FASHION FOR GOOD
SORTING FOR CIRCULARITY: INDIA
POST-CONSUMER PILOT REPORT

BUSINESS CASE ASSESSMENT

A REPORT FOR INDIAN SORTING HUBS TO GAUGE THE IMPLEMENTATION OF SORTING TECHNOLOGIES

DECEMBER 2023

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Executive Summary

About 48% of the Post-consumer Domestic Waste (PCD) has the potential to be valorised via formalised sorting hubs. Out of this, 35% of the waste can have better utilisation by adopting semi-automated & automated technologies, leading to a revenue increase of 10%. At an industry level, this translates to 1,380 kilo tonnes of waste and INR 388 Cr (going up to INR 1,348 crores in some cases) of additional revenue in one year. However, an enabling environment needs to be created to make these technologies economically viable for a sorting hub.

India has a wide but unorganised value chain for post-consumer domestic (PCD) waste. Formalised sorting hubs or Textile Recovery Facilities (TRFs) primarily dealing with PCD waste, are at a nascent stage, trying to find their feet within the market by optimising processes at both the demand and supply sides. These TRFs are sorting PCD waste through manual methods. However, despite the waste valorisation potential of these sorting hubs, their returns are limited in certain cases as they are unable to provide good quality waste feedstock and assurance of the material composition to high-grade fibre-to-fibre mechanical recyclers. This gap provides a potential area for the deployment of sorting technologies.

In light of this, Fashion for Good carried out pilots with semi-automated and fully-automated sorting technologies (Matoha's FabriTell and PICVISA's ECOSORT respectively) to understand their impact on the business and valorisation of PCD waste. Based on the pilot learnings, a detailed business case assessment of sorting hubs deploying different sorting methods was conducted with the following objectives:

- Assess the financial viability and returns of different sorting methods
- Understand the readiness of integrating semi and fully-automated sorting technologies in the PCD waste value chain
- Identify the gaps, challenges and opportunities in the current ecosystem to further the establishment of PCD collection and sorting hubs in India.

The business case has been assessed for three sorting methods, namely, manual sorting, sorting through semi-automated technology by Matoha's FabriTell and sorting through fully-automated sorting technology by PICVISA's ECOSORT. Financial modelling for each of the methods was done for 8 years, with 2023 being the Year 0 (Y0) and 2030 being the Year 7 (Y7). The financial models were developed based on detailed assumptions around future predictions through secondary research, pilot data and stakeholder interviews. For analysis, the daily operational capacity of 600 kgs was assumed for the sorting hubs increasing at a steady rate across years to reach ~1500 kg in Y7. Furthermore, five future scenarios were developed in the study to analyse the potential changes in the market and their impact on the business viability of the sorting hubs.

The report on 'The Untapped Potential of Post-consumer Textile Waste Stream in India' underlines that technology intervention plays a significant role in optimising the sorting process of large volumes of post-consumer textile waste. Through the post-consumer pilot learnings, it is understood that semi-automated and fully-automated technologies for sorting can enable accurate and efficient sorting of post-consumer textile waste primarily based on colour and composition.

While technologies suit the purpose of sorting, a key deciding factor in its implementation is commercial viability. Standing at the juncture of deciding on technology adoption, it is natural to consider the financial aspects of the new initiative. A business case assessment can help to determine the most effective way

forward to leverage the technology and evaluate the right fit for a sorter.

The business case presented here assesses commercial viability for both semi-automated and automated technologies and validates the hypothesis under five different scenarios. Thus, it demonstrates the infrastructure and investment requirements to valorise the post-consumer textile waste, serving as a framework to enable well-informed decision-making for sorting hubs to implement sorting technologies.

BUSINESS CASE ANALYSIS

Under the current scenario where the market price of rewearables and recyclable waste is low, none of the sorting technologies was found to be profitable. Furthermore, a capital infusion of about INR 9.2 crores was found to be required to sustain the business in case a fully automated technology was adopted as against INR 2.5 crores required for manual sorting operations.

In the case of capital expenses as well, deployment of a fully automated sorting technology was found to have the highest capital requirement of INR 5.03 crores (almost 11 times than semi-automated technology) among the suggested modes. The cost of the PICVISA setup, of about ~INR 4.49 crores was the biggest contributor to the high capital expense. Similarly for semi-automated operations, the model estimates the capital requirement to be at INR 45.5 lakhs. Manual sorting comes with the least requirement of capital expenditure of INR 9.3 lakhs across 8 years.

On the other hand, the fully automated technology was found to contribute to the operational efficiencies of the sorting hubs. Operating expenses of a sorting hub are expected to reduce by 9.45% in the case of fully-automated operations while they might increase by 32.2% in the case of semi-automated operations when compared to operating expenses for manual sorting. The highest operational expense is incurred for semi-automated operations across 8 years owing to the increased labour requirement for semi-automated technology. Lastly, the operational expense for manual sorting stands at INR 5.9 crores, remarkably closer to the use of fully automated technology.

Deployment of technology was found to contribute to an increase in revenue. Though more than 80% of the revenue comes from rewearables and other reusable materials in all cases, the use of technology doubles the revenue coming from recyclable materials. Revenue from semi-and fully-automated operations is estimated to be equal to INR ~4.2 crores which is 11.7% higher than the revenue generated from the manual sorting processes. The revenue earned from recyclable/downcyclable materials has doubled here from INR 42.2 lakhs to INR 86 lakhs. The credible identification of material composition enables sorting hubs to unlock premium pricing for high-quality waste such as 100% cotton.

SCENARIO ANALYSIS

PCD textile waste management is a complex and rapidly evolving sector with various uncertainties, such as changing recycling markets, rules & regulations, and technological advancements. To assess the potential outcomes and risks associated with this changing environment, five different scenarios were identified and the changing business case based on these future scenarios was analysed (Illustration 1).

PARAMETERS	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4	SCENARIO 5
	Increased Daily Capacity to 7000 kg & growth rate reduced to 10%	High Price for Rewearables (upto INR 2100/kg)	High Price for Rewearables & Cost of Waste doubling in last 5 years	High Price for Rewearables, High Cost of Waste & Reducing Revenue from Sorted Waste (5% y-o-y)	Low Price of Rewearables & Increasing Revenue from certain Sorted Waste
PROFITABILITY	Profitable for fully automated sorting technology second year onwards.	All sorting models were found to be profitable under this scenario with manual sorting being the most profitable method.	All three sorting methods are profitable under this scenario, with manual sorting being the most profitable.	All three models of sorting are profitable under this scenario with manual sorting generating the highest profits.	None of the three sorting methods were found to be profitable in this scenario even though the loss % was found to be decreasing over time.
REVENUE	826% higher than current scenario for manual sorting as well as technology sorting operations.	625% higher than current scenario for manual sorting & 562% higher for technology based sorting operations.	625% higher than current scenario for manual sorting & 562% higher for technology based sorting operations.	389% higher than current scenario for manual sorting & 346% higher for technology based sorting operations.	4% higher than current scenario for manual sorting & 1% higher for technology based sorting operations.
INVESTMENT REQUIREMENT (OVER 8 YEARS)	None required for fully automated sorting technology and above INR 10 Cr needed for others.	None needed.	None needed.	INR 10 lakhs needed for fully automated sorting technology. None needed for others.	INR 9.1 Crores needed for fully-automated sorting technology while INR 4.5 crores needed for semi-automated technology.
PAYBACK PERIOD	Payback in 8 years for fully-automated technology and no payback in 8 years for others.	Payback in 1 year for Manual and Semi-automated and 5 years for fully- automated technology.	Payback in 1 year for Manual and Semi-automated and 5 years for fully- automated technology.	Payback in 1 year for Manual and Semi-automated and 6 years for fully- automated technology.	No payback in 8 years.
ECOSYSTEM SUPPORT REQUIRED	Significant ecosystem development, especially around the collection mechanisms.	Development of a strong rewearables market & increased awareness amongst the public.	The increasing cost of waste can be absorbed by a strong rewearables market.	A strong rewearables market can absorb both high cost of waste & reducing revenue from sorted waste.	This model in conjunction with Extended Producer Responsibility might be sustainable.

Illustration 1: Scenario Analysis

CHALLENGES AND OPPORTUNITIES

Through the pilot, the readiness of integrating semi and fully-automated sorting technologies in the PCD waste value chain was understood. Based on this, five broad challenges and opportunities in the current ecosystem were identified to further the establishment of PCD collection and sorting hubs in India. These include a lack of robust collection systems, limited availability of markets for sorted materials, issues with sorting technologies, low-quality waste due to blended materials and garment wear, and lack of adequate financing models. To address these challenges, a concerted effort is needed to strengthen collection systems, expand markets, improve sorting technologies, and promote better consumer awareness.

Introduction

India has a wide but unorganised value chain for post-consumer domestic (PCD) waste. Formalised sorting hubs or Textile Recovery Facilities (TRFs) primarily dealing with PCD waste, are at a nascent stage, trying to find their feet within the market by optimising processes at both the demand and supply sides.

