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(RESEARCH ARTICLE)

Assessment of plastic waste collection, recycling processes and supply chain dynamics in Savar municipality, Bangladesh

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Abstract

Plastic waste management remains a critical environmental and economic challenge in rapidly urbanizing regions. This study investigates the collection, supply chain, and recycling processes of plastic waste in Savar Municipality, Bangladesh, through a mixed-methods approach combining field surveys, structured interviews, and direct observation. The research targeted four key stakeholder groups such as waste pickers (Tokai), primary dealers, secondary dealers, and recycling industry operators. The municipality was mapped across six sub-areas, identifying 57 waste pickers, 28 primary dealers, 17 secondary dealers, and 4 recycling industries. The results demonstrate that the backbone of the plastic waste supply chain are informal waste pickers, who are collecting an average 62kg of plastic daily per picker(3.53tons/day). This data was consolidated indicating that primary and secondary dealers aggregated 2.88tons/day and 2.52tons/day, respectively, behind the value added layers and underlining the key role of intermediary stakeholders in material consolidation. Hard plastics made up most of the wastes collected, which points to areas suitable for targeted and more efficient recycling interventions. From mass balance assessment, recycling industries recycled 2.7tons of plastic with 2.6tons being redirected to manufacturing industry as direct input for new products. The work additionally describes the commercial recycling process—from sorting by colour/drainage type, slicing into mm to gm parts, washing/drying, thermoplastics use creates a uniform pellet or long-term products. Challenges were weather dependent drying and sorting efficiency variability. Taken together, these results highlight the critical role of informal sector involvement in recycling;the potential for technology-driven aggregation and/or process improvement strategies to minimize leakage and improve efficiency;and ultimately, underscore the need for proactive strategies to inform regulation, design waste management systems and advance sustainable plastics management approaches with specific application to secondary cities. The findings offer evidence-based information for policymakers and urban municipal waste management authorities aiming to scale-up circular economy initiatives in emerging urban municipalities.

Keywords: Plastic Waste Management; Recycling Processes; Waste Pickers; Circular Economy

1. Introduction

Plastic has become an indispensable component of modern society due to its versatility, durability, and low cost. However, the widespread use of plastic products has resulted in substantial environmental challenges, particularly in urban areas where waste management infrastructure is limited. Globally, plastic production has increased exponentially, from 1.5 million tons in 1950 to over 400 million tons annually in 2020, with a significant portion ending up as waste in landfills, rivers, and oceans (Geyer et al., 2017). Developing countries, including Bangladesh, face acute challenges in managing plastic waste due to inadequate collection systems, insufficient recycling facilities, and high reliance on informal waste sectors (Abdullah & Abedin, 2024).

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Vassar Municipality, located in Dhaka District, Bangladesh, exemplifies the challenges faced by rapidly urbanizing secondary cities. With a population exceeding 384,000 within 14 km^2, the municipality experiences high volumes of household and commercial plastic waste, much of which is handled through informal collection and recycling networks (BBS 2022). Informal waste pickers, locally known as 'Tokai', serve as the primary collectors of recyclable plastic materials, channeling them to small-scale primary dealers and subsequently to secondary dealers and recycling industries. Previous studies have highlighted the critical role of such informal actors in ensuring material recovery in contexts where formal municipal waste management systems are underdeveloped (Wilson et al., 2006).

Effective plastic waste management involves a combination of collection, sorting, processing, and redistribution into the manufacturing sector. In urban municipalities, informal collection networks often dominate the initial stages of waste management due to low operational costs and accessibility (Maphanga et al., 2025). Primary and secondary dealers function as intermediaries, aggregating materials to achieve economies of scale for recycling industries. The recycling process typically includes mechanical size reduction, washing, drying, and molding into pellets or intermediate products, which are then supplied to manufacturing units for production of new plastic goods. Studies in Southeast Asia and South Asia indicate that the efficiency of recycling largely depends on the organization of informal supply chains and the technical capacity of recycling facilities (Hoornweg & Bhada-Tata, 2012). Despite the contributions of informal actors, several challenges persist, including seasonal fluctuations in waste collection, variability in material composition, contamination of plastic streams, and operational inefficiencies in recycling industries. For instance, household participation in source separation is often low, reducing the purity of collected plastic and increasing processing costs (Pottinger-Glass et al., 2024). Furthermore, recycling infrastructure in municipalities like Savar is constrained by limited mechanization, reliance on manual labor, and vulnerability to weather conditions, which affect drying and storage of washed plastics.

