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Eco-trap: An Innovative Low-Cost Trash Trap to Remove Solid Waste on River Surface

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Abstract: The rapid development in Malaysia from agriculture, industrial and commercial sectors have resulted in many environmental problems including the solid waste and water pollutions. In year 2010, Malaysia had ranked as the 8th country with highest mismanaged plastic waste entered the oceans. On top of that, in 2012, 41.00 % of the rivers in Malaysia were classified as polluted. Therefore, this research is interested to design a cost-effective and eco-friendly trash trap that can be used as an instrument to clean the river. The prototype, called eco-trap, is designed to trap the solid waste on the river surface. Eco-trap is made from plastic bottle waste, and it was installed at the Panchor River to test for its trapping performance. The data collection was conducted for a month with four times of waste collection. At the end of the testing period, a total of 953.5kg of solid waste were collected using eco-trap. Bulky waste recorded the highest weight composition of 620.5 kg (51.00 %). This is followed by plastic waste (217.0 kg, 35.00 %), steel can waste (61.0 kg, 10.00 %) and aluminium can waste (24.5 kg, 4.00 %). All in all, it can be concluded that the prototype had successfully trapped the wastes flow into the study area and helped in river cleaning process.

Keywords: River Pollution, Plastic Waste, Trash Trap, Cost Effective

1. Introduction

Water pollution in rivers and oceans are becoming a worrying global issue. It can take place in lakes, rivers, drains, oceans, and groundwater. The water pollution in the river is caused when pollutants were added into the water body as our rivers are now being used as disposal routes for liquid and solid waste by irresponsible parties [1]. In 2010, an estimation of around 4.8 to 12.7 million metric tonnes (MT) out of 31.9 million MT of mismanaged plastic wastes entered the ocean. Malaysia is ranked as 8th among the 192 selected coastal countries with high amounts of mismanaged plastic waste. In Malaysia, around 0.36 million out of 0.90 millions of mismanaged plastic waste had become plastic marine debris [2]. Furthermore, in year 2012, the Ministry of Natural Resources and Environment (NRE) reported that 41.00 % of rivers were classified as polluted based on the Water Quality Index (WQI) in Malaysia

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[3]. Polluted rivers can bring adverse impacts to aquatic life and the balance of ecosystem at that place. Besides, the bioavailability of potable water will be reduced, and the human health can be badly affected with numerous diseases after consuming polluted water [1].

The rapid consumption of plastics had contributed to the generation of a great amount of plastic wastes as one of the main types of waste in Malaysia [4]. The increasing trend of plastic wastes generated poses greater difficulties for disposal [5]. Polyethylene Terephthalate (PETE/PET) is assigned the category of number 1 as it is the easiest and most common plastic to recycle [6]. However, according to the news published by The Star in 2019, only 16% of the PET bottles produced in Malaysia were collected and sent for recycling. The average national recycling rate of the six countries including Malaysia, Indonesia, Vietnam, the Philippines, Thailand and Myanmar was estimated to stand at 26.00 %, while another 26.00 % of the PET bottles were sent to landfills and 48.00 % leaked into the environment [7]. When plastic wastes were accumulated in landfills and natural habitats, it could cause many problems and damages to the environment and human health, such as contamination of terrestrial, freshwater and marine habitat and also ingestion of chemicals from the plastic waste [8].

To deal with the river pollution, various types of trash trap have been implemented worldwide. Trash traps such as Interceptor, Litter Boom, Trash Rack and Downstream Defender have been used to help in river cleaning process. However, it can be concluded that most of the trash traps developed are advanced, expensive and can only be operated in large area or specific site conditions. Therefore, in this study, a prototype of a trash trap made from plastic bottle waste, also known as the Eco-trap, will be designed to remove solid waste on the water surface. The eco-trap will be able to ease the river cleaning process without using any machinery equipment. In addition, the use of plastic bottle waste as floaters in the eco-trap will contribute to the reduction of plastic waste disposal at the landfill.