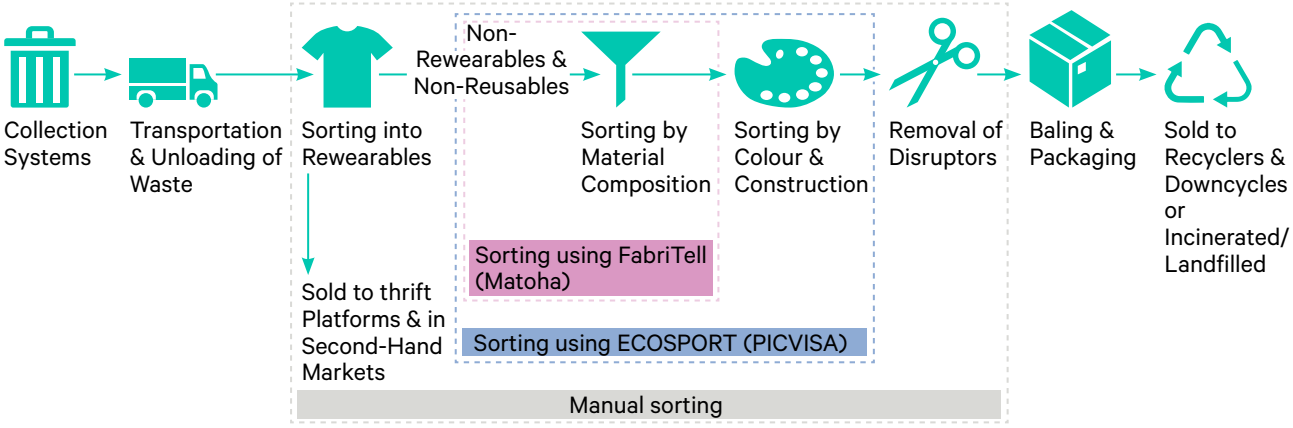


Illustration 2: Processes carried out by a sorting hub

Currently, PCD waste sorting is carried out manually, in primarily three stages (sorting into rewearables, sorting by the material composition and sorting by colour) as depicted in Illustration 2. The material is sorted into two broad categories of rewearables and non-rewearable material. The material sorted for rewearables is further sorted into high-quality rewearables, low-quality rewearables and other reusable materials, each of them having its market. The remaining material, or the non-rewearable material can further be sorted by material composition, colour and construction based on which it is sold for recycling (high-grade and low-grade), downcycling, incineration and landfills. The formal sorting hubs in the country usually focus on identifying the cotton waste and segregating it into white, light and dark shades in a single step. All other materials are combined as a mixed waste. In the absence of these formalised sorting hubs, most of the non-rewearable PCD waste has been estimated to be going to either downcycling, incineration or landfills.[14] However, despite the waste value valorisation potential of these sorting hubs, their returns are limited in certain cases as they are unable to provide good quality waste feedstock and assurance of the material composition which is usually required by the high-grade fibre-to-fibre mechanical recyclers. This gap has provided a potential area for the deployment of technology. The assurance on material composition has further added another value-addition step on the removal of disruptors that the sorting hubs are taking up to reduce the efforts of the recyclers and earn premium value.

So far, technology integration, similar to other unorganised /semi-organised sectors, has been slow within the PCD waste value chain. The deployment of technology has been limited to the pre and post-processing of the sorted material, including the installation of machines such as cutting (to remove disruptors), and baling machines with the sorting process being manually done for the entire value chain. In light of this, Fashion for Good piloted the aforementioned Fabritell scanning technology by Matoha and ECOSORT by PICVISA to understand their impact on the business and value valorisation of PCD waste.

Post the pilots, a detailed business case assessment of sorting hubs deploying different sorting methods was conducted with the following objectives:

- Assess the financial viability and returns of different sorting methods
- Understand the readiness of integrating semi and fully-automated sorting technologies in the PCD waste value chain
- Identify the gaps/ challenges and opportunities in the current ecosystem to further the establishment of PCD collection and sorting hubs in India

Assessment Methodology

The business case assessment was done for three sorting methods, namely, manual sorting, sorting through semi-automated technology by Fabritell Matoha and sorting through fully automated sorting technology by ECOSORT by PICVISA. Financial modelling for each of the methods was done for a period of 8 years, with 2023 being the year 0 (Y0) and 2030 being the year 7 (Y7). A uniform profile of the sorting hub was developed as discussed further to ensure that the findings across the three methods are comparable.

The financial models were built over 2.5 months by developing detailed assumptions around future predictions. These assumptions were based on the following data sources:

- Secondary research on clothing consumption, material compositions, prices of standard commodities (e.g. vehicles, baling machines, etc.) and economic rates like inflation, depreciation, interest, etc.
- Data on PCD material, colour, construction and disruptors from Fabritell and ECOSORT pilots (refer to the report - Unlocking India's Waste Opportunity: Capitalising on the Untapped Potential of Post-Consumer Waste)
- Interviews with participating sorters and recyclers for all other inputs on operating expenses and value-added of the technology
- Interviews with technology developers to understand the technology and its features like electricity consumption, installation and maintenance, etc.

A detailed list of assumptions has been provided in section 3.2 of the Toolkit Annexure.

Once the model was built, an analysis of the following financial elements was done to draw comparisons and findings across the three models:

- **Capital expenses:** This includes the cost of technology, setting up the infrastructure like tables, sorting bins, etc. and the one-time utility expenses like additional electricity connections.
- **Operating expenses:** This includes the cost of purchasing waste, labour, rental, electricity, factory overheads (wi-fi, housekeeping, pantry) and miscellaneous costs such as the cost of marketing, administration, etc.
- **Revenue:** Since rewearables and reusable materials form 20% of the PCD waste collected during the pilots, the share of revenue through this waste stream was found to be an inherent part of the sorting hub businesses in India. Along with this, Revenue analysis includes income from recyclable and downcyclable waste.
- **Profits:** Apart from revenue and operating costs, profits also account for depreciation and interest being paid out for capital expenses.
- **Pay-back period:** Pay-back period analysis was done to understand the number of years needed to recover the capital expenses being made by the sorting hub.

This analysis was also repeated across different future scenarios, details of which have been laid down in the Scenario Analysis section.

LIMITATIONS OF THE ASSESSMENT

Since the segment of PCD textile waste management is fairly nascent in India, certain limitations were faced in conducting this assessment:

- **Lack of data availability:** Since the model has been built on the data collected through 3 months of pilots, information on operational aspects like machine maintenance, electricity consumption, etc. was not available in a few cases. These data points have, hence, been built on assumptions and estimates from technology providers. Similar assumptions have been built for future trends since there have been no detailed studies conducted on this before.
- **Technological challenges:** Since there are limitations to the number of categories into which sorting can be done through technology and the accuracy of identification of a few material compositions such as elastane, slight variation in actual composition can be expected in the data.
- **Limited visibility on the variations due to limited scale:** Current assumptions are built on the pilots that were conducted. However, when a similar model is followed at scale and in evolving market conditions, certain assumptions might be subject to change.

Profile of a Sorting Hub

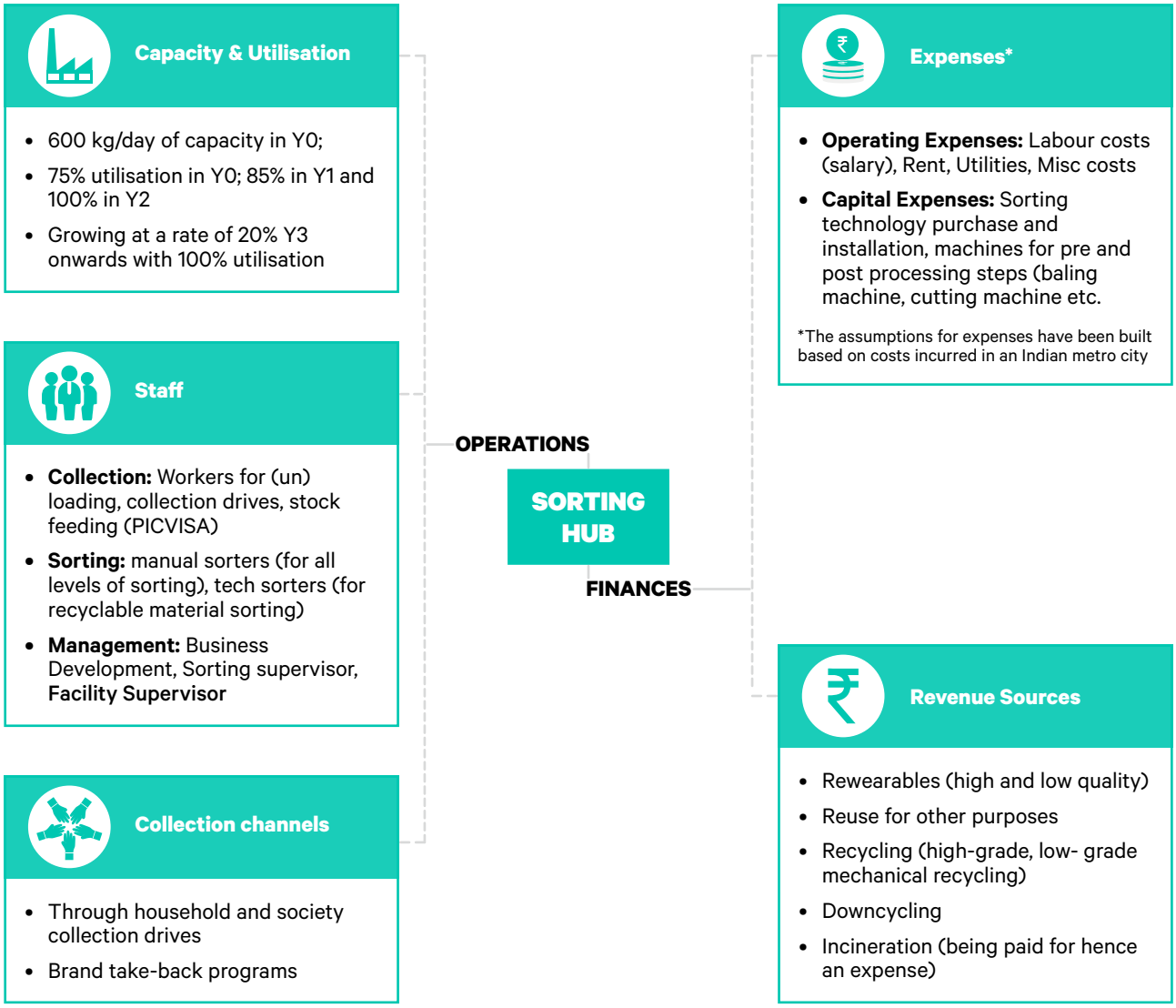


Illustration 3: Profile of an Indian Sorting Hub of post-consumer textile waste

Since India does not have many formalised PCD waste sorting hubs operating, the average size of the four pilot sorters was taken as the standard sorting hub. We do anticipate sorting hubs of differing sizes to come up in the country in the coming years but for analysis, a capacity of 600 kg per day has been assumed. In Y0, capacity utilisation of 70% has been considered, which grows to 85% in Y1 and 100% in Y2. After that, a constant growth of 20% has been assumed for financial modelling. In 2030 (Y7), the unit is expected to handle ~1500kg of PCD waste daily (as shown in Illustration 4).

