improve communities.

Your email (22103633@uc.edu.ph) was recorded when you submitted this form.

Fig 2. The questionnaire used was through a Google form

The second task was to roam around the study area to search for spots that had observable piles of trash or waste bins. The data gathered were photos taken along with the coordinates. The coordinates of the common collection point were also recorded so that the researchers could plan out a map of the garbage collector's path.



Fig 3. The location of the collection point

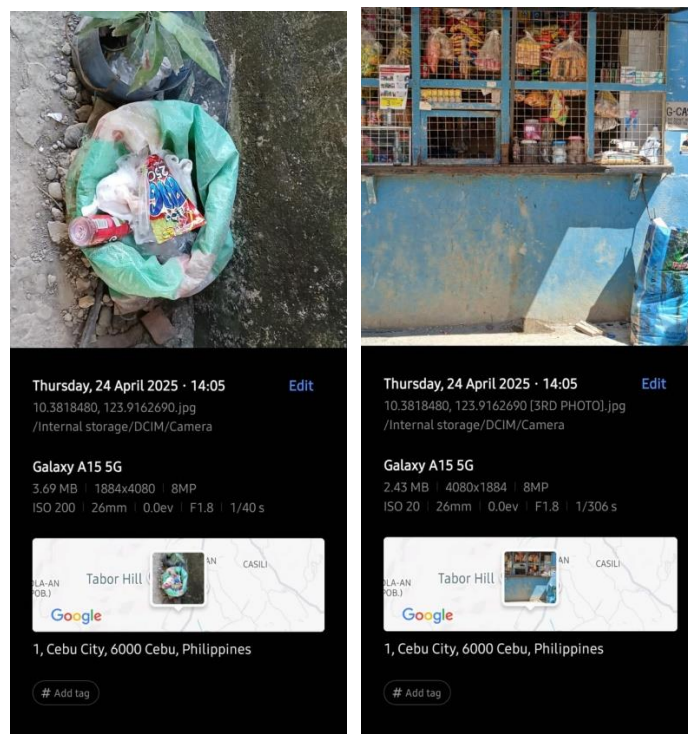


Fig 4-5. Sample photos taken with details that can be tracked on Google Maps

The third task for data gathering is the measurement of maximum flood height was determined by utilizing both the interviews from the residents and data from the barangay hall. The barangay secretary relayed the information from the barangay council to the researchers about how much garbage they collect from the site per day.



Fig 6. The height of the old riprap was measured



Fig 7. The estimated height of the flood according to residents



Fig 8. The height of the riprap was measured

III. DISCUSSION OF RESULTS

A. Site Observation

The researchers from the fieldwork have also observed biodiversity in the community. Barangay Bacayan is abundant with plants. The place has observable clumps of bamboo (*Bambusa blumeana*) growing in the community. Bamboos around the area were even cut because they had grown so tall, due to their fast-growing nature. Researchers have spotted some households that use bamboo as their fence.

B. Household socio-economic and waste management survey

The questionnaire consists of questions about the resident's profile, awareness, disaster vulnerability, and household characteristics. The researchers focused on the necessary questions from the awareness, vulnerability, and household characteristics that can be used to analyze the problem, depending on the percentage of answers.

For awareness, all of the respondents are aware of the waste policies of their community. Aside from waste policies, they also know the proper way of segregating waste into biodegradable, non-biodegradable, and recyclable.



Fig 9-10. 100% of the respondents are aware of the waste policies and segregation

There is a need to know how the residents became aware of their policies and segregation, as it can help assess how influential their source of information can be. There are 75% of respondents who gained information for awareness from the Barangay officials. Some respondents learned about the policies from their neighbors or other community members, with a 17% result, while only 8% of the respondents got their information from seminars.

