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Redefining Trash into Treasure: A Case Study of Guwahati's Waste Recycling Economy

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Abstract

Globally, as cities grow at an accelerated rate, urban waste management has turned into a crucial challenge. Rapidly urbanising cities such as Guwahati in northeast India face unprecedented volumes of municipal solid waste (MSW) due to accelerating rate of waste generation and population growth. Driven by the impact of MSW on greenhouse gas emissions, the clustering of waste poses a significant risk to human health and disrupts local ecosystem while intensifying climate change. Being an innovative approach, the circular economy offers a promising solution to address these challenges as a closed-loop system in which resources are continuously cycled through the economy. An attempt has been made to understand the role of a local recycling plant in Guwahati in converting waste into resources in view of the circular economy. To conduct this study purposive sampling technique has been used and to collect first-hand data a semi-structured questionnaire has been prepared to carry out informal interviews along with Focus Group Discussion (FGD) and direct observation. For the analysis, this study adopts a qualitative descriptive approach. Moreover, this study sheds light on adopting effective sustainable waste management at the grassroots level, redefining waste from a societal burden into a treasure, leading to a greener, resource-efficient future for other cities.

Keywords: Circular Economy, Guwahati, Case Study, Sustainability, Urban Waste Management

INTRODUCTION

Waste generation has been a critical concern since the beginning of the Roman Empire, around 6th century BC, marking one of the earliest efforts to manage urban waste (Barles, 2014). Over millennia, the challenge of managing solid waste has evolved, with modern cities facing unprecedented volumes of municipal solid waste (MSW). The accumulation of waste in urban environments presents significant risks to human health and local ecosystems if not managed effectively. Local governments often bear the financial and operational burden of waste management, making it a major cost driver for municipal budgets (Hoornweg et al., 2013). Furthermore, MSW contributes significantly to greenhouse gas emissions, aggravating climate change concerns (IPCC, 2023).

In view of waste management, the term circular economy has emerged as a transformative approach to addressing these challenges. Circular economy emphasises the recycling and reuse of materials to minimise waste, reduce environmental impact, and create a closed-loop system where resources are incessantly cycled through the economy (Camilleri, 2018). This approach differs strikingly with the traditional linear model of 'take-make-dispose', which often results in substantial waste and resource depletion.

Waste management and circular economy are two reciprocally connected concepts that promote sustainable approaches to environmental sustainability. The former aims to reduce environmental risks, waste accumulation, disposal, and production through recycling, reuse, and reducing. The latter seeks to create sustainable products, reduce waste, and increase efficiency to address socio-economic and environmental challenges (Schützenhofer et al., 2022).

Global annual MSW generation is estimated to reach 2.01 billion tonnes, with industrialised regions, despite representing only 16% of the global population,

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accounting for 34% of this waste (Kaza & Yao, 2018). This disparity highlights the critical requirement for potent waste management strategies in developed as well as developing regions. In India, the situation is particularly acute. Since the mid-1990s, plastic usage has surged, leading to substantial increases in waste generation. By 1996, Mumbai was using five million new plastic bags daily (Gupta & Kumar, 2021). Today, with over a billion people living in urban areas, India generates approximately 62 million tonnes of MSW annually, a figure expected to rise to 165 million tons by 2030 (The Times of India, 2022). Consequently, greenhouse gas emissions from MSW are projected to double, reaching 41 million tonnes of CO_2 equivalent by 2030 (Jha et al., 2008).

The current waste management landscape in India is characterised by a reliance on landfills and unmanaged dumpsites, which contribute to significant environmental and health issues. Landfills and dumpsites not only emit greenhouse gases but also disrupt the operations of composting facilities, material recovery facilities (MRFs), biomethanation plants, and refuse-derived fuel (RDF) systems. These challenges are compounded by barriers such as inadequate waste segregation at the source, deficient management capacities, lack of comprehensive data on waste composition, and insufficient enforcement of regulations (Bhankhor, 2017; Kumar et al., 2017; Sharholy et al., 2008).

