YUNUS ENVIRONMENT HUB

Evaluation of Circularity Innovations Ecosystem in Solid Waste Management System of Bengaluru

Baseline Report

28/12/2023

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II. List of Abbreviations

ACTREC -	Advanced Centre for Treatment, Research and Education in Cancer
ADB –	Asian Development Bank
AI –	Artificial Intelligence
AICCTU –	All India Central Council of Trade Union
AMU –	Automatic __ Unit
BBMP –	Bruhat Bengaluru Mahanagar Palike
B2B –	Business to Business
BIG –	Biotechnology Ignition Grant
BIRAC -	Biotechnology Industry Research Assistance Council
BMP –	Biomethanation Plant
BSF –	Black Soldier Fly
BWGs –	Bulk Waste Generators
CAIF –	Circular Apparel Innovative Factory
CCRA –	Clean City Recyclers Association
CPCB –	Central Pollution Control Board
CPHEEO –	Central Public Health and Environmental Engineering Organization
CSR –	Corporate Social Responsibility
DWCC –	Dry Waste Collection Centre
EoI –	Expression of Interest
EPR –	Extended Producer Responsibility
EY/ E&Y –	Ernst and Young
GoI –	Government of India
GPS –	Global Positioning System
GST –	Goods & Services Tax
IAWP –	International Alliance of Waste Pickers
ICSSR –	Indian Council for Social Science Research
IGG –	I Got Garbage
IoT –	Internet of Things
KCDC –	Karnataka Compost Development Corporation
KPSCB –	Karnataka State Pollution Control Board
LDPE –	Low Density Value Plastic
MLP –	Multi-Layered Plastic
MNC –	Multi National Corporation
MNRE –	Ministry of New and Renewable Energy
MRF –	Material Recovery Facility

MSME –	Micro, Small and Medium Enterprises
MSW –	Municipal Solid Waste
MSWM –	Municipal Solid Waste Management
MTPD –	Metric Tonnes Per Day
NEP –	National Environment Policy
NGO –	Non-Government Organizations
NSKFDC –	National Safai Karamcharis Finance and Development Corporation
PCC –	Pollution Control Committees
PET –	Polyethylene Teraphthalate
PIBO –	Producers, Importers, Brand Owners
PPP –	Public Private Partnership
PRISM -	Promoting Innovations in Individuals, Startups and MSMEs
PWM –	Plastic Waste Management
RDF –	Refuse Derived Fuel
RFID –	Radio Frequency Identification
RWA –	Resident Welfare Associations
SBIRI -	The Small Business Innovation Research Initiative
SCGJ –	Skill Council for Green Jobs
SPCB –	State Pollution Control Board
SUP –	Single Use Plastic
SWM –	Solid Waste Management
SWMRT –	Solid Waste Management Round Table
TPD –	Tonnes per Day
ULB –	Urban Local Body
UNDP –	United Nations Development Program
VAT –	Value Added Taxes
WWM&CS –	Waste Wise Management & Consulting Services

III. List of definitions

1. Circular Economy in SWM – Circular economy in SWM aims to reduce material waste, redesign materials, products and services to be less resource intensive and recapture waste as a resource to further manufacture products and services.

2. Formal Waste Workers – Those waste pickers who are integrated into the system and legally recognized with government identification cards like that of Aadhar card, ration card etc. Furthermore, some of them would work with organizations or the ULB, trained to manage the DWCCs of certain organizations, trained to use their digital applications.

3. Informal Sector Industry - An informal economy is part of any economy that is not taxed nor monitored by any form of government. It makes up for the significant part of economies in developing countries; yet the stakeholders within are stigmatized as unmanageable, troublesome and unsafe.

4. Informal Waste Pickers –Waste pickers who are yet to be integrated into the system and legally be recognized. These waste pickers are mostly migrants or those that belong to the lower castes in India, and lack the skills to effectively collect, manage DWCCs, transact waste to earn efficiently. They collect waste from the roads and bins in their clothes (not uniforms). They are also locally known as Kabadiwallas and Safai Saathis.

5. Aggregators – Key stakeholder in the waste supply chain that buys material from waste pickers and bulk generators of recyclable waste. To be viable, they must be able to store much larger volumes of recyclables, and so favour setting up shop on the periphery of the city. Greater specialisation with regards to material is typically found at this level, in terms of segregation and/or processing.

1. Executive Summary

The Circular Innovation Ecosystem baseline report seeks to inform EIT Climate KIC (CKIC) investment in the development of Bengaluru's circular economy ecosystem. In collaboration with SecondMuse (India), CKIC is to engage with diverse stakeholders within the city, facilitate the adoption of circular economy principles, enhance investments in the growth and expansion of circular innovations and as well build a community of practitioners that will bring together circular economy enablers in Bengaluru. skills, and solutions.

This baseline report profiles the Circularity Innovation Ecosystem in Bengaluru, focusing especially on waste management. It establishes a foundational understanding of this ecosystem by analysing general circularity indicators, examining prevailing entrepreneurial endeavours, identifying the various stakeholders involved, and scrutinizing the social, institutional, and market factors influencing it. The report also delves into the current obstacles and prospects for expansion, along with providing an overview of the key players within this burgeoning ecosystem.

The report combines primary and secondary data collection methods. It utilises a mix of literature reviews, stakeholder interviews, site visits and working sessions to gather data from the ecosystem stakeholders. The quantitative approach focuses on gathering waste management system data, while the qualitative aspect delves into understanding stakeholders, including incubators, start-ups, and the urban local body (ULB). Data collection involved leveraging pre-existing information from organizations like UNDP, GIZ and conducting 22 interviews, creating an exhaustive stakeholder list.

The report identifies several challenges and opportunities that are worth noting in the characterization of Bengaluru's circularity ecosystem. The key challenges identified are inefficiencies in the end-of-life processes leading to the diversion of organic waste to landfills, that should be sent to composting facilities. There is also lack of collaboration amongst ecosystem players, leading to ineffectiveness in waste management.

Lack of investment in the working conditions of the informal waste pickers was also identified as a key challenge, often exposing them to severe conditions leading to health concerns and other related complexities.

Due to the vast nature of Bengaluru as a city, the report does not capture all the possible views and interests of the different stakeholders. The scope is limited only to the key deliverables as specified in the terms of reference and thus the findings and outcomes of the report might not necessarily hold outside the scope as defined.

2. Research Methodology

2.1 Methodology and Data Sources

This section outlines the report objectives, along with the methodological approach and data sources used. This refers to the overall research design as well as respective steps of data collection and analysis.

2.1.1 Report objectives and outputs

- Characterize the circularity ecosystem in Bengaluru.
    - Description of different waste systems and a recommendation of which one could be the focus of the project.
    - Institutional and Regulatory Environment for waste management in Bangalore
    - Mapping of private and public stakeholders involved in the waste management ecosystem and their relationships.
- Status of living and working conditions of informal workers in the waste management system, and opportunities to improve their condition.
- Stakeholder Network Mapping: Identification of local resources, networks, and organizations that are or could become part of the innovation ecosystem.

2.1.2 Methodological approach

Research Design
The research follows an exploratory approach combining primary and secondary data collection methods. The team carried out a comprehensive literature review, stakeholder and expert interviews and working sessions with key actors in carrying out the research.

The applied quantitative approach enables the compilation of existing data and information on the waste management system, whereas the qualitative approach covered the human element of understanding the open-ended questions with the stakeholders such as incubators, start-ups, ULB etc.

Data Collection
There is a considerate amount of pre-existing data regarding solid waste management work done in Bengaluru. The key mode of data collection was secondary research from organizations such as UNDP, NSKFDC, GIZ, Saahas, Hasiru Dala, Sattva etc. were referred to.

From the primary data collection perspective, 22 interviews were conducted covering stakeholders like startups across plastic, organic, e-waste, tech development; support organizations, incubators, public bodies, companies, recyclers etc.
The exhaustive stakeholder list was created by reaching out to key stakeholders who introduced us to more players in the ecosystem.

We collected data from four major sources:
- Literature Review and Desktop research (14 Published academic articles and reports; 26 newspaper and websites articles)
- 22 Individual interviews
- Site visit to organic waste management facilities
- 2 Interactive workshops

In the following sections, each of the four major sources of data collection is briefly outlined:

Literature review and desktop research

An extensive review of the academic literature was conducted iteratively throughout the entire research project. This literature review covered the current state of the waste management sector in Bengaluru, data on organic and inorganic waste streams and the processing of such materials, current situation of the informal waste sector and identified is to improve their lives towards a just transition, understand the situation at the landfills, level of plastic pollution etc.

Additionally, we conducted desktop research from various online sources for information on local networks, ecosystems, Multinationals and other organizations in Bengaluru, across India and in the international context, identify potential interview candidates, and for inspiration from other geographies working on circular innovations for waste management.

Individual interviews

We conducted 22 interviews with various stakeholders including start-ups, incubators from the kick-off workshop, multinational CSR departments, consulting firms, incubator leaders, government officials and workers during site visit.

Over the course of our data collection phase, the expert interviews served the purposes of:

- Identifying willingness of multinationals to work with start-ups on circular waste management solutions.
- Understanding how incubators select cohorts, incubate and enable circularity in the ecosystem. We also received insights on circular innovation trends in waste management, and understood key challenges faced by start-ups working on circular waste management.
- Gaining insights from government officials on needs and aspirations for the SWM System.
- Understanding the methodology of organic waste management.
- Validating the core findings at a later stage of the research process (after interviews with stakeholders from the waste value chain have been conducted)

At the time of the baseline report submission, the interviews we conducted that complemented the data saturation analysis method. When similar themes were being covered by the interviews to that of the secondary data collected, the data was analysed and documented.

Site visit to waste management facilities

The exploration included a visit to the BBMP's composting facility and biomethanation plant in HSR Layout. The aim of the visit was to understand the on-ground reality vis-à-vis the reports read online regarding organic waste processing. The Karnataka Compost Development Corporation (KCDC) premises were subject to tight security, and the tour was conducted under the supervision of the KCDC auditor and another official.

Although BBMP has multiple facilities, access was granted for a visit to only one during the data collection phase. Efforts were made to explore DWCCs under BBMP's jurisdiction to gain insights into their management; however, permission for such visits was declined.

Interactive Workshops

In collaboration with Climate-KIC we held 2 interactive workshops, one on 11/10/2023 and another on 07/12/2023 with key stakeholders within the ecosystem of the SWM System.

The goal of the workshops was to understand the expectation of the key stakeholders, network and enable the players to support us in identifying the needs of the SWM ecosystem for ClimateKIC to step in.

Data Analysis

Primary and secondary data collection was done over a period of two months. The study employed data saturation analysis. Through this analysis method, we identified the themes that frequently cropped up against each stakeholder through the interviews, reports and other articles we referred to. The challenges and opportunities identified through the report were set against these themes.

The data collected were segmented into different stakeholders and the themes identified were done so using advanced Microsoft Excel; while the interconnectivity of the stakeholders was visualized through Kumu.

#	Stakeholder	Frequent Themes
1	Government Officials	- Organic Waste being the problem to be addressed - Inability to share data on inorganic waste. - Research to use only publicly available data
2	Consultants	- Inability to share research done and to use publicly available data. - Willingness to connect to newer reports. - Hesitance in connecting to various stakeholders
3	Incubators	- Internal Theme/ Theory of Change to identify the parameters for selection of Startups into Cohort - Challenge: Start-up struggle to raise funds post cohort incubation - Partial willingness to offer the network connectivity
4	Start-ups	- Need for funds: post incubation. There is a struggle to raise funds from Venture Capitalists if their gestation period for proof of concept is longer - Struggle to expand operations due to difficulty in collaborating with the government bodies - Need for connections to increase network for project scalability
5	Waste Pickers	- Initiatives taken to provide Waste workers with govt. IDs, suggest recommendations for policy inclusivity and facilitate social justice. - Waste Pickers' Social Stigma - Saamuhika Shakti: A movement for professionalization of Waste Pickers
6	MNCs	- Increase in Investments for Climate Action - Need for sustainability

Table 02: Identification of themes in Baseline Study

The above-mentioned categories of stakeholders were identified and mapped through interactions at the workshops, interviews and secondary research. The strength of the connections was understood as they were explicitly mentioned by the stakeholders involved, through other surveys or were identified through secondary research – that described the frequency of interaction.

The connections that were tagged strong were either on legally bound agreements for a long time, was of superior-subordinate nature or frequently interacted amicably. The connections that were tagged moderate were on contracts for a stipulated time. The relationships that were

tagged poor were identified through conversations with other stakeholders who suggested explicitly that the said organizations could not meet each other eye to eye.

2.2 Methodological Challenges

- Given the short timeline of the research report, it was difficult to secure interviews with many of the target stakeholders. As most contacts we had to reach without a personal introduction, especially with multinational CSR wings, we often did not receive a response.

- Accurate data regarding the volume of waste generated in cities remains elusive, and the available figures should be regarded as approximations at best. The numbers found in existing literature should be considered as estimates due to the inherent challenges within the waste industry. These challenges include the complexities arising from factors such as the scale of waste generation, the diverse mix of waste types, varying levels of moisture content, and the methods used for waste management. Consequently, the precise quantification of waste, encompassing municipal collection, processing, and informal recycling, is not conducted in a formal or precise manner.

- There is limited data available on the informal waste sector regarding the aggregators, workers and recyclers in the informal sector. We received limited access to data of the informal sector through documents shared by social enterprises such as Hasiru Dala, Saahas Zero Waste etc.

3. Introduction

3.1 Context Setting of Bengaluru

Bengaluru, a dynamic city nestled in the southeastern region of India, confronts a formidable waste management predicament. This sprawling metropolis encompasses 8 zones, 198 wards, and 27 divisions, sprawled across an expansive area of 713 square kilometres. Within this vast expanse, approximately 2.9 million households are scattered, contributing to a total population of 13,088,022 residents.

Despite its burgeoning size and population, Bengaluru grapples with the colossal task of managing waste. The city generates an astonishing 5,000+ metric tons of waste each day. An astonishing 30% of this waste is directly collected by the Bruhat Bengaluru Mahanagara Palike (BBMP), the municipal corporation/ Urban Local Body (ULB) responsible for the city's administration, while the remaining 70% of municipal solid waste is left to be managed through private, contracted services. It is essential to secure private sector support in tackling the waste challenge, and for these circular solutions focusing on waste prevention and product life extension that take a systemic approach are needed. Circular models that identify ways to manage the entire material lifecycle, design out unnecessary waste, and increase reuse and repair before recycling and proper disposal are key. This report will shed light on opportunities for collaboration between the private sector and start-ups designing circular waste solutions to help tackle the issue. We will outline the circular ecosystem in Bangaluru, looking at current challenges and opportunities as well as regulatory and institutional context.