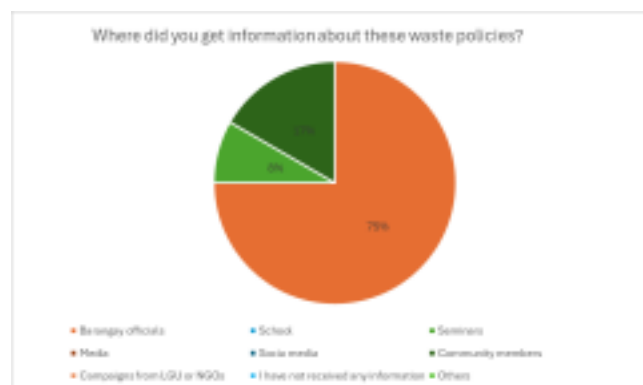


Fig 11. The percentage of respondents' source of information about waste policies

For waste collection, 25% of respondents reported that garbage was collected twice a week, while 75% stated that it occurred only once a week. When asked about the frequency of waste disposal, around 17% of respondents disposed of their waste daily, while 83% did so only once a week.

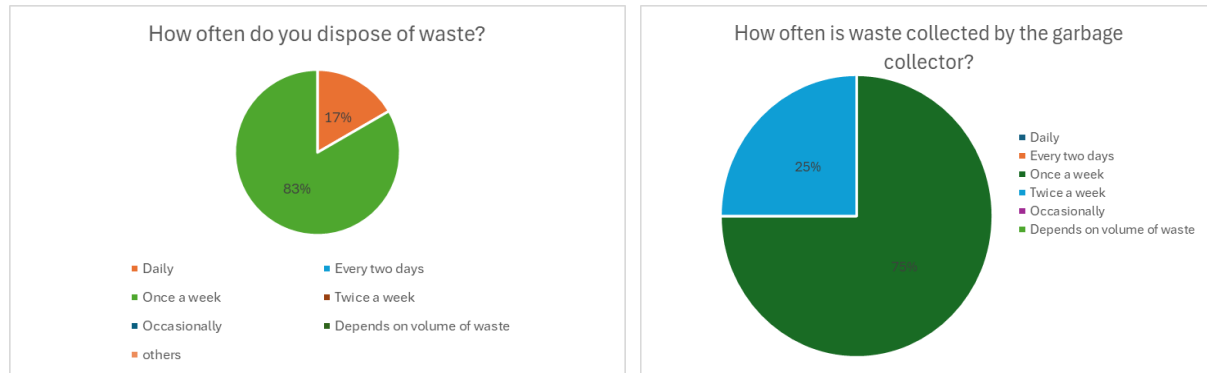


Fig 12-13. The percentage of respondents' frequency of waste disposal and collection

The respondents were also interviewed about the designated areas for the collection of waste and how far they are from residential houses. 50% of the respondents reported that the collection point is somewhat far away from their houses, 33% agreed that the location is far from their houses, while 17% of the respondents said no. This information can be used for applying task 2 (collection path mapping).

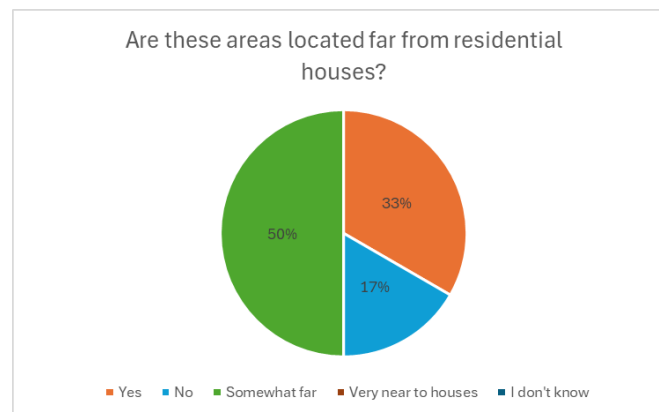


Fig 14. The percentage of respondents' views on how far the location is

A better understanding of the different disasters is essential in evaluating the vulnerability of a community and improving its preparedness. The data shows the disasters that highly affect the community, the highest being floods at 54%, landslides were also mentioned by 23% of the respondents, and another 23% were attributed to other types of disasters. When asked about the leading cause of such disasters 31% of respondents stated that heavy rainfall plays a crucial role in floodings, 19% claimed that it is due to improper waste disposal, 13% attributed it to climate change and the remaining 12% cited that the accumulation of waste blocking the drainage systems is the primary cause of flooding in the community.

