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Assessing the Financial Viability of Urban C&D Waste Recycling Plants: Case Studies from Delhi, Ahmedabad, and Pune

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Abstract

India's rapid urbanization has led to a surge in construction and demolition (C&D) waste, with over 150 million tonnes generated annually and less than 1% being formally recycled. This study assesses the financial viability of C&D waste recycling plants in three Indian cities—Delhi, Ahmedabad, and Pune—using key financial indicators: Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period. Data was collected from plant operators, municipal bodies, and secondary sources, and analyzed over a 10-year horizon. The findings indicate that all three plants are financially feasible, with Delhi performing the best (IRR: 14.2%, Payback: 5.6 years) due to its higher capacity and policy support. The analysis confirms that C&D recycling, when implemented with appropriate institutional backing and consistent waste inflow, can offer a sustainable and economically viable waste management solution. The results provide actionable insights for urban planners, policymakers, and investors seeking to integrate circular economy practices into India's construction sector.

Keywords: C&D waste, financial viability, IRR, NPV, payback period, urban recycling, India, sustainability

1. Introduction

Rapid urbanization and the continual expansion of infrastructure have dramatically increased the generation of construction and demolition (C&D) waste in Indian cities. Roads, buildings, bridges, and other civic structures are being built or redeveloped to meet rising urban demands. While these developments signal economic growth, they also produce an overwhelming volume of waste materials—concrete, bricks, metals, and debris—that often go unmanaged. India generates over 150 million tonnes of C&D waste annually, yet less than 1% of this waste is formally recycled (CPCB, 2023). The rest finds its way into unauthorized landfills, roadside dumps, or vacant land, posing serious threats to the environment, urban aesthetics, and public health (MoEFCC, 2022).

Recycling of C&D waste presents a compelling solution to this growing

problem. Globally, advanced economies such as Germany and Japan have demonstrated how circular economy practices can reduce landfill burden and promote sustainable construction (Yuan & Shen, 2021). In India, however, challenges related to financial uncertainty, low public awareness, and weak policy enforcement continue to hinder the growth of C&D recycling (Sharma & Desai, 2023). Recycled products—such as aggregates, tiles, and blocks—are often overlooked due to misconceptions around their quality and durability, despite the existence of BIS standards like IS 383:2016, which permit their use in non-structural applications (Kumar et al., 2020).

One of the key reasons behind the slow adoption of recycling practices is the lack of reliable data and clarity around the financial feasibility of operating C&D waste recycling plants. Municipal corporations and private players are hesitant to invest in recycling infrastructure without robust economic projections. Concerns related to capital costs, operating expenses, revenue uncertainties, and market demand for recycled materials continue to limit private sector participation (Gupta & Sinha, 2021; Dasgupta & Singh, 2022).

This research seeks to address that gap by conducting a city-wise financial feasibility assessment of C&D waste recycling plants in Delhi, Ahmedabad, and Pune. These three cities were selected for their contrasting levels of policy engagement, infrastructure capacity, and existing recycling practices. The study employs key financial indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period to evaluate the economic performance of plants operating in these urban environments. By combining quantitative analysis with real-world data from plant operators and municipal bodies, this paper aims to provide grounded, actionable insights for investors, urban planners, and policymakers.

Ultimately, this study contributes to the broader conversation around sustainable urban development and resource efficiency. By showcasing that C&D waste recycling can be not only environmentally essential but also economically sound, the paper supports India's push toward achieving its Sustainable Development Goals (SDG 11 and 12), Swachh Bharat Mission-Urban 2.0, and the National Resource Efficiency Policy (MoHUA, 2022; UN-Habitat, 2021).

2. Review of Literature

The issue of construction and demolition (C&D) waste management has received

considerable global attention over the last two decades, especially in the context of sustainable urban development and circular economy principles. However, while the environmental and technical aspects of recycling have been widely researched, the financial feasibility of C&D waste recycling—particularly in the Indian urban context—remains underexplored.

2.1 Global Context

Internationally, countries such as Germany, the Netherlands, and Japan have achieved recycling rates exceeding 80% of their C&D waste, largely due to robust regulatory mechanisms and strong economic incentives (European Environment Agency, 2023). Policies such as the EU Waste Framework Directive (2008/98/EC) mandate source segregation and quality assurance for recycled materials, which has helped build trust and a market for recycled products. A study by Cheng et al. (2023) highlighted how financial instruments like landfill taxes, green public procurement, and Extended Producer Responsibility (EPR) frameworks contribute significantly to the economic viability of recycling ventures in Europe and East Asia.

In contrast, cities in developing countries struggle with inadequate infrastructure, weak enforcement, and informal waste management systems. According to Li et al. (2022), C&D waste recycling rates in countries like India, Brazil, and Nigeria remain below 30%, largely due to lack of formalized economic models, underfunded municipal bodies, and fragmented supply chains.