Plastic waste management carries both socioeconomic and environmental implications. Informal waste pickers derive livelihoods from material collection, creating economic incentives for participation and supporting household incomes. Aggregation by dealers and processing in recycling industries generate employment and contribute to the local economy (Barford & Ahmad, 2021). Environmentally, effective recycling reduces the volume of waste sent to landfills, lowers plastic leakage into waterways, and minimizes greenhouse gas emissions associated with virgin plastic production. The circular economy model emphasizes such flows, where waste materials are reintroduced as raw inputs, promoting sustainability (Lanau et al., 2021).

In Bangladesh, plastic waste management has received increasing attention due to its implications for public health and environmental quality. Dhaka and its surrounding municipalities have faced substantial plastic accumulation, with studies reporting that approximately 70% of municipal plastic waste is collected informally, while the rest remains unmanaged, contributing to environmental pollution (Abdullah & Abedin, 2024). Savar Municipality, as a rapidly urbanizing hub for industrial and commercial activities, provides a representative context for studying the operational dynamics and challenges of informal recycling systems in secondary cities (Pasha et al. 2022).

Although numerous studies have examined plastic waste generation and recycling at national and metropolitan scales, there is limited empirical evidence regarding the operational structure, efficiency, and economic contribution of informal recycling networks in secondary municipalities like Savar. Few studies quantify daily collection rates, supply chain throughput, or the mass balance of plastic waste across collection, processing, and manufacturing stages. Additionally, comprehensive field-based observations documenting industrial recycling workflows including sorting, cutting, washing, drying, and molding remain scarce.

The aim of this study is to quantify the collection rates and material composition of plastic waste at different stages of the supply chain in Savar Municipality. Beside, Map the distribution and operational roles of stakeholders, including waste pickers, primary and secondary dealers, and recycling industries. In addition, Analyze the recycling processes and efficiency of plastic transformation from waste to marketable products.

2. Materials and Methods

2.1. Study Area

This study was conducted in Savar Municipality, which is an administrative and urban local government area in Savar Upazila, Dhaka District, Bangladesh covering an area of 14.08 km^2 with population of 384,105. It is located about 24 km northwest of Dhaka city serves as a connecting suburb to the urbanised areas and rural regions into Delhi. It is an average urbanized municipality, with a city center and surrounding neighborhoods and also medium-scale stores or buildings. . Savar Municipality is among the more prominent urban municipalities in Bangladesh and has experienced

rapid population growth and land use intensification driven by industrial expansion, particularly in the garment sector. The municipality lacks adequate infrastructure for formal solid waste management, making it a representative case of informal recycling systems common across secondary cities in South and Southeast Asia.

2.2. Research Design and Target Groups

A mixed-methods field survey approach was adopted, combining structured questionnaire interviews with direct observation and photographic documentation. The target population comprised four distinct stakeholder groups within the plastic waste supply chain: (i) waste pickers (locally known as 'tokais' or hawkers), (ii) primary dealers operating small-scale 'vangari shops', (iii) secondary dealers operating larger aggregation shops, and (iv) recycling industry owners. Data collection was conducted in February 2020 to ensure comprehensive coverage of the study area.

2.3. Field Survey on Waste Collection

The Waste was collected from Savar Municipality by primary collector which was observed to operate through two primary modes. The first involved door-to-door collection by hawkers, predominantly adult males who purchased recyclable materials directly from households. The second mode involved waste picking from communal bins, predominantly performed by children under the age of 13. Transportation of collected materials was carried out either manually on foot or by tricycle. In Savar Municipality, approximately 50 to 60 active hawkers were identified, each carrying collected materials in locally woven baskets ('jhuri'). Materials collected included PET bottles, jars, buckets, hard plastic items, and rubber shoe soles. Collection of recyclable solid waste by primary collectors in Savar Municipality is shown in Figure 1. Primary waste collectors were systematically interviewed to gather essential insights into the operational structure of the municipality's waste collection system.