As Guwahati's urban growth continues at a rapid pace, the city faces significant challenges in managing its waste. In Guwahati, approximately 550 tonnes of waste is generated daily, with 85–90% of this waste being transported to the Boragaon landfill (Gohain & Bordoloi, 2021). In light of the application of circular economy in waste management practices, Guwahati's recycling ecosystem is primarily composed of both formal and informal sectors, each playing a distinct yet interconnected role in managing the city's waste. The formal sector operates under the control of municipal authorities, and private waste management companies, i.e., Geron, Zigma, and government-driven initiatives aimed at promoting sustainability. While the informal sector plays a critical, albeit often overlooked, role in waste management, comprising waste pickers, scrap dealers, and local recyclers who operate outside the formal municipal systems, they are essential for recovering recyclable materials from the city's waste stream (Baishya & Mahanta, 2013).

Considering the issues faced by many recycling units such as lack of space, outdated technology, and limited manpower along with the informal sector dealing with minimal oversight, circular economy has emerged as a crucial component for reducing the socio-economic and environmental burden (Bao & Lu, 2020; Kurniawan et al., 2021; Rakesh et al., 2023).

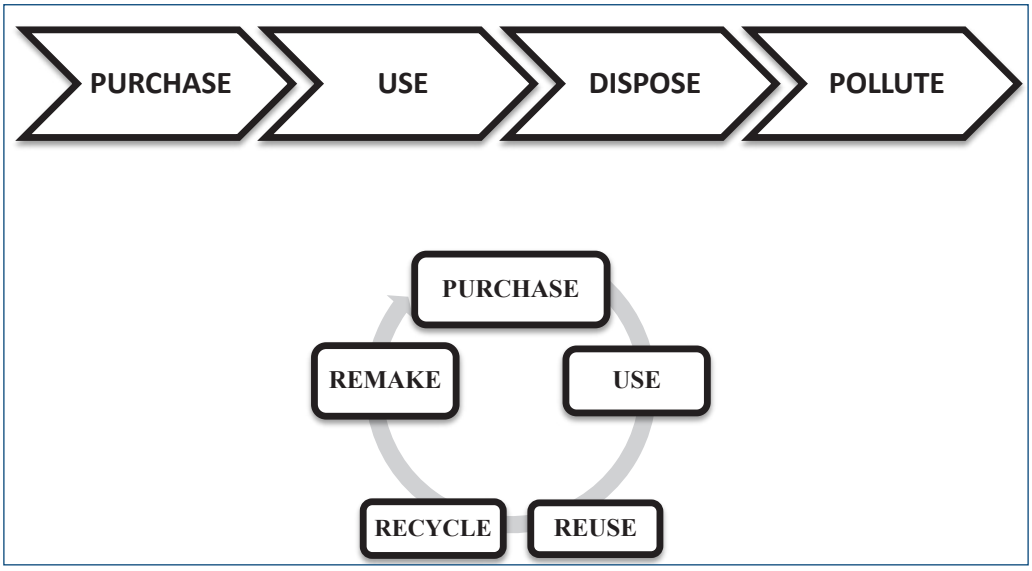

Fig. 1: An Illustration Showing the Difference Between Linear and Circular Waste Recycling Economy (Researcher, 2024)

OBJECTIVES

Concentrating on the concept of waste management and the circular economy, the main aim of this paper is:

- To understand the basic infrastructure and waste management practices of a local recycling plant in Guwahati.
- To investigate the waste recycling economy of the plant in modifying waste as a product.
- To explore the socio-economic sustainability of the involved actors along with the environmental regeneration of the plant.
- To identify the challenges and opportunities of the local recycling plant.

METHODOLOGY

This study has been carried out through a case study approach to have an in-depth understanding of the waste recycling economy of a local recycling plant. Secondary data have been collected through different sources such as research articles, research papers, newspapers, journals, and so on, along with primary data, which has been collected through a semi-structured questionnaire with field observations to understand the recycling process including waste segregation, processing, and product manufacturing. Informal interviews and focus group discussion (FGD) have been carried out with different actors, including the owner of the recycling plant and non-governmental organisations (NGOs) such as The Midway Journey, involved to understand their perspective regarding challenges, security, dependency, benefits, as well as the data related to wages, product pricing, and so on. Collected data has been analysed through content analysis to identify themes such as health risks and job insecurity as well as descriptive statistics for further comparison coupled with document analysis of relevant policies, regulations, reports on waste management, and environmental assessment report to contextualise the findings.

