

From Waste to Wealth: Plastic Waste Management and Entrepreneurial Opportunities in West Bengal State, India

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Submitted: 12 April 2026

Revised: 14 June 2026

Accepted: 19 June 2026

Abstract: West Bengal reportedly generates approximately 330,000 tonnes of plastic waste annually, of which slightly more than half is segregated and utilized for processing. While the state faces mounting challenges related to plastic waste management, it also presents significant opportunities for entrepreneurship that align environmental management with local economic development. This paper assesses the potential of plastic-waste utilization and recycling to stimulate entrepreneurial activities across West Bengal, with particular attention to collection and segregation systems, value-added manufacturing, innovations in road construction (such as plastic-modified pavements in Mainaguri), and the establishment of formal recycling units equipped with shredders, blenders, and other processing machinery. The Government of India's Plastic Waste Management (PWM) Rules, 2016, along with Extended Producer Responsibility (EPR) mandates, are accelerating the adoption of formal recycling practices. As industries increasingly seek compliant and sustainable material sourcing, recyclers are entering a rapidly expanding market characterized by consistent demand for recycled inputs. Consequently, investment interest in the profitability of plastic recycling businesses has grown as part of long-term sustainability strategies.

When supported by state agencies such as the West Bengal Pollution Control Board (WBPCB) and initiatives like Swachh Bharat Mission (SBM), these ventures generate direct employment, secondary livelihoods in collection and transport, and new income streams—particularly for workers in the informal sector—while simultaneously reducing landfill pressure and dependence on imported raw materials. Plastic-waste recycling in West Bengal thus holds the potential to foster a resilient circular economy, provided that policy incentives, capacity building, access to affordable machinery, and market linkages are prioritized. The paper recommends targeted public-private partnerships, structured training programs for waste collectors, quality standards for recycled materials, and the scaling up of pilot plastic-mixed road projects to catalyze entrepreneurship and sustainable development across the state.

Keywords: Plastic waste, Recycling entrepreneurship, Secondary livelihoods, Circular economy, Plastic-modified roads, Sustainable development

INTRODUCTION

Plastic waste management has emerged as a critical environmental and developmental concern globally, particularly in developing economies experiencing rapid urbanization and rising consumption patterns. India is among the largest generators of plastic waste, where inadequate segregation practices, inefficiencies in collection systems, and limited recycling infrastructure continue to exacerbate environmental degradation. Within this national context, West Bengal presents a compelling case in which escalating plastic waste generation coexists with emerging opportunities for entrepreneurship and

circular economic development. When effectively collected, segregated, and processed, plastic waste can be transformed from an environmental liability into a valuable economic resource.

Plastic-waste recycling and utilization offer significant scope for the creation of new enterprises across the value chain, ranging from collection and segregation to processing, manufacturing, and diverse end-use applications. For a state like West Bengal, where informal waste work already supports thousands of livelihoods, the formalization and technological upgrading of this sector hold substantial potential for

employment generation while simultaneously strengthening environmental governance. Institutional support plays a decisive role in fostering recycling-based entrepreneurship. Government initiatives such as the Swachh Bharat Mission (SBM), the Plastic Waste Management Rules, and regulatory oversight by the West Bengal Pollution Control Board (WBPCB) have contributed to an enabling policy environment through regulatory mechanisms, awareness programs, and the promotion of public-private partnerships. When effectively implemented, these measures encourage employment creation, formalization of informal labour, reduction of landfill dependence, and decreased reliance on virgin raw materials, thereby aligning with broader sustainable development objectives.

This paper explores the potential of plastic-waste recycling as a catalyst for entrepreneurship development in West Bengal. It examines existing collection and segregation systems, evaluates processing technologies and value-added applications, and assesses the socio-economic and environmental impacts of recycling-based enterprises. The study argues that targeted policy incentives, capacity-building initiatives, access to affordable machinery, standardization of recycled materials, and strengthened market linkages—particularly in infrastructure applications such as plastic-modified roads—can significantly accelerate the transition toward a resilient circular economy in the state.

