



# Trash Pollution in Butuanon River at Sitio Almers Brgy. Tabok, Mandaue City

*A Practical Solution Proposal*

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## I. Design of the Solution

The solution aimed to address the alternative disposal paths for the trash is designed with the objective of providing convenience to waste disposal, minimizing the influx of trash into the river, and ultimately improving water quality by significantly reducing litter contamination within the river ecosystem. Encompass of container, trolley, cable or line, utilizing sturdy and lightweight materials to ensure maneuverability. The zipline drum and the user interface adheres to easy operation with the features such as intuitive control for proper deployment of the container.



Figure 1-A. The Zipline Drum

Functional components are organized to efficiently transport and dispose of trash while minimizing environmental impact. The container serves as the main compartment for holding, to secure the contained waste during transit, preventing spillage or loss. The zipline cable or line provides the pathway to support and guide the movement of the zipline drum. The tilting mechanism to release the trash from the zipline drum upon reaching the destination point is designed with a release lever to facilitate control of the tip over of the trash. By incorporating these components, the zipline drum can effectively transport trash to the desired destination and facilitate its efficient unloading for disposal or further processing. The non-functional requirement for the zipline drum should operate reliably under environmental conditions, be designed for efficient loading, be durable and able to withstand repeated use, and be scalable to accommodate varying amounts of trash and different types of waste. Risks are mitigated by implementing safety protocols for loading and operating the zipline drum with regular inspections for any potential hazard

and developing clear and effective emergency procedures to address potential accidents. Through a combination of sturdy construction, user-friendly design, and rigorous safety measures, the zipline drum offers a reliable and sustainable solution for managing waste while safeguarding water quality and natural habitats.

## II. Locational Analysis



Figure 2-A. River Site Inspection.

A barrio in Mandaue City called Tabok has 19,486 population according to the 2020 Census, this amounted to 5.35% of Mandaue's total population. The Butuanon River's three-meter easement zone is home to 1,074 families in 11 barangays. Barangay Tabok, Sitio Almers with an estimated 97 households already subjected to clearing operations by the Government in Mandaue City since floods are not the only problem but also the presence of the polio virus as Local Government Unit(2020) declared and should make the river off-limits. In September 2022, Mandaue was also declared a state of calamity due to severe flooding that impacted 11 out of the 27 barangays in the area. Representative Emmarie Ouano-Dizon of Mandaue City's Lone District supported and carried out flood mitigation projects for the Department of Public Works and Highways, which piled soil to make it accessible to construction trucks and allowed the dumb truck to collect resident waste. Given the amount of trash in the river, Barangay Tabok, Sitio Almers is a good place to adopt a "zipline drum" for the transportation of waste/trash

because of its slight inclination, which will also make it easier for any individual or household to dispose of their waste since the goal of this method is to restore the river's cleanliness, which could result in better water quality.



Figure 2-B. Trash Monitoring.

The installation of zipline drum may provide difficulties due to severe weather and other concerns, and regular transportation routes may become obstructed during natural disasters like hurricanes and floods, making it difficult to transfer waste and debris from affected areas. However, if constructed and maintained properly, zipline systems could be used. Personnel operating zipline systems may face serious safety concerns as a result of severe weather linked to flooding. To protect worker safety, activities may need to be suspended in the event of strong winds, lightning, or flooding. Even in difficult environmental circumstances, zipline-based trash delivery can support effective waste management procedures by addressing these issues through careful planning, coordination, and risk reduction techniques.

### III. Social Cost-Benefit Analysis with Explanation

Table 1.1 *Estimated Cost*

Materials	Unit Price	Unit	Quantity	Subtotal
GI Steel rope (12m)	₱1,500	pcs.	1	₱1,500
Trolley	₱1,800	pcs.	1	₱1,800
Plastic Drums (200L)	₱800	pcs.	1	₱800