SHREE GURU PLASTIC: A CASE STUDY

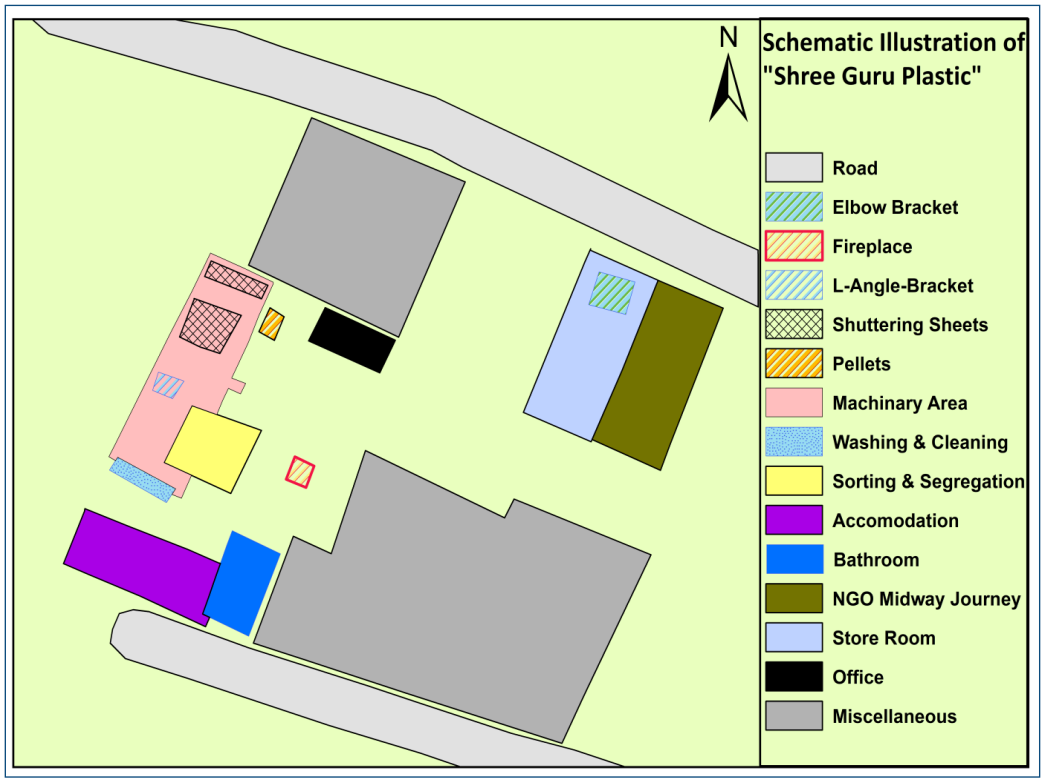

Fig. 2: Schematic Illustration of Shree Guru Plastic (Researcher, 2024)

Shree Guru Plastic (SGP), established by the 57-year-old Dilip Das in 2012 and formally registered in 2015, is a local recycling enterprise based in Barsapara Industrial Road, Guwahati. He has been awarded the Waste Aids 'zero-waste city' challenge for his efforts in waste management and sustainability. This award highlights the company's commitment to reducing waste and promoting recycling within the locality. The company specialises in converting various categories of plastic waste into two main products: shuttering sheets, L-shaped angle brackets (LAB), and the newly introduced plastic elbow for water pipes. With a workforce of 17 employees and a 24/6 production schedule, SGP demonstrates a strong commitment towards zero waste and sustainability. The owner provides above-average salaries and employs a diverse workforce, including widows and divorced women. Highly skilled female workers handle the delicate separation process of plastics, while male workers, particularly those of Bangladeshi migrant backgrounds perform more physically demanding tasks and operate the machinery. Employees benefit from regular working hours, access to clean water, and a safe working environment. The convenient location of the workplace provides accessibilty to grocery stores and restaurants.

Circular Economy in the Waste Recycling Value Chain

Whatever serves its use in the linear economy is normally dumped as waste, contributing to pollution and resource depletion. However, SGP treats scrap plastic waste as an asset in congruence with the circular economy principles. SGP plays a pivotal role in the value chain of the waste recycling industry, facilitating the circular flow of materials from the waste picker to small and big scrap dealers, and finally to formal recycling plants. In fact, this flow is very important in the circular economy since it reuses waste constantly, buys again, and readmits into the circle of production (Wang et al., 2022).