The report maps out the stakeholders in the waste management ecosystem and highlight the relationship between key actors, as well as their motivation and resources. Additionally, it identifies other actors not currently in the ecosystem but who could be considered to achieve systemic impact.

Ensuring proper conditions and wages for the informal waste sector is also critical for a holistic and systemic approach, where stakeholders across the waste value stream collaborate towards zero waste and to achieve a just transition. The report will define the situation of the informal waste sector in Bengaluru, indicating living and working conditions, as well as their relationships along the waste management value chain. We will recommend opportunities to ensure a just transition for these key stakeholders while working towards circular waste solutions.

As Bengaluru undergoes rapid urbanization and development, it is critical that we urgently understand and address waste management challenges, and through collaboration across the broader stakeholder group, outline a systemic and circular approach to effectively manage waste.

Image 01: Mitaganahalli Landfill (Deccan Herald)

3.2 Overview of Bengaluru's SWM System

The state of Karnataka and the city of Bengaluru have taken large strides for managing their municipal waste. To tackle 4,000 – 6,000 MT waste of Bengaluru, the BBMP reinforced itself with a fleet of 27 mechanical sweepers, 4,646 auto tippers and 593 compactors to enhance systematic waste collection.

Post collection of segregated waste from the waste generators – the organic waste is taken forward to composting facilities and biogas plants, whereas the inorganic waste is taken to DWCCs in each of the wards. After the waste is sorted at the DWCCs, each waste stream is taken for further processing through recycling, RDFs and pelletization.

The following table summarizes the number of processing plants in Karnataka and specifically Bengaluru, for organic and inorganic waste.

Karnataka			Bengaluru		
Composting Sites	Biogas Plants	RDFs and Pelletization Plants	Composting Sites	Biogas Plants	RDFs and Pelletization Plants
216	15	217	7	13	Unknown
5,834 MTD	68 MTD	215 MTD	1,570 MTD	65 MTD	Unknown

Table 03: Summary of State of Karnataka and city of Bengaluru regarding end-of-life solutions (CPCB Action Plan)

Non-governmental organizations, like Hasirudala, Swachha Eco Solutions, and Saahas Zero Waste, play a vital role in operating dry waste collection centres. In collaboration with the BBMP, these organizations ensure the collection of dry waste from each Dry Waste Collection Centre (DWCC) in every ward.

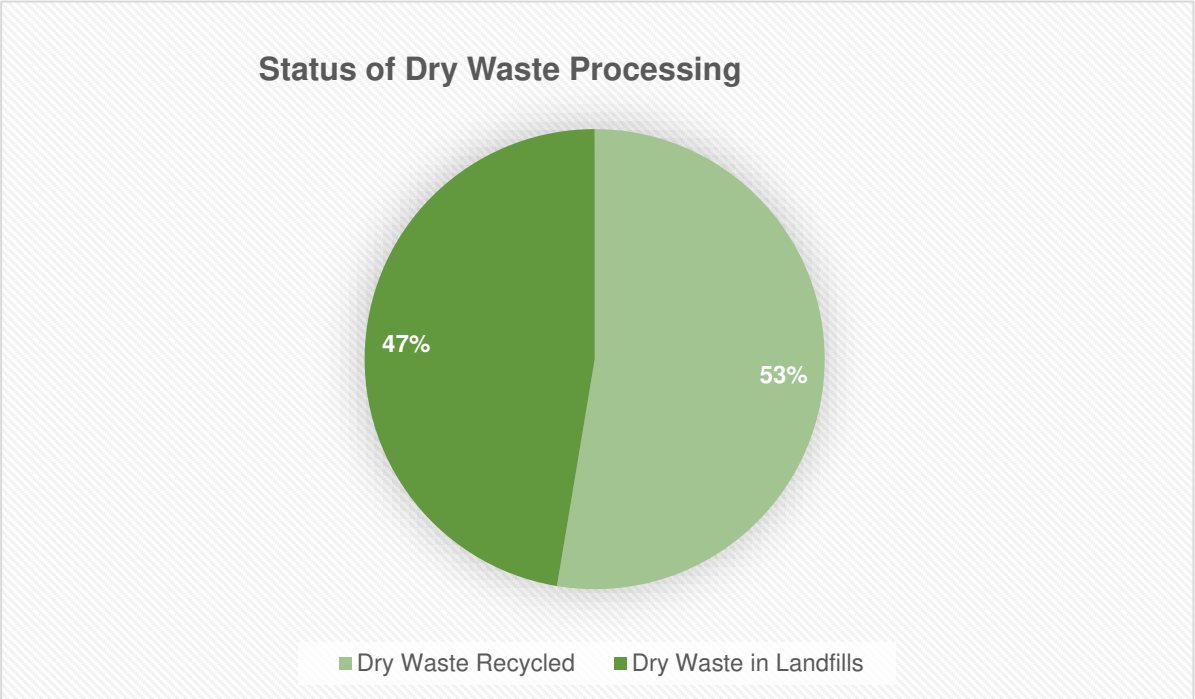

Image 02: Extent of Dry waste recycling at Bengaluru

Out of approximately 1,167 TPD, only around 53% (612 TPD) is successful recycled, leaving approximately 47.2% (551.7 TPD) to go to landfills every day. These astonishing numbers emphasizes the urgency for more efficient waste management practices and enhanced recycling efforts in the city.

DWCCs serve as crucial hubs where waste pickers sort dry waste into various streams, covering materials like paper, glass, plastics, wood, and cloth. While the BBMP actively processes wet waste, the responsibility for extensive dry waste processing lies with contracted recyclers. The recyclers collect dry waste from DWCCs across the city, enabling the efficient redirection of over 2,000 TPD of dry waste toward recycling or disposal in landfills.

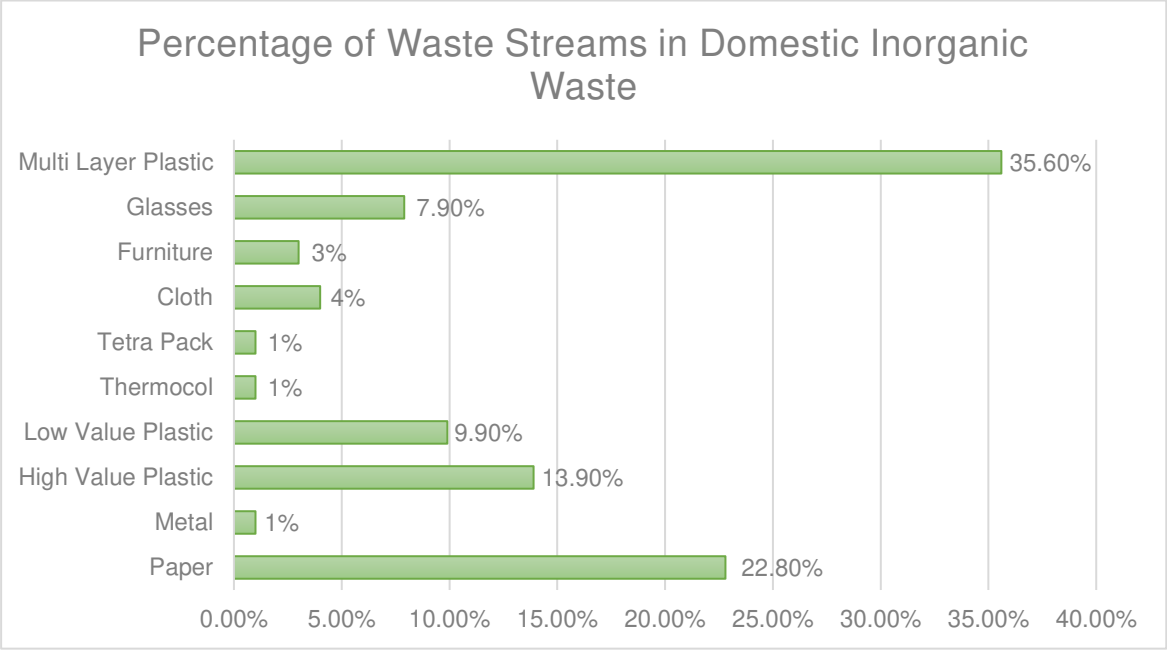

Image 03: Waste Streams to be found in domestic inorganic waste (HD)

3.2.1 Plastic waste

According to UNDP, in Bengaluru, plastic is estimated to occupy 20% of the 4,000 tonnes of municipal solid waste generated. According to the Karnataka State Plastic Association, plastic consumption in the city is approximately 16 kg per person every month. To help curb plastic waste Karnataka has reportedly prohibited the use of plastic carry bags under 500 microns and emphasizes processing plastic waste, managing to process 14,400 tonnes in the year 2021. Out of this total, 3,600 tonnes were co-processed at cement kilns, while the remaining quantity was recycled.

BBMP has been active in plastic waste management, having collected approximately 144,000 tonnes during the fiscal year 2020-21. To facilitate the processing and disposal of plastic waste, BBMP has established two facilities, each with a capacity of 10 tonnes per day (TPD). Furthermore, Bengaluru is home to 66 registered plastic recycling units, contributing to the city's comprehensive approach to plastic waste management (CPCB, 2021). Although the ULB has partnered with more than 66 recyclers, the ULB does not want to disclose information on their partnered organizations. Nevertheless, through desktop research we could identify up to 100+ recyclers of inorganic waste. These recyclers' primary role is to collect the plastics from DWCCs and recycle them mechanically.

As the CKIC project is focused on post-consumer waste, we have chosen to highlight the data from the plastic and brand audit conducted by Hasirudala and SWMRT.

A plastic waste audit conducted by Hasirudala and SWMRT revealed several key findings. Food packaging constituted the majority, accounting for over 59.6% of the audited plastic items, followed by other packaging materials at 19.9%. (Chandran. P, 2022)

The following tables elaborate the plastic and brand audit done in Bettahalasur among other cities and extrapolated to the city of Bengaluru:

#	Type Of Plastic	% Of Generation	Products	Comments
1	LDPE	33%	Milk & Curd packets	Nil
2	Multi Layered Plastics (MLP)	30.6%	Shampoo, biscuit, chocolate packets, tetra packs	73% of MLPs are Single Use Plastics (SUPs)
3	Other types of Plastics (Unknown)	33.4%	Nil	Nil

Table 04: Percentage of identified types of plastics and the products within the said categories

#	Type Of Packaging	Percentage	Brands
1	Food Packaging	60%	- KMF - Dodla - Heritage - Milky Mist
2	Delivery Packaging	18%	- Amazon
3	Remaining Unknown Types of Packaging	12%	- Nil

Table 05: Percentage of identified types of packaging and the brands contributing to the said waste

#	CATEGORY	POLLUTING BRANDS IDENTIFIED
1	Smoking Materials	- ITC - Imperial Brand - Phillip Morris International - Badshah Masala - Swagat Gold - Star Paan Masala - Preet Bidi
2	Other Domestic Polluters	- Parle - ITC - Dodla - Brittania - D-Mart
3	Other International Polluters	- Hindustan Unilever - Pepsi - Mondelez

Table 06: Categories of waste generated and brands contributing to the same

Two of the abovementioned top polluters claim attempts to tackling plastic waste and improving conditions of the informal waste sector.

- Unilever has a "waste free future" statement on their website, where they have an ambitious goal to collect and process more plastic than they sell and transition to100% recyclable, reusable, or compostable plastic by 2025, 15% recycled plastic by 2025. They are also working with the United Nations Development Programme (UNDP) in India to create a circular economy for plastic and support the social inclusion of thousands of workers within the informal waste sector and are working on designing out waste in their product packaging, for example with reuse and refill options.

- The 'Purna – Unnati ki Sajhedaari' initiative, a collaborative effort involving PepsiCo Foundation, Recity Network Private Limited, and Mathura Vrindavan Nagar Nigam (MVNN), was launched with the primary goal of transitioning waste workers into skilled waste professionals and to establish a circular, equitable, and inclusive model for effective waste management in the Mathura-Vrindavan region. By embracing a circular and inclusive strategy to combat plastic pollution, PepsiCo Foundation, Recity, and Mathura-Vrindavan Nagar Nigam have successfully professionalized over 100 waste workers, impacted more than 20,000 citizens, and involved 10 lakh tourists and 7,000 school children in waste segregation initiatives. Additionally, awareness about waste segregation has been raised among 4,000 property units, resulting in the diversion of 500 metric tons of municipal waste to date. This initiative exemplifies a concerted effort to bring about positive change in waste management practices while promoting inclusivity and sustainability.

#	Organization	Details	Geographical Reach
1	EcoKaari	upcycles plastic trash into handcrafted fabrics, while giving local artists decent work, and have prevented approximately 20 million plastic bags from ending up in landfills	India

2	Reconnai	uses AI for plastic waste sorting platform for consumers, producers, and governments	International (Japan)

Table 07: Examples of startups in the plastic waste management

Challenges Identified in Plastic Waste Stream:

- The quality of plastic that is segregated to recycle is very poor. It does not abide by the standards expected in Europe and America. As the segregation of waste is ineffective (with food mixed in the packets, sanitary pads contaminating other plastics etc.) the quality of pellets made from plastics is poor.

- There is a lack of state-of-the-art machinery for sorting of plastics in the DWCCs (into its 7 different types), unless the DWCCs are managed by a larger investor

- Saturation of recyclers in the market for plastics (specifically PET, HDPE and few in LDPE)

Opportunities Identified in Plastic Waste Stream:

- Educate the population on the types of plastics and how effectively dry waste must be segregated.

- Educate the population to reuse plastic products than discarding the same.

- There are no recyclers for MLPs, for the lack of effective technology to recycle the same, in a profitable fashion.

- Need for solutions/alternatives upstream that design out plastic waste.

3.2.2 Textile waste

India's textile waste accounts for 8.5% of the global total; only 59% of the textile waste in India finds its way back into the textile industry through reuse and recycling, with a mere fraction making it back into the global supply chain. As trends in fast fashion continue to grow there is a huge need for collaboration and innovation in circular business models and waste management to drastically reduce textile waste.

When it comes to textile management, there is a generation of 220 MT of textile waste on an average and this waste is usually mixed with non-recyclable materials. As of now, it has been identified that clothing waste of 220 MT accounts for about 3.5% to 4% of dry waste collected by weight and they represent little to no value to the DWCC waste pickers. There is a notable increase in post-consumer textile waste, signifying a departure from historical patterns when easily recyclable cotton dominated the textile landscape. (Saahas Zero Waste et al, 2023)

Holistic solutions are imperative for the effective management of textile waste, particularly at DWCCs. These solutions require destinations equipped with appropriate technologies, enhanced economic viability through better cost coverage, and streamlined segregated collection systems. To realize this vision, it is crucial to treat textile waste as a distinct stream, necessitating investments in infrastructure and scaling operations. Temporary methods like

landfilling or incineration not only displace work for the informal sector but also contribute to severe environmental issues such as air, water, and soil pollution.