Figure 1 Collection of recyclable solid waste by primary collectors in Savar Municipality

During the survey, the locations of all primary and secondary dealer shops ('vangari shops') were mapped across six areas of Savar Municipality: Aminbazar, Ashulia, Savar, Birulia, Shimulia, and Yearpur. A total of 25 shops dealing in recyclable plastic waste were identified. Shops were classified into two categories based on their position in the supply chain:

Primary dealers: Smaller establishments that transact directly with individual waste pickers and sell aggregated materials to secondary dealers or directly to recycling industries.

Secondary dealers: Larger establishments that procure materials from both waste pickers and primary dealers, and supply aggregated waste to recycling industries.

During the survey, the primary dealers and secondary delears were interviewed the gather essential infromation about the waste collection system in Savar municipality. A primary dealer shop which is located in Muktirmor, Savar Municipalityare shown in Figure 2.

Figure 2 Primary dealer shops in Muktirmor, Savar Municipality

The recycling process followed by industries in Savar Municipality was documented through direct observation and structured interviews. The process was found to involve six sequential unit operations: (1) collection from dealers, (2) manual sorting by plastic type and color, (3) mechanical size reduction via cutting machines, (4) mechanical and manual washing, (5) sun or fan-assisted drying, and (6) molding into pellets or shaped products for sale to manufacturing industries.

2.4. Questionnaire Survey Instrument

Structured paper-based questionnaires were developed and administered to dealer shop owners, their workers, and recycling industry managers. The questionnaire for waste collectors and dealers addressed the types and quantities of plastic waste collected, buying and selling prices per kilogram, sources (households, bins, or upstream dealers) and destinations (downstream dealers or industries), number of workers engaged, daily working hours, and monthly wages.

The questionnaire for recycling industry operators covered raw material procurement sources and quantities, buying and post-recycling selling prices, types of products manufactured, production capacity, demand-side constraints, supply area coverage, and number of workers and their income.

2.5. Profit and Mass Balance Calculations

Net daily profit at each supply chain tier was calculated as the product of quantity sold per day and the per-kilogram margin between buying and selling prices. Mass balance analysis was performed by tracking the flow of plastic waste (in tonnes per day) from households through each supply chain stage to the final manufacturing input, accounting for material losses at each transition point.

3. Results and Discussion

3.1. Stakeholder Distribution Across Savar Municipality

A comprehensive list of waste management stakeholders for six sub-areas of Savar Municipality and the different actors are being grouped into four types are presented in Table 1. Aminbazar recorded the highest attendance of 31, consisting of 16 waste pickers, followed by 8 primary dealers, 5 secondary dealers and 2 recycling industries which suggests a fully operational waste handling network functioning optimally in this region. The lowest participation were found in Ashulia and Savar where 10 waste pickers, 5 primary dealers, 3 secondary dealers, and 1 recycling industry were reported from Ashulia meanwhile the values of Savar were as (11 waste pickers, 3 primary dealers, 3 secondary dealers and 1 recycling industry). On the other hand, Birulia and Shimulia were relatively inactive, where Berulia accommodates 7 waste pickers, 6 primary dealers, 2 secondary dealer & lack of recyclers; whereas Shimulia comprises of 9 waste pickers, 4 primary dealers, 4 secondary dealer and no recycling industry. At Yearpur, stakeholders were very low: there are only 5 waste pickers and 2 primary dealers; no secondary dealers or recycling industries found. When combining

the data for the entire municipality, there were 57 waste pickers, 28 primary dealers, 17 secondary dealers and 4 industries in recycling throughout the stakeholders sampled with great spatial heterogeneity of waste management infrastructure and participation.

Table 1 Distribution of waste management stakeholders across sub-areas of Savar Municipality.