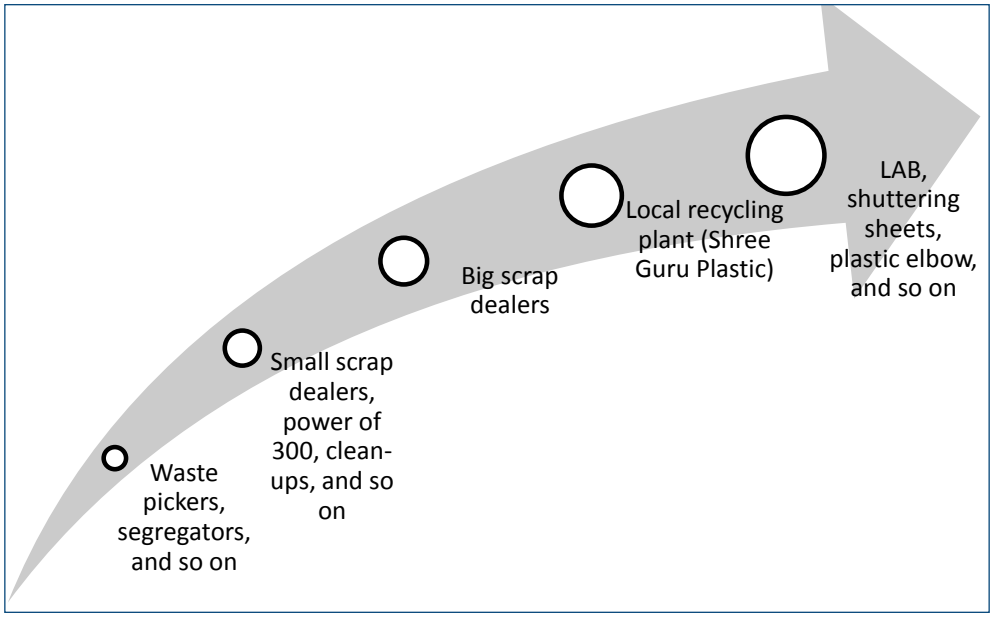

Fig. 3: Illustrating the Material Flow of Solid Waste (Researcher, 2024)

By forming the foundational link in the material recovery chain, different workers, often waste pickers or small-scale segregators, and NGO's such as The Midway Journey, gather discarded plastic waste from streets, dumpsites, and residential as well as commercial buildings, which they sell to plants like SGP. The Midway Journey, through its 'Power of 300' initiative, accomplishes its mission of waste segregation and recycling by engaging environmentally conscious citizens in a collaborative effort. The initiative encourages households to segregate and clean their recyclable plastics, which the team collects door-to-door and sells to SGP. By promoting the value of waste segregation at the source, the initiative has successfully involved over 350 households in Guwahati.

The recycling process begins with the collection of plastic by waste pickers, who sell it to small scrap dealers for Rs. 13–16 per kg. These shops add value by sorting and cleaning the waste, earning Rs. 3–7 per kg. Big scrap dealers handle further segregation and preparation, adding Rs. 2.5–5 per kg in value.

SGP then transforms this sorted plastic into high-value products, capturing the maximum utility of the material. The value chain described here embodies a circular economy approach, where discarded materials serve as continuous inputs for transforming waste into a recurring resource for new production cycles. By manufacturing items such as plastic elbows and LAB, the facility exemplifies how waste can be repurposed and reintroduced into economy. This approach minimises environmental degradation; furthermore, it reduces the unnecessary depletion of resources.

Processes Involved in SGP's Waste Recycling Economy

- *Sorting and Separating:* Plastic waste is initially sorted in a semi-covered, semi-exposed area. This sorting facility is strategically located between Das's office and a fireplace. The open-air component of this space allows for natural ventilation but may expose workers to other environmental elements such as dust, weather conditions, heat, cold, rain, and so on.
- *Washing:* The sorted and segregated material undergoes a washing process to remove impurities. This step is critical to ensuring the quality of the final products and preventing impurities from affecting the end materials.
- *Melting and Mixing:* This post-washing process involves the blending of low-quality plastic pellets with higher-quality purchased pellets. This blending process consists of mixing 40% high-quality pellets with 6% low-quality pellets. This blending process helps balance the quality of the final products while keeping the cost reasonable.
- *Production of End Products:* The mixed plastic pellets are sent to the hydraulic machine that melts the pellets and compresses them into finished products, i.e., shuttering sheets, LAB, and plastic elbows.
- *Cooling and Crushing:* To create sticky, partly burning, and toxic plastic mass the linear low-density polyethylene (LLDPE) is melted. Later, this material is cooled on a stone floor and crushed into lower-quality plastic pellets.