2.2 Indian Scenario

India, despite being one of the fastest-growing construction economies, recycles less than 1% of its C&D waste through authorized channels (CPCB, 2023). The Construction and Demolition Waste Management Rules, 2016, introduced by the Ministry of Environment, Forest and Climate Change (MoEFCC), outline mandates for segregation and authorized recycling. However, the rules have seen limited implementation due to institutional inertia, inadequate monitoring, and minimal financial backing for recycling infrastructure (Sharma & Garg, 2022).

Metropolitan cities like Delhi, Ahmedabad, and Pune have initiated recycling projects—often under Public-Private Partnership (PPP) models. However, a study by Reddy & Ghosh (2021) showed that these plants operate at 30–50% of their designed capacities, primarily due to an underdeveloped market for recycled products and skepticism among

construction professionals regarding product quality.

2.3 Financial Modeling in C&D Recycling

A growing body of Indian literature attempts to model the economics of C&D recycling plants. Gupta & Sinha (2021) conducted a cost-benefit analysis of urban recycling plants and emphasized the need for standardized financial indicators—such as Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period—to assess long-term profitability. Their findings indicated that operational costs typically form 45–60% of the total lifecycle cost, and breakeven points are achievable only with reliable tipping fee structures and consistent waste inflows.

Similarly, Srivastava & Kumar (2022) found that the IRR of C&D recycling projects in Tier-1 cities like Delhi can range between 9% and 13%, provided the plants are supported through policy incentives and guaranteed procurement of recycled materials by government agencies.

2.4 Challenges in Financial Feasibility

Despite positive case studies, several barriers limit financial feasibility. These include low market demand, lack of confidence in recycled products, absence of price parity with virgin materials, and high initial capital investment (Dasgupta & Singh, 2022). The Bureau of Indian Standards (BIS) has updated norms for the use of recycled aggregates in IS 383:2016, but adoption in large-scale projects remains minimal due to lack of awareness and weak enforcement mechanisms (Kumar et al., 2020).

Moreover, logistical inefficiencies, especially in collecting and transporting debris from dense urban zones, increase operational costs by up to 20–25% (Chatterjee & Iyer, 2023). This further skews financial indicators and undermines investor confidence.

2.5 Gaps in the Literature

Although a few recent studies address the economics of recycling plants, most models are limited in scale, are city-specific, or fail to account for variables like market volatility, seasonal waste generation, or inflation. There is also a lack of comparative city-wise analysis that includes financial benchmarking across multiple operational plants in India. Additionally, long-term projections such as lifecycle returns and risks remain absent from most publicly available reports (Gupta & Singh, 2021; Das et al., 2023).

3. Research Methodology

This study adopts a case-based analytical approach to evaluate the financial viability of Construction and Demolition (C&D) waste recycling plants in selected urban settings in India. The methodology is designed to assess whether operating such plants can be a financially sound decision for urban local bodies and private investors, using real-world data and established financial metrics.

3.1 Research Approach

The study utilizes a quantitative financial modeling framework supported by qualitative insights from stakeholder interactions. It focuses on three cities—Delhi, Ahmedabad, and Pune—which represent varying degrees of recycling infrastructure maturity and policy enforcement. These cities were selected due to their operational recycling facilities, availability of data, and relevance in urban waste management discourse.

3.2 Data Collection

Primary Data:

Primary data was gathered through direct communication with stakeholders involved in the planning, operation, and regulation of C&D recycling plants. This included:

- Interviews with plant operators and municipal engineers
- Collection of data on capital investment, operating expenses, and revenue from recycled products and tipping fees

Secondary Data:

Secondary information was sourced from:

- Government publications (CPCB, MoHUA, State Urban Reports)
- Academic journals and technical studies (e.g., Gupta & Sinha, 2021; Srivastava & Kumar, 2022)
- Project reports, policy documents, and plant feasibility studies

All financial figures were adjusted to 2023–24 price levels for consistency.

3.3 Financial Analysis Tools

Three standard financial indicators were used to evaluate project feasibility:

- Net Present Value (NPV): Assesses overall profitability by discounting future net cash flows.
- Internal Rate of Return (IRR): Indicates the rate at which a project breaks even; a higher IRR suggests greater attractiveness to investors.
- Payback Period: Measures the time required to recover the initial

investment, offering insight into short-term financial risk.

The models were developed using Microsoft Excel, and projections were made for a 10-year operational horizon, applying a discount rate between 8% and 12%, depending on perceived financial risk and inflation levels.

3.4 Comparative Framework

Each city's plant was evaluated individually and comparatively to understand how factors like capacity, municipal support, and policy incentives impact financial performance. Key performance metrics such as capital cost, operating cost, product sales, and employment generation were also compared across cases.

3.5 Limitations

- The analysis is limited to non-hazardous C&D waste and excludes rural areas.
- Some financial data relied on estimates due to incomplete public records.
- Externalities such as environmental and social impacts are not monetized in this financial model but are acknowledged as important complementary benefits.

4. Results and Discussion

This section presents the financial performance analysis of C&D waste recycling plants operating in Delhi, Ahmedabad, and Pune. The evaluation is based on standard financial metrics: Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period, supported by real operational data. These results are contextualized through comparison with prior studies and aligned with India's urban waste management goals.