Literature Review

The exponential growth of plastic production and consumption has led to a global waste-management crisis. Ike et al. [1] recommend integrating informal settlements into urban planning through investments in infrastructure, inclusive governance, flexible policy frameworks, and access to financial and social protection mechanisms to enhance sustainable urban development. Schlitz et al. [2] examine the plastic-recycling network in Kolkata as a case illustrating the complex entanglement of economic survival and environmental sustainability within informal urban contexts of the Global South. Their study highlights both the environmental contributions of informal recyclers and the potential to improve the economic and ecological performance of their enterprises. Baziene et al. [3] examine the role of emerging waste-recycling technologies in advancing the circular economy, noting a transition from traditional linear “take–make–dispose” systems toward innovative models that reduce waste generation, extend product lifecycles, and recover resources from end-of-life products. Kale et al. [4] emphasize the pivotal role of the informal sector in plastic-waste recovery, noting that informal waste pickers often outperform formal municipal systems in segregation efficiency and cost-effectiveness. Pilapitiya et al. [5] report that plastic commercialization began during the Second World War and expanded globally within less than a century, with current annual plastic production exceeding 359 million tonnes. Despite their widespread utility, plastics pose severe environmental and public health challenges. Kotyal et al. [6] conclude that the circular economy offers a viable pathway toward minimizing waste, conserving resources, and reducing environmental impacts, while simultaneously promoting

economic resilience and social well-being in an increasingly resource-constrained world.

In the Indian context, Gour and Singh et al. [7] review solid waste management in India and identify persistent challenges such as inadequate segregation at source, insufficient infrastructure, and weak integration of informal workers, despite the sector’s crucial role in recovering recyclable materials.

Liang et al. [8] discuss waste-trade management policies in Asia, arguing that reversing current trends requires a shift from linear economic models toward circular approaches emphasizing waste reduction at source, improved segregation, recycling, composting, and energy recovery. Radhakrishnan et al. [9] demonstrate that the integration of circular economy principles with social entrepreneurship creates a powerful framework for achieving economic sustainability alongside social equity and environmental protection. Baziene et al. [3] examine the role of emerging waste-recycling technologies in advancing the circular economy, noting a transition from traditional linear “take–make–dispose” systems toward innovative models that reduce waste generation, extend product lifecycles, and recover resources from end-of-life products.

Research Gap

Existing literature provides extensive insights into plastic-waste generation, recycling technologies, circular economy frameworks, and the critical role of the informal sector in waste recovery, both globally and within the Indian context. Several studies underscore the environmental urgency of plastic-waste management, the potential of circular economy models, and the socio-economic importance of informal recycling networks, particularly in urban settings such as Kolkata. Other works emphasize policy instruments such as the Plastic Waste Management (PWM) Rules, Extended Producer Responsibility (EPR), and the need for technological innovation in recycling systems. Despite this broad scholarly engagement, a clear and integrated research gap remains.

First, region-specific empirical studies focusing on West Bengal are limited, particularly those that systematically link plastic-waste management with entrepreneurship development and local economic growth. While national-level analyses dominate the discourse, the unique institutional, socio-economic, and infrastructural characteristics of West Bengal—such as its strong informal recycling base, emerging plastic-modified road initiatives, and state-level regulatory mechanisms—remain insufficiently examined.

Second, the existing literature largely treats environmental management and entrepreneurship as separate analytical domains. There is inadequate exploration of plastic waste as an entrepreneurial resource across the full value chain, ranging from collection and segregation to value-added manufacturing and infrastructure applications. Most studies prioritize recycling efficiency or environmental outcomes, with limited attention to business viability, market demand, investment potential, and employment generation associated with recycling-based enterprises.

Third, although the contribution of the informal sector to plastic recycling is widely acknowledged, research on pathways for its formalization through entrepreneurial models remains underdeveloped. Existing studies document the vulnerabilities and operational efficiencies of informal waste workers but rarely examine how policy incentives, access to affordable machinery, skill-development initiatives, and public-private partnerships can facilitate the transformation of informal waste activities into sustainable micro- and small-scale enterprises.

Fourth, gaps in policy implementation are insufficiently addressed in the literature. While regulatory frameworks such as the PWM Rules and EPR are well documented, there is limited empirical assessment of how these policies influence entrepreneurial behavior, investment decisions, and market linkages at the state or local level, particularly in West Bengal.

