Muhammed Alamgir, S.M. Tariqul Islam and J. A. Saju (Eds.)
ISBN: 978-984-35-4034-8

Full Paper of the WasteSafe 2023 –8th International Conference on
Integrated Solid Waste & Faecal Sludge Management
25-26 February 2023, Khulna, Bangladesh

DEVELOPMENT OF AN EFFECTIVE WASTE-BIN HOLDER TO REDUCE PLASTIC POLLUTION IN COASTAL AREA

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ABSTRACT

At present, the use of plastic items is rising rapidly than population growth. Debris from land-based sources continues to flow into the marine environment due to a lack of suitable waste disposal facilities. Marine life and the human food chain are threatened by the accumulation of plastic and other debris. In developing nations like Bangladesh, effective on-site handling can play a crucial role in avoiding plastic pollution with little effort. Usually, the open drums are served as a Waste-bins for storage of debris from our surroundings to be transported to the main waste management system. A dustbin holder can offer some stability to the bin, protection against stray animals drawn to the rubbish, and hygiene for the surroundings. An open drum can easily be turned over by dogs and other stray animals. These overturned dumped items may cause congestion on the roadside, unhygienic conditions, and drainage blockages. Residents who live near the shore may throw their litter down the riverbank since these containers are dysfunctional and contaminate the ocean. In this study, from 6 No Ghat (Walkway Park) to 7 No (Roosevelt Jetty), a Standing-stock survey based on the NOAA Marine Debris Shoreline Survey Field Guide was carried out to determine a total load of riverbank debris. This debris was categorized into seven groups: plastic, glass, metal, rubber, cloth or fabric, processed lumber, and other/unclassifiable. At 6 No Ghat (Walkway Park) the majority of the debris was processed lumber, accounting for 59.41% of the total waste recorded. Plastic was the next largest category, accounting for 38.61%. Then, 0.99% cloth/fabric was identified along with 0.50% both for glass, unclassified category. There was no metal or rubber present .At 7 No Ghat (Roosevelt Jetty), the majority of the trash was made out of plastic, accounting for 84.56 % of the total rubbish counted. With 5.15 % and 4.41 %, respectively, rubber and processed lumber were the next two most important sectors. Glass, the unclassified category, and metal each had percentages of 3.68%, 1.47%, and 0.74%. No fabric or cloth was observed during the survey period. To avoid waste from recreational and dumping activities, a waste bin with a holder which may provide stability to the bin has become necessary. The opening of the half-cut drum was elevated to 2 feet, 10 inches to minimize overturning by stray dogs. Two waste bin holders were set in two different sites (Fulbarigate residential area and 6 No Ghat Waterway Park, Khulna) to see if they might solve the problem. They were found to be functioning over two months, holding the bins in their identical placements.

Keywords: *Wastebin holder, marine environment, onsite handling, plastic, recycling*

INTRODUCTION

The present modern world is advancing towards technologies that make our day-to-day lives comfortable. For this effortless and more advanced life, the production solid waste is also increasing. Usually the solid wastes are undesired, pointless, and dumped materials that come from production and consumption. Waste products are produced as a result of all human activities and reflect the full range of man's actions. Minimizing the negative environmental consequences brought on by the careless disposal of solid waste is the primary goal of solid waste management. The improper management of solid waste leads to a number of issues with the environment and human health. Common issues with incorrect solid waste management include the spread of illness by rodents and insects, fire dangers, odour annoyances, contamination of the air and water, aesthetic issues, and financial loss. One of the major part of the generated solid waste is plastic. The production of plastic items has increased 200 times from 1950 to 2014 (Li et al. 2016). Plastic products offer resistance to deterioration in addition to being durable. These substances are constantly entering our marine ecosystem and never decompose while there. They transformed into secondary microplastics through

a breakdown process like weathering, photodegradation, and mechanical forces. Land-based sources account for 80% of this plastic debris. The remaining 20% are responsible for ocean-based sources (Li et al. 2016). There are two types of waste from these land-based sources based on its value: high-value waste (plastic bottles, pipes, etc.) and low-value waste (plastic covers, polythene bags, grocery bags, ropes, etc.). These low-value wastes are categorised into three groups for marine sites, such as floating, benthic, and beached debris (Chen et al., 2019). This land-based waste debris is the result of improper solid waste management. Plastic debris remained in the marine environment for a long time as macroplastic (> 25 mm) or microplastic (<5 mm). These contaminated particles are ingested by marine life and make their way into the human food chain. Plastic ingestion has a variety of effects, including intestinal blockage, the inhabitation of gastric enzyme secretion, the removal of feeding stimuli, a decrease in steroid hormone levels, a delay in ovulation, and failure to reproduce (Li et al. 2016).