The diverse and heterogeneous nature of textiles poses a challenge for processing or disposal, often resulting in Refuse-Derived Fuel (RDF) in co-processing units or landfill dumping. Moreover, there is a preference among textile waste recyclers for imported clean segregated cloth waste, post-production waste, and post-consumer clean reusable waste. Small and medium entrepreneurs engage in picking up post-production waste for applications like filling beds and pillows. However, reluctance persists in using post-consumer waste, driven by concerns about customer acceptance of once-used clothes and potential disruptions to their own production systems. As a consequence, post-consumer waste faces limited demand beyond landfills and dump yards, perpetuating reliance on incinerators. (C. Pinky et al; Hasiru Dala)

We have seen several examples of multinational foundations working on the textile waste management initiatives throughout our research. For example, the H&M Foundation partnered with Stitching Enviu Nederland (Enviu) and Intellecap's Circular Apparel Innovation Factory (CAIF), to increase the initiatives taken for the Waste Pickers through the Saamuhika Shakti program (to be discussed in another section). The focus was on developing Circular Textiles Waste Models, with a particular emphasis on empowering waste pickers.

The collaboration with CAIF involves establishing a micro-entrepreneurship model. CAIF will leverage Bengaluru's Dry Waste Collection Centres (DWCCs) as hyperlocal hubs to aggregate and segregate post-consumer textile waste. Working with 6-7 waste entrepreneurs running the DWCCs, CAIF aims to implement the Circular Textiles Waste Model by enhancing sorting capacity, providing training for waste sorters and pickers, and facilitating textile waste collection, sorting, and selling to generate revenue.

Enviu, on the other hand, will spearhead a circular business-to-business (B2B) textile service model, starting with the hotel industry. This initiative involves recycling waste hotel linen and reintegrating it into the loop as new towels, with waste pickers actively involved in the process. By December 2023, Enviu aims to collect and divert approximately 30-35 tons of cotton waste, sorted by waste workers, from landfills. The project also aims to create alternative livelihood opportunities for waste workers in hotel laundry, logistics, and warehousing services.

This textile recycling endeavour within the Saamuhika Shakti initiative, supported by seed funding from the IKEA Foundation, contributes to a broader multi-year textile-recycling program across India. Importantly, it adds a social perspective, ensuring that waste pickers' voices are integral to the overall equation.

#	Organization	Details	Geographical Reach
1	Muddle Art	First formal player in India's textile & fashion ecosystem to provide customized pre-consumer textile waste management solutions	India
2	H&M	Set up of re-sell platform on their website	International

3	Rent the Runway	Sharing and leasing models who offer everything from everyday clothes to special occasion dresses	International

Table 08: Examples of startups in the textile waste management

Challenges in Textile Waste Streams:

- The quality of textile that is discarded is very poor (ie) they are tattered in nature. This prevents effective thrifting and upcycling.
- Multifibers (synthetic and non-synthetic) and mixed colour of clothes across varied fabrics hinders the process of recycling. For instance, synthetic is a remnant of petroleum product. The recyclability of synthetic varies from that of cotton.
- The ability for citizens to handover their e-waste has not been made easier. The supply chain from waste generator to e-waste aggregator has not been formally set. So, citizens either casually choose to sell to anyone who informally comes to collect it or disposes the same with the rest of the waste.

Opportunities in Textile Waste Streams:

- Creation of awareness among citizens regarding thrifting and upcycling.
- Educate the public to consume from ethnic brands rather than large conglomerates that facilitate fast fashion.
- Piggyback off new business models (ie: clothes rentals, second hand platforms) which have proven successful in global markets and help reduce waste prior to production.
- Leverage new technologies for greater efficiencies and improved waste reduction.

3.2.3 E – Waste

According to the World Health Organization, electronic waste (e-waste) is the fastest growing solid waste stream in the world, increasing 3 times faster than the world's population. India is the world's third-biggest e-waste generator, producing over 3.23 million metric tonnes of e-waste per year, behind the US and China (Global E-waste Monitor 2020), thereby making e-waste a huge area of concern and opportunity. E-waste is not only an environmental concern, but a health concern as it contains toxic materials or can produce toxic chemicals when treated inappropriately.

According to E-Parisara, Bengaluru generates 12,000 tons of e-waste per year compared to approximately 330,000 tons generated in India with another 50,000 tons being illegally imported. Manufacturers and assemblers generate about 1,800 tons of electronic scrap every year. However, this continues to be a problem due to improper segregation (by mixing wet waste and batteries or other electronic items), improper system maintained to sort, repair, refurbish and recycle. Furthermore, just as textiles is going through phases of fast fashion; newer versions of phones, laptops and other gadgets are always remodelled and sold

attractively – which is bought by consumers in the name of adhering to brands, even if their gadgets might not have depreciated completely.

There are more than a hundred recyclers for e-waste that have been set up in Bengaluru. There are also a number of startups in this space, like E-Waste Mart that facilitates e-waste pick up from home and incentivizes people for the same. There are companies like Cerebra Technologies that repair and refurbish the electronic products such as laptops to extend the product life cycle. As a last resort they offer e-waste recycling. Another example is, ENSYDE supported Saahas Zero Waste in the implementation of their CSR Project – bE-Responsible (discussed in later sections). ENSYDE went a step ahead and set 40 e-waste pick up boxes to collect more than 73 MT of e-waste from the city of Bengaluru for refurbishing and recycling.

Many multinationals are focusing on management of their e-waste and implementation of circular business models. For example, HP has an extensive refurbishment program to prolong the life of their products, and publishes a list of recycling vendors, including TESS-AMM India as several national locations. They also support the transition towards a circular economy by promoting the return of end-of-use devices to HP for secure repurposing or recycling.

#	Organization	Details	Geographical Reach
1	Karo Sambhav	Brings manufacturers, distributors and recyclers together to coordinate their efforts to tackle e-waste, using Microsoft technology. They have worked with hundreds of companies, government institutions, 5,000 informal sector aggregators and 800 repair shops.	India
2	Zobox	a platform for both online and offline purchases of refurbished mobile phones that operates in both B2B and B2C models	International
3	Fairphone	a Dutch company leading the way in refurbishing and repairing smart phones. This social business not only reduces e-waste, but also focuses on social dimensions through fair and decent work along their supply chain	International

Table 09: Examples of startups in the e-waste management

Challenges Identified in E-Waste Stream:

- As of 2023, the global average replacement cycle length for a smartphone is 3.6 years, indicating a clear need to move to innovative circular business models for phones, however to the change to sharing, reuse and refurbish models require a shift in consumer mindset and adoption to ensure success. Some mobile phone companies may come on board, but there is a risk that others could resist as they could see it as a threat to their sales and profits.

- One aspect that needs addressing is around consumer behaviour and addressing awareness around how to recycle/refurbish phones, improve perception of buying refurbished versus new, and mitigate concerns around data protection from the sales or donation of old phones.

- The ability for citizens to handover their e-waste has not been made easier. The supply chain from waste generator to e-waste aggregator has not been formally set. So, citizens either casually choose to sell to anyone who informally comes to collect it or disposes the same with the rest of the waste.

Opportunities Identified in E-waste Stream:

- Opportunities to work in the phone recycling industry – to set a closed loop in the supply chain.
- Support circular business models to keep phones and/or their parts in use longer.
- Incubating/ supporting organizations that work on establishing the supply chain.
- Work with programmatic organizations that aim to create awareness among citizens.

3.2.4 Organic Waste

Current BBMP's directive is to have in-situ composting, specifically by Bulk Waste Generators (BWGs). These BWGs are ideally restaurants, hotels, Residential Welfare Associations (RWAs) and other residential colonies. The BBMP suggests that since the market is flooded with composting bins and technologies of multiple kinds, therefore, households are expected to purchase them and process their organic waste within their apartments. This way, the ULB believes that citizens and BWGs will take extra care in the quality of their segregation.

Over and above, they have suggested that BWGs can resort to 24-hour composting technologies. However, experts recommend the citizens to not use the same as it is not compost but biochar developed. Biocharring does not lead to formation of compost from organic waste. Instead, biochar's components will lead to soil pollution, if it is sold as compost or dumped away. Hence, 24 hours in-situ composting is also ruled out. Furthermore, the cost of the machinery is almost a million INR and the electricity charges per month would be INR 30,000 – which is exorbitant, even for a residential complex to collectively maintain. This has ultimately left the citizens of Bengaluru confused when it comes to management of their organic waste. (Desai. D, 2022)

Although BBMP intends that BWGs manage the waste through in-situ processing and the situation remains unresolved, the ULB simultaneously processes up to 2,000 MT of organic waste through its multiple composting facilities. This processing method and end-of-life method is further explained in the upcoming sections.

#	Organization	Details	Geographical Reach
1	Too Good to Go	European startup with a mobile app connecting consumers with local restaurants, bakeries and cafes to sell leftover food at the end of the day at a reduced cost to avoid food waste	International
2	Government of India	India has come up with a technology to develop organic waste into torrefied coal. However, the quality of it is not yet upto the mark	India

Table 10: Examples of startups in the organic waste management

Challenges identified in Organic Waste Stream:

- There is yet no viable solution identified in India that is cost-effective and time bound (as most composting time period ideally takes 3 weeks minimum)

- Organic waste management is usually ignored compared to inorganic wastes due to the low profitability of the outputs

- The type of food to be processed in India is varied in nature (moisture and carbon content) that makes it difficult to process as effectively as other countries

Opportunities identified in the Organic Waste Stream:

- Encouraging research and development of wet waste management methods

- Incubating and encouraging start-ups to identify organic waste management
- Drive solutions for organic waste that solve social challenges at same time (ie: lack of food for poor)

The following table summarizes the pros and cons of the different post-consumer waste streams in Bengaluru that would allow CKIC to choose the waste they wish to specialize in, if a need or request from a demand owner arises:

Waste Stream	Pros	Cons
Plastic	- Resource Recovery (recycling is the go-to methods for managing plastic) There is quick money when it comes to resource recovery - Avenues of newer research (viable processing of MLPs) - Upstream innovations (reuse, refill etc.) should be prioritized	- Saturated market especially for high quality plastic waste - Existence of waste mafia. There is a need to have contacts within to obtain feedstock ethically - Limited options to integrate waste pickers in upstream innovations (requires reskilling)
Textile	- Existence of fast fashion and need for solutions - Recent upcoming trend of upcycling – through social media - Avenues to create awareness among people to reuse and thrift clothes	- Most textiles use multi-fibers which are hard to recycle - Lack of segregated waste and insufficient quantities (synthetic and organic fabric)
E-waste	- Bring innovation in new business models focused on re-use/refurbish/sharing - Potential to support lower-income access to devices - Huge waste stream in growing market for smart devices. Could be tested in mobiles then expanded to other electronics (ie: tablets, computers) - Incorporating technologies can enable just transition along supply chain - Lack of awareness among citizens to manage e-waste	- Dependent on consumer adoption - Could get push back from mobile companies
Organic	- Managing organic waste will mean management of up to 50% of Bengaluru's waste - Open willingness among BBMP for supporting management of organic waste - Avenue to introduce startups with innovative solutions for organic waste	- High CAPEX and land intensive to process waste if large scale composting and biomethanation plants are considered - Frequent breakdown of machinery leads to backlog of waste to be processed - High expenses for BBMP

Table 11: Pros and Cons of each waste stream in consumer waste

4. Characterize Circularity Innovation Ecosystem

Circularity in SWM embodies a comprehensive and interconnected framework that revolutionizes waste management practices. Beginning with the crucial stages of collection, transportation, and segregation, it emphasizes the need for efficient systems to manage diverse waste streams. This initial step sets the tone for the entire process, promoting the integration of technology and innovation to enhance the efficacy of waste management. Simultaneously, academic research plays a pivotal role, driving continuous improvement and the development of sustainable solutions. As waste progresses through end-of-life processing, the focus shifts to resource optimization, where recycling, reuse, and energy recovery are prioritized, transforming waste into valuable resources.

The circular approach requires multi-stakeholder collaboration, bringing together government bodies, industries, communities, and academia to collectively address the complexities of waste management. The establishment of a waste market, influenced by policies and regulations, further stimulates circularity by creating economic opportunities. Policies guide practices, encouraging responsible waste management, while regulations ensure accountability and adherence to circular principles. In this intricate web of interconnected elements, each point reinforces the others, collectively contributing towards the establishment of a circularity driven SWM system, where waste is not just managed but transformed into an asset for sustainable development.

The abovementioned pointers that characterize a circular economic ecosystem are mentioned in the MSWM Manual by CPHEEO. These characteristics define the waste supply chain and the stakeholders within.

The following image depicts the waste supply chain process.

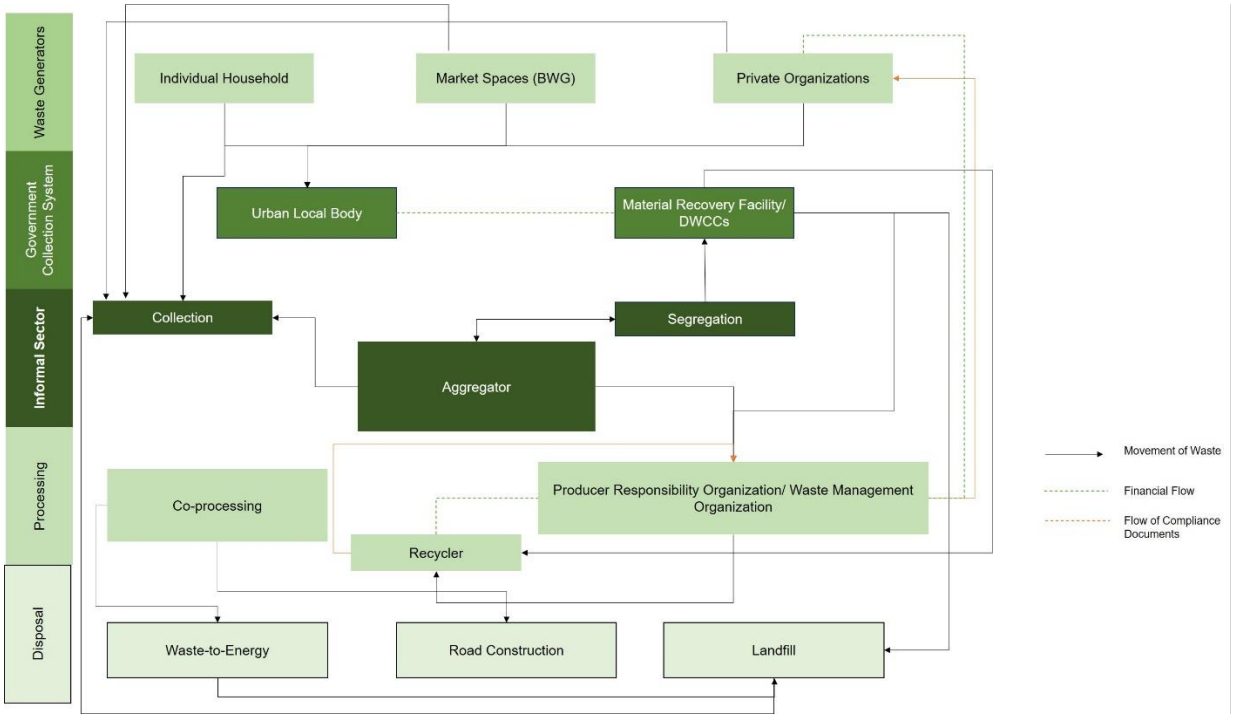

Image 04: Flow of Materials among the key stakeholders in Waste Supply Chain SZW

These characteristics are elaborated with the relevance of the Bengalurean ecosystem.