In summary, there is a notable absence of integrated, context-specific research within India that links plastic-waste management, entrepreneurship development, informal-sector livelihoods, and policy implementation under a circular economy framework. Addressing this research gap is essential to understand how plastic waste can be transformed from an environmental burden into a driver of inclusive and sustainable economic development in West Bengal.

Research Objectives

The primary objective of this study is to examine how plastic-waste management can be transformed into a driver of entrepreneurship and sustainable economic development in West Bengal within the framework of a circular economy. Building on this overarching aim, the study seeks to achieve the following specific objectives:

- i. To assess the existing plastic-waste management ecosystem in West Bengal by analyzing collection, segregation, processing, and recycling systems, and to evaluate whether current industrial, policy, and market conditions are conducive to the development of successful entrepreneurship in the sector.
- ii. To identify and analyze entrepreneurial opportunities across the plastic-waste value chain, including collection and segregation, recycling and processing, value-added manufacturing, and innovative applications such as plastic-modified road construction, with particular emphasis on market demand and economic viability.
- iii. To examine the economic performance and long-term sustainability of existing plastic-waste-based enterprises in West Bengal by analyzing their demographic characteristics, investment patterns, profitability prospects, employment generation, and scalability potential.
- iv. To explore the key challenges and constraints faced by entrepreneurs in the plastic-waste sector, including regulatory compliance requirements, access to finance and technology, market linkages, skill gaps, and policy implementation issues.

v. To analyze the role of government policies and institutional support mechanisms—such as the Plastic Waste Management (PWM) Rules, Extended Producer Responsibility (EPR) mandates, and initiatives undertaken by the West Bengal Pollution Control Board (WBPCB) and the Swachh Bharat Mission (SBM)—in shaping entrepreneurial behavior, business formation, and sectoral growth.

vi. To examine the role of the informal sector in plastic-waste recycling and to assess the potential for its integration and formalization through entrepreneurial models, capacity-building initiatives, and public-private partnerships.

vii. To evaluate the potential contribution of plastic-waste-based entrepreneurship to sustainable development outcomes, including employment generation, creation of secondary livelihoods, reduction of landfill pressure, conservation of natural resources, and the advancement of a resilient circular economy in West Bengal.

Research Methodology

The present study adopts a mixed-method research design to examine whether the conditions necessary for successful entrepreneurship in the waste sector are adequately met, to identify the key challenges faced by existing actors, and to assess the overall attractiveness of the sector for potential entrepreneurs. The methodological approach is designed to capture both objective market and policy conditions and the subjective perceptions and lived experiences of relevant stakeholders. The research methodology is structured around four interrelated components that together provide a comprehensive understanding of entrepreneurship in the waste sector. By integrating macro-level analysis with firm-level data and stakeholder perspectives, the study offers a holistic assessment of both structural conditions and individual agency within the sector.

Industrial and Environmental Analysis

The first component involves an industrial and environmental analysis of the waste sector to assess the broader external conditions shaping entrepreneurial activity. This stage relies primarily on secondary data collected from government publications, policy documents, regulatory frameworks, and industry reports related to waste management and recycling. The analysis examines the size and growth trajectory of the waste and recycling market, the scope and effectiveness of regulatory and policy support mechanisms—such as waste management rules and Extended Producer Responsibility (EPR) norms—and the availability and consistency of waste streams as raw materials.

In addition, the study evaluates the level of technological infrastructure, competitive intensity, and entry barriers faced by new firms. By systematically mapping these factors, this component assesses whether the waste sector offers viable business opportunities, sufficient and solvent market demand for recycled products and services, and an overall business

environment capable of sustaining entrepreneurial ventures over the long term.

Enterprise-Level Demographic and Economic Analysis

The second component focuses on a demographic and economic analysis of enterprises currently operating within the waste sector. Using data drawn from industry databases, government records, and enterprise-level reports, this stage examines firm-specific characteristics, including size, ownership structure, years of operation, and areas of specialization within the waste value chain—such as collection, segregation, processing, recycling, and value-added manufacturing.

