Recycling Plastic Waste for Enabling Circular Economy

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I. INTRODUCTION

Municipal solid waste management is a major issue for many nations striving for a sustainable future. According to the United Nations Environmental Programme report [1], Municipal solid waste management is both a resource and a burden as it contains valuables and leftover waste that need to be managed carefully to keep the public healthy. Biodegradable and non-biodegradable components make up the majority of this waste; the latter includes things like plastics, tires, e-waste, glassware, building debris, metals, ceramics, some textiles, and batteries. Notably, there is significant worry about non-biodegradable waste, especially plastics. Sri Lanka is currently experiencing an economic crisis, import restrictions, shortages of goods, and hike in foreign exchange rate, all of which highlight the need to adopt a circular economy. Natural ecosystems are seriously threatened by Sri Lanka's rapidly increasing plastic usage, which is increasing at a pace of 16% per year [2]. Every year, over 265,000 megagrams (Mg) of plastic are consumed [2], most of which wind up in landfills. Sri Lanka has not yet adopted practices akin to those of other nations that recycle plastic waste into the circular economy. Failure to convert plastic waste could lead to adverse impacts such as reliance on imports, financial losses, unstable foreign exchange rates, shortages of necessities, rising demand for plastics, problems with the carbon cycle and environmental equilibrium, resource depletion, and failure to meet the Sustainable Development Goals.

II. LITERATURE REVIEW

Using plastic in line with the circular economy idea was a major priority in the European Union region, with the goal of increasing resource efficiency and lowering resource dependency. This was accomplished by encouraging a system of production and consumption that recovered, recycled, and reused materials while repurposing waste [3]. Reclaiming plastics that were previously disposed of in landfills was thought to be possible through landfill mining, an alternate technique for reintroducing landfilled waste into the circular economy [4]. The mechanical recycling represented a green operation by minimizing environmental impact through recycling plastic waste and contributing to a circular economy [5]. When plastic waste was recycled and used as a raw material such as plastic pavement blocks, it helped to reduce total operating expenses, which in turn lowered the price of the finished product when compared to traditional concrete pavement blocks [6]. Plastic-Soil pavement blocks were produced in a number of nations, including Ghana, Mexico, Peru, and others, using recycled waste plastic. These blocks were used in parking lots, pavement walkways, and road infrastructure. Compared to traditional concrete blocks, their manufacture not only lowered building costs but also enabled faster installation. This offered a sustainable substitute for non-biodegradable waste, reduced the accumulation of plastic waste, and created jobs in addition to economic benefits [7]. Recycled plastic had become increasingly economically competitive with new ones due to declining recycling cost [8]. To do this, a significant infrastructure investment was required, especially in low- and middle-income countries [8].

Commonly for such feasible research, mixed-method strategy was used for data collection and employing field observations as a method for background study [9]. Secondary data obtained from official reports, and stakeholders in Municipal Councils' solid waste management units were the subjects of unstructured interviews [10]. It was imperative to recognize the constraints associated with localized "best" solutions because what works effectively in a local setting might not perform optimally when applied to a large regional or global context and the finding from these case studies were confined in their generalizability but the concept itself could potentially have broader applicability [11].

III. MATERIALS AND METHODS

The study examined the Oluvil, Pallakadu waste dumping site, which was the main open dumping facility in the South Eastern region of Sri Lanka. It managed waste that was both biodegradable and non-biodegradable and brought from the Kalmunai Municipal Council, Akkaraipattu Municipal Council and different Pradesha Sabhas in Ampara District. Since it was established in 2007, the Addalaichenai Pradesha Sabha was in charge of overseeing this 27-acre site. It was initially granted a 25-year permit, and it has been in operation for 15 years. It was observed that 16,308.6515 tons of waste was received annually, including 1236.02 tons of non-biodegradable and 123.03 tons of degradable waste each month. Significantly, a staggering 14,832.24 tons of non-biodegradable waste, mostly plastics were being carelessly disposed of without any sort of segregation [12]. A concerning composition of plastic waste, such as polyethylene bags, plastic bottles, wrapping and packaging materials, lunch sheet, yoghurt cups, straws, meal boxes, broken plastic furniture and milk packets, could be discovered [12]. Possible outputs through recycling plastic were discussed and the background study was done using field observations. A variety of data collection techniques were used in the study, including unstructured interviews with officials and secondary data gleaned from official reports. The discussion was held with the stakeholders to see the potential and available facilities around the Pallakadu

waste dumping site for any further recycling processes. Investigation was carried out with possible investors who were willing to take up any start up projects. The possibility for the required infrastructure and facilities as well as the feasibility of transferring plastic waste to the to be proposed manufacturing plant were investigated. The discussions were held with plastic manufacturers and wholesalers regarding marketing the finished product and ensuring a fair price, which included analyzing prices.

IV. RESULTS AND DISCUSSION

The study revealed that the Plastic-Soil pavement blocks were a viable solution for managing plastic waste. In comparison to some other recycling practices, the mechanical recycling like Plastic-Soil pavement block manufacturing by using plastic waste, cost saving, simplicity, and lower carbon impact. It also addresses plastic pollution and promotes sustainable construction. This innovative approach could attract investors due to its cost-effectiveness and ability to produce eco-friendly pavement blocks with value additions. The study highlighted the potential and available facilities around the Pallakadu waste dumping site as well as the location of the infrastructure and machinery installation (manufacturing plant) which were in front of the Pallakadu waste dumping site. It was found that there was feasibility for using conveyor belts to transport mined plastics from landfills to manufacturing plant, significantly cutting down labor cost and transport expense of raw materials. Plastic collected at segregated collection points could be directly transported to the manufacturing plant. The plastic waste was shredded by grinder and the shredded plastic mixed with sand. The shredded plastic was then melted by gently pouring this mixture of plastic and sand into a machine, turning it into a pulp that was both plastic and sand. The pulp was then compressed using a hydraulic press machine to create pavement blocks in a range of sizes and forms that might be customized to meet the needs of the customers.

TABLE 1. Cost of a pavement block

Pavement block Types	**Pavement Block Price in Rupees**
Plastic-Soil Pavement Block	50-75
Concrete Pavement Block	150-200
Other Pavement block	200-450

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This cost efficiency makes these blocks a promising solution for managing dumped plastics and accommodating future collections. The use of Plastic-Soil Pavement blocks not only demonstrates sustainable waste management but also anticipates the development of new markets and employment opportunities, promoting innovative outputs such as parking lots, pavement walkways, and road infrastructure, and lucrative prospects for business owners. This study aims to support the transition of Municipal solid waste management from a linear to a circular economy model by promoting the use of Plastic-Soil pavement blocks. This technique has the potential to create jobs, encourage innovations, reduce reliance on conventional building materials, minimize plastic waste, deal with water contamination, manage the dumping yard capacity, and safeguard local wildlife, especially elephants affected by plastic ingestion. This eco-friendly approach might also enhance the area's aesthetic appeal, bringing in more tourists and promoting local tourism. Furthermore, plastic-soil pavement's long-lasting durability might lead to cheaper maintenance costs, solving environmental concerns and continuing to provide economic benefits. The transition to a circular economy promotes domestic manufacturing, lowers reliance on plastic imports, increases GDP.

V. CONCLUSION

The research aimed to address the challenge of plastic waste by proposing eco-friendly Plastic-Soil Pavement Blocks. It covered practical ways to handle plastic waste and how the end products benefit the circular economy, environment and our ultimate goal of a sustainable future. This study contributed to the ongoing debate concerning plastic waste and themes related to the circular economy.

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