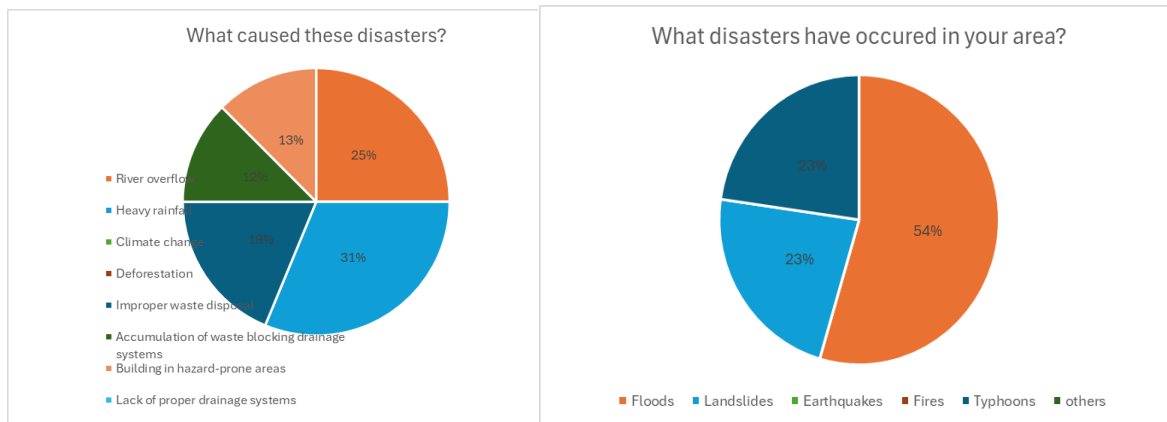


Fig 15-16. The percentage of the types and causes of disasters according to the respondents

Knowing the types and causes of disasters from the residents is important for data gathering, as well as their household characteristics. The data from one particular question is necessary for the researchers to further understand other problems in the community. Problems that they may not be aware of, but are coming from their households. Based on the answers provided by the respondents, 83% of them use a flush toilet while 17% use a pail system. This gave the researchers an understanding that black water does not go directly into the river, but mostly grey water.

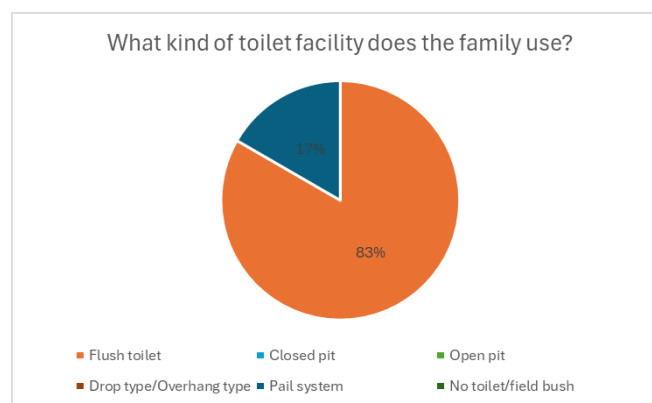


Fig 17. The percentage of respondents' kind of toilet facility they use

C. Waste management mapping

With the use of QGIS (Quantum Geographic Information System), the coordinates of the waste bins and areas where there is a pile of trash were used to map out the collection path of the garbage truck. The data of this map can be used to track or give information on the suitable designated areas of trash bins and the path to going to the collection point.