Ground anchors	₱600	pcs.	2	₱1,200
Turnbuckle	₱280	pcs.	1	₱280
Stopblock	₱3,400	pcs.	1	₱3,400
U-bolt clamps	₱43.30	pcs.	11	₱476.30
Cable Thimble	₱21	pcs.	1	₱21
200 mm GI Pipe (6m)	₱25,454	pcs.	2	₱50,908
Labor (3 Days, 3 Workers)	₱400	per/day/worker	9	₱10,800
2x6 Wood (8ft)	₱1,000	pcs.	10	₱10,000
Roof Sheet (3x4 ft)	₱450	pcs.	3	₱1,350
Common Nails	₱135.78	kg.	1	₱135.78
Garbage Bin (660 L)	₱13,900	pcs.	1	₱13,900
Tarpaulin (24"X60")	₱120	pcs.	1	₱120
Umbrella Nails	₱95	kg.	1/2	₱47.5
<b>Total Cost</b>				<b>₱96,738.58</b>

The zipline drum's cost estimation for construction is **₱96,738.58**, making it a viable option that aligns with the financial budget of Barangay Tabok, Mandaue City, Cebu. The solution does not only establish affordability but also highlights the practicality and accessibility of implementing the project on the riverbanks of Sitio Almers. Beyond the cost-effectiveness of the proposed solution, it offers a multitude of benefits to the community, providing a better mechanism for waste disposal.

It is important to take note that most of the materials that would be used for this project are sourced and provided by the residents through the use of recyclable materials. Through the use of recyclable materials we could reduce the waste piling up in Sitio Almers and the river, reducing waste accumulation helps to prevent pollution and to preserve valuable land space. Sustainable practices are also promoted through the use of recyclable materials, the community would be encouraged to adopt more sustainable consumption and waste management practices.

**Table 1.2** *Estimated Costs with budget cuts*

<b>Materials</b>	<b>Unit Price</b>	<b>Unit</b>	<b>Quantity</b>	<b>Subtotal</b>
Nylon rope (12mm)	₱15	Per meter	12	₱180
Trolley	₱1,800	pcs.	1	₱1,800
Plastic Drums (200L)	Can be from donation or old oil or water drum			₱0
Ground anchors	₱600	pcs.	2	₱1,200
Turnbuckle	₱280	pcs.	1	₱280
Stopblock	₱3,400	pcs.	1	₱3,400
U-bolt clamps	₱43.30	pcs.	11	₱476.30
Cable Thimble	₱21	pcs.	1	₱21
Mahogany Lumber (6 by 6 by 4)	₱650	pcs.	3	₱1,950
Labor (3 Days, 3 Workers)	Can be done by the community without pay			₱0
2x6 Wood (8ft)	Can be source from cut down trees near the river			₱0
Roof Sheet (3x4 ft)	Can be recycled form scrapped roofing sheets			₱0
Common Nails	₱135.78	kg.	1	₱135.78
Garbage Bin (660 L)	Can be made with scrap materials: Wood, Tarpaulin, Metal Roofing Sheets			₱0
Tarpaulin (24"X60")	Can be recycled from old tarpaulins			₱0
Umbrella Nails	₱95	kg.	1/2	₱47.5
<b>Total Cost</b>				<b>₱9,490</b>

Through resource optimization the estimated total cost that we calculated in table 1.1 have lessened as can be seen on table 1.2, the total estimated cost being **₱9,490..** We have minimized our cost and made sure that promoting recycling and sustainability is put at the utmost importance.

The segregation of waste is present in the project, preventing landfill disposals, which reduces the environmental impact. It also promotes efficiency. The residents of Almers had stated that trash disposal was a problem yet to be provided with a solution because the waste disposal area was situated far away from them. With this proposal of building a zipline, we

simply intend to get rid of waste as much as possible so that it does not mount up in the area. The purpose of the zipline idea is for a way to dispose of the waste as fast as possible, with the main intention that it removes waste efficiently. The waste accumulation on the Butuanon river will hopefully be reduced to none, this waste accumulation has been a problem for the community for a long time especially during heavy rainfall, the waste accumulation has made it hard for the water to be drained therefore floods become inevitable. With the faster rate of waste disposal, we intend to ensure that we minimize the chances of water levels rising. Getting rid of waste as much as possible provides a number of benefits for the community, one of them is simply improved hygiene, with the removal of waste reassures that any pest infestation or any odor is reduced that will increase if the waste still builds up within the community, this generally promotes and contributes to overall public health.