Particulars	Unit	2023	2024	2025	2026	2027	2028	2029	2030
Capacity	kg/day	600	600	600	720	864	1036.8	1244.2	1493
Utilisation	kg/day	70%	85%	100%	100%	100%	100%	100%	100%
Capacity	tonnes/annum	172.8	172.8	172.8	207.4	248.8	298.6	358.3	430

Illustration 4: Operational capacities of the sorting hub

Further, the sorting hub is expected to be located in a Tier 1 city (Bengaluru, for instance) and all operating costs have been accounted for in such a location. This is because we foresee the growth of these hubs in urban areas of the country which have easier access to this waste and an existing Urban Local Body (ULB) infrastructure for municipal waste collection which can be leveraged, if required. This unit has been assumed to be managed by a facility manager along with a business development manager, sorting supervisors and sorting workers depending on the sorting methods deployed.

> **“By turning its wealth of textile waste into resources for its textile production industry, India is putting circularity into action and showcasing what a circular textiles value chain could look like at scale. An efficient sorting ecosystem supported by innovative technologies is fundamental to safeguard the availability of the consistent feedstock closed loop recycling requires.**
>
> Hilde van Duijn, Head of Global Value Chains at Circle Economy

Business Case Analysis

About 48% of the PCD waste can be pushed up the value valorisation due to formalised sorting hubs. Out of this 35% of the waste can further be better utilised because of the use of semi-automated & automated technology and add to revenue increase of 10%. At an industry level, this translates to 1,380 ktonnes of waste and INR 388 Cr (going upto INR 1,348 crores in some cases) of additional revenue in one year. However, an enabling environment needs to be created to make these technologies economically viable for a sorting hub.

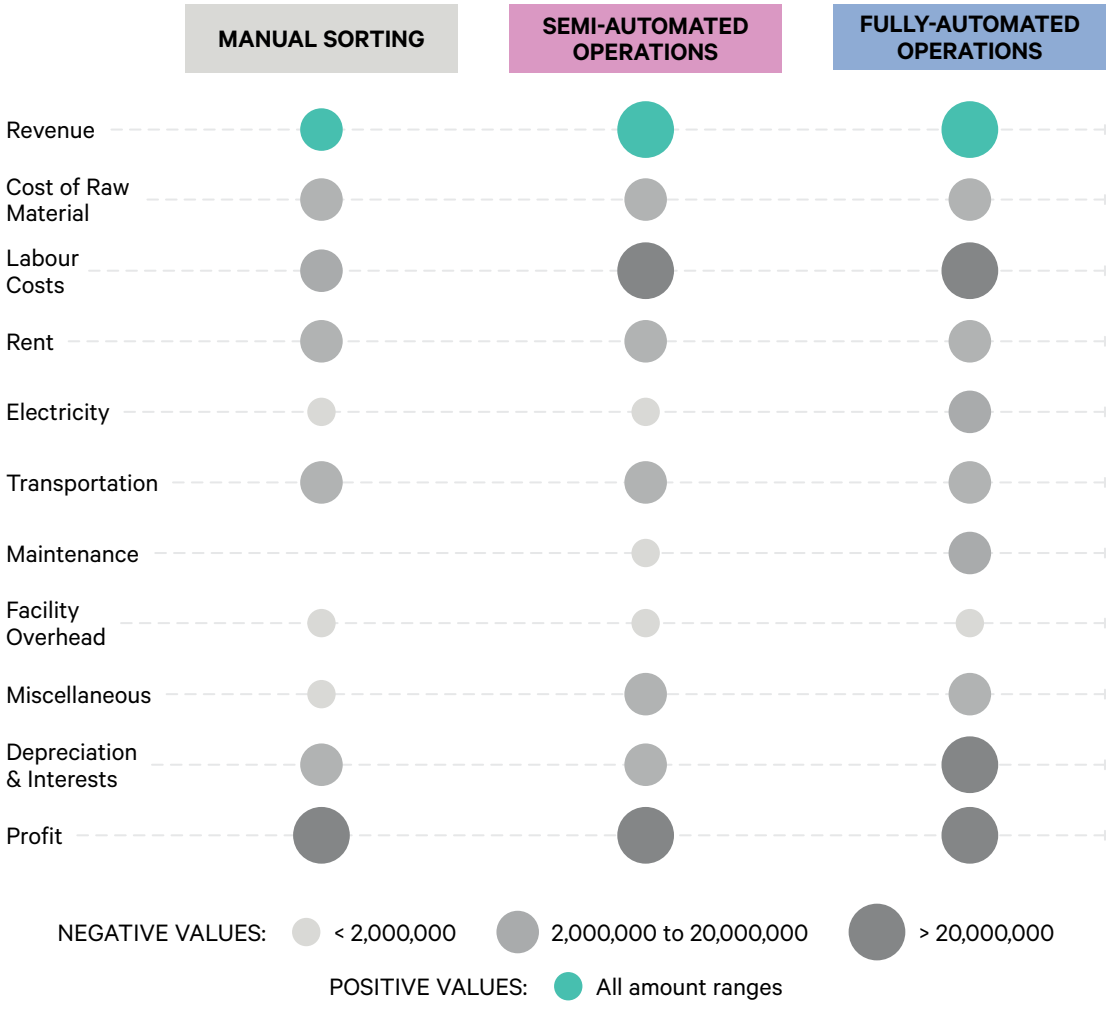


Illustration 5: Business case assessment of sorting methods in India

CAPITAL EXPENSES

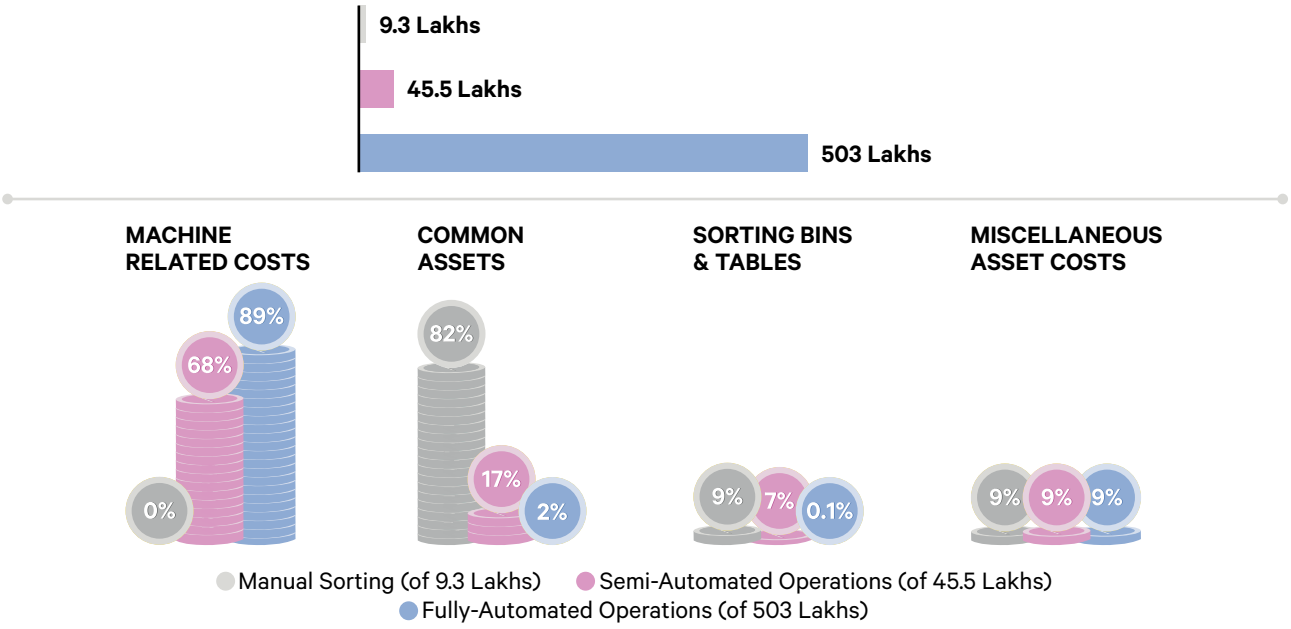


Illustration 6: Share of the capital expenses incurred by a sorting hub

A sorting hub incurs certain initial investments in all three sorting methods (manual, semi-automated, and automated) to purchase assets to begin operations. This includes the purchase of vehicles for the collection of waste, baling machines, cutting machines for removal of disruptors, sorting bins, tables, manual stackers or forklifts for loading & unloading, and other miscellaneous assets (including compliance, utility setups, etc.). Additional capital investments need to be made for semi-automated (purchase of Fabritell Matoha machines, their transportation, installation & tablets) and fully automated (purchase of ECOSORT by PICVISA*) technologies. Similar investments need to be made during the course of the business to grow the operations and maximise benefits.