If the plastic waste is seperated at the source or at the waste-bins, there will be profitable recycled products if all of this waste is properly processed (Purkayastha, et. al. 2015). In most cases, environmental issues are discussed after waste material reaches the final disposal point. On-site handling and storage can provide the facility for recycling these waste materials just after their point of generation. The recycling and reusing is mostly done by the private sector in coastal cities like Khulna. Paper, glass, aluminium, tins, bones, and tyres are recyclable solid waste (RSW) collected by the private sector (Moniruzzaman, et. al. 2011, Bari, et. al. 2012a, Bari, et. al. 2012b).

Solid waste management is greatly influenced by urbanization due to the increase in living standards. In a developing country like Bangladesh, on-site handling and storage play a vital role. This functional element describes the activities associated with the handling, onsite storage, and processing of solid waste at or near the point of generation (Ahmed and Rahman, 2000). In this study, the stability issue of the onsite storage bin that is dustbin or waste-bins is to be analyzed. Those act as a middle approach for the debris from our surroundings to be transported to the main waste management system. Careless dumping causing overflow to the garbage bin influencing the effectiveness of the wastebin. Usually open light-bins are used for primary storage of solid waste. These open light-bin can easily be turned over by dogs and other stray animals. These upturned, dumped goods may result in traffic nuisance, unsanitary conditions, and drainage obstructions along the roadside. Since these containers are damaged, locals who live close to the sea may toss their trash down the riverbank, contaminating the ocean. Poor odours condition near waste storage bins that are not regularly emptied or not cleaned and disinfected periodically; blocking of the drainage system resulting in wastewater overflow due to indiscriminate dumping of solid waste; transmission of vector-borne diseases; health risks to solid waste workers; disposal of hospital waste without separation leading to the spread of infectious diseases; and soiled streets due to uncontrolled littering and dumping of domestic waste are some specific issues associated with inadequate solid waste management and improper methods and techniques typical of urban areas in developing countries like Bangladesh (Ahmed and Rahman, 2000). These conditions are also happens due to impropre placement of the bins as if the average distance to the closest bin is long, only 37% of people will be eager to use the waste bin (Parrot et al., 2009). Half-cut 250-liter polyethylene oil drums are becoming popular as household waste-bins or waste storage containers for sub-urban and riverside neighborhood stores. A dustbin holder can provide some stability to the bin, protection against stray animals drawn to the rubbish, and hygiene for the surroundings. With proper collection, transfer, and transport of this debris, a wastebin holder will become an effort for a sustainable and green world. Therefore, Stability and proper allocation of the wastebin are needed to be optimized. For proper location-allocation optimization, an individual should have access to the bins. It can be a part of a sustainable and cost-efficient solid waste management system.

METHODOLOGY

Study Area

After Dhaka and Chattogram, Khulna (22.8456° N, 89.5403° E) is the third-largest city in Bangladesh. The Rupsha and Bhairab Rivers flow through Khulna. The city is home to a large number of domestic businesses as the hub of the Bangladeshi industry. It is served by Port of Mongla, the second-largest seaport in Bangladesh. One of the most established and active river ports in the country is Khulna River Port.

Figure 1 Location of 6 No. Ghat (Waterway Park) and 7 No. Ghat (Roosevelt Jetty)

6 No. Ghat (Walkway Park) is mainly a tourist spot on Ghat Road 7. Numerous food and drink vendors are there, as well as a jetty for river transit. 7 No. Ghat (Roosevelt Jetty) is a commercial space to transport goods like cement raw materials to the factories.

Survey of the study area

A standing-stock survey using the NOAA Marine Debris Shoreline Survey Field Guide (Opfer et al. 2012) was conducted at 6 No. Ghat (Waterway Park) and 7 No. Ghat (Roosevelt Jetty) to determine the total load of riverbank debris. Both the jetty's (Ghat) are situated on the west bank of the river Rupsha. Studies of standing stocks can tell us how much and what kind of litter is on the coast. During standing stock surveys, debris inside the separate transects at the coastal location is measured. It is used to calculate the density (number of objects per unit area) of the debris present and provides a rapid evaluation of the total amount of waste present. Understanding the total effect of debris depends on knowing the density of the debris, which indicates the long-term equilibrium between debris inputs, outputs, and removal (Opfer et al. 2012).