Place	Waste Pickers (No.)	Primary Dealers (No.)	Secondary Dealers (No.)	Recycling Industries (No.)
Aminbazar	16	08	05	02
Ashulia	10	05	03	01
Savar	11	03	03	01
Birulia	07	06	02	00
Shimulia	09	04	04	00
Yearpur	05	02	00	00
Total	57	28	17	04

3.2. Waste Collection and Supply Chain Dynamics

The plastic waste supply chain in Savar Municipality operates through a four-tier informal hierarchy, with each level contributing to material aggregation and value addition. Waste pickers form the foundational collection layer, operating without any formal employment contract, government subsidy, or personal protective equipment. Their work was observed in highly unhygienic conditions, and collection volumes were found to decline appreciably during the rainy season due to reduced outdoor mobility and wet material quality.

Table 2 presents the collection data for waste pickers. Each waste picker collected approximately 62 kg of plastic waste per day, comprising primarily hard plastic 50kg, soft plastic 7 kg, and rubber/shoe materials 5 kg. At a selling price of BDT 35–40/kg for hard plastic, the total material collected by all 57 active waste pickers amounted to approximately 3,534 kg/day (3.5 tonnes/day) (Table 3).

Table 2 Plastic waste collection quantities and price margins at the waste picker level

Types of Recyclable solid waste (RSW)		Amount of RSW collection (Kg/day)	Price (BDT/Kg)		Profit per kg (BDT)	Total Profit (BDT)
			Buying	Selling		
Plastic	Soft	7	25	35	10	70
	Hard	50	30	40	10	500
	Rubber/ Shoe	5	12	20	8	40
	Total	62				610

The Table 3 presents the quantification of plastic waste collected per day within Savar Municipality. On average, each waste picker was reported to collect 62 kg of plastic daily. The total number of active waste pickers involved in collection across the municipality was 57, yielding a cumulative daily plastic waste collection of 3,534 kg. The collected plastic was primarily sourced from households and subsequently directed to primary and secondary dealers for further processing or recycling. These findings illustrate the substantial contribution of informal waste pickers to the municipal solid waste management system, highlighting their role in diverting recyclable materials from the general waste stream and supporting the supply chain of secondary recycling operations (Table 3).

Table 3 Total Plastic waste collection in saver municipality per day

Types of waste	Plastic collected by a picker (Kg/day)	Total waste picker (nos)	Total plastic waste collect (Kg/Day)	SSource → Destination
Plastic	62	57	3534	Households → Primary/Secondary Dealers

Table 4 summarizes the collection volumes and price spreads at the primary dealer level. Each primary dealer shop aggregated approximately 115 kg/day of plastic waste, purchased from waste pickers and resold to secondary dealers or recycling industries. With 25 primary dealer shops in operation, the daily throughput at this tier totaled approximately 2,875 kg/day (2.8 tonnes/day). Workers at primary dealer shops were typically employed for 10-hour shifts (8 am to 6 pm).

Table 4 Plastic waste collection and pricing at the primary dealer level

Type	Sub-type	Qty. (kg/day)	Buy Price (BDT/kg)	Sell Price (BDT/kg)	Total shops	Total plastic collection (kg/day)
Plastic	Soft	10	35	41	25	250
	Hard	95	40	45		2375
	Rubber/Shoe	10	20	25		250
	Total	115				2875

The Table 5 summarizes the daily collection of recyclable solid wastes (RSW) by type and sub-type at Shopna Store, a secondary dealer shop. Three categories of plastic wastes were recorded: soft plastic, hard plastic, and rubber/shoe material. The average daily collection for soft plastic was 20 kg, hard plastic 230 kg, and rubber/shoe 30 kg. Across a total of 9 shops, the cumulative collection of plastic wastes was 2,520 kg per day, with hard plastic representing the largest fraction (2,070 kg/day), followed by rubber/shoe (270 kg/day) and soft plastic (180 kg/day). This distribution indicates that hard plastic constitutes the dominant component of solid waste collected, highlighting potential targets for recycling interventions and waste management optimization..

Table 5 Quantity of collected solid wastes according to 'Shopna Store' a secondary dealer shop.