Economic indicators, including capital investment levels, revenue generation, cost structures, and profitability trends, are analyzed alongside employment generation and workforce skill composition. This component provides critical insights into the financial performance, operational sustainability, and scalability potential of waste-sector enterprises, thereby helping to determine whether the sector offers realistic and attractive prospects for new entrepreneurs seeking long-term business viability.

Qualitative Stakeholder Interviews

The third component adopts a qualitative research approach through semi-structured interviews with key experts and sector stakeholders, including policymakers, waste-management entrepreneurs, industry professionals, and academics. These interviews are designed to capture in-depth perspectives on the practical realities of operating within the waste sector. Particular attention is given to identifying challenges and risks faced by entrepreneurs, such as regulatory compliance burdens, access to finance, technological constraints, market uncertainty, and supply-chain inefficiencies.

At the same time, the interviews explore the role of entrepreneurial aptitude, innovation, and sector-specific knowledge in achieving business success, as well as discrepancies between policy objectives and on-ground implementation. The qualitative insights generated through this component serve to contextualize the quantitative findings and provide a nuanced understanding of the enabling and constraining factors shaping entrepreneurial outcomes.

Perception and Intent of Potential Entrepreneurs

The fourth component examines the attractiveness of the waste sector for potential entrepreneurs by focusing on perceptions and entrepreneurial intent among students and aspiring start-up founders. Using structured questionnaires and follow-up interviews with individuals from business, environmental studies, and engineering backgrounds, this stage assesses awareness levels of entrepreneurial opportunities in the waste sector, perceptions of risk and reward, and willingness to enter the sector as business owners. This component also explores views regarding the importance of training, mentorship, access to finance, and policy support in facilitating entrepreneurial entry. By capturing these perceptions, the analysis highlights gaps between existing market opportunities

and the mindset of potential entrepreneurs, offering insights into how education, capacity-building initiatives, and institutional support mechanisms can enhance the sector's appeal and encourage new venture creation.

Integrated Analytical Framework

Together, these four components constitute an integrated methodological framework that links market conditions, enterprise performance, expert knowledge, and entrepreneurial intent. This holistic approach enables the study to assess not only whether the structural conditions for successful entrepreneurship in the waste sector exist, but also how these conditions are perceived, navigated, and constrained by both current and prospective actors. As such, the methodology supports a comprehensive evaluation of plastic-waste-based entrepreneurship as a pathway toward sustainable economic development within a circular economy framework.

Data Analysis

The analysis begins with an examination of firms operating in the plastic-waste management sector and their key characteristics. Based on corporate demographic data, several important insights emerge regarding the availability of business opportunities within this sector. In the plastic collection and processing segment, approximately 74% of the currently operating enterprises have been in existence for more than five years. In the plastic recycling segment, this proportion is even higher, with about 82% of firms having operated for over five years.

Firm entry and exit dynamics over the past five years further highlight the sector's growth potential. In the collection and processing segment, 114 new units were established while 82 units ceased operations during this period. Similarly, in the recycling segment, 43 new units were opened and 25 units were closed. The resulting net increase in operating units across both segments indicates sustained entrepreneurial activity and underscores the presence of significant business opportunities within the plastic-waste management sector.

The development of annual cash inflows was assessed using data from 440 Collection and Processing companies and 242 Recycling companies, each with five completed business years. The aggregated net sales revenue of these firms increased by 39% in the Collection and Processing sector and by 41% in the Recycling sector between 2020–21 and 2024–25, reflecting steady financial growth and improving market performance. Financial viability indicators further support the attractiveness of investments in both segments. The Net Present Value (NPV) is positive for both Plastic Collection and Processing Units and Plastic Recycling Units, indicating that both represent financially sound investment options. However, the break-even period for the Collection and Processing Unit is 5.27 years, which is slightly higher than that of the Recycling Unit. The Recycling Unit reaches its break-even point in 4.95 years, suggesting a comparatively faster recovery of the initial investment. Figure 1 shows the annual cash inflow of enterprises/organizations operating in the plastic waste recycling sector.