Products, Market, and Financial Performance

SGP mainly produces LAB and plastic elbows, which are usually used for construction in fixed windows, doors, or installation of water pipes. However, the company is able to produce nearly five tonnes of LAB monthly, which is equivalent to 50,000 pieces. The LAB are sold at Rs. 6–7 per piece, depending on the buyer and market conditions.

The pricing of products is generally influenced by national recycling hubs in Delhi, which regulate plastic prices and ensure market stability. SGP operates with an overall profit margin of about 30%. However, material costs represent a significant challenge, comprising 50% of this margin due to the blending of low- and high-quality pellets. The high material cost indicates a substantial expense in maintaining product quality and highlights the need for efficient cost-management strategies.

Table 1: Illustration of LAB Buyers (Researcher, 2024)

Name	*Type*	*Location*	*Quantity/Month*	*Buying Price (Per Piece) in Rs.*
Eco Interior	Company	Industrial area, Rani	30,000	6
Vinayak Traders	Door manufactering	Bhetapara, Dispur	11,000	6.75
Purvanchal Plywood	Trader/Door manufactering	Lalganesh	5,000	6.75
Destiny Enterprise	Trader	Fatashil	2,500	7
Rahul Ji	Trader	Barsapara	2,000	6.75
Other Traders	Traders	Beltola, Lalganesh, Jorhat	2,500	7

Source: Primary Survey, 2024.

Socio-Economic and Environmental Sustainability

In emerging urban centres such as Guwahati, informal waste workers play a significant role in waste management; informal waste workers include waste pickers, small scrap dealers, segregators, and local recyclers. Their significant contribution is essential in retrieving valuable materials from various sources, efficiently separating them, and selling recyclable items to recycling facilities; this enables the reintroduction of such materials into the production cycle, playing a vital role in the city's waste management ecosystem.

Financial Security and Social Impact

SGP's formal employment structure offers financial security to workers, which is a key factor in the social sustainability pillar within the circular economy. SGP's operations involve a workforce of 17 employees, including both salaried and daily wage workers. The plant employs nine female daily wage workers for plastic segregation and eight salaried employees (four males and four females) who handle the more specialised tasks of processing and production. The wages range between Rs. 12,000 and Rs. 15,000 per month for salaried employees, while daily wage workers earn Rs. 250–600 per day, depending on the task and gender. The wages at SGP are higher than those in the informal sector, where waste pickers earn significantly less. For instance, waste pickers typically earn Rs. 5,200–6,750 monthly, while SGP's salaried employees earn up to Rs. 15,000.

Formal employment at SGP also offers additional advantages including social security benefits such as Employee State Insurance (ESI), secure healthcare access, and other welfare schemes. Compared with the informal sector, this represents a significant refinement, where the absence of formal job structures makes people more susceptible to economic insecurity.