Type	Sub-type	Amount of RSW collection (Kg/day)	Total shops	Total plastic collection (kg/day)
Plastic	Soft	20	9	180
	Hard	230		2070
	Rubber/Shoe	30		270
	Total			2520

The figure illustrates the mass flow and distribution of plastic waste within the municipal waste management system of Savar. At the initial stage, households generate approximately 3.1 tons of plastic waste per day, reflecting the primary source of municipal plastic. A substantial portion of this waste, around 1.69 tons, is collected by informal waste pickers (Tokai), underscoring the critical role of the informal sector in diverting plastic from open dumping. Collected waste is subsequently transferred to primary dealers, who handle roughly 2.2 tons, and secondary dealers, managing 0.4 tons. These intermediaries serve as essential aggregation points, enabling the consolidation and sorting of recyclable materials before entering the formal recycling system. The recycling industry then processes about 2.7 tons of plastic, which is subsequently supplied to manufacturing industries, where 2.6 tons are utilized for the production of new products. Smaller intermediate flows, including 0.5 tons and 1.41 tons, represent redistribution, processing losses, or transfers within the waste network.

Overall, the mass balance highlights key nodes where intervention could optimize plastic recovery and recycling efficiency. The data emphasize the dominant contribution of households and the pivotal function of both informal collectors and recycling facilities in maintaining a circular flow of plastic materials. By identifying stages where losses or inefficiencies occur, policymakers and waste management authorities can target strategies to enhance recycling rates, reduce environmental leakage, and support sustainable plastic management in Savar Municipality.