TABLE 1
Business demography of enterprises/organizations operating in the plastic waste recycling sector

Sl. No.	District	Number of enterprises in 2024		Enterprises surviving during last 5 years		Enterprises closed during last 5 years	
		Collection & Processing	Recycling	Collection & Processing	Recycling	Collection & Processing	Recycling
1	Darjiling	29	0	21	0	4	0
2	Jalpaiguri	20	19	14	15	3	2
3	Alipurduar	6	3	5	2	1	0
4	Cooch Behar	6	3	4	3	2	1
5	Kalimpong	4	0	4	0	0	0
6	Uttar Dinajpur	14	9	11	7	3	2
7	Dakshin Dinajpur	5	0	4	0	0	0
8	Maldah	14	3	9	3	2	0
9	Murshidabad	24	17	19	15	5	4
10	Birbhum	6	2	5	2	1	0
11	Nadia	15	5	12	4	3	0
12	Purba Bardhaman	12	3	9	3	3	0
13	Paschim Bardhaman	25	5	18	4	5	1
14	Puruliya	2	2	1	2	0	0
15	Bankura	6	5	4	4	1	0
16	Hooghly	21	13	14	10	4	2
17	Howrah	12	18	8	15	2	3
18	North 24 Parganas	29	19	19	15	4	2
19	Kolkata	60	90	47	74	11	5
20	South 24 Parganas	36	10	28	8	7	1
21	Purba Medinipur	60	13	44	10	15	2
22	Paschim Medinipur	32	2	24	2	6	0
23	Jhargram	2	1	2	1	0	0
Total		440	242	326	199	82	25

TABLE 2
Annual Cash Inflow of Enterprises Operating in the Plastic Waste Recycling Sector

Sl. No.	Particulars	Unit-wise Annual Cash Inflow (Amount in Rs.)				
		2020–21	2021–22	2022–23	2023–24	2024–25
1	Plastic Collection & Processing Unit	985,000.00	1,050,000.00	1,140,000.00	1,259,000.00	1,370,000.00
2	Plastic Recycling Unit	3,950,000.00	4,080,000.00	4,325,000.00	4,905,000.00	5,570,000.00

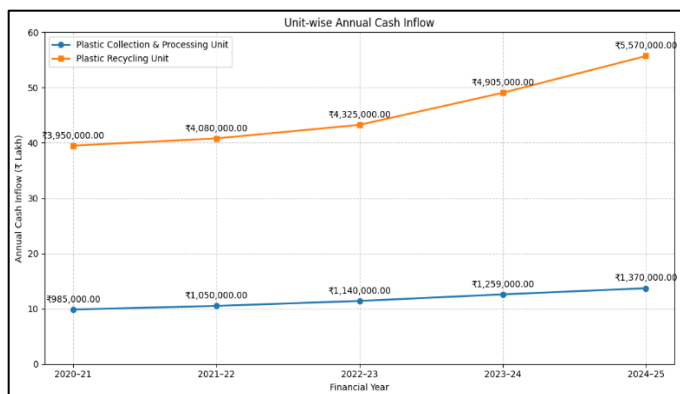


Fig. 1: Annual Cash Inflow of Enterprises/Organizations Operating in the Plastic Waste Recycling Sector

Table 3 summarizes the profitability of enterprises in the plastic waste recycling sector. Both units have positive NPV, BCR above 1, and break-even periods of 5.27 years (Collection & Processing) and 4.95 years (Recycling), indicating sound financial viability.

TABLE 3
Profitability Characteristics of Enterprises/Organizations Operating in the Plastic Waste Recycling Sector

Sl. No.	Particulars	Net Present Value (NPV, Rs.)	Break-even Analysis (BEA, yrs)	Benefit-Cost Ratio (BCR)
1.	Plastic Collection & Processing Unit	1,370,000.00	5.27	1.07
2.	Plastic Recycling Unit	5,570,000.00	4.95	1.11

Findings of the Study

The study finds that the plastic waste management sector in West Bengal presents strong and growing opportunities for entrepreneurship, particularly in the areas of plastic collection and processing as well as plastic recycling. A good proportion of existing enterprises are relatively young, with nearly 26% of Collection and Processing units and 18% of Recycling units having been established within the last five years. This dominance of newly established firms, along with the net increase in the number of operating units despite some closures, clearly indicates an expanding market and sustained entrepreneurial interest in the sector. The continuous entry of new firms suggests low to moderate entry barriers and a favorable business environment driven by increasing plastic waste generation and regulatory push for recycling.