For the business case assessment, the following key assumptions regarding capital expenses have been made:

1. The model assumes that the sorting hubs shall take the initial 2 years to set up their collection systems and will be outsourcing the collection in this time frame. Hence, vehicles are purchased in the third year of operations. Further, additional vehicles are purchased when the maximum capacity of a vehicle is exceeded by 50%.
2. Miscellaneous asset costs have been assumed to be 10% of the total capital expenditure incurred.
3. The productivity of workers sorting the waste using semi-automated machines was found to be 100 kg per day per worker. Hence, the number of machines has been calculated based on this productivity rate.
4. The optimum throughput of a fully automated machine with 24 sorting bins is 7,000 kgs of waste per day. 1 fully-automated machine which can handle 2,016 tons of waste in a year is sufficient to handle the growing capacities over the period of 8 years.

* PICVISA setup includes the ECOSORT optical sorter, lateral air blowing system (including air nozzles, compressor, and the conveyor), hopper/ basket, and a tablet for the dashboard.The 24 bin setup has been considered in this assessment. Equipment such as the conveyor and the hopper can be purchased at a cheaper price from within the region to lower the costs.

5. A 7-year loan with a moratorium period of 2 years and an interest rate of 12% has been considered to finance all capital expenditures.
6. The price of all machines is assumed to experience an inflation rate of 5% every year.

Deployment of a fully automated sorting technology was found to have the highest capital requirement (almost 11 times than semi-automated technology) among the suggested modes. PICVISA technology incurred a capital expense of INR 4.49 crores in 8 years, while Fabritell Matoha sorting technology required INR 45.5 lakhs in 8 years and the manual sorting method only required INR 9.3 lakhs in the same period. The common investment required in all setups included one baling machine, one cutting machine, one vehicle and one manual stacker.

Particulars	Manual Sorting	Semi-Automated Operations	Fully-Automated Operations
Machinery Expenditure across 8 years	None	28,60,000	4,48,70,000
1 Baling Machine	1,55,000	1,55,000	1,55,000
1 Cutting Machine	5,000	5,000	5,000
Other Capital Expenses	7,73,752	15,27,739	6,06,375

Illustration 7 (all figures in INR): Comparison of capital expenditures across the three sorting methods

The cost of the PICVISA setup, of about ~INR 4.49 crores was the biggest contributor to the high capital expense required for the same. Given the significant focus of the Indian government towards technology integration in textile waste management, technology subsidy models can also be looked at in the country. A 50% tech-subsidy model holds the potential to reduce the bootstrap capital requirement for the business by 38%, while a 100% tech-subsidy model can reduce it by 76% for the first 8 years of operations.

Similarly for semi-automated operations, the model estimates that 11 Fabritell Matoha machines will have to be purchased across 8 years to cater to the growth in daily operational capacity, costing around INR 28.6 lakhs. Additionally, INR 81.5 thousand went towards machine installation and INR 1.3 lakhs were used to purchase tablets. Other assets purchased for semi-automated operations included eight sorting bins and one table for each Fabritell Matoha device utilised.

Manual sorting comes with the least requirement of capital expenditure of INR 9.3 lakhs across 8 years with the major capital expenditures coming from the purchase of vehicles for INR 5.5 lakhs in the third year. Capital subsidy shall not be relevant in this case as no new technology is being deployed. Hence, the sorting hub can either be bootstrapped or raise grants.

OPERATIONAL EXPENSES

MANNUAL SORTING
Total operating costs: INR 5.8 Crores
Operating costs per kg: INR 29.24
72% | 9% | 7% | 4%
3% | 4% | 1%

SEMI-AUTOMATED OPERATIONS
Total operating costs: INR 7.8 Crores
Operating costs per kg: INR 39.32
77% | 7% | 5% | 5%
3% | 1% | 2%

FULLY-AUTOMATED OPERATIONS
Total operating costs: INR 5.5 Crores
Operating costs per kg: INR 27.73
53% | 16% | 10% | 7%
4% | 5% | 4% | 1%

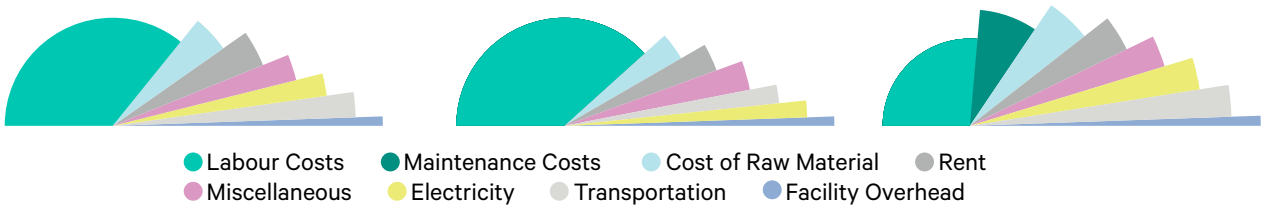


Illustration 8: Split of the operating expenses incurred by a sorting hub

Operating expenses of a sorting hub are expected to reduce by 9.45% in the case of fully automated operations while they will increase by 32.2% in the case of semi-automated operations when compared to operating expenses for manual sorting.

Sorting hubs incur various kinds of operating expenses across the three types of sorting methods. This includes labour costs, rent, electricity, raw materials, transportation, maintenance, facility overhead costs and miscellaneous costs. The labour costs further vary depending on the type of workers utilised during operations (including loading/unloading staff, manual sorters, sorters handling technology, other sorters (for sorting rewearables & disruptors), stock feeding staff, collection supervisors, facility managers, and sorting supervisors).

For the business case assessment, the following key assumptions regarding operating costs have been made:

1. Labour costs are increasing at a rate of 7.5% per annum while the inflation rate for all other inputs is 5%.
2. Rent has been assumed at INR 20 per square foot, transportation costs are derived to be INR 5 per kg and electricity costs are pegged at INR 9.4 per unit. Per kg space requirement was estimated at 1 sqft in the case of manual and semi-automated sorting. For fully automated setup, machine space requirements have been added along with a 0.8 sqft space requirement for other sorting processes of 1 kg of waste.
3. As ecosystem players such as brands and consumers realise the inherent value of PCD waste, the cost of purchasing feedstock is expected to rise. Hence, the cost of purchasing raw materials has been assumed to be 0 for the first two years & then INR 3 per kg from the third year, increasing at a rate of 5% per annum.
4. Facility overhead costs are calculated at 10% of the facility rent and miscellaneous costs are calculated at 5% of total operating costs.

The highest operational expense is incurred for semi-automated operations, i.e., INR 7.8 crores across 8 years owing to the increased labour requirement for semi-automated technology, a marginal increase in electricity cost and facility maintenance cost while the lowest operational expense is incurred for fully-automated operations, i.e. INR 5.35 crores for 8 years, owing to the reduced worker requirement. Lastly, the operational expense for manual sorting stands at INR 5.9 crores, closer to the use of fully automated technology.

Labour costs were found to be the biggest differentiating factor between semi and fully-automated sorting technologies. The labour costs in semi-automated operations were estimated to be INR 6 crores in 8 years which is more than double the labour costs for automated operations (INR 2.9 crores in 8 years) and 42.4% more than the labour costs for manual sorting (INR 4.2 crores in 8 years). This is because while the number of workers sorting for rewearables & disruptors remains the same, additional workers are required to operate the semi-automated machines to sort by material composition & the fully-automated machine reduces the labour requirement for sorting by material composition to just three workers for feeding and operating the machine. Additionally, in manual sorting, only one material composition (cotton) is segregated and the sorting by composition and colour is performed in a single step.

Similarly, automated operations have the highest electricity costs (INR 24 lakhs in 8 years), which is 29.5% more than the electricity costs of semi-automated operations (INR 18.6 lakhs in 8 years) & 31.8% more than the electricity costs for manual sorting (INR18.3 lakhs in 8 years). The semi-automated machines don't consume large amounts of electricity explaining the minimal difference between the electricity costs of manual sorting & semi-automated operations. Further, Automated operations also have the lowest rent costs (INR 36.92 lakhs in 8 years) while manual sorting & semi-automated operations have a similar rent cost of INR 42.55 lakhs in 8 years. This is because the fully-automated sorting machine utilises a fixed amount of space, which is lesser when compared to the space required for sorting by colour & material compositions in manual sorting & semi-automated operations.

The operating costs would have been significantly lower in an informal setup that usually does not have proper wages and working conditions for workers. Hence, setting up of these formalised sorting hubs does add to the operating cost but also enables better waste value valorisation and social benefits for workers.

REVENUE

More than 80% of the revenue comes from rewearables and 'reusable' materials in all cases, however, the use of technology doubles the revenue coming from recyclable materials.