4.1 Collection, Transportation & Segregation

BBMP boasts of an impressive waste management infrastructure that includes a substantial fleet of 4,646 auto tippers, 593 compactors, and the dedicated support of over 18,000 pourakarmikas – purely for collection and transportation of waste.

Citizens play a key role for waste collection to be effective. Multiple organizations have come together to create awareness among people to segregate their waste. Bengaluru has been one of the initial cities to work on SWM Systems, and citizens are more or less aware of the idea of segregation and how it must be done. According to BBMP's SWM website, they assert an average segregation rate of 70-80%. They believe that the citizens of Bengaluru are effectively segregating their waste into wet and dry categories, and this segregated waste is efficiently processed. This extensive network of various stakeholders within the BBMP enables Bengaluru to achieve a remarkable feat—ensuring 100% waste collection and transportation in the city.

4.2 End – Of – Life Solution Infrastructure

4.2.1 Overview

There is a need for the city of Bengaluru to address end-of-life solutions for organic and inorganic waste. For organic waste, the go to options nationally have been Composting and Biomethanation Plant. Whereas, for inorganic waste, the solutions have always been either recycling (which is seen as resource recovery) and then incineration – co-processing at the cement kilns of through pyrolysis to obtain pyro fuel (a waste to energy option).

4.2.2 Organic Waste Management

(i) Composting

The Karnataka Compost Development Corporation (KCDC) was established in 1983 near HSR Layout, at a time when this area was considered the outskirts of Bengaluru. Operating at a capacity of 150-200 TPD (Tons Per Day), with a maximum capacity of 300-350 TPD, this composting plant manages various processes, including Windrow composting, curing, vermicomposting, and packaging for sales.

Currently, BBMP operates seven different composting plants across Bengaluru, each working at an average capacity of 150 TPD, even though the optimum average capacity of these seven plants would be 250 TPD.

The waste brought in undergoes a drying process before entering the windrow composting area, where it remains for 32-60 days, depending on the season. After windrow composting, the waste is passed through a 35mm trommel to filter it. Waste that passes through the trommel goes through a 16mm trommel for further refinement and sorting, while the waste that doesn't pass through is mixed with fresh waste to create a bed for absorbing leachate during composting.

The waste that passes through the 16mm trommel undergoes 16 days of curing, after which it becomes true compost. This is then passed through a 4mm trommel before being sent for packaging. The waste that doesn't pass through the 16mm trommel is returned to be mixed

with fresh waste to create a bed for absorbing leachate during windrow composting. The compost is sold to an agency at the rate of INR 2,050, which subsidizes the rates and sells it to farmers at INR 200 per ton. The HSR Layout composting plant also includes a biomethanation plant (BMP) processing at a rate of 5 TPD, although it often requires maintenance and repair. This BMP provides power for seven streetlights within the composting facility.

Within the facility, vermicomposting is carried out by feeding worms with cow dung at the rate of INR 1,200/kg. They purchase up to 10-12 kgs of cow dung to breed the worms for composting. Every 10-14 days, they collect the vermicompost from the top layer and sort it through the 4mm trommel. The fine compost is sold at INR 100 for 5 kg, making it relatively expensive. One of the major challenges in maintaining such plants is their financial viability. BBMP had invested up to INR 50 Crores in setting up the machinery. Moreover, the monthly expenses typically amount to INR 1.5 Crores, covering labour charges, machinery maintenance, compost maintenance, odour management, facility management, and more. Sales of the compost cover only up to 24% of these costs, with BBMP covering the rest every month.

This financial scenario holds true for every other composting facility as well. Additionally, the 'Not in my backyard' attitude of residents who later moved into HSR Layout makes it challenging to sustain the composting facility.

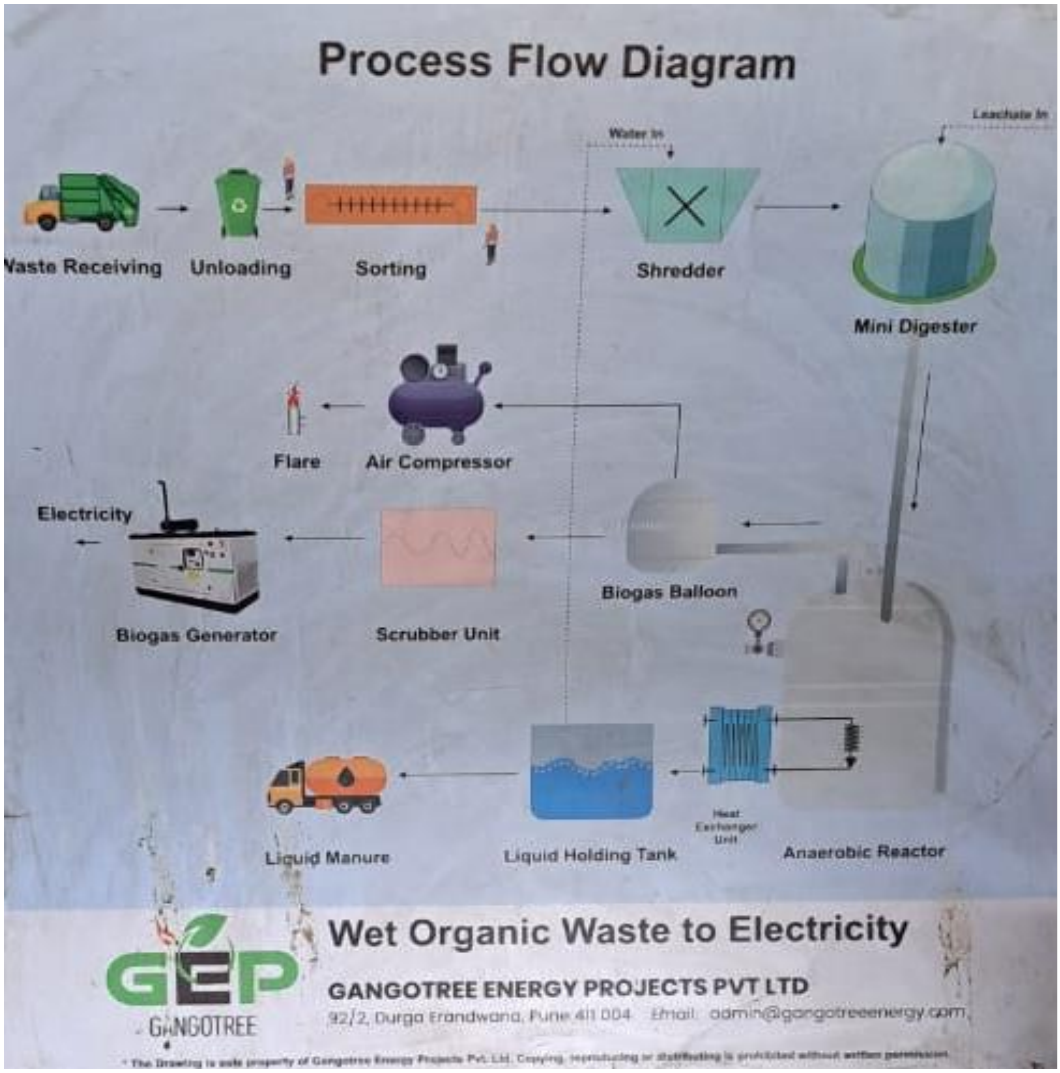

Image 05: Waste to Energy processes set by Gangotree Vendor at BBMP biomethanation plant

(ii) Biomethanation Plants

BBMP incorporates Biomethanation Plants in each of its composting sites, processing organic waste at a capacity ranging from 5 to 50 TPD, depending on the operational capability and setup of the machines. The methane produced in this process is utilized to illuminate the roads within the facility. Nevertheless, there are lingering concerns about the management of sludge. Additionally, the machinery experiences frequent breakdowns, leading to the inclusion of waste intended for biomethanation in the composting stream.

Challenges at Compositing Facilities:

- **Poor Viability of the Investments:**
  With the BBMP allocating an average monthly expenditure of up to 15 million for each composting facility, processing 150 – 300 TPD of organic waste, and encountering substantial viability gaps, as only 25% of the expenses are covered by the sale of compost, it results in a persistent financial burden for BBMP. This situation renders organic waste more of a challenge than a resource.

- **Impact on Citizens' Quality of Life due to Compost Odor:**
  Residents in the vicinity of composting facilities have raised concerns about the unpleasant smell generated during the decomposition of organic waste. This process produces leachate that infiltrates the groundwater table, contributing to malodorous conditions in the surrounding area. Those living in proximity to these facilities endure the unpleasant odor round the clock, affecting their overall quality of life.

Challenges at Biomethanation plants

- **Machine Breakdown:**
  Frequent machinery breakdowns result in diverting organic waste intended for the plants to the composting facilities.

- **Poor Return on Investment:**
  The return on investment is suboptimal due to the substantial capital requirements for setting up and commissioning the machinery. Moreover, each breakdown contributes to escalating operating expenses.

- **Extra Expenses:**
  Machinery breakdowns result in the unavailability of waste-to-energy resources, necessitating the conventional powering of streetlights. This incurs additional expenses for BBMP, in addition to the costs associated with machinery repairs.

4.2.3 Inorganic Waste Management

(i) Dry Waste Collection Centres (DWCCs)

Dry Waste Collection Centres (DWCCs) play a crucial role in decentralized waste management for dry waste management, drawing inspiration from the principles of the waste hierarchy—

specifically, the application of the three R's: reduce, recycle, and reuse at the local level. These centres are designed to facilitate the collection and buy-back of all dry waste from residents, contract workers, waste workers, waste pickers, and scrap dealers. Furthermore, DWCCs aim to integrate waste pickers into their operations and encourage or implement Extended Producer Responsibility (EPR) for packaging materials currently not being recycled. Notably, Bengaluru took the pioneering step of establishing DWCCs, setting a precedent for municipalities across the country. The principles underlying DWCCs emphasize a zero-subsidy approach in municipal operations, with a focus on source segregation, operations guided by business principles, recovery of recyclables through buy-back/take-back or drop-off schemes, prevention of landfilling for materials that can be processed alternatively, and the integration of informal waste workers through employment opportunities. Additionally, DWCCs engage citizens in recycling by serving as dissemination points for segregation information, create interfaces for industry engagement to fulfil their EPR, and provide facilities for warehousing and economies of scale with back-end integration.

Since 2012, the BBMP has been actively establishing DWCCs in the city. Out of the sanctioned 198 DWCCs, 166 are currently operational, with capacities ranging from 0.5 tons to 4.5 tons per day. These centres operate with the active involvement of waste-pickers and informal waste collectors. By 2019, Hasiru Dala supports 33 DWCCs, with 14 of them managed by women waste pickers, focusing on the bi-weekly collection of dry waste. DWCCs handle various types of dry waste, including high-value recyclables, low/no value materials like multi-layered plastic, and rejects such as bedding, furniture, shoes, and cloth. The introduction of segregated door-to-door collection by Dry Waste Collection Operators has significantly increased the collection of low-value waste, constituting around 82 percent of the total dry waste collected. Hasiru Dala has implemented design changes in the municipal ward 44, Marapana Palya, resulting in tangible improvements in both the operational efficiency and the well-being of those employed at the centre (P. Anjanee et al; IAWP, 2019).

(i) Pyrolysis

Pyrolysis is a waste to energy solution for inorganic waste. Different types of materials and streams are collectively burnt at a set temperature to derive pyro oil. This oil is then used in generators and other appliances to power them. However, in Bengaluru, the Karnataka State Pollution Control Board (KSPCB) has decided to shut upto 8 pyrolysis plants for fear of pollution. It is said that there are alarming rates of effluents released that are actually damaging the city than benefiting (TNN, 2023)

(ii) Refused Derived Fuels

Refused Derived Fuels (RDF) are also yet another waste to energy option that is obtained through co-processing varied inorganic products along with coal to generate energy. This has been proved as one of the unsustainable methods of processing. Nevertheless, there are several cities and countries that continue to incinerate their waste.

Bengaluru has faced the problem of having no purchasers for the RDF. With 2,000+ tons of RDF and no takers, BBMP requested cement kilns to take them back. However, when the cement factories demanded the transportation to be covered, BBMP refused and decided to bury it. The raised a lot of questions at the KSPCB as RDF contained 3,000kcal/kg and cannot be merely buried (Rao. S; 2017). However, it is uncertain whether this is an ongoing problem.

This implies that BBMP is struggling to find effective end-of-life solutions for inorganic waste. The DWCCs are merely points of dry waste accumulation and movement for recycling.

4.3 Technology and Innovation

4.3.1 National trends

Leveraging technology has the potential to revolutionize circular waste management processes, moving beyond manual approximations to precise measurements of waste generation. Tech tools can play a crucial role in this transition, with robots contributing to the sorting and segregation of waste. The integration of artificial intelligence (AI), advanced cameras, sensors, and robotics offers a solution. Automation, where applicable, can enhance efficiency and scalability, allowing for the accurate measurement of collected waste volumes.

The use of artificial intelligence through AI powered robots has been seen in textile waste management to automate the cutting and sewing of fabric, thereby reducing the amount of material waste. AI has also proven useful to improve the textile recycling process by predicting the optimal combination of recycled materials for producing new textiles, also leading to reduction in waste. AI powered chatbots have been used to help consumers become aware of how to properly recycle waste from different value streams, as well to reduce food waste.