2. Materials and Methods

In this study, an eco-friendly and cost-effective prototype named as Eco-trap is developed and tested on its ability to trap solid wastes at river surface. The eco-trap is developed by using the following materials:

i. Fishing net – High Density Polyethylene (HDPE) material of gill net with 3.5 meters wide, 7 meters long and 1cm openings.
ii. Plastic Bottle Waste –1.5 L plastic bottle of carbonated drinks such Coca-Cola, 100 Plus and Pepsi.
iii. Chain- 4 kg and 4 m long of metal chain.
iv. Rope – Polypropylene (PP) rope.

First, the same type and size of plastic bottle wastes will be attached to the net and formed a consistent buoy line. The plastic bottles will act as the floaters to hold the net perpendicularly towards the direction of water flow while trapping the floatable trash brought by the water flow. Then, a metal chain is attached at the bottom of the net. The metal chain will act as a weight to hold and keep the net from being flipped over by a strong water current. Furthermore, ropes are attached along the side of the net based on the concept of a drawstring bag. Once the trap is developed, it will be installed and released to the river where the net will act as a filter to trap the waste flow into it. The ropes will be tied at the riverbank to keep the trap at the point. When the trap is filled with waste, the ropes tied at the riverbank will be pulled and the trap will be enclosed. Finally, it can be lifted for the weighting and disposal of waste.

In general, the methodology of the research has 3 main stages. These 3 stages are development of the prototype of Eco-trap, testing and monitoring of the installed trap at the research area and lastly the result and discussions of the research. The flowchart of the research was illustrated in Figure 1 below.

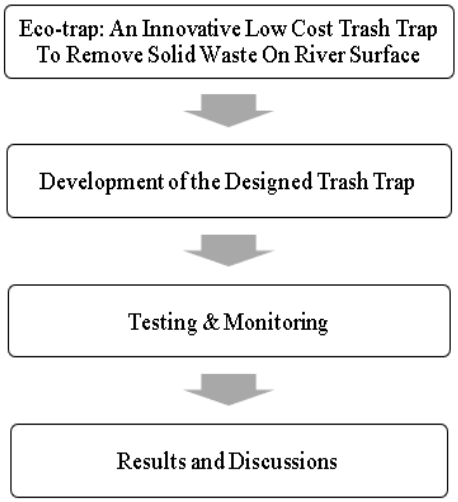

Figure 1: Flow chart of the research methodology

The prototype is designed by using the materials as mentioned above. After it is developed, it will be tested and monitored at Panchor River, Muar on its performance to trap the solid wastes in the river. The data collection is carried out for one month and 4 times of collection had been done within the period. The collection is carried out when the trap is full of wastes and thus it will be lifted for weighting and disposing of the wastes. Finally, the result obtained after conducting the testing is analyzed based on the weight composition of each type of waste collected.

3. Results and Discussion

Throughout the data collection period, a total of four times of waste collection had been carried out. For each collection, all the wastes collected will be sorted and weighted according to its category before being disposed properly. The data obtained is analysed based on the weight composition for each type of waste collected.

3.1 The Composition and Amount of Wastes Collected at Panchor River, Muar

The data recorded for waste collected during the data collection period is shown in Table 1.

Table 1: Types and amount of waste collected in Panchor River, Muar, Johor

Types of waste	Amount of Waste Collected (kg)			
	28/10/2020	11/11/2020	20/11/2020	25/11/2020
Steel Cans	61	5	24.5	19.5
Plastic	217	62	56	67
Aluminium Cans	24.5	1.5	6	15
Bulky Waste	620.5	311.5	98	128
Total	61	5	24.5	19.5

Basically, there are 4 main categories of waste collected during the prototype testing which is steel cans, plastic, aluminium cans and bulky waste. The examples of steel can waste accumulated include food cans and insecticide containers. For the plastic waste, it includes PET bottles, polystyrene containers and plastic bags. Next, the examples of aluminium can waste collected include soda cans and also food cans. Lastly, bulky waste in this context refers to coconut fruit, its branches, and fronds;

and pieces of furniture that were large and heavy. The composition of waste collected throughout the collection period is illustrated in Figure 2.