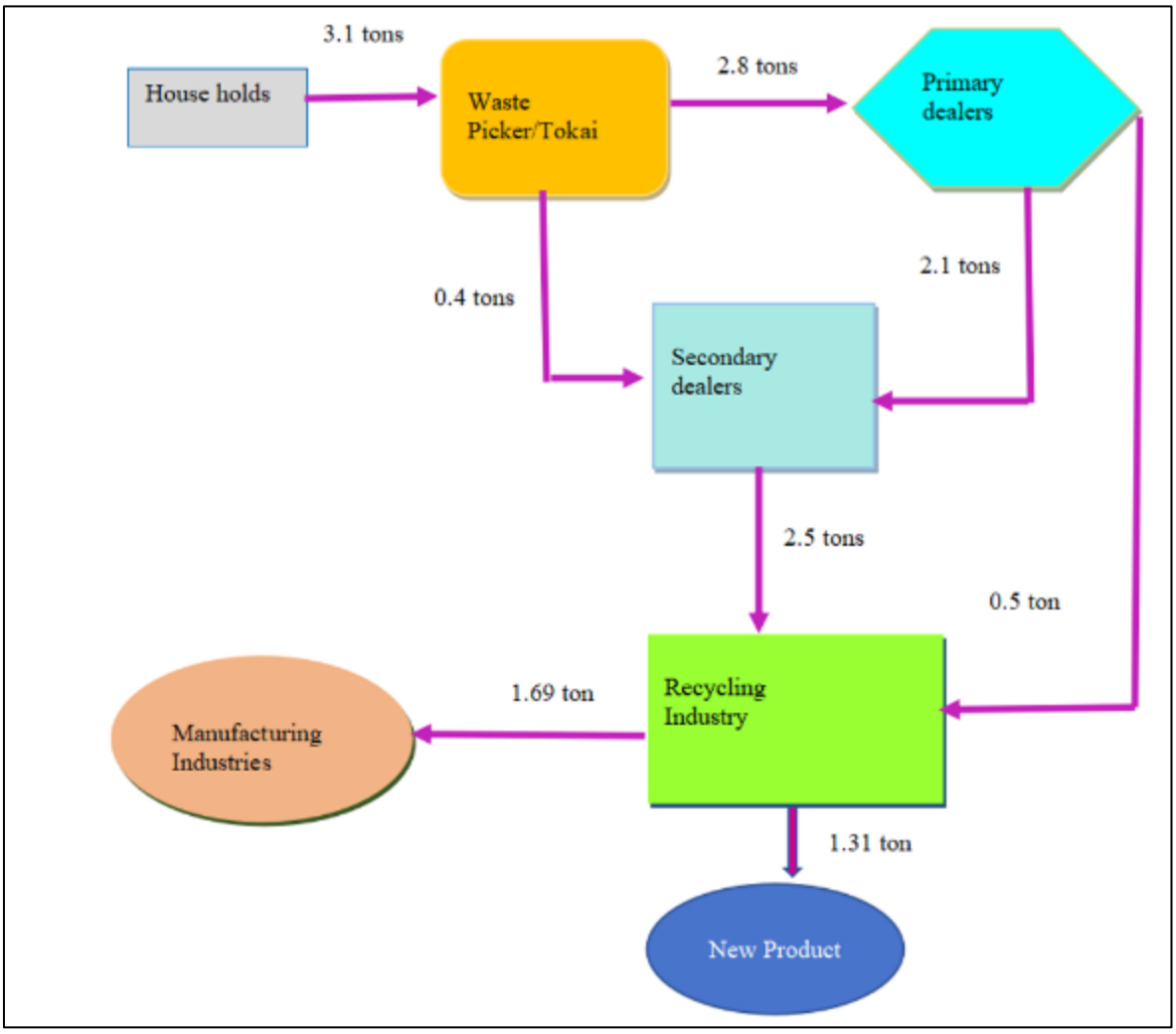

Figure 3 Mass balance of plastic waste in Savar Municipality.

3.3. Recycling Process and Industrial Operations

In Savar Municipality the collector collects recyclable plastic from households. After that they sell it to the primary as well as secondary dealers. Primary and secondary dealers sell it to the industries in Savar Municipality for recycling. The recycling industries in Savar Municipality recycle the plastic waste to usable product and to a raw material for the higher recycling industries in other industries. The steps of the recycling process are described in the following sections.

3.3.1. Waste Collection

Collections of plastic waste in Savar Municipality are carried out by recycling industries through both primary and secondary dealers. Public participation plays a crucial role in waste collection, as it provides direct economic incentives for individuals to engage in the process. To enhance cost efficiency, a strict collection schedule should be maintained. The initial stage of this process is performed by hawkers who collect plastic waste door-to-door and sell it to primary and secondary dealers. Figure 4 illustrates the flow and quantity of plastic waste collected in Savar Municipality.

Figure 4 Collection from door to door in Savar Municipality.

3.3.2. Sorting

Incoming plastic waste was sorted by resin type and color using manual visual inspection. PET (polyethylene terephthalate) and HDPE (high-density polyethylene) bottles were preferentially identified and separated. Materials were classified as hard plastic, soft plastic, and rubber/shoe, and further sorted by color to maximize the market value of the recycled output. Sorting efficiency was identified as a key determinant of both product quality and economic yield at the industrial stage. n Figure 5 depicts the sorting process of plastic in Savar Municipality.

Figure 5 Sorting of recyclable plastic in Savar Municipality.

3.3.3. Cutting

The collected plastic waste that was sorted, were put into motor driven cutting machines which are suitable for mincing plastics. They were supplied with internal rotating knives and a semi-conical feed basket, allowing for an even feed through the raw material without clogging when introduced. The Plastic Cutting process successfully converted larger and bulkier plastic-based materials into flat homogeneous chips about 5–10mm in size. Size reduction of this kind is hugely important for further processing once the contaminated plastic has been washed away, since it will make those subsequent steps in washing all more effective and easier to conduct melt processing, or recycling. Furthermore, having chips that are the same size also ensures a uniform melting behavior and allows for better material handling as well as predictable mechanical properties of recycled plastic products. Figure 6 illustrates the cutting procedure of plastic waste in Savar Municipality.

Figure 6 Cutting machine in plastic recycling industries.

Figure 7 Washing procedure of plastic waste

3.3.4. Washing

The plastic chips were subjected to mechanical and manual washing to remove surface contaminants, adhesive labels, and residual product. A motor-driven washing machine with a rotor agitator was used for bulk washing, supplemented by hand washing for heavily soiled materials. The washing procedure of plastic waste in saver municipality are shown in Figure 7.

3.3.5. Drying

Washed chips were spread on open surfaces and dried by solar exposure under favorable weather conditions. During the monsoon season and overcast periods, electric fans were employed to accelerate drying. This stage introduced operational variability, as inclement weather conditions constrained throughput and product quality.