Beyond improving accuracy, technology can render waste management processes more visible, uniform, and efficient, while at the same time enabling data to be tracked. Fleet services equipped with GPS can enable public waste management companies to track their vehicles, similar to practices in the logistics sector. This can also enable more efficient route planning leading to reduction in emissions. Additionally, the integration of recycling apps into the system offers a streamlined approach to waste management, further enhancing the overall effectiveness of the waste collection and recycling processes.

Block chain technologies also have a way to bring accountability, traceability and transparency along the entire supply chain. IBM promotes blockchain for social good and shares several examples of how it can be implemented. Blockchain technology can power new models for change, advancing knowledge and helping social organizations create shared systems of record that respond to corporate donors' requirements. For example, Agora Tech Lab which leverages policy ideas with blockchain technology, works with the Rotterdam principality in the Netherlands to register waste management-related transactions and integrate IoT waste systems to create a fully monitored and blockchain-based waste management system.

These technological interventions have the potential to elevate the value chain of waste pickers' activities, introducing a significant shift in the waste management system. The adoption of technology is expected to accelerate the pace of waste collection and segregation, thereby optimizing the overall process. Incorporating technologies such as blockchain can contribute to a just transition, ensuring to work with ethical suppliers along their value chain.

In the space of innovation in India, a range of applications has emerged to streamline processes related to the collection of segregated waste, trace the movement of waste, and ensure proper end-of-life processes. These applications serve various purposes, including facilitating waste trade, incentivizing citizens for segregation, and connecting waste pickers with individuals.

#	App Type	Organization
1	Waste Traceability	Recity Green Worms ChainFlux
2	EPR Waste Tracker	Nirmal Vasundharaa
3	Waste Trade Market Place	Recykal
4	Plastic Take back	Dow + Recykal
5	E-Waste Pickup	Book My Junk

Table 12: List of Digital Applications in Waste sector and the organizations behind them

These kinds of technologies add to the circularity as they enable people to segregate their domestic waste better, facilitate startups and ULBs to trace the movement of the waste (that way there would not be waste leakage in the supply chain and effective accountability of waste generated and processed would be maintained). This also allows for ULBs to make data driven decision making as they would be able to analyse how their waste moves in the city formally, due to digital integration. This facilitates formalization of supply chain, accountable waste and financial transactions.

Digital monitoring, evaluation, accountability and transparency in the supply chain will allow MNCs to confidently invest their CSR funds in startups and specifically the ULB. Digital intervention provides opportunities for effective Private Public Partnerships among stakeholders.

Finding innovative ways to connect players through technology platforms, as seen in the Apkudo example, can also bring relevant and much needed solutions. Innovations in business models that leverage data driven technologies are appealing to investors that are focused on funding circular solutions such as Closed Loop Partners.

4.3.2 Technologies in Bengaluru

Bengaluru presently operates a fleet of compactors and auto-tippers equipped with built-in GPS and RFID systems, enabling the ULB to monitor the movement of their vehicles, the extent of waste collection from designated regions, and the corresponding bins.

Despite being a burgeoning startup hub, Bengaluru has witnessed a surge in digitally integrated applications within its ecosystem. Notable examples include E-Waste Mart, akin to Book My Junk, facilitating e-waste collection and encouraging citizens to segregate waste for refurbishing and recycling. Saahas has actively deployed an application for waste traceability, that keeps account of the varied waste streams collected, sorted and sent for recycling from their DWCCs. Similarly, Recykal engages in waste traceability and has developed an interface to facilitate waste trade, a marketplace for aggregators, waste workers, DWCCs, recyclers and PROs.

In 2017, BBMP collaborated with a group of college students known as Waste Samaritans to launch the Shuchi Mitra App. This application meticulously monitors household waste segregation with a primary focus on fostering behavioural change among individuals. BBMP intended to scale this app throughout Bengaluru after the pilot at Domlur. BBMP envisioned

an improvement in the quality of segregated waste, leading to more efficient waste processing and recycling management while, minimizing machinery damage. (Dutta. S, 2017)

There is more scope for digital integration to come about in the city of Bengaluru. Every technological application or innovation implemented in the city is working in silo or struggles to scale from the pilot phase.

There is a need to facilitate the scalability of viable digital applications that have established a proof of concept. The future of Shuchi Mitra App and its scalability must be further discussed with BBMP as they publicly announced to partner with the Waste Samaritans to deploy the said app for Bengaluru.

Additionally, there is an app called 'I Got Garbage' (IGG) which focuses on SWM and the livelihood of waste pickers. IGG collaborates with various organizations like Hasiru Dala, Solid Waste Management Round Table (SWMRT), Clean City Recyclers Association (CCRA), and Waste Wise Management and Consulting Services (WWM&CS). Operating on a cloud-based digital platform, IGG provides an array of integrated business services accessible through user-friendly mobile apps tailored for each stakeholder involved in waste management. They do so by engaging four key stakeholders: government entities, social and non-governmental organizations, citizens, and waste pickers.

In addition to its mobile applications, IGG offers city-level assessment and planning support for sustainable SWM, encompassing training, solution modelling, roadmap definition, and a technology platform to facilitate comprehensive operations for SWM stakeholders. The services provided by IGG cover a spectrum of activities, including door-to-door collection, dry waste donation, community composting, and citizen engagement.

Established in 2013, IGG's primary focus is to formalize the activities of waste pickers and create a digital marketplace for the fluid exchange of waste between generators and collectors, fostering sustainable disposal and recycling. The platform's scalability across Indian cities has been a key expectation, and to date, IGG has made strides in meeting these expectations by extending its services to cities such as Bengaluru, Pune, Varanasi, Hajipur, and Bhubaneshwar.

Challenges in Technology for Solid Waste Management:

- **Same tech, geographic isolation:**

Multiple organizations have created applications for waste traceability and are working within the same city. Due to difficulty in scalability, they struggle to implement the application at a variety of geographies at the same time. For example, companies like Recykal, Recity, Saahas have their applications implemented only in the areas they are physically present and are implementing their projects.

There is an absence of a medium that brings all the applications onto a single portal. This lack keeps the citizens unaware of the applications that can be availed to resolve their problems regarding waste. Currently, these apps cannot be implemented in regions where these organizations are not physically present. Unless these organizations with their technologies are not present in their areas, citizens would not be aware of availing to the applications for problem resolution. This restricts the presence of effective SWM services and waste traceability in all areas of Bengaluru and Karnataka. When all applications and tech would be brought under one portal, citizens from other cities could use the applications too. This would enable scalability of the startups' technologies.

- **Customer Service:**

Companies that develop waste traceability apps are implementing their service only within the DWCCs they manage, with just a few startups like Recykal that sell their applications to other organizations for their implementation. There have been responses from the customer organizations stating existence of bugs in the application that are unrectified despite request for servicing Ineffective customer services can affect lability of the tech developed.

- **User adoption:**

User adoption of technology happens when there are effective services provided and citizens are made aware of the existence of the said applications. The lack of awareness is often due to the lack of a 'marketing' budget among startups. As startups usually receive funds for piloting and implementing the product/ application, marketing is usually skimped out on.

Opportunities in Technology for Solid Waste Management:

- Support to develop a single portal to bring all applications together whereby people can access multiple services in waste management in different regions and from different regions of India, that they find suitable. This way there will be higher user adoption and scalability of the companies.

- Incubation for product-oriented startups can have a marketing budget separately developed.

- Startups must be trained to be effective with their customer service to ensure repeated customers sustain.

4.4 Resource Optimization

Resource recovery is a pivotal component of a sustainable Solid Waste Management (SWM) system, encompassing the identification and extraction of valuable materials from waste streams. The aim is to divert these materials from landfills, promoting their reuse, recycling, or conversion into energy. The concept aligns with the principles of a circular economy, where waste is considered a resource rather than a burden on the environment. In Bengaluru, a city grappling with rapid urbanization and increasing waste generation, resource recovery has become an essential focus of the waste management strategy.

Key Aspects of Resource Recovery in SWM

- **Material Recycling:**

Resource recovery involves segregating and recycling materials like paper, plastic, glass, and metal. Efficient recycling processes contribute to reducing the demand for raw materials, conserving natural resources. Each of the waste stream – textile, e-waste, plastic etc. - is an industry by themselves. Even ten years ago, Bengaluru had recycled more than 12 million tons of inorganic waste and is very active in recycling compared to other cities. However, it is difficult to access detailed information as recycling stakeholders (aggregators and recyclers) are afraid to share their network for the fear of their feedstock source being captured. Recycling is a cutthroat industry that works from the formal and informal space. (Naveen BP, 2021)

In the informal market, the trading of waste from waste pickers to aggregators takes place. If the exchange of products happens with an unregistered recycler, it stays within the informal economy. However, once the product moves to a registered recycler, the segregated feedstock of plastics/ textiles/ e-waste becomes accounted for. Aggregators and recyclers strive to source feedstock in tons and they refuse to share their network and connectivity within the system.

In addition, there are MNCs using their CSR budgets for recycling. For example, Cofresco invested into the set-up of a recycling plant for LDPE that is called Vishuddh based in Bengaluru and operated as a social business. The recycled LDPE gets bought back by Cofresco to produce their products in Europe. The feedback is being collected by local NGOs and social enterprise such as Hasiru Dala and Sahaas Zero Waste.

- **Waste-to-Energy Conversion:**

Energy recovery from waste such as bio methanation, Bio – CNG or incineration through RDF at the cement kilns, aims to retrieve a value out of the waste that is generated. Bengaluru has 13 bio methanation plants set up by BBMP, a Bio-CNG startup called Carbon Masters and co-processing done by the ULBs at the cement kilns. Waste-to-Energy conversion not only reduces the volume of waste to landfill but also harnesses energy from the waste stream. Although Bengaluru is striving to utilize waste-to-energy conversion, it comes with challenges such as the easy breakdown of machines, high capital expenditure to set up bio methanation plants and finally toxic outputs during processing of waste.

- **Composting and Organic Waste Utilization:**

Bengaluru attempts at processing up to 300 MT of organic waste to be turned into compost. This is done at each of the composting facilities, through startups focusing on creating protein feed like Eco-Protein or creating compost at an accelerated pace through Black Soldier Flies like Vyuuham. All these stakeholders contribute towards resource recovery of organic waste. Irrespective of what the waste has turned into, the new output has a market value that is seen as a resource for stakeholders in the agricultural domain.

- **Recovery of Specialized Materials:**

The various e-waste recyclers of go through a process of breaking down gadgets, extracting micro-elements, plastic and other precious metals within and then recycle them. Each of these elements from these gadgets have value in their market. These elements can range from simple plastics to valuable metals and products like chromium, gold, silver, lead, lithium etc.

While Bengaluru has made commendable progress in the space of resource recovery, challenges such as rapid urbanization, population growth, and infrastructure limitations persist. To further enhance resource recovery, ongoing efforts are required to optimize waste management practices, invest in infrastructure, and foster a culture of segregation, waste-to-value mindset among citizens and businesses. The city's commitment to resource recovery is a vital step toward building a more resilient and environmentally conscious waste management system.

4.5 Multistakeholder Collaboration

Multistakeholder collaborations in SWM System has been suggested by the GoI in the MSWM guidelines by Central Public Health and Environmental Engineering Organization (CPHEEO). According to the guidelines, every SWM project implemented on ground must be integrated in

a holistic nature through a participatory approach. The guidelines suggest that the key stakeholders to be involved in every step would be the ULB, Implementation Partners (NGOs/ concessionaire/ for-profits startups etc.), Corporates (for funding), waste pickers and citizens.

The different types of collaborations existing in Bengaluru can be categorized as follow:

#	Types of collaboration	Domain	Examples
1	ULB + Consultant	Governance and large-scale implementation	- BBMP + E&Y - BBMP + Sattva
2	CSR + Startups + Incubator + Support Organizations	Waste Workers	- H&M + CAIF + Hasiru Dala + Social Alpha + LabourNet + BBC Media India etc.
3	CSR + Organization	Recycling	- Cofresco setting up Vishuddh Recyclers (Vishuddh Recyclers sourcing their feedstock from Hasiru Dala, Sahaas Zero Waste and other aggregators) - Unknown MNC Client + Repurpose Global - MNC Client + Recircle
4	CSR + Organization	Multiple spaces in circular supply chain	- Saahas Zero Waste + IKEA Foundation - Sensing Local + Wipro Foundation
5	ULB + Organization	DWCC Management (Recycling)	- BBMP + Hasiru Dala - BBMP + Other registered recyclers

Table 13: Different types of partnership models existing in the ecosystem and examples for the same

With the instances from the above table, it can be deciphered that there has not been a holistic ideal project developed that includes all the key stakeholders suggested by the CPHEEO – one that includes the ULB, CSR, Incubator, startups and the citizens.

Challenges identified in multi-stakeholder collaboration:

- Sense of competition among varied organizations despite the awareness to collaborate and develop partnerships.
- Difficulty in bringing multiple stakeholders to consensus on decisions.

Opportunities identified in multi-stakeholder collaboration:

- New avenue to develop a holistic project inclusive of stakeholders to develop a participatory approach
- Easier to implement pilots of project and scale the same.

4.6 Waste Market

The concept of a waste market plays a crucial role in promoting waste circularity by creating economic incentives for the responsible management of waste. A waste market operates on

the principles of a circular economy, where waste is viewed as a valuable resource that can be bought, sold, and traded.

Through an interaction with a waste trader from the South of India, we came to know that there are trade wards within the waste market. Given that the price of plastics is dependent upon the price of petrol, there is quite a bit of fluctuation. These traders, who are the middlemen, reach out to aggregators in different parts of the country for feedstock. This trade happens in quantities of several tonnes. These waste traders step in to provide recyclers with products in other parts of the states or other countries.

However, the trader had shared that there is a strong hold of waste mafia who gets to decide who steps into the waste sector. If a new recycler informally opens and tries access the networks in existence for feedstock, the mafia gets together to ensure the new players are bankrupt. Hence, the waste trade market is usually informal.

However, there are efforts made to make the same formal including the process of formalizing informal waste pickers. Recykal, has developed a platform for waste trading wherein waste pickers, aggregators and recyclers can get onto the portal to buy and sell the products (waste streams). Since this process has been digitized and the financial transactions are online, this part of waste trading becomes transparent and more formal in nature.

A responder who is part of an organization that makes state-of-the-art recycling machinery suggested that a lot of players and the biggest players of India in recycling – Reliance, Dalmia Polypro etc. – purchase latest waste and plastic sorters for quicker recycling and profits. He suggested that the most profitable material is the PET, followed by HDPE, LDPE and other categories.