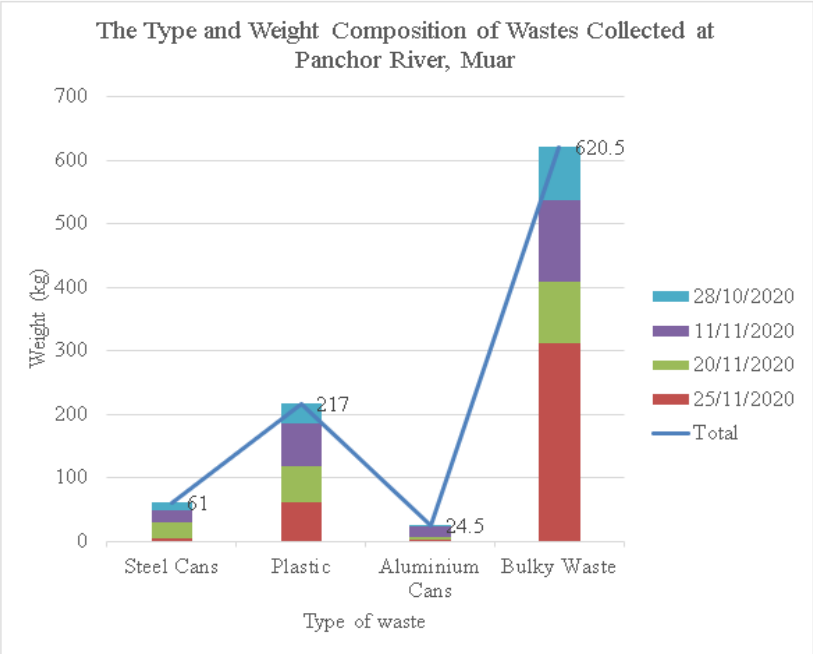

Figure 2: The Composition and Amount of Wastes Collected at Panchor River, Muar, Johor

During the first data collection, the total amount of wastes collected is 129.0 kg. From this amount, bulky waste recorded the highest amount of wastes collected which is 83.0 kg (64.00 %). This is followed by plastic waste (32.0 kg, 25.00 %), steel can waste (12.0 kg, 9.00 %) and aluminium can waste (2.0 kg, 2.00 %). Next, within the second collection, a total amount of 229.5 kg of wastes are collected. From this amount, bulky waste again recorded the highest composition of 128.0 kg (45.00 %). This is followed by plastic waste (67.0 kg, 36.00 %), steel can waste (19.5 kg, 11.00%) and lastly aluminium can waste (15.0 kg, 8.00 %). During the third collection, the total amount of waste collected is 184.5 kg. From this amount, bulky waste recorded the highest amount of wastes collected which is 98 kg (53.00 %). This is followed by plastic waste (56.0 kg, 31.00 %), steel can waste (24.5 kg, 13.00 %) and aluminium can waste (6.0 kg, 3.00 %). For the last collection, the total amount of waste collected is 380.0 kg. From this amount, bulky waste recorded the highest amount of wastes collected which is 311.5 kg (82.00 %). This is followed by plastic waste (62.0 kg, 16.00 %), steel can waste (5.0 kg, 1.00 %) and aluminium can waste (1.5 kg, 1.00 %).

In overall, a total of 953.5 kg of wastes were collected and disposed of by using the Eco-trap. From this amount, bulky waste recorded the highest weight composition of 620.5 kg (51.00 %). This is followed by plastic waste (217.0 kg, 35.00 %), steel can waste (61.0 kg, 10.00 %) and aluminium can waste (24.5 kg, 4.00 %). Figure 3 illustrates the overall weight composition of waste collected during the data collection period.