4.1 Financial Performance Summary

The financial metrics for each plant, based on a 10-year projection and a discount rate of 10%, are summarized below:

City	Plant Capacity (TPD)	Capital Cost (₹ Crores)	NPV (₹ Lakhs)	IRR (%)	Payback Period (Years)
Delhi	500	7.2	155	14.2	5.6
Ahmedabad	300	4.1	82	11.8	6.1
Pune	200	3.5	65	10.5	6.8

Interpretation:

- The Delhi plant outperformed the others across all financial indicators. Its higher processing capacity, assured municipal waste supply, and long-term PPP model helped reduce unit operating costs and increase sales of recycled products.
- The Ahmedabad facility, though smaller, maintained moderate profitability, supported by growing awareness and steady municipal engagement.
- The Pune plant showed the longest payback period, primarily due to lower tipping fee recovery, smaller market for recycled products, and higher operational overhead per tonne.

4.2 Revenue and Cost Analysis

Revenue Components:

- Sale of recycled aggregates, paver blocks, and sand substitutes.
- Tipping fees from municipal corporations and private contractors.
- Subsidies/incentives under Swachh Bharat Mission-Urban (SBM-U 2.0).

Cost Components:

- Capital investment in land, machinery, civil infrastructure.
- Operating costs: labor, fuel, water, maintenance, electricity.
- Logistics: transportation of debris, especially in congested urban zones.

A sensitivity analysis revealed:

A 10% increase in product price or tipping fee can improve IRR by 1.1–1.5%, shortening the payback period by up to 0.4 years.

4.3 Comparative Benchmarking with Previous Studies

The table below compares the findings of the present study with key Indian literature:

Study	IRR (%)	Payback Period (Years)	Context/Remarks
Srivastava & Kumar (2022)	9–13	5–8	Modeled Smart City Mission plants with municipal support
Gupta & Sinha (2021)	10–15	4–7	Highlighted role of tipping fees and

			policy incentives
Kumar et al. (2020)	–	6–9	Case-based analysis in Tier-2 cities with subsidy constraints
Present Study (2025)	10.5 – 14.2	5.6–6.8	Real-world performance from 3 functional urban plants

Insights:

- The results are consistent with national benchmarks, especially in cities with structured PPP arrangements (e.g., Delhi).
- Plants in low- to medium-capacity ranges like Pune are more sensitive to input costs and require stronger government facilitation (Dasgupta & Singh, 2022).
- Delhi's strong IRR (14.2%) reinforces the financial potential of large-scale C&D recycling when supported by reliable waste inflow, product marketing, and enforcement of source segregation.

4.4 Comparative City-wise Observations

Factor	Delhi	Ahmedabad	Pune
Plant Capacity (TPD)	500	300	200
Market for Recycled Products	High (government-led procurement)	Moderate (some private uptake)	Limited (mostly small contractors)
Revenue from Tipping Fees	Consistent	Moderate	Irregular
Policy & Institutional Support	Strong PPP with DDA	State-level engagement	Municipal-level only
Financial Performance	Best among three	Moderate	Least Viable

4.5 Key Discussion Points

- Scale Matters: Larger plants, like Delhi's, benefit from economies of scale and more diversified revenue.
- Government Support is Critical: Municipal contracts, land subsidies,

and assured tipping fee policies significantly improve financial performance (Gupta & Sinha, 2021).

- Product Demand is Key: Financial success depends not only on cost management but also on the market demand for recycled products, which remains inconsistent across cities.
- Need for Policy Enforcement: Cities lacking source segregation mandates, quality standards awareness, or buyer incentives risk longer payback and underutilization of plant capacity.

5. Conclusion

The study set out to examine the financial viability of construction and demolition (C&D) waste recycling plants in three major Indian cities—Delhi, Ahmedabad, and Pune—using real-world data and standard financial indicators: Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period. The findings clearly demonstrate that, when properly managed and supported by enabling policies, C&D recycling plants can operate as financially viable and sustainable ventures.

Among the three cities, Delhi's plant emerged as the most successful model, showing the highest IRR (14.2%) and the shortest payback period (5.6 years), largely due to its larger capacity, integration with public infrastructure projects, and steady inflow of segregated waste. Ahmedabad followed closely, while Pune, though functional, reflected the financial challenges faced by smaller-capacity plants with limited policy and market support.

The results are consistent with previous studies (e.g., Gupta & Sinha, 2021; Srivastava & Kumar, 2022), reinforcing the view that scale, steady waste inflow, tipping fee assurance, and a reliable market for recycled products are the key drivers of financial success. Additionally, the study highlights that financial performance can be further optimized through marginal increases in tipping fees, stronger public procurement mandates, and operational efficiency improvements.

In conclusion, urban C&D waste recycling in India is not only an environmental necessity but also an economically feasible opportunity—especially in cities that adopt a structured approach involving public-private partnerships, long-term policy

incentives, and awareness-building among stakeholders. As India continues its push toward circular economy models under initiatives like the Swachh Bharat Mission – Urban 2.0 and the National Resource Efficiency Policy, scaling up and replicating successful recycling plant models becomes not just feasible—but essential.

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