#### **IV. Planning**

The primary objective of the zipline drum solution is to provide a convenient and environmentally friendly waste disposal method for the residents of Barangay Tabok, Sitio Almers, thereby reducing the influx of trash into the Butuanon River and improving water quality. The planning and implementation cover the aspects of introducing the zipline drum system in Barangay Tabok, Sitio Almers.

In the first phase of the planning and pre-implementation stage, meetings with the local government units, community leaders, and residents will be held to discuss the zipline drum solution and gather feedback. Community assessment will be conducted where the topography, infrastructure, and environmental conditions of the target area will be assessed to determine the optimal placement and configuration of the zipline drum system. Detailed designs for the zipline drum and the trolley will be developed and shared with community partners, ensuring compliance with local regulations and standards. Determining the sources and suppliers for the materials to be used in the creation of the zipline drum and the trolley falls under this stage. Additionally, efforts will be made to secure PVC drums from nearby factories to serve as the primary material for constructing the zipline drums, promoting sustainability and local resource utilization.

In the second phase of the planning is the installation of the zipline. It must be ensured that the area along the zipline path is clear from obstructions or hazards. The three zipline cables will be installed, securing it to existing structures or installing support posts as needed. Proper alignment and tension must be observed in the attachment of the zipline drum and trolley to the cable. A waiting shed will be provided as a shelter area for the individual awaiting for the transportation of trash. Meanwhile, three trash bins will be situated on the other side of the zipline to facilitate proper waste segregation, allowing for the separation of different components of trash such as recyclables, organic waste, and non-recyclable materials. A pilot testing will be conducted to ensure the reliability of the proposed mechanism and to identify any gaps before its full implementation.

Moreover, learning sessions will be conducted for community members on the proper use and maintenance of the zipline drum system. Regular monitoring on the operation of the zipline drum system will also be conducted to facilitate smooth and efficient operation. To ensure safety, there will be a bi-monthly inspections of the zipline drum system to identify any potential issues or maintenance needs. Safety protocols for loading and operating the zipline drum, including regular inspections for potential hazards and the development of clear and effective emergency procedures will also be provided during learning sessions and on-site. Severe weather conditions, safety of personnel operators, and contingency plans during natural disasters will also be taken into consideration in the planning of operational guidelines of the zipline drum system.

During the implementation, feedback from community members and stakeholders on the effectiveness and usability of the zipline drum system will be done regularly to evaluate the performance of the zipline drum system, including its impact on waste reduction and water quality in the Butuanon River. Based on feedback and evaluation results, modifications, improvements and adjustments to the zipline drum system will be made to allow for its effectiveness and sustainability.

## **V. Stakeholders Involved**

The following stakeholders are involved in the conceptualization of this solution:

### **Mandaue City Environment and Natural Resources Office (MCENRO)**

The Mandaue City Environment and Natural Resources Office coordinates with government agencies and non-government organizations in the implementation of measures to prevent and control land, air and water pollution with the assistance of the Department of Environment and Natural Resources (DENR). They work with different stakeholders to collaborate in performing routine inspections and monitor the operation in the river that could have an adverse impact on the environment and water quality of the river. It is with their valuable data and insights were the students able to not only understand the river better but also in devising a potential solution. The support and available resources were beneficial to the students in carrying out the rehabilitation plan. Furthermore, they uphold the Butuanon River's protection and conservation within the existing environmental laws, rules, and ordinances.

### **University of San Carlos (USC)**

The University of San Carlos is one of the key coordinators in the annual Metro Cebu River Scan Challenge 2024. It is a two-week event that aims to investigate and seek innovation and implementable solutions to the current problems of the Butuanon River and Mahiga River. The University plays a pivotal role in this event as they provided the manpower and resources necessary to perform this report; it is participated by Filipino-Dutch students from the University of San Carlos, Rotterdam University of Applied Sciences, and Hanze University of Applied Sciences. The participating USC students came from different departments—Civil Engineering, Political Science, and Anthropology. They contribute to the research, and resources by assessing the current situation of the major rivers in Metro Cebu. Through expertise, data collection, analysis, water quality testing, and identification of the existing problems and policies, the participants were able to formulate strategies and solutions that they can propose to the stakeholders involved. Moreover, the Metro Cebu River Scan Challenge encourages sustainable resource use and management while restoring and maintaining the ecological integrity and water quality of the river.