Figure 2 Field survey at 6 No. Ghat (Waterway Park) and 7 No. Ghat (Roosevelt Jetty).

Materials

The following materials are required to complete the surveys: a smartphone, a portable GPS device for standing-stock surveys alone, additional batteries (ideally rechargeable) are required for the GPS and camera, as well as a surveyor's measuring wheel, flag markers, or stakes. fibreglass measuring tape 100 feet long Work gloves, a sturdy 12" ruler, clipboards for data sheets, data sheets, and pencils are also required. A first aid package with sunscreen, insect spray, and drinking water is also recommended.

Analysis of the collected data

Seven categories were used to classify the sample of marine trash, which was then documented on a datasheet or form. Among these seven categories are: (1) Plastic, which includes plastic rope/net pieces, disposable cigarette lighters, food wrappers, beverage bottles, other jugs or containers, buoys and floats, fishing lures and line, cups (including foamed plastic), plastic cutlery, straws, and other items; (2) metal, such as aerosol cans, aluminium cans, and metal fragments; (3) glass, such as drink bottles, medication bottles, and syrup bottles; (4) rubber, such as flip-flops, gloves, tyres, and rubber fragment; (5) processed timber, including paper, cardboard, and cardboard containers; (6) cloth/fabrics, including clothes; (7) other/unclassifiable; and (7) rope/net pieces, non-nylon (Fitria, et. al. 2020).

The sources of debris were divided into five categories: seashore and recreation; smoking and associated activities; dumping; personal care and hygiene; and ocean and waterway activities (The Ocean Conservancy 2010).

Design and Fabrication of Waste-bin holder

Several trials have been done to finalize the light weight waste-bin holder made by concrete or cement mortar. Tripod stand type holder is selected in this study as shown in Figures 3, 4 and 5. The casting is performed in the concrete laboratory of the Department of Civil Engineering, KUET.

RESULTS AND DISCUUSION

PRELIMINARY DESIGN OF WASTE BIN HOLDER

The usage of 250-liter half-cut plastic oil drums as domestic waste bins or waste storage bins for riverfront neighbourhood shops is growing. Based on its shape, a preliminary design of a wastebin holder was made and shown in the following:

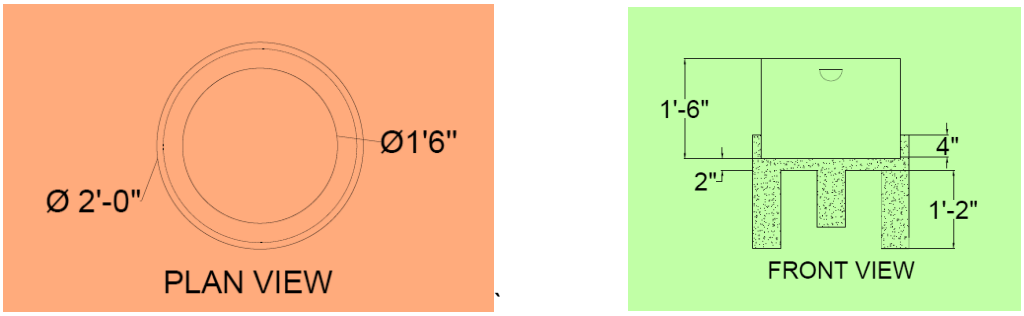

Figure 3 Preliminary Design of waste-bin Holder

This preliminary design is based on the locally available material and available workmanship to understand the desired outcome.

Fabrication of wastebin Holder

The holder was fabricated as a monolithically cast concrete block with a 1:2:4 ratios. Two holders were prepared. To prepare each sample, 27 kg of coarse aggregate (material passing a 19.0-mm (3/4-inch) sieve and being retained on a 4.75-mm (No. 4) sieve), 14 kg of fine aggregate, 7 kg of cement, and about 4 kg of water were required. Each of the holder's three legs is 14 inches tall. To achieve this height, circular pipes 3 inches in diameter were cut at 14 inches. No. 12 GI wire was utilised as reinforcement to provide a specific level of strength. Three circular reinforcements (No.12 GI wire) were employed since the holder's bocks are round to reduce stress. For the two samples, a steel mould with a certain diameter was used. Cardboard was used to prepare the upper edge of the mould for the first sample. For the second prototype, a 6-inch-high round of tin was utilized to create a smooth form. A settling time of 48 hours was required for each sample. The curing of the block was continued for seven days to gain certain strength for the lightweight concrete block.