3.3.6. Molding

Dried plastic chips were placed into molding bags and manually compacted or thermally processed to form pellets or shaped intermediate products. These products were subsequently sold to larger manufacturing industries outside Savar Municipality as raw material inputs for the production of new plastic goods.

Figure 8 illustrates the recycling process of plastic waste, starting from collection and sorting of waste plastic. The sorted plastic is then subjected to cutting, washing, and drying to prepare it for molding. Finally, the molded plastic is transformed into desired products, completing the recycling workflow.

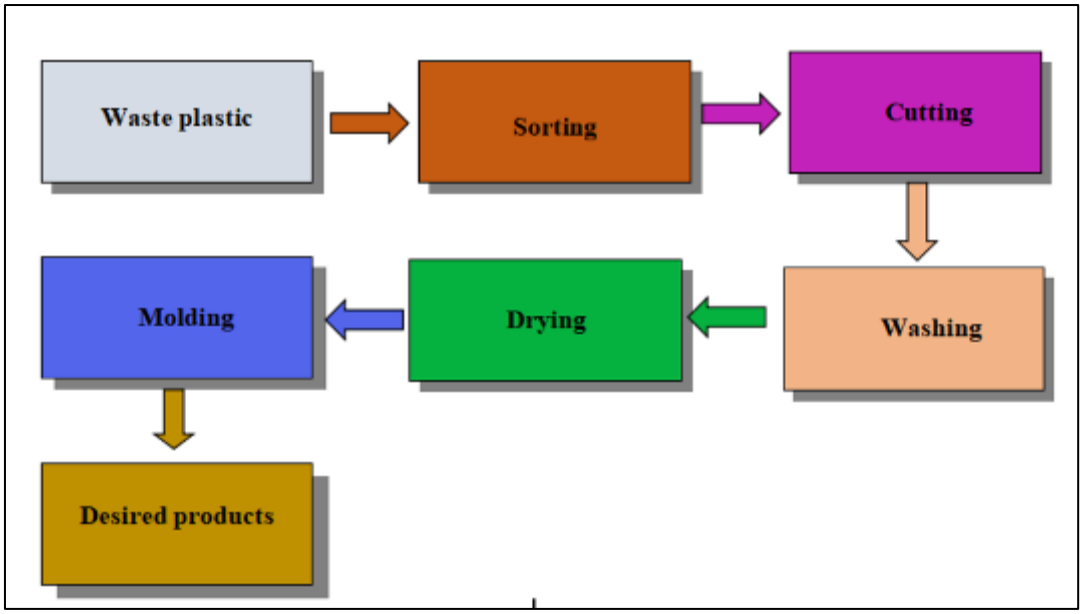

Figure 8 Flow diagram of recycling of plastic in Savar Municipality.

4. Conclusions

The plastic waste management system in Savar Municipality operates through a four-tier informal hierarchy, with 57 waste pickers, 28 primary dealers, 17 secondary dealers, and 4 recycling industries identified across six sub-areas. Waste pickers collected an average of 62 kg/day per person, amounting to 3.53 tons/day, with hard plastic constituting 50 kg/day, soft plastic 7 kg/day, and rubber/shoe materials 5 kg/day. Primary dealers aggregated approximately 115 kg/day per shop (2.88 tons/day total across 25 shops), while secondary dealers collected 2.52 tons/day across 9 shops, with hard plastic forming 2.07 tons/day of this total. Recycling industries processed 2.7 tons/day of plastic, of which 2.6 tons were supplied to manufacturing industries for new product production. The industrial recycling workflow—including sorting, cutting, washing, drying, and molding—enabled conversion of heterogeneous waste into uniform pellets or intermediate products. Seasonal variations and weather-dependent drying introduced operational constraints, affecting throughput and product quality.

Overall, the data highlight the critical role of informal waste pickers and the hierarchical supply chain in sustaining circular plastic flows. Optimizing collection schedules, enhancing sorting efficiency, and strengthening process infrastructure could further increase recovery rates, reduce environmental leakage, and support sustainable plastic management in urban municipalities similar to Savar.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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