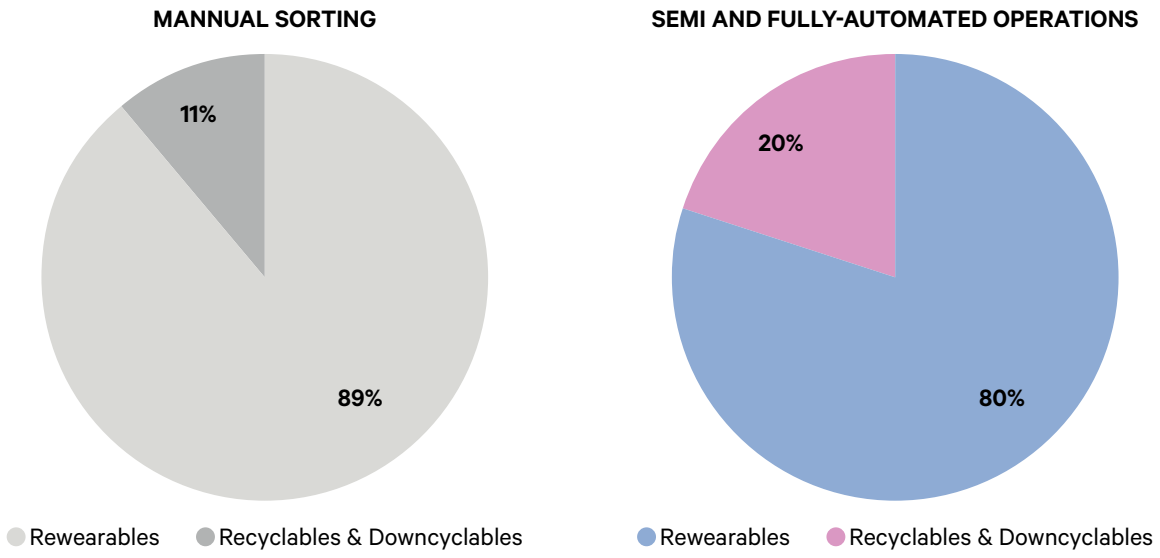


Illustration 9: Share of the revenue earned by a sorting hub

A sorting hub of PCD textile waste earns revenue from the sales of rewearables, recyclables/ downcyclable waste, and disruptors while they have to bear the cost of incineration of leftovers.

For the business case assessment, the following key assumptions regarding revenue have been made:

1. The price of high-grade rewearables obtained by sorters is INR 200 per kg while the price for low-grade rewearables is INR 20 per kg.
2. Recyclables have been divided into high-grade recyclables (sold between INR 20 and INR 100 per kg), low-grade recyclables (sold between INR 5 and INR 15 per kg), and downcyclable waste (sold at INR 5 per kg).
3. Disruptors are resold at INR 35 per kg. Sellable disruptors form only 10% of the total recyclable waste.*
4. The sorting hubs have to bear a cost of INR 7 per kg for the incineration of rejected waste materials.
5. The rate of price increase for all categories of sorted waste is assumed to be 5% per annum

Revenue from semi-and fully-automated operations is estimated to be equal to INR ~4.2 crores which is 11.7% higher than the revenue generated from the manual sorting processes. This is because the revenue earned from recyclable/downcyclable materials has doubled in this case from INR 42.2 lakhs to INR 86 lakhs. The credible identification of material composition enables sorting hubs to unlock premium pricing for high-quality waste such as 100% cotton. A detailed breakdown of the revenue splits has been provided in Illustration 9.

However, the revenue split changes only marginally due to the increased earnings. The larger share of revenue continues to come from the rewearables and reusable sections. In the absence of a formalised setup, the entire revenue would have come from the rewearables market only and would have been around ~INR 3.4 crores.

This scenario can change in the future as the market for recyclable materials strengthens and other material compositions such as blends, polyester-rich materials, etc find higher acceptability. This has been further explored in the Scenario Analysis section (Scenario 5) of this report.

* According to the pilot results, ~56% of the recyclable materials were found to be disruptors. Out of this ~82% were found to be waste and print material (including seams, prints, applique, etc.). Hence only ~18% of the disruptors had a resale value. The resale value differs by type of disruptor with brass-based materials soaring as high as ~INR 300/kg and plastic-based materials sold at ~INR 5-7/kg. Average price of ~INR 35/kg is taken for modelling purposes.

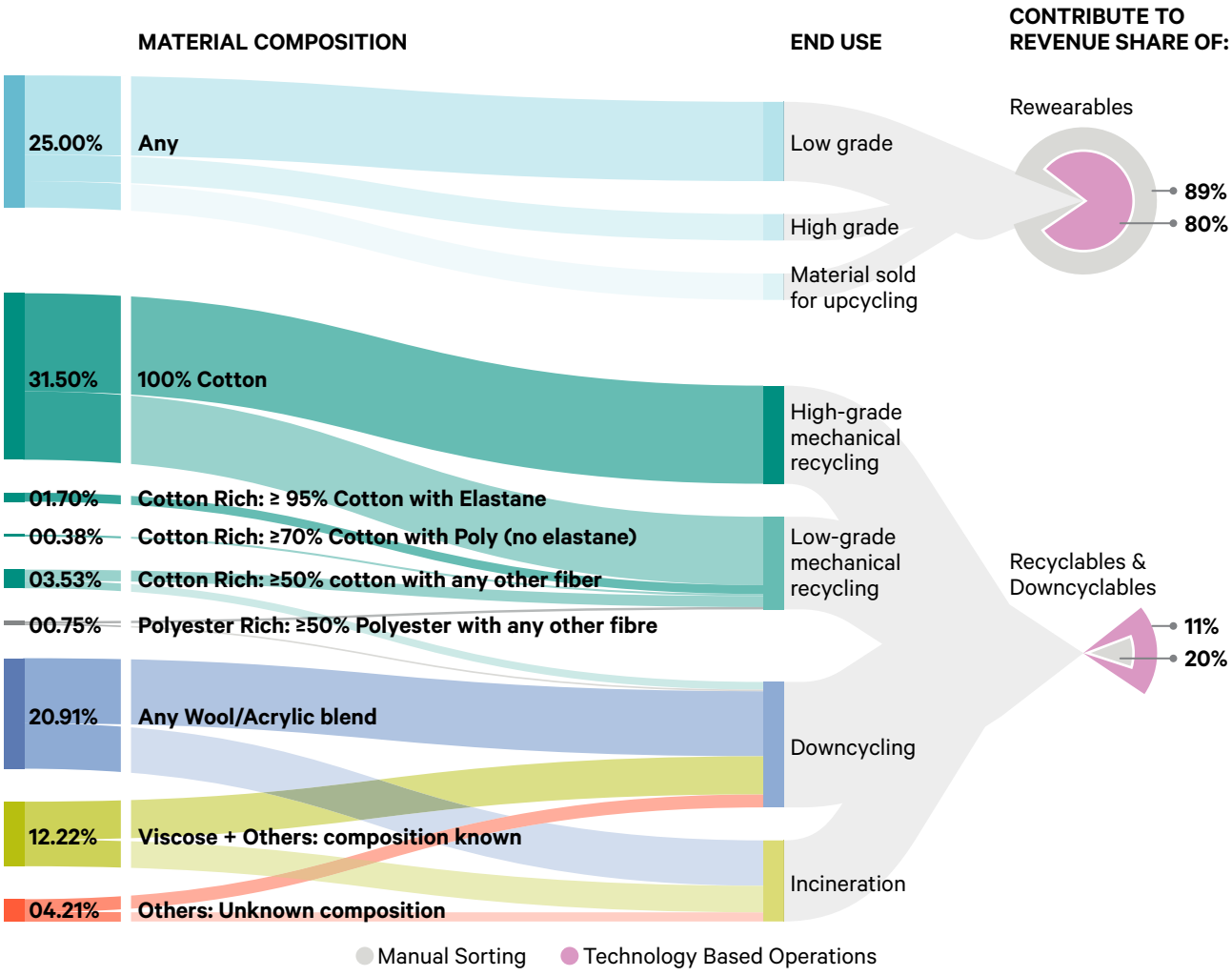


Illustration 10 (all figures in INR): Revenue distribution as per material composition

PROFITS AND CASH FLOW

None of the three sorting types proved to be profitable in 8 years of operation. The fully-automated operations proved to be the least profitable with a loss of INR 6.42 crores in 8 years, owing to the high depreciation costs involved. Semi-automated operations generated a loss of INR 3.97 crores in 8 years while manual sorting generated a loss of INR 2.23 crores in 8 years. Each year resulted in an increasingly negative cash outflow situation. A grant requirement of 2.2 crores in the case of PICVISA and 3.2 crores in the case of Fabritell Matoha technology was estimated to sustain the business for 8 years, despite a 100% tech subsidy.

Particulars	Manual Sorting	Semi-Automated Operations	Fully-Automated Operations
Income from Operations	3,76,04,698	4,18,19,211	4,18,19,211
Total Revenue	3,76,04,698	4,18,19,211	4,18,19,211
Expenses:			
Cost of raw material (purchasing cost)	52,05,845	52,05,845	52,05,845
Labour Costs	4,23,94,416	6,03,67,978	2,85,45,651
Rent	42,55,929	42,55,929	36,92,544
Electricity	18,28,198	18,60,825	24,09,769
Transportation	21,30,797	21,30,797	21,30,797
Maintenance Costs	0	1,65,211	85,69,370
Facility Overhead	4,25,593	4,25,593	3,69,254
Miscellaneous	28,12,039	37,20,609	26,14,247
Total Operating Expenses	5,90,52,817	7,81,32,788	5,34,69,392
EBITDA	-2,14,48,119	-3,63,13,576	-1,16,50,181
Depreciation & Amortisation	3,72,820	14,43,494	2,54,20,348
Interest	4,89,744	18,95,865	2,71,37,633
Total Expenses	5,99,15,381	8,14,72,148	10,60,27,372
Profit before Tax	-2,23,10,683	-3,96,52,936	-6,42,08,161
Tax	0	0	0
Profit after Tax	-2,23,10,683	-3,96,52,936	-6,42,08,161
Capital Expenditure (CAPEX)	9,33,752	45,47,739	5,02,54,875
Investment Needed over 8 years (Capital Infusion excluding Bank Loans)	2,50,00,000	4,00,00,000	9,20,00,000
Payback Period	No payback in the first eight years of operations		

Illustration 11: Profit & Loss Statement under the three sorting methods (all figures in INR)