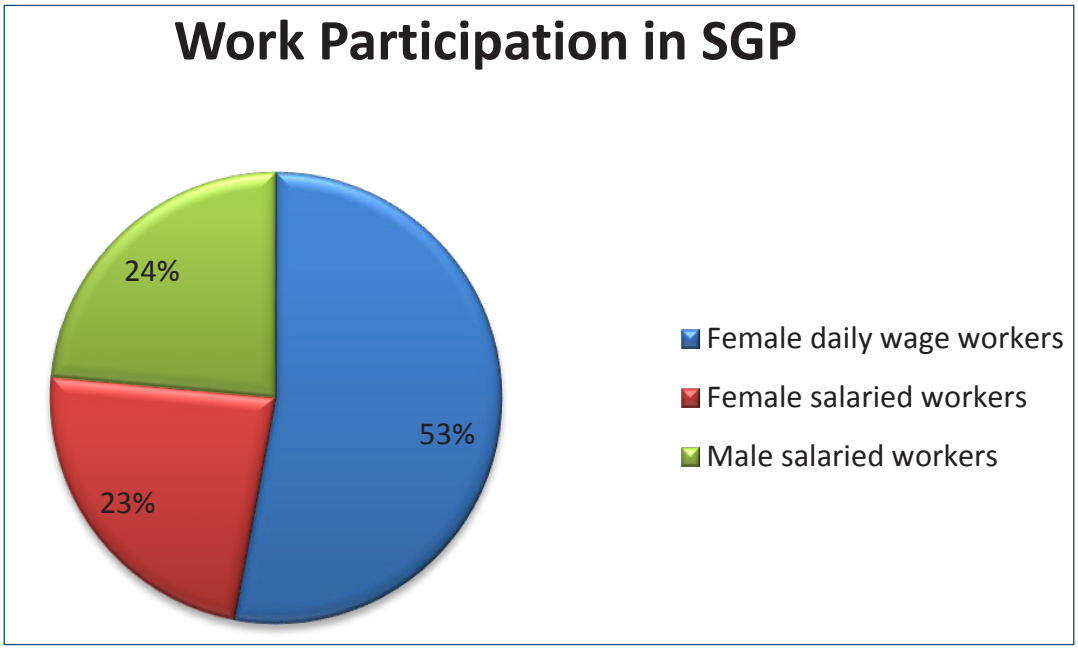

Fig. 4: Distribution of Work Participation in SGP (Researcher, 2024)

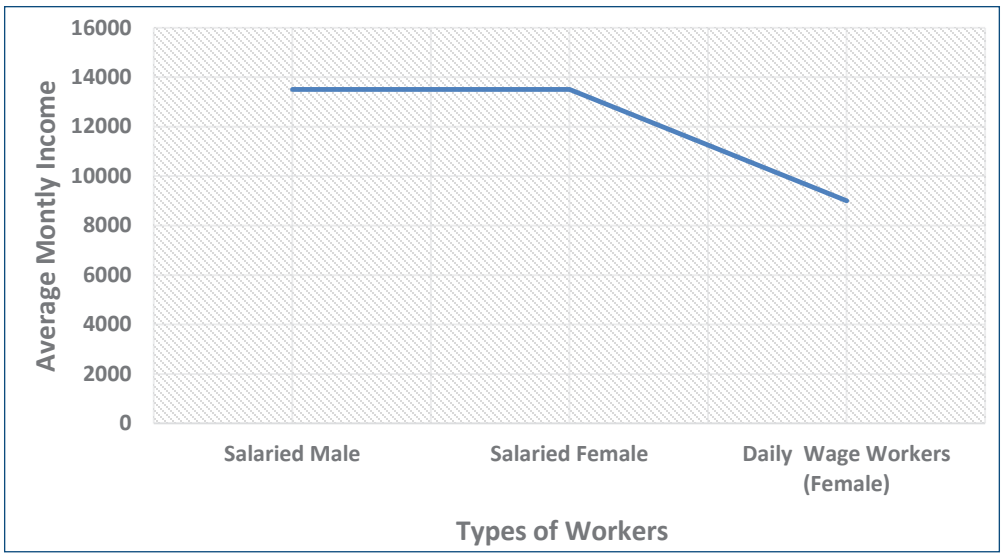

Fig. 5: Illustrating Income Disparity Among Different Category of Workers at SGP (Researcher, 2024)

Gender Dynamics and Health in the Recycling Process

A circular economy seeks to regenerate both environmental and social systems (Terra dos Santos et al., 2023). When it comes to integrating employees into the recycling process at SGP, gender plays a significant role. Plastic segregation is mostly done by female employees, who deal with pre-washed materials, which poses fewer health risks. In contrast, male employees are exposed to toxic fumes while performing the riskier operation of melting plastic. Health risks remain a major concern although SGP offers a more controlled, structured, and safer environment than informal waste sectors.

Environmental Regeneration from Waste to Resource

SGP's contribution to the circular economy extends beyond financial and social impacts to environmental regeneration. The positive impact of the ecological aspect in the circular economy is huge. By converting plastic waste into reuseable products, SGP reduces the need for virgin materials, conserving natural resources and minimising environmental harm. The plant operates under relatively sanitary and secure conditions, offering workers access to potable water, clean air, and stable housing closer to the plant. These conditions reflect a commitment to create a sustainable working environment that aligns with circular economy principles.