The analysis of financial performance reveals steady growth in the sector's economic strength. Aggregated net sales revenues show significant increases between 2020–21 and 2024–25, with growth of 39% in the Collection and Processing segment and 41% in the Recycling segment. This upward trend in cash inflows reflects rising demand for waste management and recycled products, improved market linkages, and greater acceptance of recycled materials across industries. The results

indicate that plastic waste-based enterprises are not only environmentally relevant but also commercially sustainable in the medium term. Investment appraisal results further confirm the viability of the sector. Both Plastic Collection and Processing Units and Plastic Recycling Units exhibit positive Net Present Values, signifying that investments in these activities are economically justified. Although the break-even period for Collection and Processing Units is slightly longer at 5.27 years compared to 4.95 years for Recycling Units, both time frames remain within acceptable limits for small and medium enterprises. The comparatively faster recovery period in recycling highlights its higher efficiency and profitability potential.

Finally, the Benefit–Cost Ratio analysis demonstrates that both segments generate benefits exceeding their costs, reinforcing their economic and social relevance. For every rupee invested, Collection and Processing Units generate Rs. 1.07, while Recycling Units generate Rs. 1.11. These findings underscore that plastic waste-based enterprises not only yield financial returns but also deliver broader social benefits through employment generation, livelihood support for informal workers, reduced landfill pressure, and advancement of a circular economy. Overall, the study establishes that plastic waste management in West Bengal is a viable, impactful, and scalable pathway for entrepreneurship-led sustainable development.

CONCLUSION

The present study concludes that plastic waste management in West Bengal holds substantial potential as a driver of entrepreneurship, economic growth, and sustainable development within a circular economy framework. The analysis of sectoral demographics, financial performance, and investment feasibility clearly indicates that both Plastic Collection and Processing Units and Plastic Recycling Units are economically viable and socially beneficial. The high proportion of newly established enterprises, combined with steady revenue growth and positive investment indicators such as Net Present Value and Benefit–Cost Ratio, reflects a dynamic and expanding market supported by increasing waste availability and policy mandates like the Plastic Waste Management Rules and Extended Producer Responsibility.

The findings further highlight that recycling-based enterprises not only contribute to environmental protection by reducing landfill pressure and dependence on virgin raw materials but also generate direct and indirect employment opportunities, particularly for informal-sector workers. While the Collection and Processing segment shows slightly longer break-even periods, it remains a critical entry point in the waste value chain, ensuring a stable supply of raw material for recycling units. Overall, the study establishes that plastic waste can be transformed from an environmental burden into an economic resource, provided that supportive policies, access to technology, skill development, and market linkages are effectively strengthened. Plastic waste-based entrepreneurship thus emerges as a promising pathway for inclusive and sustainable development in West Bengal.

Future Scope

The scope for future research in this area is wide and multidimensional. Further studies may focus on district-level or urban–rural comparative analyses within West Bengal to capture localized variations in waste generation, entrepreneurial activity, and institutional support. Longitudinal research tracking enterprise performance over extended periods could provide deeper insights into business sustainability, risk factors, and growth trajectories in the plastic waste sector.

Future research can also examine the scalability and techno-economic feasibility of innovative applications such as plastic-modified road construction and advanced re-cycling technologies, including chemical recycling and energy recovery. In addition, greater emphasis can be placed on studying models for formalizing and upgrading the informal sector through cooperatives, social enterprises, and public–private partnerships.

Another important area for future inquiry is the evaluation of policy effectiveness, particularly the on-ground impact of Extended Producer Responsibility and incentive-based mechanisms on entrepreneurial investment and market development. Finally, integrating social and environmental impact assessments—such as carbon savings, public health outcomes, and livelihood security—would help in developing a more holistic understanding of how plastic waste-based entrepreneurship contributes to sustainable development goals. Such research would further support evidence-based policymaking and strengthen the transition toward a resilient circular economy in West Bengal.

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