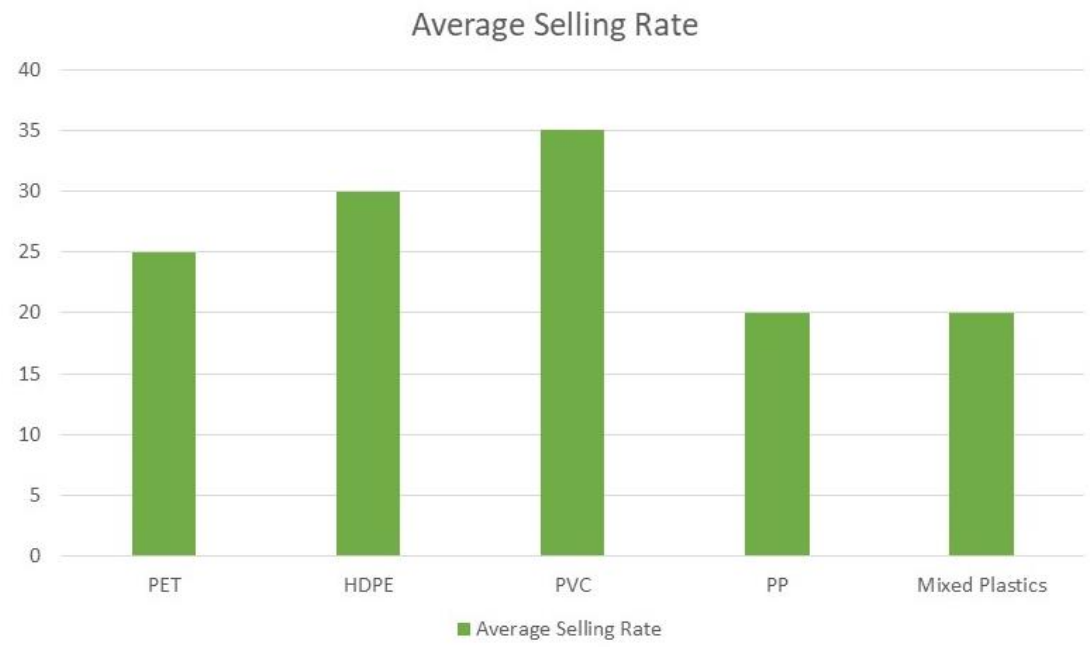

Image 06: Average selling rate of various types of plastics

A study estimated that while the PET recycling business has a turnover of Rs 3,500 crore (€386 Million) in a given year in India, the end products sell at anywhere between Rs 50-110 per kg. Discarded PET bottles fetch waste collectors Rs 14-15 kg. These bottles are bought by kabadiwallahs (scrap dealers) or waste traders, who employ people to segregate, sort and further sell it to large vendors or recyclers. (Chatterjee. B, 2017)

The waste market contributes to circularity in the following ways:

- **Value Creation from Waste:**

A waste market transforms waste into a commodity with economic value. Materials such as paper, plastic, glass, and metals, which were once considered waste, become valuable resources that can be bought and sold.

- **Encourages Recycling and Recovery:**

By encouraging the recycling industry, the ecosystem boosts resource recovery, thereby ensuring waste does not reach the landfill. The existence of a waste market creates a demand for recycled materials. Companies engaged in recycling and recovery operations can sell their processed materials to industries seeking recycled inputs, thereby closing the loop in the production cycle.

- **Reduction in Landfilling:**

By providing economic value to waste materials, a waste market reduces the reliance on landfills. Landfills are expensive to maintain and contribute to environmental degradation, so incentivizing the diversion of waste from landfills is a key aspect of waste circularity.

- **Promotes Extended Producer Responsibility (EPR):**

A waste market encourages producers to take responsibility for the entire life cycle of their products. Through EPR, producers are incentivized to design products with recyclability in mind, fostering a circular approach and reducing the environmental impact of production.

In conclusion, a waste market is a catalyst for waste circularity by redefining the economic value of waste materials. It transforms the linear "take, make, dispose" model into a circular system where materials are reused, recycled, and reintegrated into the production cycle. The economic opportunities created by a waste market drive sustainability, innovation, and responsible waste management practices, contributing to a more circular and resilient economy.

4.7 Economic Opportunities

In India, it is anticipated that by the conclusion of 2023, there will be around 18.5 million green jobs spanning various industries, and this figure is projected to nearly double by the year 2047. The Principal Scientific Advisor of GoI, suggest that addressing the issues of waste disposal, deteriorating air quality and increasing pollution of water bodies by leveraging global technological capabilities will create socio-economic benefits for 1.3 billion Indians. The idea is to leverage science, technology, and innovation to create circular economic models that are financially viable and sustainable for waste management to streamline waste handling in the country.

As per the Karnataka Economic Survey (2021-22), effective composting of organic waste generated in Bengaluru could yield 218 TPD of compost, resulting in a daily revenue of Rs 11 Lakhs on a monthly basis. The Refuse Derived Fuel (RDF) is estimated to have a value ranging from Rs. 600 to Rs. 2400 per ton, serving as a consistent revenue stream for ULBs. The anticipated total income from the imposition of user fees for Solid Waste Management (SWM), and SWM processing in Bengaluru alone is estimated to be approximately Rs. 1030 Crores.

The current ecosystem of startups, NGOs and Public Private Partnerships that develop SWM projects; along with the expanding number of players in the waste supply chain (detailed in the stakeholder mapping chapter), has opened green jobs in the sector.

There has been a significant surge in green job advertisements in metropolitan cities, with Delhi-NCR taking the lead with a remarkable 289% year-on-year increase, trailed by Mumbai with a 216% year-on-year rise, and Bengaluru with a 174% year-on-year upswing.

The sectors of environmental services and waste management experienced the highest surge in hiring activities, exhibiting an impressive annual growth rate of 1,765%. The heightened emphasis of cities on effectively managing solid waste and the proactive measures taken to limit transport emissions and decrease carbon footprint are key contributors to this remarkable growth. Furthermore, there is a notable demand for professionals in green initiatives in other industries, such as chemicals, petrochemicals, plastics, and rubber, showing a growth of 220%, as well as in the fast-moving consumer goods sector, where the demand saw a substantial increase of 42%. (Kaur L, 2023)

Challenges identified:

- There is a demand-supply mismatch – citizens in general are not adept with the required skills for employing the technology used to tackle the sustainability issues.
- There is a lack of knowledge and awareness regarding the roles that exist in the green jobs sector

Opportunities identified:

- There is a new space to upskill individuals when it comes to becoming employable in the waste management sector.
- There is a need to educate digital literacy ranging from blockchain, IoT, AI etc.
- Curriculum can be designed that inculcate the newly required skills in the domains of climate tech and green entrepreneurship at an early age.

4.8 Policy and Regulations

The following section covers the national policies on waste management that regulate how waste must be managed; National Frameworks that suggests the ideal scenario regarding cleanliness and waste management and finally national schemes that facilitate research for innovation & technology as well as the growth of startups.

Image 07: Timeline of National Policies and Frameworks implemented

4.8.1 National Policies

(i) Municipal Solid Waste Management Rules, 2016

The Solid Waste Management (SWM) Rules, 2016, represent a significant overhaul of waste management policies, replacing the Municipal Solid Wastes (Management and Handling) Rules 2000. Introduced by the Central government and officially notified on April 8, 2016, these rules encompass a broad scope of application. They are designed to be applicable to every urban local body, ranging from mega cities to Panchayat levels, outgrowths in urban agglomerations, census towns, industrial townships, areas under the control of Indian Railways, airports, ports, harbours, defence establishments, special economic zones, state and central government organizations, places of pilgrims, and areas of religious and historical significance.

Waste generators under these rules include not only households but also extend to diverse entities such as event organizers, street vendors, Resident Welfare Associations (RWAs), market associations, and gated communities exceeding an area of 5000 sq.m. Furthermore, hotels, restaurants, and other non-residential solid waste generators fall within the ambit of these regulations.

The duties of waste generators and authorities are clearly outlined in the rules. Waste generators are required to segregate waste, store it separately, and hand it over to municipal workers or authorized waste pickers. The Ministry of Environment, Forest & Climate Change is mandated to constitute a 'Central Monitoring Committee' for annual monitoring and review. Other responsibilities include framing a National Policy on SWM, coordination with states/UTs, provision of technical guidelines, financial support, training to local bodies, and facilitating market development for city compost.

Distinct authorities such as the Departments of Fertilizers & Chemicals, Ministry of Agriculture, Ministry of Power, Ministry of New and Renewable Energy (MNRE),

Secretaries-In-Charge at state/UT levels, District Collectors/Magistrates, Central Pollution Control Board (CPCB), local authorities/Panchayats, State Pollution Control Boards/ Pollution Control Committees (SPCBs/ PCCs), manufacturers/brand owners, and industries (cement, power plants, etc.) each have specified roles to ensure effective waste management and compliance with the rules.

For hilly regions, the criteria emphasize avoiding landfill, constructing waste transfer stations, taking strict action against littering, and establishing landfills in plain areas. Additionally, provisions for Waste to Energy plants for waste with 1500 Kcal/kg and above are outlined for co-incineration in cement and power plants.

The rules provide a clear time frame for the implementation of various aspects, such as landfill identification, procurement of waste processing facilities, ensuring waste segregation, and setting up sanitary landfills. Implementation timelines vary for cities based on their population size.

A robust system of reviews at different levels, conducted by the Ministry of Environment, Forest & Climate Change, Central Monitoring Committee, District Collectors, SPCBs, and State-level Advisory Committees, ensures periodic assessment and course correction as needed. These reviews take place annually, quarterly, half-yearly, and as stipulated by the specific roles and responsibilities of each authority.

Although MSWM, 2016 has been set on paper; the extent to which it is implemented in Bengaluru is questionable. It became evident that the Bengaluru falls behind:

- In its capabilities in processing inorganic waste
- In finding large scale solutions for in-situ organic waste processing
- In developing awareness among waste generators to provide effective segregated waste

(ii) Plastic Waste Management Rules, 2016:

The Guidelines on Extended Producer Responsibility (EPR) for plastic packaging were introduced by the Ministry of Environment, Forest and Climate Change, Government of India, as part of the Plastic Waste Management Rules, 2016. This initiative, outlined in the fourth amendment in February 2022, places the responsibility on Producers, Importers, and Brand Owners (PIBOs) to manage the plastic waste generated by the packaging of their products. The primary directive is for these entities to collaborate with local governments in developing effective strategies for handling the plastic waste resulting from their products.
In the practical implementation of EPR at the state level, the engagement of stakeholders, particularly PIBOs and Plastic Waste Processors, is deemed crucial. A cooperative effort between these entities is essential to ensure compliance with the EPR framework, contributing to the effective management of plastic packaging waste.

The regulation categorizes plastic packaging into four types: Rigid (Category 1), Flexible (Category 2), Multi-Layered Packaging (Category 3), and Compostable Plastic Packaging (Category 4). PIBOs are assigned specific targets, measured as a percentage of Put-on Market (PoM) packaging. These targets encompass recycling, the use of recycled content

in packaging, reuse of packaging material (limited to Brand Owners), and appropriate end-of-life disposal. The stipulated targets progressively increase each year.
Recyclers registered with the Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs) play a pivotal role. They report the quantity of recycled plastic packaging waste, receiving credits that can be traded with PIBOs. PIBOs are then responsible for purchasing these credits directly from recyclers or engaging with other agencies to fulfil their EPR obligations. In the event of non-fulfilment of targets, PIBOs are subject to paying Environment Compensation (EC) (GIZ, 2023).

(iii) E- Waste Management Rules, 2022:

The E-Waste Management Rules, 2022, are applicable to every entity engaged in the manufacturing, production, refurbishing, dismantling, recycling, and processing of electronic waste (e-waste) or electrical and electronic equipment as outlined in Schedule I. This includes manufacturers, producers, refurbishers, dismantlers, and recyclers involved in the various aspects of the e-waste lifecycle. The scope extends to encompass components, consumables, parts, and spares integral to making the product operational. However, these rules do not apply to waste batteries, as they are addressed under the Battery Waste Management Rules, 2022, and packaging plastics, which fall under the jurisdiction of the Plastic Waste Management Rules, 2016. The delineation of applicability ensures a comprehensive and targeted approach to managing e-waste in accordance with the specific requirements of the electronic and electrical industry.

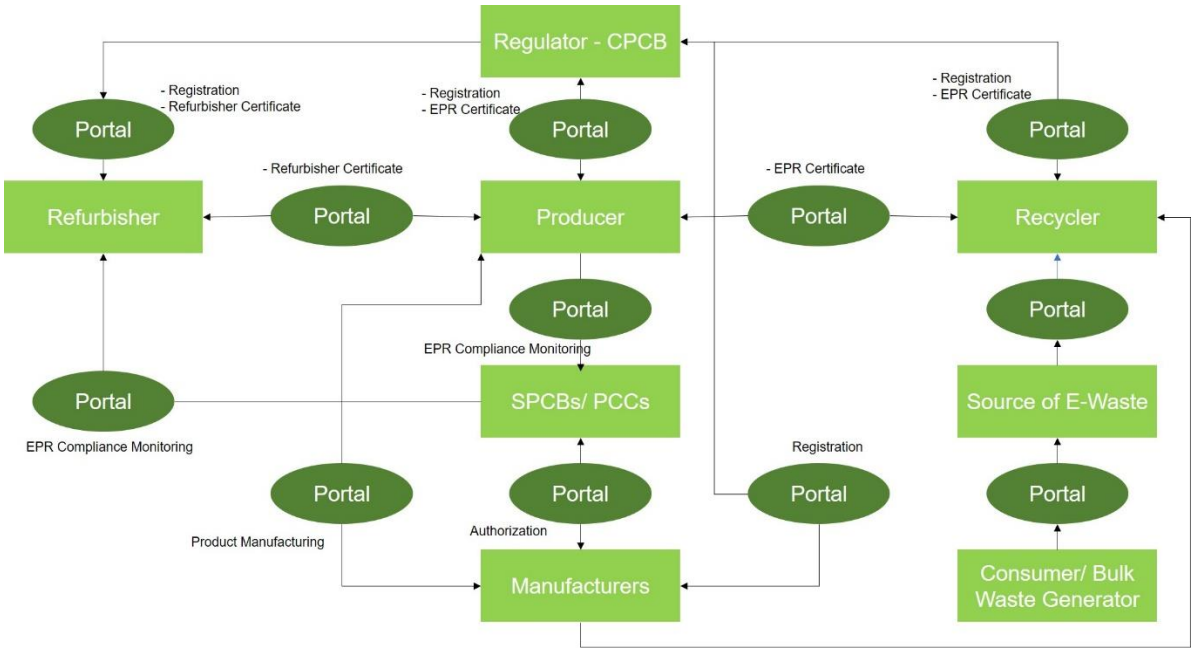

Image 08: System chain to obtain EPR accreditation and certificate

The regulation of Extended Producer Responsibility (EPR) for producers involves obtaining EPR Authorisation, a process for which producers need to submit an application in the prescribed form according to the rules of the Central Pollution Control Board (CPCB). The Online E-Waste Management System serves as a web portal where producer applicants can submit their applications online to obtain EPR Authorisation. The current module specifically

focuses on the EPR Application process, limited to the submission of online applications and the subsequent grant of EPR Authorisation.