(a) (b) (c)

Figure 4 (a) Wastebin without Holder, (b) Light bins are being overturned by stray dogs, & (c) Overturned bin polluting the area.

After casting a waste-bin holder was placed in Fulbarigate residential area to check its stability against stray dogs.

(a) (b) (c)

Figure 5 (a) Wastebin Holders Casting, (b) Holder without Waste-bin (After Fabrication), (c) Installation of waste bin holder in the Fulbarigate Residential Area.

Waste Composition

A total of 335 debris items were categorized into seven groups: plastic, glass, metal, rubber, cloth or fabric, processed lumber, and other/unclassifiable. The majority of the garbage in 6 No Ghat (Walkway Park) was processed lumber, accounting for 59.41 percent of the total rubbish documented (Figure 6). Plastic was the second-most important category, accounting for 38.61%. Then 0.99% cloth/fabric and 0.50% unclassified glass were detected. There was no metal or rubber debris item.

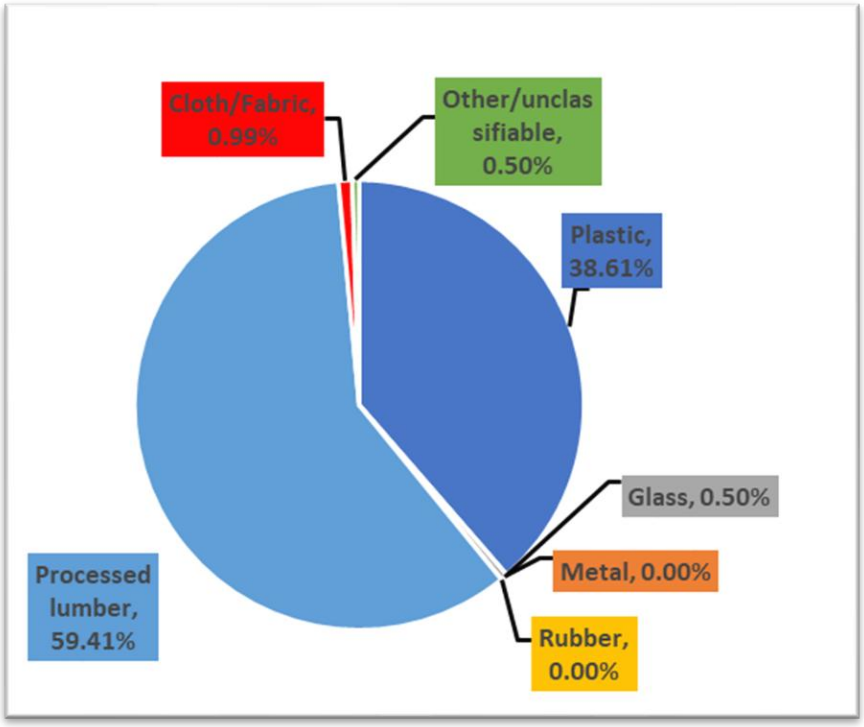

Figure 6 Waste composition of 6 No. Ghat based on the number of items.

Plastic made up 84.56 percent of the debris tracked at 7 No Ghat (Roosevelt Jetty), making it the most common type of waste there (Figure 7). Rubber and processed lumber were the two next-most significant categories, each with 5.15 percent and 4.41 percent, respectively.. The percentages for glass, the unclassified category, and metal, respectively, were 3.68, 1.47%, and 0.74%. There was no evidence of cloth or fabric.