### **Barangay Tabok Officials**

The Officials of Barangay Tabok play an important role as they serve as liaison between Sitio Almers community and the participating stakeholders. They facilitate the Metro Cebu River Scan Challenge by providing background information about the rivers, community, and mobilized volunteers and strategic plans to help and guide the participants. They provided plenty of on-site assistance to the students performing this study. Through their assistance, the students were able to easily navigate the area and easily connect with the residents of the area. Furthermore, they ensured that the participants were able to connect with the residents, gather relevant data and information, and concerns were raised during the assessment process. The barangay officials shall continue the clean-up drives, tree planting activities, and the monitoring system of individuals, and establishment owners in building new establishments and houses. Thus, they must ensure that there is a proper implementation of rules and regulations to all stakeholders in establishing infrastructure and houses.

### **Sitio Almers Residents**

The Residents of Sitio Almers were the essential primary source of information in this report. With their own personal experiences of being a resident of the area, the students were able to realize the severity of the issues faced by the Butuanon River via community meetings and interviews. They provide information about the history and current state of the Butuanon River, the negative impacts of the Butuanon River in their health, and various perspectives and concerns that they want to address to seek immediate solutions. Moreover, the active community engagement of the residents have contributed to the success of the project and contribute a proposed solution to the Metro Cebu River Scan Challenge participants to have a better and cleaner community.

### **Partner Universities: Rotterdam University of Applied Sciences and Hanze University of Applied Sciences**

Co-coordinating Rotterdam University and Hanze University assisted in bringing the Riverscan Challenge 2024 into fruition. Both Universities were able to bring their

knowledge and expertise in designing potential solutions to the numerous issues faced by both the residents and the river.

## **VI. Operations and Maintenance**

The maintenance and supervision of zipline drums as a waste transportation method in Barangay Tabok, Sitio Almers usually require cooperation between multiple stakeholders, such as local government units, community stakeholders/organizations. The operation and maintenance of the solution – the zipline drum for alternative trash disposal, are primarily the responsibility of the Local Government Units (LGU) and the community residing in Barangay Tabok, Sitio Almers. The Local Government Units role is to oversee the implementation, management, and regulation of waste management initiation. Community involvement is crucial for the effective and sustainable operation of a solution. Local community groups also play a major role in promoting public awareness, fostering community involvement, and generating support for innovative waste management initiatives such as zipline-based transportation. They might encourage outreach programs, volunteer labor, and monitoring projects. The effectiveness of garbage management efforts based on the ziplines system depends on the involvement and engagement of local residents and other stakeholders during the planning and implementation stages. In order to resolve issues, ensure acceptance, and cultivate a sense of ownership and responsibility for the system, their cooperation, involvement, and feedback are essential.

The maintenance required for the zipline drum is a comprehensive process aimed at ensuring its continued functionality, efficiency, and safety. This systematic procedure encompasses various tasks, including regular inspections, thorough cleaning, and meticulous lubrication of key components such as bearings, bolts, gears, and the zipline cable or rope line. Additionally, proactive measures are taken to address any signs of wear and tear, with prompt repair or replacement of worn components being a priority. Requests for replacement parts are formally submitted to local government units, supported by evidence and petition papers to facilitate timely action.

Moreover, preventive maintenance strategies, such as rust prevention, are diligently implemented to extend the lifespan of the zipline drum and minimize the frequency of repairs. To uphold a high standard of maintenance, established schedules dictate bi-monthly maintenance sessions, during which trained personnel from the community meticulously conduct inspections and execute necessary tasks. By adhering to these rigorous maintenance protocols, the zipline drum can reliably fulfill its role in providing an alternative trash disposal path, ensuring the smooth and uninterrupted operation of this vital waste management solution.

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*30KN Dual Pulley Zip Line Cable Trolley Outdoor Rock Climbing Equipment Ne*  
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*Ground Anchor Heavy Duty Anchor Hook*  
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