Challenges and Suggestions

Integrating the circular economy into waste management is a challenging but necessary step to achieve environmental sustainability. The challenges span across social, economic, and environmental dimensions. It requires co-operation between various public and private sectors, investment in new technologies, and raising awareness among the people (Zhang et al., 2019). Among many challenges, male workers often experience exploitative working conditions than female counterparts while the overall workplace safety measures are still inadequate to provide protection to all workers. Waste pickers and segregators (female) at the lower end of the recycling value chain continue to face precarious working conditions. Their marginalised position is reflected in the recycling industry as they are lesser paid workers than the salaried and daily wage workers. Due to the lack of formalisation of informal workers, their chance of having financial stability is hampered. Financial independence of waste pickers and the equitable distribution of benefits among the workers are undermined by their reliance on middlemen and scrap dealers for advances and material sales. Although SGP provides a cleaner and safer environment than informal sectors environmental

standards could be improved, especially regarding air quality in processing areas where plastic is melted. Due to the melting of LLDPE, a toxic mass is released, which creates environmental and health issues. When this substance cools, it is crushed into pieces on the floor without proper containment or treatment, which could potentially pose environmental risks. The effectiveness and safety of the sorting process may be affected by the presence of a semi-covered sorting area. Although better infrastructure could lead to better working conditions and efficiency, the high cost of blending pellets may hinder the long-term profitability. It is of essence therefore that one should continue to search for alternative sources of high-value pellets or continuously improve the recycling process to lower such costs (Rosmiati & Hadiyanto, 2020).

Gender plays a significant role in the types of tasks assigned to workers, with female segregators earning lower daily wages (Rs. 250 per day) compared with male workers (up to Rs. 600 per day). These gender wage gaps highlight the inequalities present within the recycling value chain, despite its goal to promote inclusive growth. The unequal distribution of health risks between male and female workers also reflects a challenge in ensuring gender equity in workplace safety (Jung et al., 2018). While SGP operates as a formal recycling unit with salaried as well as waged employees and provides social security, a significant portion of the waste recycling economy remains informal. The majority of waste workers including waste pickers, segregators, and small scrap dealers operate without any formal recognition.

Regarding the pricing and market dynamics, the pricing is determined by market hubs like Delhi, but price volatility can affect smaller actors such as waste pickers and small scrap dealers. This uncertainty in pricing, especially for low-value plastic, complicates their ability to plan financially and reduces their economic security (Stromberg, 2004). The reliance on wholesalers to sell SGP's products (such as plastic elbows) at competitive rates (often sold at Rs. 24 per piece but discounted to Rs. 30–40 in the market) creates challenges in maintaining profit margins and stable pricing within the value chain.

The process of recycling, especially handling and melting plastic, is technologically underdeveloped, leading to hazardous fumes and other byproducts that could be better managed with more advanced technology (Pan et al., 2020). The absence of such advanced technology hinders SGP from fully eliminating harmful emissions and ensuring that trash is processed safely. Despite recycling plastic into useful products, SGP has not yet fully utilised its product design and innovation ability to optimise material use. Recycling existing waste is prioritised over investigating novel, sustainable materials or design advancements that could further reduce waste generation.

CONCLUSION

Compared with cities such as Delhi and Bengaluru, which have more established waste segregation systems and higher recycling rates, Guwahati's efforts are still developing. By turning trash into a valuable resource, the city has laid the path for sustainable development besides showing an integration of various stakeholders, be it waste pickers or segregators, workers at recycling plants, or the policymakers, in driving this circular economy of waste (Singhal et al., 2021).

Plastic waste recycling in the city, especially through the studied local recycling plant, acts as a role model for the rest of the cities facing problems related to mounting solid-waste generation. However, in addition to ensuring equitable financial stability throughout the whole recycling chain, there are several challenges entailing scaling up the present model to meet the growing demand for waste processing, raising public awareness, and securing governmental recognition. Addressing these gaps would make Guwahati's recycling ecosystem more efficient in showing how urban waste can be harnessed as a renewable resource. The case study essentially shows that with effective strategies and community engagement right at the grassroots level, waste can indeed be redefined from a societal burden into a sustainable treasure.

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