Scenario Analysis

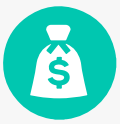
PARAMETERS	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4	SCENARIO 5
	Increased Daily Capacity to 7000 kg & growth rate reduced to 10%	High Price for Rewearables (upto INR 2100/kg)	High Price for Rewearables & Cost of Waste doubling in last 5 years	High Price for Rewearables, High Cost of Waste & Reducing Revenue from Sorted Waste (5% y-o-y)	Low Price of Rewearables & Increasing Revenue from certain Sorted Waste
 **PROFITABILITY**	Profitable for fully automated sorting technology second year onwards.	All sorting models were found to be profitable under this scenario with manual sorting being the most profitable method.	All three sorting methods are profitable under this scenario, with manual sorting being the most profitable.	All three models of sorting are profitable under this scenario with manual sorting generating the highest profits.	None of the three sorting methods were found to be profitable in this scenario even though the loss % was found to be decreasing over time.
 **REVENUE**	826% higher than current scenario for manual sorting as well as technology sorting operations.	625% higher than current scenario for manual sorting & 562% higher for technology based sorting operations.	625% higher than current scenario for manual sorting & 562% higher for technology based sorting operations.	389% higher than current scenario for manual sorting & 346% higher for technology based sorting operations.	4% higher than current scenario for manual sorting & 1% higher for technology based sorting operations.
 **INVESTMENT REQUIREMENT (OVER 8 YEARS)**	None required for fully automated sorting technology and above INR 10 Cr needed for others.	None needed.	None needed.	INR 10 lakhs needed for fully automated sorting technology. None needed for others.	INR 9.1 Crores needed for fully-automated sorting technology while INR 4.5 crores needed for semi-automated technology.
 **PAYBACK PERIOD**	Payback in 8 years for fully-automated technology and no payback in 8 years for others.	Payback in 1 year for Manual and Semi-automated and 5 years for fully- automated technology.	Payback in 1 year for Manual and Semi-automated and 5 years for fully- automated technology.	Payback in 1 year for Manual and Semi-automated and 6 years for fully- automated technology.	No payback in 8 years.
 **ECOSYSTEM SUPPORT REQUIRED**	Significant ecosystem development, especially around the collection mechanisms.	Development of a strong rewearables market & increased awareness amongst the public.	The increasing cost of waste can be absorbed by a strong rewearables market.	A strong rewearables market can absorb both high cost of waste & reducing revenue from sorted waste.	This model in conjunction with Extended Producer Responsibility might be sustainable.

Illustration 12: Scenario Analysis

SCENARIO 1: INCREASED DAILY CAPACITY

Particulars	Manual Sorting	Semi-Automated Operations	Fully-Automated Operations
Operational Expenditure	₹ 44,47,15,335	₹ 62,93,80,271	₹ 19,91,69,678
Capital Expenditure (CAPEX)	₹ 50,56,868	₹ 3,28,22,949	₹ 10,32,31,166
Revenue	₹ 34,83,58,938	₹ 38,74,32,980	₹ 38,74,32,980
Earnings before Interest, Tax, Depreciation & Amortisation (EBITDA)	₹-9,63,56,397	₹-24,19,47,291	₹ 18,82,63,301
Profit after Tax (PAT)	₹-9,95,17,628	₹-26,77,60,354	₹ 6,98,02,692
Investment Needed over 8 years (Capital Infusion excluding Bank Loans)	₹ 11,70,00,000	₹ 27,50,00,000	Not Required
Payback Period	No payback in 8 years of operations		8 years

Illustration 13: Key numbers for Scenario 1

CONTEXT

As discussed in the previous sections, there might be bigger sorting hubs that can potentially be established at a city or state level to unlock economies of scale. This scenario considers a significantly large sorting hub with a daily capacity of 7,000 kg (roughly 10 times of a regular sorting hub described in the previous section). The growth rate at which the sorter's annual operational capacity is increasing reduces to 10% from 20% in this scenario as growth is expected to subside when the quantum of waste handled increases. This capacity is also considered the optimum capacity for operating a fully automated technology such as PICVISA. All other assumptions for the modelling have been kept constant in this scenario.

FINANCIAL ANALYSIS

The model was found to be profitable for the fully automated sorting technology second year onwards, being able to generate an accumulated profit after tax of INR 6.98 crores in 8 years. No capital infusion is required across the 8 years except bank loans. However, neither semi-automated nor manual sorting methods saw a profit in this scenario.

The revenue generated in fully automated and semi-automated technologies is approximately the same and 11.5% higher than the revenue generated by manual sorting. The lowest operating cost is also attributable to automated operations (INR 19.92 crores in 8 years), owing to the significantly reduced worker requirement despite the increase in electricity and maintenance costs for the machine. Semi-automated operations have the highest operating cost in this scenario,i.e., INR 62.94 crores in 8 years, owing to the increased labour requirement for semi-automated machines, a marginal increase in electricity

cost and facility maintenance cost. The operating cost for manual sorting was estimated to be around INR 44.5 crores for 8 years.

The capital expenditure for automated operations increases to INR 10.3 crores in 8 years as two PICVISA machines are required to handle the increased quantum of waste. The capital expenditure for semi-automated operations increases to INR 3.28 crores in 8 years and INR 50.56 lakhs for manual sorting.

CONCLUSION

Economies of scale were found to work in the case of fully automated technologies that can handle large quantities with increased efficiency. However, the realisation of this scenario would require significant ecosystem development, especially around the collection mechanisms. Further collective business models will have to be sought to set up centralised units for sorting the PCD waste generated in a large city/district/state.

SCENARIO 2: STRENGTHENED REWEARABLES MARKET

Particulars	Manual Sorting	Semi-Automated Operations	Fully-Automated Operations
Operational Expenditure	₹ 5,90,52,817	7 ₹,81,32,788	₹ 5,34,69,392
Capital Expenditure (CAPEX)	₹ 9,33,752	₹ 45,47,739	₹ 5,02,54,875
Revenue	₹ 27,26,82,343	₹ 27,68,96,856	₹ 27,68,96,856
Earnings before Interest, Tax, Depreciation & Amortisation (EBITDA)	₹ 21,36,29,526	₹ 19,87,64,069	₹ 22,34,27,464
Profit after Tax (PAT)	₹ 17,27,85,183	₹ 14,65,68,532	₹ 12,81,52,113
Investment Needed (Capital Infusion excluding Bank Loans)	Not Required	Not Required	Not Required
Payback Period	1 year	1 year	5 years

Illustration 14: Key numbers for Scenario 2

CONTEXT

During the pilot, stakeholders received quotes of INR 700+ per piece for rewearables but the size of this market could not be ascertained, hence this was not considered in the business case analysis. However, a potential case for such a market exists in the wake of the rising thrift culture in the West and India. Therefore, in this scenario, the price of high-quality rewearables has been assumed to be INR 700 per piece, i.e., 2100 per kg for high-quality rewearables and the price of low-grade rewearables remains the same at INR 20 per kg. All other assumptions for the modelling have been kept constant*.

* Capacity and growth rate of the sorting hub has been kept constant at the base level, i.e., 600 kg/day with a growth rate of 20% annually.

FINANCIAL ANALYSIS

All sorting models were found to be profitable under this scenario with manual sorting being the most profitable method because of averaged-out operating costs and capital expenditures. Manual sorting generated a profit after tax of INR 17.3 crores which is 18% higher than the profit from semi-automated operations and 35% higher than the profit from automated operations.

On the contrary, the highest revenue is generated by automated operations and semi-automated operations (approx INR 27.7 crores in 8 years) which is marginally higher (1.5% higher) than the revenue from manual sorting (INR 27.3 crores in 8 years).

The highest operating cost was found to be borne by semi-automated operations (INR 7.8 crores in 8 years), owing to increased labour requirements for Matoha, a marginal increase in electricity cost and facility maintenance cost. This is followed by operating costs for manual sorting (INR 5.9 crores in 8 years) which is 24.4% lower than the operating costs for semi-automated operations. Automated operations have the lowest operating costs (INR 5.35 crores in 8 years) owing to the reduced worker requirement. However, additional costs on machine maintenance do get added bringing it almost equal to the operating cost for semi-automated operations. Despite the operating efficiencies and high revenue provided by the fully automated technologies, its profitability was found to be lower than manual sorting methods due to the high depreciation and interest involved with the capital expenditure.

The capital expenditure remains the same as the business case analysis, i.e., INR 5.03 crores for automated operations, INR 45.5 lakhs for semi-automated operations, and INR 9.3 lakhs for manual sorting. However, due to increased profits coming in from the sales of rewearables, no capital infusion is required across the sorting methods. Adding to this, the massive capital investment required in the case of automated operations is also recovered in the fifth year of operations.

CONCLUSION

This scenario can be ideal for manual sorting due to averaged-out operating and capital expenditures. The scenario also highlights the necessity of developing a strong rewearables market within the country as it would make all three sorting methods profitable and hence the sorting of PCD waste can be termed economically sustainable. Building this market would also require increased awareness amongst consumers about rewearables in-line with the rising thrift culture in India.