All relevant stakeholders, including producers, PROs (Producer Responsibility Organizations), dismantlers, recyclers, refurbishers, transporters, and collection points/centres, are required to register on this system. In this context, a "Producer" is defined as any individual who, regardless of the sales technique employed (such as dealer, retailer, e-retailer, etc.), either manufactures and offers to sell electrical and electronic equipment and their components, consumables, or parts under its own brand, assembles electrical and electronic equipment and their components under its brand using products from other manufacturers or suppliers, or offers to sell imported electrical and electronic equipment and their components.

(iv) Environmental Protection Act:

The Environmental Protection Act of 1986 is a crucial legislative framework in India aimed at safeguarding the environment and promoting sustainable development. Enacted on May 23, 1986, the law was a response to the growing concerns about environmental degradation and the need for a comprehensive legal mechanism to address environmental issues.

The primary objective of the Environmental Protection Act is to empower the central government to take measures to protect and improve the quality of the environment. The law provides the government with the authority to set standards for emissions and discharge of pollutants from various industries, automobiles, and other sources. It also enables the government to regulate the handling and management of hazardous substances.

Key features of the Environmental Protection Act include the establishment of regulatory bodies, such as the Central Pollution Control Board (CPCB) at the national level and State Pollution Control Boards (SPCBs) at the state level. These bodies play a crucial role in enforcing environmental standards, collecting data on pollution, and formulating strategies for pollution control and abatement.

One of the significant aspects of the Act is its focus on the "precautionary principle," which places the burden of proof on those who undertake activities that may harm the environment. This principle encourages preventive measures to avoid environmental damage rather than waiting for conclusive evidence of harm. The Act empowers the government to take necessary steps to protect and restore environmental quality. It provides for the regulation of activities that are likely to have adverse effects on the environment, such as the handling of hazardous substances, the operation of industries, and the location of industrial units. The law also includes provisions for the handling and disposal of hazardous wastes.

Under the Environmental Protection Act, the government has the authority to take punitive action against those who violate environmental norms. Violations can result in fines, closure of non-compliant industries, and even imprisonment in certain cases. This deterrent approach aims to ensure compliance with environmental regulations. Over the years, the Environmental Protection Act has been amended to address emerging environmental challenges and align with international environmental standards. It continues to be a cornerstone of environmental governance in India, providing a legal framework for

sustainable development and the protection of the nation's natural resources. The Act reflects India's commitment to balancing economic growth with environmental conservation, acknowledging the importance of environmental sustainability for the well-being of present and future generations.

(v) National Environmental Policy:

The National Environment Policy (NEP) of India, formulated in 2006, provides a strategic framework for sustainable environmental management and development. This policy reflects India's commitment to balancing economic growth with environmental protection.

The key objectives of the National Environment Policy (2006) include:

- Integration of Environmental Considerations: The policy emphasizes the need to integrate environmental considerations into various sectors and decision-making processes. It seeks to ensure that environmental concerns are mainstreamed into developmental planning.

- Sustainable Development: The NEP advocates for sustainable development, highlighting the importance of conserving natural resources and ensuring their judicious use. It recognizes the interdependence of environmental, social, and economic factors.
- Conservation of Natural Resources: The policy underscores the significance of conserving and enhancing natural resources, including water, air, soil, and biodiversity. It promotes the sustainable utilization of these resources for present and future generations.

- Pollution Control: The NEP places a strong emphasis on pollution control measures. It encourages the adoption of cleaner technologies, waste minimization, and effective pollution monitoring and enforcement mechanisms.

- Public Participation: Recognizing the importance of public participation in environmental decision-making, the policy seeks to involve the public in the formulation and implementation of environmental policies and programs.

- International Cooperation: The NEP acknowledges the global nature of environmental issues and underscores India's commitment to international cooperation. It aims to actively participate in global efforts to address environmental challenges, including climate change and biodiversity conservation.

- Capacity Building: The policy emphasizes the need for capacity building at various levels, including government institutions, non-governmental organizations, and the general public, to effectively address environmental issues.

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(vi) CSR Policy:

Corporate Social Responsibility (CSR) in India is guided by a legal framework that requires businesses' responsibility to contribute positively to society. The Companies Act, 2013, introduced Section 135, by the Ministry of Corporate Affairs mandates certain qualifying companies to spend a percentage of their profits on CSR activities. As per the legislation,

companies meeting specific criteria, such as a net worth of $500 million or more, a turnover of $1 billion or more, or a net profit of $5 million or more, are required to allocate a minimum percentage of their profits towards CSR initiatives.

CSR activities in India encompass a wide range of social, economic, and environmental initiatives. Common focus areas include education, healthcare, poverty alleviation, environmental sustainability, and rural development. Companies often design their CSR policies to align with India's developmental challenges, seeking to make a meaningful impact on the communities in which they operate.

Companies formulate their CSR policies based on the principle of sustainability, considering the long-term socio-economic and environmental implications of their actions. They engage in projects and partnerships that promote inclusive growth, support marginalized communities, and address pressing issues such as sanitation, education, and healthcare.

Additionally, transparency and disclosure are key aspects of CSR in India. Companies are required to report their CSR activities in their annual reports, detailing the projects undertaken, funds allocated, and outcomes achieved. This transparency ensures accountability and allows stakeholders, including shareholders and the public, to assess the impact of a company's CSR initiatives.

The evolution of CSR in India reflects a growing recognition of the role businesses play in addressing societal challenges. It has become an integral part of corporate governance, influencing companies to go beyond profit-making and actively contribute to the well-being of society and the environment. Currently, 6.65% of total CSR funds of INR 9.1 Crores spent on the state of Karnataka is on the environmental sector. The CSR landscape in India continues to evolve, with companies adapting their policies to address emerging social and environmental issues and contribute meaningfully to sustainable development.

4.8.2 Other National Frameworks:

(i) Swachch Bharat Mission:

The Swachh Bharat Mission, launched by the Government of India in 2014, represents an ambitious nationwide initiative aimed at transforming India into a cleaner and more hygienic country. One of its key pillars is the effective management of solid waste. Under this mission, there is a strong emphasis on improving waste collection, segregation, transportation, and disposal processes. Urban and rural areas alike are targeted to adopt sustainable solid waste management practices, including the promotion of waste-to-energy technologies and recycling. This holistic approach not only enhances the cleanliness and sanitation of cities and villages but also promotes environmental sustainability by reducing the burden on landfills and ensuring responsible waste disposal.

The "People's Movement" policy, launched by the Prime Minister of India, incentivizes cities to engage in Swach Survekshan, receiving star ratings based on their undertaken initiatives. Currently, the program proudly highlights the processing of over 119,000 metric tons per day (MTPD) of waste and outlines plans to address and remediate a staggering 152,200,000 tonnes of waste.

(ii) Swachch Survekshan:

The 'Swachh Survekshan,' a comprehensive survey conducted to assess cities on various sanitation and cleanliness parameters, represents an initiative led by the Ministry of Urban Development (MoUD). This evaluation process involves assigning marks to each state and city based on several key factors, which include cleanliness, the efficient management of municipal solid waste, and the level of commitment demonstrated by the city's residents in managing waste effectively. This commitment encompasses critical aspects such as waste segregation, collection, transportation, processing, including waste-to-energy initiatives, and the cleanliness of roads. As part of this evaluation, a city's Municipal Corporation's successful integration of waste pickers into its solid waste management system plays a crucial role, with a maximum of 29 marks being allocated for this specific criterion.

(iii) National Public Private Policy:

According to Department of Economics of Ministry of Finance, GoI; The Indian government is dedicated to enhancing both the standard and quality of economic and social infrastructure services nationwide. To achieve this objective, the government envisions a significant involvement of Public Private Partnerships (PPPs), aiming to leverage private sector investment and operational efficiencies in delivering public assets and services.

A Public Private Partnership (PPP) refers to a collaboration between a government, statutory entity, or government-owned entity on one side and a private sector entity on the other. This partnership involves the provision of public assets and/or services, with the private sector entity making investments and/or undertaking management responsibilities for a defined period. The arrangement includes a clear allocation of risk between the private sector and the public entity, and the private entity receives performance-linked payments that align with specified and pre-established performance standards. These standards are measurable by the public entity or its representative.

4.8.3 National Schemes for Facilitating Research in Tech and Growth of Startups:

(i) PRISM Scheme:

The PRISM initiative, officially known as “Promoting Innovations in Individuals, Startups and MSMEs”, operates under the auspices of the Ministry of Science & Technology and the Department of Scientific and Industrial Research. Focused on the key sector of Science and Technology, PRISM aims to foster innovation by offering grants, technical guidance, and mentoring to individual innovators, guiding them through the incubation of their ideas and facilitating the establishment of new enterprises. Additionally, the scheme extends grant-in-aid support to technology solution providers engaged in developing solutions geared towards assisting MSME clusters. The implementation of PRISM unfolds in two distinct phases, reflecting a comprehensive approach to promoting innovation across various domains.

(ii) Biotechnology Ignition Grant:

The Biotechnology Ignition Grant (BIG) stands as a flagship initiative under the auspices of the Biotechnology Industry Research Assistance Council (BIRAC), operating within the Ministry of Science & Technology. Positioned within the key sector of Science and

Technology, BIG is designed to identify and invest in innovative concepts within the biotechnology domain, with a specific focus on ideas showcasing clear potential for commercial product or technology development. The scheme provides crucial support to individual entrepreneurs and start-ups, guiding them from the initial ideation stage through to the Proof of Concept (PoC) phase, thereby fostering the progression of groundbreaking biotechnological innovations into tangible and commercially viable realities.

(iii) Technology Development Program:

The Technology Development Programme, operating under the Ministry of Science & Technology within the Department of Science and Technology, centres its efforts on advancing the key sector of Science and Technology. The primary aim of the program is to facilitate and support the development of products, techniques, and technologies tailored for specific end-use applications. In pursuit of this overarching goal, the program delineates specific objectives, emphasizing the holistic development and integration of technologies within identified areas. Furthermore, the initiative seeks to promote the application of modern and advanced technologies as solutions to socio-economic challenges, foster the modernization of traditional technologies, tools, and skills, enhance the quality and performance of both traditional and non-traditional items, and encourage advancements in the application of research and development activities. This comprehensive approach underscores the program's commitment to driving innovation and technological progress across various domains.

(iv) Small Business Innovation Research Initiative:

The Small Business Innovation Research Initiative (SBIRI), an initiative under the Biotechnology Industry Research Assistance Council (BIRAC) within the Ministry of Science & Technology, operates within the key sector of Science and Technology. Launched in 2005 by the Department of Biotechnology, Ministry of Science & Technology, SBIRI serves as a catalyst for enhancing Public-Private-Partnership (PPP) efforts in the country. This scheme has played a pivotal role in fostering innovation and encouraging risk-taking by small and medium-sized companies. By bringing together the private industry, public institutions, and government entities under a unified framework, SBIRI aims to promote research and innovation within the Indian Biotech Sector. The projects supported through this initiative have yielded notable outcomes, with some resulting products already making their mark in the market. SBIRI stands as a testament to the collaborative efforts driving advancements in the biotechnology landscape in India.

(v) Startup Policy Karnataka:

Karnataka stands at the forefront of India's pursuit of a USD 1 trillion digital economy by 2025, having consecutively topped NITI Aayog's India Innovation Index from 2019 to 2021. Renowned as the country's innovation hub, the state leads in software and service exports, contributing over 40 percent to India's software exports. With a mature startup ecosystem boasting around 15,000 startups, Karnataka was the first state to implement a dedicated Startup Policy in 2015. The government has rolled out comprehensive programs, offering funding, incubation support, mentorship, and co-working spaces, fostering the growth of startups. Bengaluru, the capital, with an estimated GDP of USD 110 billion, is pivotal in this

ecosystem, expected to grow at an annual real GDP growth of 9.9 percent. The city, housing a significant share of India's unicorns, has been recognized globally, ranking 8th in the Global Startup Ecosystem Index 2022. Beyond Bengaluru, emerging technology clusters in Kalaburagi, Belagavi, Dharwad, Mangaluru, Shivamogga, Mysuru, and Tumakuru offer attractive opportunities for domestic and global investments across various industry verticals, presenting a promising landscape for inclusive growth.

The Karnataka Startup Policy envisions establishing a conducive environment statewide to foster startups throughout their business lifecycle, aspiring to position Karnataka as a global innovation hub. The policy outlines several key objectives, including strengthening infrastructure in government institutions, particularly in emerging clusters Beyond Bengaluru, fostering innovation and entrepreneurial skills in students across disciplines, stimulating the growth of up to 25,000 startups with a focus on high-growth ventures, promoting social entrepreneurship and assistive technology innovations, facilitating innovative technology solutions for social governance challenges, supporting the creation and development of incubation and acceleration infrastructure, and enabling funding avenues through institutional investors, angel investors, and government funding. The policy's strategic framework is organized into nine pillars, encompassing initiatives such as creating and strengthening a New Age Innovation Network, fostering partnerships between academia and industry, providing diverse funding opportunities, supporting mentorship and incubation infrastructure, building an inclusive and equitable startup ecosystem, fostering social and rural entrepreneurship, channelizing innovation for societal impact, enabling and facilitating startups through a trust-based governance approach, and providing state support in the form of incentives and concessions throughout the policy period.

Challenges in Policy Implementation

- User Charges are not effectively being collected. Citizens refuse to pay their user charges for the waste being collected, even though there is a necessity to pay for the services availed under the current law.

- There is a need for polluter pay fee that needs to be implemented, to incentivize citizens for waste reduction and segregation.

- There needs to be a stronger enforcement on the EPR policy as many companies are free riders or using fake EPR certificates. Recent punishment cases such as on Shakti Plastics Industries are helpful as a deterrent.

- The level of implementation of the MSWM policy are still not at par given that there are fallbacks in the quality of waste segregation and BBMP’s waste processing levels.

5. Stakeholder Mapping and Analysis

5.1 Overview

The pivotal authority in charge of Bengaluru's solid waste management (SWM) system is the BBMP. Ideally, the BBMP should actively engage with citizens, implementing partners, NGOs, and MNCs, but they have delegated the responsibility of fostering partnerships and collaborations to E&Y, with whom they maintain a deep connection. Additionally, the ULB is closely affiliated with national bodies such as CPCB, SPCB, and PCC, updating them on waste generation, collection, transportation, and processing statistics, including the numbers of registered recyclers across various waste streams, establishing a link with E&Y.