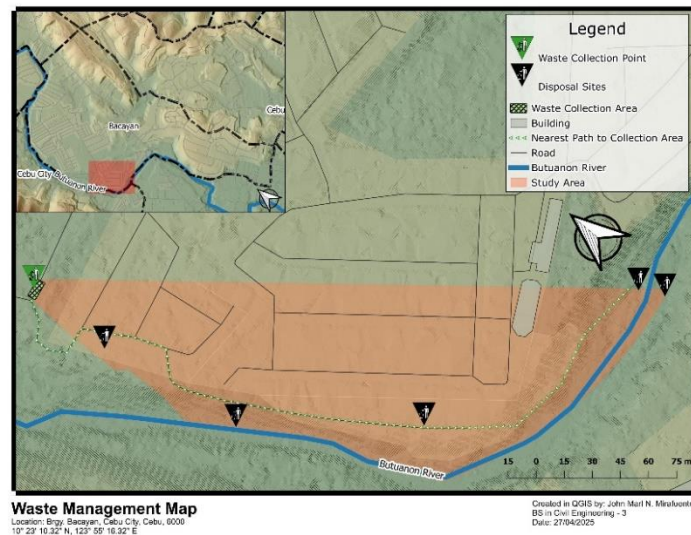


Fig 18. Locations of waste disposal sites going to the Barangay's collection point

D. Maximum flood height

The maximum flood height is the highest point a flood reaches in a location. This was done because it is crucial to know about the location's flood risk assessment and management. According to the residents, there are no current flood occurrences this year, 2025. Because of this, the researchers read news reports and gathered residents' responses to the researchers' questions on the flood occurrence. These were used to gain information about the flood heights of the last time a flood had occurred in their community. A news article from *The Freeman* reported that at least four barangays were affected by intense flooding due to torrential rains last October 2020. A total of 109 families were affected, with 433 partially listed individuals from Barangay Bacayan. From the barangay's count, Sitio Common has recorded 57 families and 246 individuals affected (Malinao, 2020).

Residents situated in the low-lying areas of the upstream parts of the barangay had given the researchers an estimation for the maximum flood height of about 420 cm from the ground, while residents situated in areas with higher elevation had given an estimation of 320 cm. The researchers have also gathered information from the barangay officials on the maximum flood height of the location. The secretary of the barangay, Janah Cabahug, relayed the information from the barangay councilor that the maximum flood height is 600 cm from the riverbed. The height of the old riprap is approximately 275 cm to 300 cm from the riverbed, while the new riprap that was constructed last 2023 is 200 cm. This new riprap aims to mitigate the recurring flooding in the community near the Butuanon River due to heavy rainfall, especially during the monsoon season. Since the new riprap was installed, there have been no incidents of flooding in the study area.

IV. CONCLUSION AND RECOMMENDATION

From the gathered data, the researchers conclude that although the residents of Sitio Common, Barangay Bacayan, have a prominent level of awareness regarding local policies on waste management and proper garbage segregation, there remains a gap between awareness and actual practice. A major indicator of this is that garbage is collected by the barangay only once a week, causing a significant accumulation of waste and suggesting that proper segregation may not be consistently practiced even at the household level. Another observation made by the researchers is that moving garbage from individual households to the pickup point may be challenging, especially for residents living beside the dike, where the elevation is lower. This difficulty in transporting waste could affect the overall efficiency of waste management in the area.

In light of the findings, the researchers recommend several measures to improve waste management practices in Sitio Common. First, the barangay should increase the number of trash bins, particularly in areas that are difficult to access or located at lower elevations, to make waste disposal more convenient and reduce the chances of garbage accumulate near homes. To further assist residents, especially those living beside the dike, the barangay could provide transport carts or small portable containers to help households move their waste to designated collection points more easily, encouraging proper and time disposal.

Alongside improving accessibility, there must also be a stricter implementation of waste segregation policies. Regular monitoring, the imposition of penalties for non-compliance, and incentive programs for households that consistently segregate their waste properly could reinforce responsible waste management behavior. Educational campaigns, information drives, and community seminars should also be conducted regularly to deepen the residents' understanding of the importance of proper waste disposal and segregation. By combining increased accessibility with stricter enforcement and continuous education, the barangay can foster a stronger culture of discipline and environmental responsibility within the community.