SCENARIO 3: HIGH PRICE OF REWEARABLES WITH HIGH COST OF WASTE

Particulars	Manual Sorting	Semi-Automated Operations	Fully-Automated Operations
Operational Expenditure	₹ 9,02,70,538	₹ 10,93,50,509	₹ 8,46,87,113
Capital Expenditure (CAPEX)	₹ 9,33,752	₹ 45,47,739	₹ 5,02,54,875
Revenue	₹ 27,26,82,343	₹ 27,68,96,856	₹ 27,68,96,856
Earnings before Interest, Tax, Depreciation & Amortisation (EBITDA)	₹ 18,24,11,805	₹ 16,75,46,348	₹ 19,22,09,743
Profit after Tax (PAT)	₹ 14,43,65,706	₹ 12,31,55,241	₹ 10,47,38,822
Investment Needed (Capital Infusion excluding Bank Loans)	Not Required	Not Required	Not Required
Payback Period	1 year	1 year	5 years

Illustration 15: Key numbers for Scenario 3

CONTEXT

Stakeholders highlighted that as the consumers and brands become aware of the inherent value of PCD textile waste, sorters will have to provide incentives to collect this material. Therefore, in this scenario, while the price of rewearables is assumed to be INR 2100 per kg for high-quality rewearables and INR 20 per kg for low-quality rewearables, the cost of purchasing waste has been considered higher. It is assumed to be zero for the first two years of operations and starts doubling after the third year, starting at INR 3 per kg and going up to INR 48 per kg. All other assumptions for the modelling have been kept constant.

FINANCIAL ANALYSIS

All three sorting methods are profitable under this scenario, with manual sorting being the most profitable (INR 14.4 crores in 8 years), followed by semi-automated operations (INR 12.3 crores). The least profitable method was found to be automated operations (INR 10.47 crores in 8 years). However, the profit % for semi-automated and manual sorting methods was found to be decreasing over the 8 years. It is to be noted that the low profitability of fully automated operations is due to high depreciation and interest costs (INR 5.26 crores in 8 years). If the operating profits (EBITDA) for the three sorting methods are compared, fully automated operations are found to be the most profitable.

This was largely because all three sorting types witnessed an increase in operating costs with semi-automated operations experiencing the highest operating expenditure (INR 10.9 crores in 8 years), which is 20.7% higher than the operating costs for manual sorting and 28.7% higher than the operating costs for automated operations. This is because the increased cost of purchasing waste adds to the already high labour costs under semi-automated operations.

The revenue under this scenario remains the same as under the previous scenario, i.e., INR 27.7 crores for fully and semi-automated operations and INR 27.3 crores for manual operations. Also, the capital expenditure remains the same as the business case analysis, i.e., INR 5.03 crores for automated operations, INR 45.5 lakhs for semi-automated operations, and INR 9.3 lakhs for manual sorting. No capital infusion is required in any sorting method, while capital investments are recovered in the sixth year of operations for automated sorting.

CONCLUSION

While the operating costs are higher under this scenario due to the increased cost of purchasing waste, this scenario is still profitable for all three sorting methods, especially for manual sorting. Thus, the increasing cost of waste can be absorbed by a strong rewearables market, again making the case for strengthening the rewearables market.

SCENARIO 4: HIGH PRICE OF REWEARABLES WITH Y-O-Y REDUCING PRICE FOR RECYCLABLE OUTPUT

Particulars	Manual Sorting	Semi-Automated Operations	Fully-Automated Operations
Operational Expenditure	₹ 9,02,70,538	₹ 10,93,50,509	₹ 8,46,87,113
Capital Expenditure (CAPEX)	₹ 9,33,752	₹ 45,47,739	₹ 5,02,54,875
Revenue	₹ 18,39,16,404	₹ 18,67,82,551	₹ 18,67,82,551
Earnings before Interest, Tax, Depreciation & Amortisation (EBITDA)	₹ 9,36,45,866	₹ 7,74,32,043	₹ 10,20,95,439
Profit after Tax (PAT)	₹ 7,06,74,334	₹ 5,54,88,040	₹ 3,71,53,094
Investment Needed (Capital Infusion excluding Bank Loans)	Not Required	Not Required	₹ 10,00,000
Payback Period	1 year	1 year	Payback seen in the 6th year

Illustration 16: Key numbers for Scenario 4

CONTEXT

During the stakeholder interviews, recyclers highlighted that the price paid to sorters for the sorted waste was expected to decrease as the collection of post-consumer waste gets more structured and additional support comes into the sector. This scenario is an extension of the previous scenario where the price of rewearables is assumed to be INR 2,100 per kg for high-quality rewearables and INR 20 per kg for low-quality rewearables and the cost of purchasing waste starts doubling after the third year. Additionally, in this scenario, it is also assumed that the price of selling the sorted waste is reduced by 5% on an annual

basis for the first 5 years till the market achieves stability. Post these 5 years, the prices have been modelled to stay constant without an increase or decrease. The decrease has been modelled for 5 years as technology infusion and disruptions in this market are expected to continue for another 5-7 years till a consensus among all stakeholders is achieved on how this space should run. All other assumptions for the modelling have been kept constant.

FINANCIAL ANALYSIS

All three models of sorting are profitable under this scenario with manual sorting generating the highest profits, i.e., INR 7 crores in 8 years, which is 27% more than the profits generated by semi-automated operations and ~90% more than the profit generated by automated operations. The profit reduction is significant in the case of automated operations as the revenue has gone down but the depreciation and interest costs remain the same, leading to reduced profits. When operations profits for the three sorting methods are compared, fully automated operations are found to be the most profitable.

The highest revenue in this scenario is generated by automated and semi-automated operations (INR 18.67 crores in 8 years) which is marginally higher than the revenue generated by manual sorting (INR 18.4 crores in 8 years). The highest operating costs are incurred by semi-automated operations (INR 10.9 crores in 8 years) which is ~21% higher than the operating cost of manual sorting (INR 9.03 crores in 8 years) and ~29% higher than the operating cost of automated operations (INR 8.47 crores in 8 years).

The capital expenditure remains the same as the business case analysis, i.e., INR 5.03 crores for automated operations, INR 45.5 lakhs for semi-automated operations, and INR 9.3 lakhs for manual sorting. No capital infusion would be required in manual sorting and semi-automated sorting for this scenario. For automated sorting, the payback period might be longer than 8 years if no subsidy is provided. A capital grant of ~INR 10 lakhs shall be required over 8 years to sustain the model if no tech subsidy is available.

CONCLUSION

This model is a highly probable scenario once the PCD waste industry evolves in India. With limited or no technology upgrades, the price for recyclable and downcyclable waste is expected to reduce. A well-developed rewearables market can absorb the increase in the cost of purchasing waste as well as a reduction in the price of other waste materials for some time and if there are no further changes in the cost of procuring and selling waste, the model shall sustain itself with a decent profit being generated annually. The scenario highlights the need to strengthen all types of markets for sorted waste to ensure a self-sustainable model.

SCENARIO 5:
INCREASE IN BLENDED FABRIC IN WASTE AND THE ADVENT OF ADVANCED RECYCLING TECHNOLOGIES

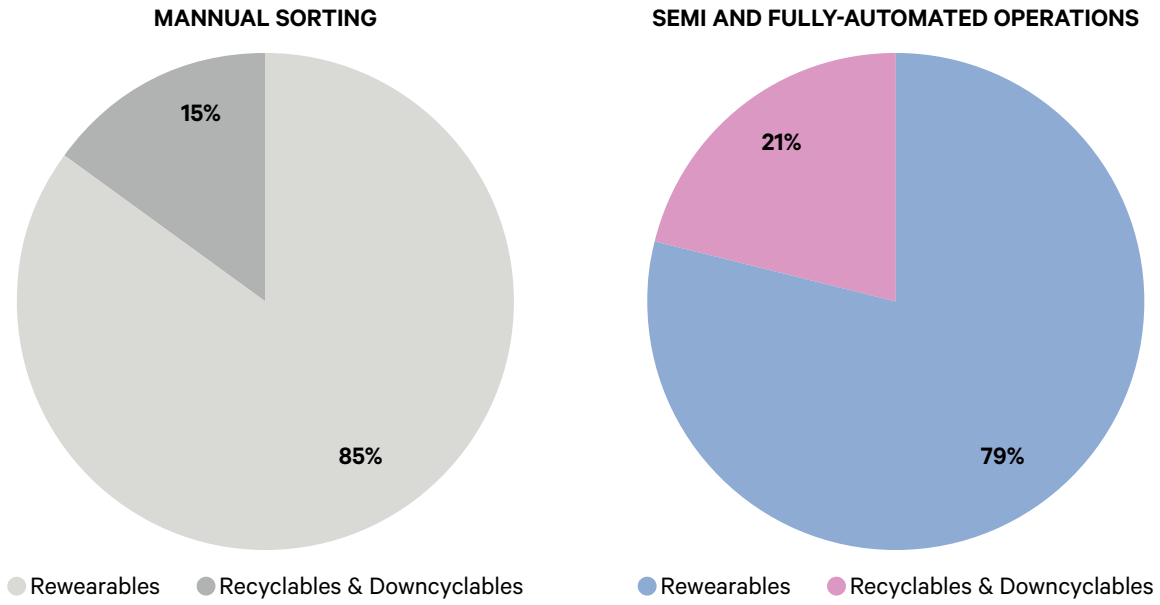


Illustration 17: Share of the revenue earned by a sorting hub for Scenario 5

Particulars	Manual Sorting	Semi-Automated Operations	Fully-Automated Operations
Operational Expenditure	₹ 5,82,97,940	₹ 7,81,32,788	₹ 5,34,69,392
Capital Expenditure (CAPEX)	₹ 9,33,752	₹ 45,47,739	₹ 5,02,54,875
Revenue	₹ 3,92,07,561	₹ 4,21,99,592	₹ 4,21,99,592
Earnings before Interest, Tax, Depreciation & Amortisation (EBITDA)	₹-1,90,90,379	₹-3,59,33,196	₹-1,12,69,800
Profit after Tax (PAT)	₹-1,99,52,943	₹-3,81,20,575	₹-3,95,97,980
Investment Needed (Capital Infusion excluding Bank Loans)	₹ 2,50,00,000	₹ 4,50,00,000	₹ 9,10,00,000
Payback Period	No payback in 8 years of operations		

Illustration 18: Key numbers for Scenario 5

CONTEXT

The changing tastes & preferences of the consumers including the rise in demand for polyester blends in garments and the advent of advanced technologies for recycling certain materials also need to be taken into consideration. Therefore, under this scenario, the material composition has been changed significantly to ensure that cotton and polyester blends form the highest share within the feedstock. Further, the selling price of the sorted material (output) going to low-grade mechanical recycling and

downcycling (except acrylics) has been estimated to increase by 10%-20% (case by case basis) on an annual basis due to expected innovations in recycling technologies (eg. chemical recycling technologies for polyester and its blends) while the selling price for all other materials has been estimated to grow at the rate of 5% on an annual basis. The price of rewearables has been assumed to be 200 INR per kg for high-quality rewearables and INR 20 per kg for low-quality rewearables. The cost of purchasing waste is increasing at a rate of 5% on an annual basis starting from the third year. All other assumptions for the modelling have been kept constant.