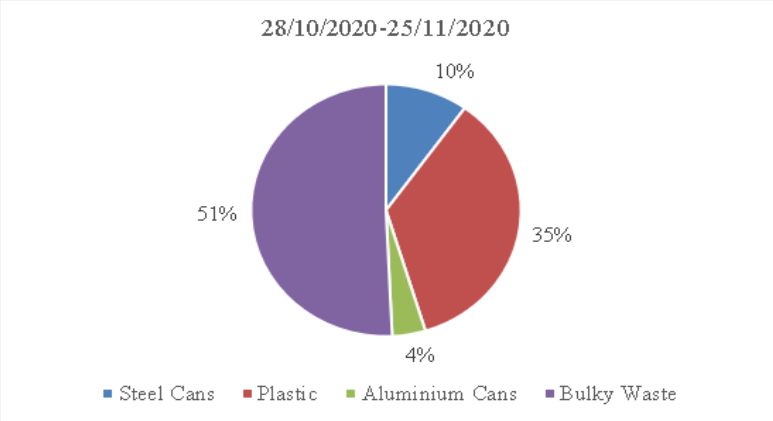

Figure 3 : Overall waste composition collected during the data collection period

3.2 Comparison of Waste Collected by using the Eco-trap with Other Studies

Bulky waste recorded the highest composition where furniture, coconut tree branches and fronds were trapped throughout the testing. It is common to trap bulky waste at the river by using a trash trap as shown in other studies. According to the news published by The Star in 2014 and 2016, bulky wastes such as discarded mattresses, sofa, or even refrigerator were found to be trapped at the log boom installed in the river. Moreover, based on an interview session conducted by WJBF News Channel on the implementation of the watergoat trash trap in the City of Augusta, the program coordinator, Mr. Truck Carlson revealed that a great number of shoes were found to be trapped by the watergoat. This situation was found to be similar at Panchor River, Muar, Johor. During the prototype testing of eco-trap, many shoes were found to be trapped inside the net. In addition, plastic wastes which recorded the second highest composition were trapped in the Eco-trap in a large quantity. This is similar with the condition of log boom that was installed in Klang River near Jalan Ipoh, Kuala Lumpur [9] and downstream of Sungai Batu, one of the tributaries of the Klang River [10]. According to a news published by The Star in 2016, heaps of wastes made up mainly of plastic bottles and polystyrene containers were trapped and collected from the trap. Another news published by The Star in 2014 revealed that polystyrene and plastic bags clogged at the river trash trap installed across the Klang River.

3.3 Sources of Wastes Collected

From the observation of the researcher, the research area is surrounded by houses and restaurants. Furthermore, based on the results obtained, most of the wastes came from the housing area nearby. Therefore, the wastes collected are most likely to be caused by some of the residents threw their waste either directly or indirectly into the river. Besides dumping of wastes directly into the river, river pollution can be caused by the open dumping activities at the roadside. According to a news published by The Star in 2016, the department's river basin and coastal management division director, Datuk Lim Chow Hock revealed that the river pollution can be caused when the wastes dumped at the roadside enter the drains and then in the rivers. Moreover, based on an informal interview with a local public concession, foreign workers from a nearby company are also among the contributors to the open dumping of waste into the river. Their ignorance of clean waste resources, in addition to convenience and no cost required were among the contributing factors that lead to the open dumping of waste into the river by the residents.

4. Conclusion

In conclusion, it can be regarded that the eco-trap had successfully trapped 953.5 kg of waste and helped in the river cleaning process at Panchor River, Muar, Johor. It is eco-friendly and cost effective where it can be operated without any machinery equipment. In addition, the utilization of plastic bottle wastes reduced the amount of plastic waste to be disposed at landfill.

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