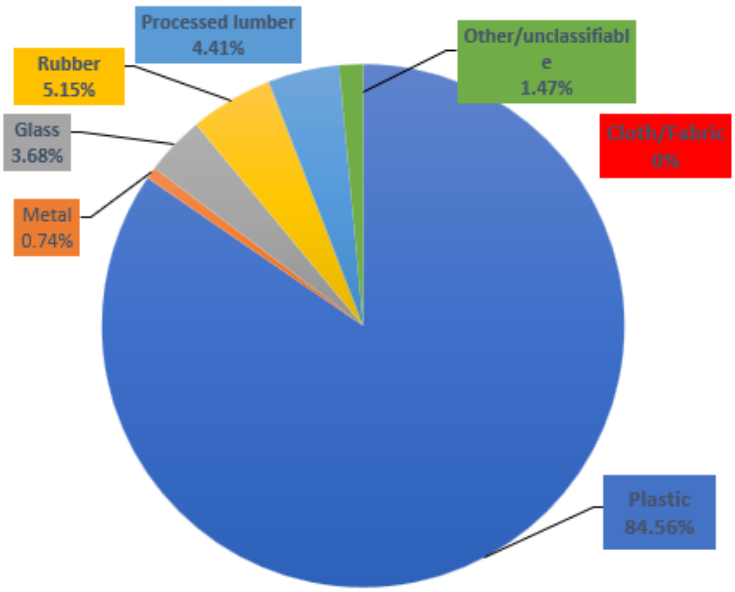

Figure 7 Waste composition of 7 No. Ghat based on the number of items

Sources

With further analysis, the debris was classified into five categories based on the sources, considering both sites together. Shoreline and recreational activities were identified as the leading source of debris (49.85%), followed by dumping activities (23.88%), smoking activities (15.52%), medical and personal hygiene activities (10.75%), and no ocean-related activities were detected (Figure 8).

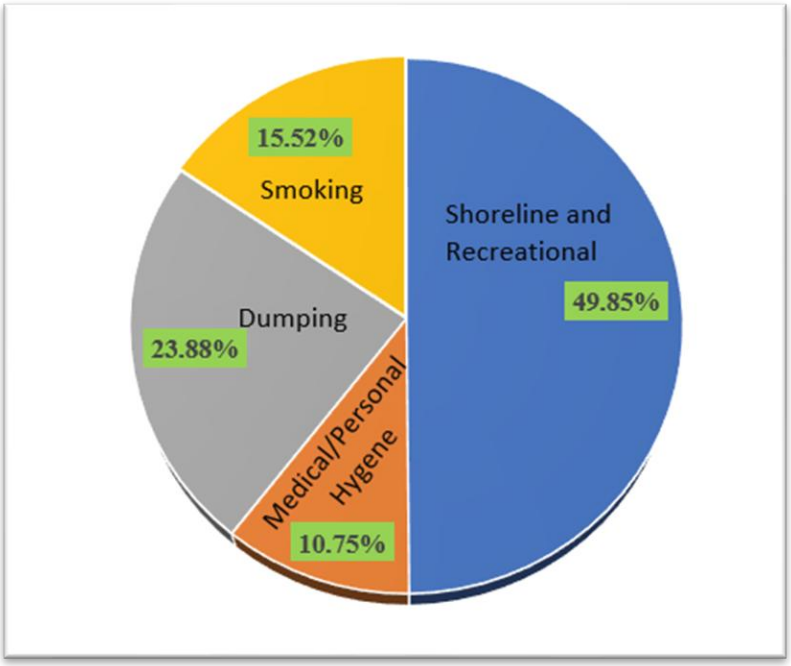

Figure 8: Composition of sources based on the number of items.

Furthermore, analysis of the debris from 6 No. (Ghat Walkway Park) revealed that 86.27% of it was recyclable and 13.87% was not.

Density

The total number of debris items discovered in the sample areas of 6 No. Ghat (Waterway Park) and 7 No. Ghat (Roosevelt Jetty) 202 and 136, respectively. The highest density of debris, however, was discovered in seven Roosevelt Jetty Sites 7.3195 item/m^2.The density of debris at 6 No. Ghat Walkway Park was 2.718 item/m^2. This variation in density is observed because the high tide waves from the river accumulated these debris on the river bank.

Holder Capacity

The total amount of waste collected may vary based on the day-to-day life of the residence. It also varies depending on the placement, purpose, and accessibility. However, to get an approximate idea, waste from wastebins placed in the Fulbarigate residential area was collected, and the total amount was measured at approximately 25 kg per day.

CONCLUSIONS

All these analyses indicate that the pollution of marine environments is caused by the mismanagement of waste from land-based sources. To avoid waste from recreational and dumping activities, a waste bin with a holder which may provide stability to the bin has become necessary. These lightweight waste-bin holders not only keep our marine shoreline clean and safe but also help in municipal solid waste management. The functional elements of a solid waste management system can be properly performed with these effective on-site handling facilities.

ACKNOWLEDGEMENTS

We are grateful to Khulna University of Engineering and Technology for providing financial and laboratory support for this research work.

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