CHAPTER 2

PRACTICAL SOLUTION

Proposed solutions

Bamboo is a significant natural resource in the Philippines. It naturally grows fast as these can grow up to 36 inches in a day. Bamboo has a widespread use because of its versatility and durability. It's a popular substitute for wood in construction, furniture, and handicrafts. From the site observation discussed in Chapter 1, this gave the researchers an idea to utilize this resource from the community. Along with the data from the survey about their environmental problems, a bamboo cart and a bamboo dumpster are connected solutions to the issue of waste management in communities along the Butuanon River. The cart and dumpster are made of sustainable materials, primarily bamboo. This can be manually operated by the residents to transport trash to the designated waste disposal areas and then goes to the main collection point. The nature of the design is simplistic and incorporates easily accessible resources so that it can be easily replicated and maintained by the community. The design of the cart also took into account the terrain of the area, which has uneven and narrow paths and may be challenging to navigate if not considered in the design process.

Design of the solution

- “Kariton de Kawayan” (Bamboo Cart Bins)

The bamboo cart, having an estimated capacity of up to 40-60 kilograms, will have a dimension of 1.5 meters in length, 0.7 meters in width, and 0.83 meters in height, being optimal for the cart's balance and ease of movement. The design features a bamboo frame with small gaps at the bottom for water drainage and a hinged lid for protection. Plastic mesh is used all around the innermost frame and floor of the bamboo cart to preserve quality. The design will be a single axle cart which is welded in the base of the bamboo frame and exhibiting two large terrain-capable wheels. An additional rear caster wheel ensures maneuverability around tight corners and rough terrain.. An ergonomic handle allows for easy pushing or pulling by individuals or small groups.

- Bamboo dumpster collection point

The researchers had observed that each household used 1-2 sacks of trash with an estimation of 20-30 kilograms. Barangay officials were interviewed about the amount of waste from the barangay per day. There are approximately 2000 to 3000 kilograms of unsegregated trash collected per day. This information is used to design the bamboo dumpster's dimensions and capacity to contain trash from the barangay to prevent trash from being scattered everywhere.