FINANCIAL ANALYSIS

None of the three sorting methods were found to be profitable in this scenario even though the loss % was found to be decreasing over time. The least loss is incurred in manual sorting (INR 2 crores in 8 years), while the losses in semi-automated operations (INR 3.81 crores in 8 years) and in automated operations (INR 3.96 crores) are almost double the loss in manual sorting. Though the modelling was not done beyond 8 years, this model holds the potential to become profitable in a slightly longer period as the prices of recyclable waste soar. This can be said as the revenue of recyclable materials has increased by INR 3.8 lakhs in this scenario as against the current scenario discussed in the Business Case Analysis section of this report. As this revenue grows further post-2030, the system might be able to sustain itself.

The highest operating expenditure is incurred in semi-automated operations (INR 7.8 crores in 8 years) which is 33.8% higher than the operating costs for manual sorting and 45.8% higher than the operating costs for automated operations. The highest revenue in this scenario is generated by automated and semi-automated operations (INR 4.2 crores in 8 years) which is 7.1% higher than the revenue generated by manual sorting.

The capital investment remains the same as the business case analysis, i.e., INR 5.03 crores for automated operations, INR 45.5 lakhs for semi-automated operations, and INR 9.3 lakhs for manual sorting. In the case of manual sorting, an INR 2.5 crores grant/capital infusion would be required to make the business sustainable for 8 years. For semi-automated operations, without any subsidy, a grant of INR 4.5 crores will be needed, while for fully-automated operations, a capital infusion of INR 9.1 crores might be required over 8 years. The capital infusion requirement for fully automated sorting operations is expected to reduce to INR 2 crores in case a 100% tech subsidy is provided.

CONCLUSION

In this scenario, about 58% of the collected PCD waste is getting pushed to a higher quality value valorisation because of the technology. At an industry level, this means 2,287 ktonnes of waste annually and 29% of the total textile waste in India. While the model is not sustainable without a strong rewearables market and despite the spike in the price of waste and change in compositions, this model is great from a sustainability aspect as it pushes 58% of waste up the value hierarchy. This model in conjunction with Extended Producer Responsibility might be sustained in the long term in India.

Challenges and Opportunities

CHALLENGE	OPPORTUNITY
Adequate Collection Systems	
• Strong and scalable collection systems needed for formalised sorting hubs • Standardised practices for disposal and source segregation of waste are required	• Awareness regarding proper disposal of PCD waste needs to be spread amongst the mass public. • Innovative collection models need to be implemented by brands to have a higher influence on consumers
Markets for Sorted Materials	
• Sorting Hubs are unable to find adequate markets for their output materials	• Extensive ecosystem support shall be required to not only make these markets more accessible but also enhance their scale and acceptability.
Sorting Technologies	
• Challenges related to maintenance, heating issues and elastane identification • Fully-automated technologies require an industrial set-up due to the heavy machinery and high electricity consumption.	• Improvement in the technologies • Local partnerships for its installation and maintenance are required. • Investments in upskilling and safety and compliances
Waste Quality	
• The quality of PCD waste in India is generally low because garments in India are used multiple times	• Proper care of clothes during their lifetime and proper collection systems can ensure that the life of clothes is long and the end-of-life value is also retained.
Financing	
• Heavy investments will be required across different scenarios to help PCD waste sorting hubs to sustain their business	• Government subsidy on technologies and blended finance models providing low interest finance can be explored to support these formalised sorting hubs.

Illustration 19: Challenges & Opportunities

ADEQUATE COLLECTION SYSTEMS

Indian textile waste management value chains have developed significantly for the pre-consumer waste segment, however, the value chain for post-consumer waste continues to remain traditional. Collection of this waste typically happens through community collection, donations or garbage bins with a very small share moving through segregated and formalised waste value chains. Irrespective of the sorting method adopted, setting up formalised sorting hubs and PCD waste management value chains would require strong and scalable collection systems. Standardised practices for disposal and source segregation of waste would be required to avoid unhygienic and soiled waste from reaching the sorters and recyclers. This would also help in increasing the inherent value of waste and its recycling potential.

Efforts at all levels of the value chain would be required to strengthen these systems. Awareness regarding proper disposal of PCD waste needs to be spread amongst the mass public. Innovative collection models such as monitored community bins, brand take-back programs, community collection drives, etc. need to be implemented to ensure the PCD textile waste reaches the sorters in good condition. Given the high influence potential, brands can play an important role in this process by creating awareness campaigns, setting up take-back systems and overall nudging the consumer behaviour change. need to play a proactive role in the entire value chain. Brands can push marketing for take-back programs to increase the collection of PCD textile waste as they will gain more traction compared to sorters.

MARKETS FOR SORTED MATERIALS

Sorting Hubs are unable to find adequate markets for their output materials which is causing them to sell the products at lower prices than expected. There are three levels of challenges associated with this market:

- For rewearables, there is a strong second-hand market available in the country. However, this market accepts the garments at a low price of INR 10-30 per kg. Existing markets such as Janpath and Sarojini (both in Delhi) have a mix of second-hand and new materials available at lower prices. Additionally, platforms such as Meesho offer new garments at competitive prices. Consequently, the perceived value of purchasing second-hand materials may not be clearly defined among consumers. Selling second-hand materials is more valuable in a community-like set-up. The high-quality rewearables market is still at a nascent stage in the country as the thrift culture is yet to be widely accepted and established in the country. This limits the revenue potential of high-quality rewearables.
- For recyclable materials, higher returns can be realised only for white cotton material as that can be recycled into high-quality yarns. Due to the lack of advanced chemical recycling technologies, blends and polyester-rich materials that are also projected to grow faster than cotton in the future, have lower acceptability and returns in the recycling value chain.
- The second-hand disruptor market is not widely accessible to all stakeholders. It is present only in small pockets and is not expected to be standardised in their operations.

The business assessment highlights that the revenue for sorting hubs is a function of all the different types of materials that can be sold by these units. Hence, for the feasibility of these units, extensive ecosystem support shall be required to not only make these markets more accessible but also enhance their scale and acceptability.

SORTING TECHNOLOGIES

Challenges with sorting technologies are present at two levels. Firstly, the installation and maintenance of the machines seem difficult for the sorting hubs as they are being purchased from other countries. During the pilots, challenges such as overheating of Fabritell Matoha machines and hardware failure were observed which required the machines to be shipped back to the source country for repair purposes. Further, both the sorting technologies faced challenges in identifying elastane composition which is known to be commonly present in garments these days and is known to hinder the process of recycling. Both these concerns point towards the need for further improvement in the technologies and local partnerships for its installation and maintenance.

The second challenge with especially fully automated sorting technologies, such as PICVISA, is that they require an industrial set-up due to the heavy machinery and high electricity consumption. Currently, sorters do not have adequate space, mechanical installations, and skilled labour to deal with automated machinery and hence the adoption of this technology might require a bit longer. Sorters will be required to skill their workers to operate the machinery and & will also have to invest in safety and compliance when dealing with these technologies and the associated quantum of waste. Further, the sorting hub representatives also suggested that for the economically viable scale of this technology, they will have to optimise the collection and manual processes which will also take some time for them.

Overall, the stakeholders suggested that while they are willing to adopt these technologies, they might not be taken up immediately as the other constraints will have to be resolved.

WASTE QUALITY

Recyclers suggested that the quality of PCD waste in India is generally low with a limited recycling potential. This is primarily because of two reasons. Firstly, the garments are made from blended materials which are hard to recycle with the given technologies. Secondly, even for pure compositions, the strength of the fibres in Indian garments is usually low because of multiple usages and washes. This problem continued to persist despite formalised collections and mechanised sorting methods.

From a waste value perspective, this is a good attribute of the Indian consumer mindset because it ensures the reuse and elongated life of the garments. While this culture needs to be promoted, additional awareness can be created around improving the care of clothing. Proper care of clothes during their lifetime including washing, abrasion, storage and other maintenance aspects can further ensure that the life of clothes is long and the end-of-life quality is also retained. Additionally, more focus needs to come from brands for designing the products for end-of-life as well.

FINANCING

As discussed in previous sections, setting up formalised sorting hubs for textile waste requires additional capital investment irrespective of the sorting method adopted. In many of the cases, bootstrapping might not be possible as the investment requirements are in a few crores and across the eight-year timespan.

Hence to ensure better waste valorisation and the sustenance of the business models, external funding will become necessary.

The funding requirement can be fulfilled in multiple ways. The study also explored the potential of government subsidies for procuring sorting technologies. However, beyond that other debt, grant and potentially blended finance models can also be explored that enable the sorting hubs to access low-interest finances. Once the ecosystem achieves a level of stability with an adequate maturity of the markets for each of the sorted waste streams, payback and ROI on these investments can also be drawn by the investors.