Fig 19. Dimensions of Kariton de Kawayan

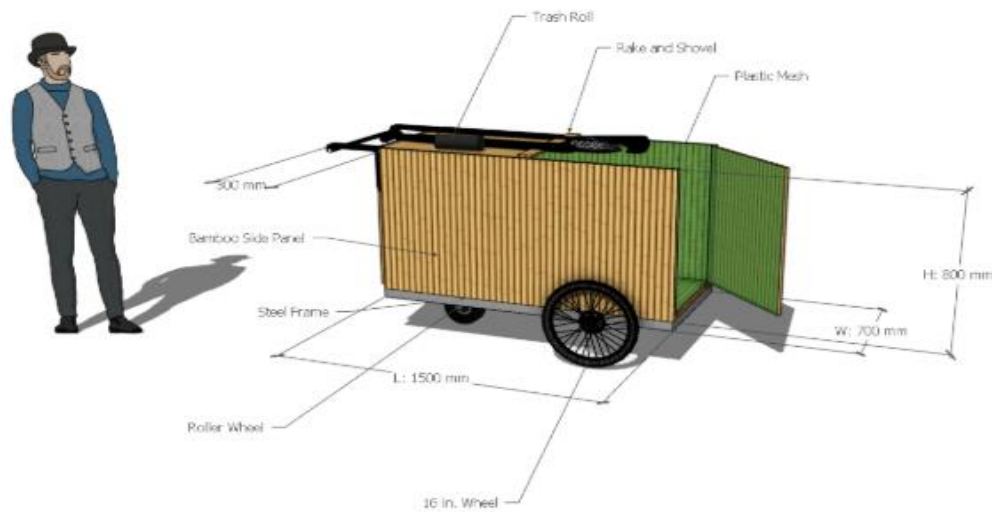


Fig 20. Perspective View of Kariton de Kawayan

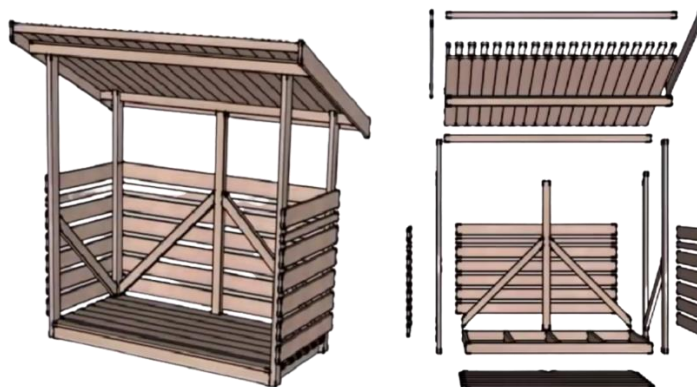


Fig 21-22. Bamboo Dumpster Bin

Design operation and maintenance

To operate the cart, users manually push or pull it using the ergonomically positioned bamboo handles, allowing for smooth navigation through narrow and uneven pathways typical of riverside areas. The wheels will provide maneuverability around corners and rough terrain, while the stopper allows stability when the cart is at rest. Waste is loaded through a hinged lid on top of the container and unloaded either by tilting the cart or manually removing the waste from the open crate. Regular maintenance involves basic tasks such as checking and tightening fasteners, cleaning the bamboo surfaces to prevent decay, and inspecting the wheels for wear and tear, particularly the rubber tires and axles. Any damaged bamboo components can be replaced with locally available materials, reinforcing the cart's long-term usability. This low-maintenance design ensures continued functionality, promotes community ownership, and supports the sustainability of the waste management system over time.

Locational Analysis

The map provided in Chapter 1, data and results of Task 2 (Waste management mapping) gave the researchers an idea of where the bamboo cart bins and the dumpster should be located. These waste collection points shall be positioned in areas it is more accessible, especially for those who are situated far from the garbage truck pick-up point. To ensure community convenience and safety, the placement of the dumpster shall not obstruct the narrow passageway that residents commonly use. Strategically, the dumpster shall be located in public open spaces, such as near the makeshift activity area, where it will be both highly visible and easy to access without interfering with the daily traffic of people passing by. The selection of these locations also considers minimizing the risk of odors, maintaining the cleanliness of the community spaces, and encouraging proper waste disposal habits among the residents.

Materials cost analysis

This section shows the detailed breakdown of the materials used for the initiative and the estimated cost involved in completing one of the proposed bamboo trash carts and the proposed bamboo dumpster collection point. It includes the amount of materials required and the prices of the plastic mesh, bamboo, tires, axle system, and other necessary hardware for constructing the cart. This section aims to assess the practicality of the project.

Bamboo (Cart Frame)

Note: The diameter of the bamboo considered is around 0.09m

Section	Computation	Length (m)
Bottom	$(3 \times 1.5) + (3 \times 0.7)$	6.6
Top	$(2 \times 1.5) + (2 \times 0.7)$	4.4
Vertical	4×0.85	3.4
Handle support	0.1	0.1
Total Frame Length (m)		14.4

Split Bamboo (Cart Flooring and Slats)

Note: The width of split bamboo is 0.05 m

Section	Computation	Length (m)
Front Side	$(0.7 / 0.05) \times 0.85$	11.9
Back Side	$(0.7 / 0.05) \times 0.85$	11.9
Two Sides	$2 \times (1.5 / 0.05) \times 0.85$	51
Floor	$(1.5 / 0.05) \times 0.7$	21
Half Top	$(1.5 / 2) \times (0.7 / 0.05)$	10.5
Handle	0.6	0.6
Total Frame Length (m)		106.9

Bamboo (Dumpster)

Section	Computation	Length (m)
Diagonal Post	$(2 \times 1.22) + (2 \times 0.98)$	4.4
Vertical Post	$(3 \times 1.78) + (2 \times 2.06)$	9.46
Roof rafters	$(3 \times 2.20) + (2 \times 1.28)$	9.16
Total Frame Length (m)		23.02

Split Bamboo (Dumpster)

Section	Computation	Length (m)
Roof	$1.28 \times (2.20 / 0.05)$	56.32
Floor joist	$(2 \times 1.8) + (5 \times 0.8)$	7.6
Flooring	$1.8 \times (0.8 / 0.05)$	28.8
Back side	$1.8 \times (1.04 / 0.1)$	19.8
Two sides	$2 \times [0.86 \times (1.04 / 0.1)]$	17.88
Total Frame Length (m)		130.4

Total Bamboo poles (3m)

Section	Computation	Amount (3m poles)
Frame	$(37.42 / 3)$	12.47
Split Bamboo	$237.3 / (3 \times 3)$	26.37
Total		39

Wire Mesh (PVC Coated)

Section	Computation	Area (m ²)	Price
Floor	1.5 x 0.7	1.05	200
Back	0.7 x 0.85	0.595	
Two Sides	2 x (1.5 x 0.85)	2.55	
Total		4.2	

Additional Parts

Material	Amount	Units	Price
GI hollow pipe	1	m	400
Tire Wheelset - 16" Ø	2	pcs	3500
Caster wheel	1	pc	300
Wood Varnish 1L	1	pc	300
Miscellaneous			600
Total			5100

Planning

As shown from the data in Chapter 1, 75% of the respondents get their information from the Barangay officials, which means they are influential in information dissemination. This solution proposes that the LGU actively engage and collaborate with the community, particularly in the planning, funding, and installation of the design. It encourages residents to organize among themselves and designate individuals who will take turns transporting the design to the assigned garbage collection area. In support of this initiative, the LGU should allocate funds for the purchase of materials required to build the garbage collectors or Kariton de Kayawan.

When adopted by the LGU, the solution can be implemented by first assessing local needs and engaging stakeholders to ensure community support. The LGU should pass a supporting ordinance, allocate funding, and provide a community seminar. They must also identify locations for placing the Kariton de Kawayan, considering accessibility and proximity to the garbage collection points.

Involvement of stakeholders

The success of this initiative hinges on the participation of various sectors. Through community engagement and support from institutions, meaningful and sustainable solutions can be implemented for the long-term benefit of the community.

Community Members: All residents in Sitio Common, especially in households far from the garbage truck route and garbage pick-up point.

Local Government Units (LGUs):

Barangay Bacayan Officials - They shall be responsible for coordinating the project at a community level to ensure the smooth implementation within the barangay, particularly by raising awareness among residents, providing logistical support, organizing community involvement, and ensuring that local waste management regulations are followed and that residents are actively engaged in the project.

Cebu City Environment and Natural Resources Office (CCENRO) - They shall oversee the project's alignment with the city's environmental policies and regulations and shall provide technical support regarding waste management, offering expertise on waste segregation, reduction, and disposal; and, shall monitor the environmental impact of the project, suggesting strategies for its long-term sustainability to ensure that the initiative contributes to a cleaner greener community.

Cebu City Department of Public Services (DPS) - They shall be directly involved in the waste collection and logistics aspect of the project, and they shall assist in organizing the garbage collection by providing the necessary equipment, vehicle, and manpower, particularly in transporting the garbage from the site to the city landfill.

Non-Government Units (NGOs):

They shall play a vital role in supporting the success of the waste management project as they assist by providing funding or grants to help with the initial production of the bamboo carts and cover training and maintenance costs. These groups, also focused on environmental sustainability can offer technical expertise and insights in improving the cart's design, ensuring it remains eco friendly and durable. NGOs can act as a bridge between the community and other potential partners, such as businesses willing to donate materials and offer sponsorships. Through their involvement, these groups can strengthen the community's capacity to manage waste sustainably and empower residents to take greater ownership of their environment.

These are the NGOs in Cebu City that are well-positioned to support the project through additional funding, technical assistance, community engagement, and environmental education:

1. *Go Green Program Cebu (GGPC)* - a youth-led environmental organization focused on educating students about climate change and environmental issues. This NGO aims to create a network of young environmentalists and has goals that include educating the youth about climate change, developing environmental education curricula, and implementing eco-friendly initiatives in schools.
2. *Code Green PH* - their active involvement in environmental initiatives positions them as a potential collaborator for community-based waste management projects.

3. *Friends of Hope* (Aling Tindera Program) - has partnered the Cebu City LGU to establish “waste-to-cash” sites, allowing residents to exchange plastic waste for money.
4. *Cebu Archdiocesan Commission on Environmental Concern (CACEC)* - focuses on ecological spirituality formation, habitat restoration, and solid waste management, and the group’s advocacy for environmental stewardship and community involvement makes them a suitable partner for implementing this project.

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