NGOs in the city are assuming roles in waste management, including collection, transportation, awareness creation, DWCC management, and processing. This has sparked debates suggesting that NGOs should support the ULB instead of assuming its responsibilities. (Singh. A et al, 2022). Notably, two NGOs turned for-profit, Saahas and Hasiru Dala, have been actively involved with the ULB for a decade, providing policy amendment suggestions and managing DWCCs. However, their strong ties have drawn criticism from smaller organizations struggling to establish rapport at the grassroots level.

The intricate web of connections extends to waste pickers, aggregators, and recyclers, both formal and informal. The reluctance to share networks due to business concerns makes it challenging to determine the extent of these connections.

In this complex ecosystem, MNCs prefer collaborating with implementation partners, often choosing Saahas and Hasiru Dala, causing discontent among smaller players.

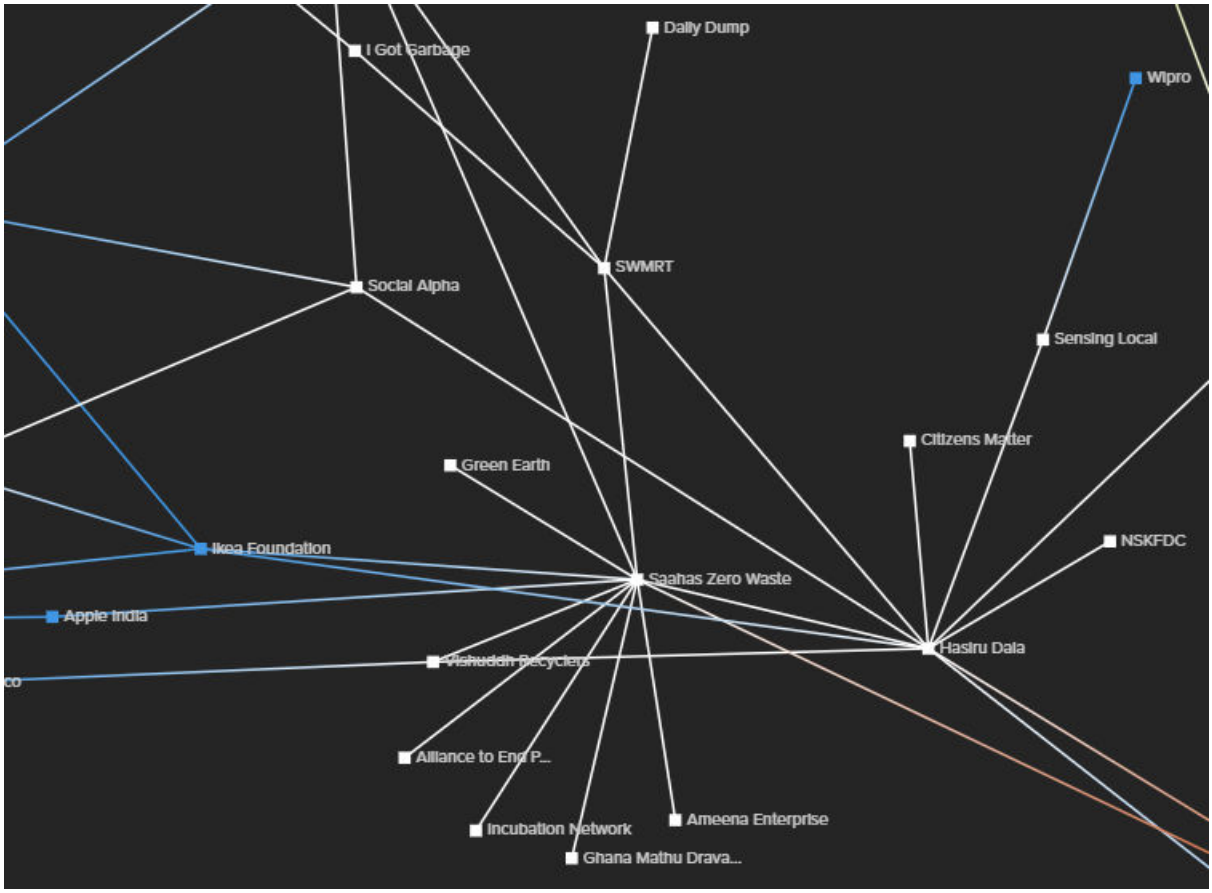

Image 09: Connectivity of Saahas Zero Waste, Hasiru Dala with other categories of stakeholders

From the above image, it can be observed that Saahas Zero Waste and Hasiru Dala are connected with various categories of stakeholders like that of MNCs – Ikea Foundation, Apple India; incubators – Social Alpha, Incubation Network; other implementation partners – Ameena Enterprise, Green Earth, Citizens Matter etc. and have also attempted at collaborating with other organizations like Daily Dump, through SWMRT.

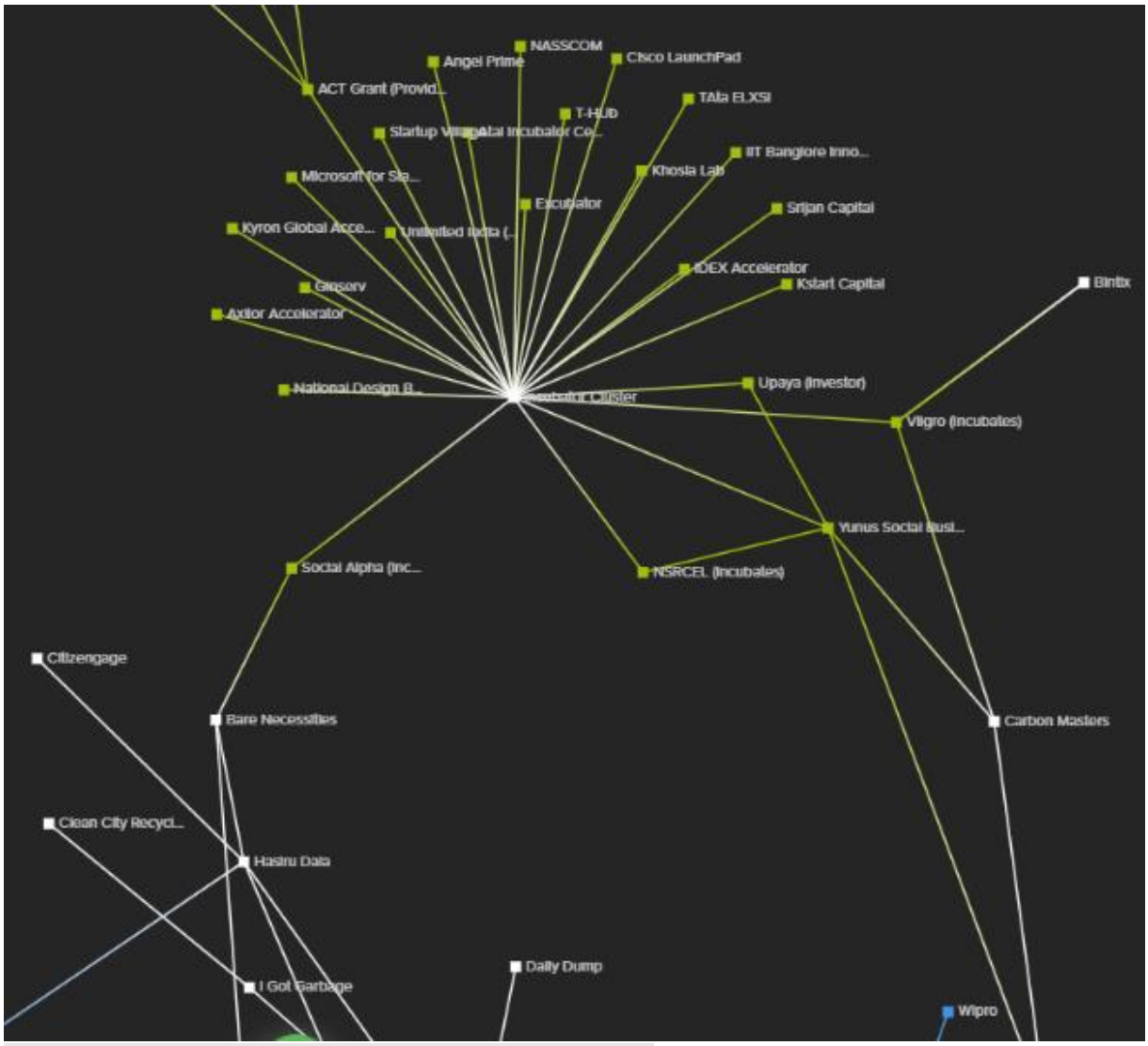

Image 10: Cluster of Incubators connected represented on Kumu

In the above image, we can see the cluster of incubators existing the Bengalurean ecosystem. We can observe few incubators that are connected amongst themselves – NSRCEL and Upaya with Yunus Social Business. We can further see that Vilgro and Yunus Social Business have collectively funded Carbon Masters. We can also observe that Social Alpha who supports Bare Necessities, that is further connected with Hasiru Dala.

Amidst the diverse connections that can be identified on Kumu, there is a noticeable link between MNC CSRs and incubators, as CSR aims for large-scale impact through startups. However, this connection could be strengthened by involving other players such as NGOs and the ULB. Surprisingly, citizens, the primary stakeholders generating waste, are often overlooked. Although there is awareness of waste segregation, the quality of segregation remains a challenge, impacting the processing and waste-to-value business models of startups. This unidirectional dependence, with startups relying on citizens, underscores the need for behavioural change initiatives targeting citizens.

Currently, there is a gap in establishing a comprehensive partnership loop between the ULB, MNCs, implementing partners (NGOs/startups), and incubators for large-scale implementation in Bengaluru. Bridging this gap is crucial for creating an effective and inclusive waste management ecosystem in the city.

5.2 Public Bodies in Bengaluru

The Bruhat Bengaluru Mahanagar Palike (BBMP)'s key responsibility is to manage the Solid Waste Management System in a holistic manner. There is a State Government company called the Bengaluru Solid Waste Management Limited which is involved in collection and recycling of metal (rejected aluminium, utensils, other items etc.) in Bengaluru.

Apart from this, the BBMP directly works with consultants like Ernst & Young and Sattva to enable them to identify the right partners/ vendors and concessionaires to outsource their responsibilities of collection and transportation. They also support in technical processes of documentation of registered recyclers, account for implementation of tenders etc.

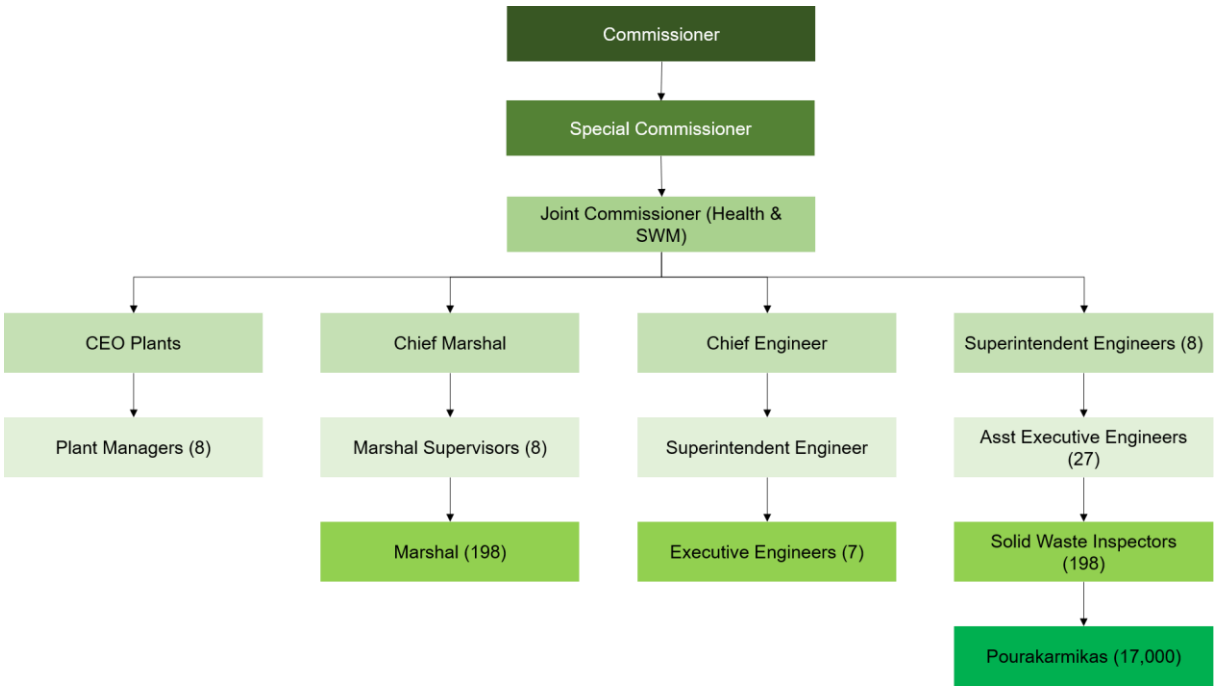

Image 11: BBMP SWM Institutional structure

Sattva is currently involved in restricting the hierarchy in BBMP's SWM department. This implies that this institutional structure will be modified towards the end of December 2023 or January 2024.

From this image, it can be noted that BBMP has 17,000 Pourakarmikas (Safai Sathis/ waste pickers). These workers would mostly be involved with the vendor assigned for collection and transportation.

As proactive as BBMP is regarding collaboration with multiple stakeholders and identifying the right vendors for various tasks, they are afraid to extend their partnership on an immediate basis to start-ups that approach them – unless they have a minimum of 5 years of existence

with proof of exemplary work. This fear exists because multiple ULBs across India have experimented and implemented newly identified technologies, only to fail – after having spent several millions in investments. Bengaluru does not wish to go through the same.

Challenges:

- Unwillingness to partner with startups despite strong business models, unless there is proof of financial sustainability and long-term work.

Opportunities:

- ULBs could create Expression of Interest (EOIs) to assign roles to startups that are promising, to support the implementation and scaling of their solutions.

- Collaboration with consultants of the ULB that allow effective partnership with the ULB to implement solutions.

5.3 Private Sector

5.3.1 MNCs

The following section is drafted after the conversations with Sattva – a consulting company that works in tandem with governments, MNCs, their CSR wing and several startups. MNCs invest INR 1.37 billion as part of their CSR funds in the state of Karnataka. These funds are spread across multiple towns, cities and villages of Karnataka into a variety of sectors such as education, livelihood, skill development, pollution control, waste treatment, biodiversity management, tribal development as shown in the graphic below. Information on the percentage of the funds invested into Bengaluru ecosystem was not available.

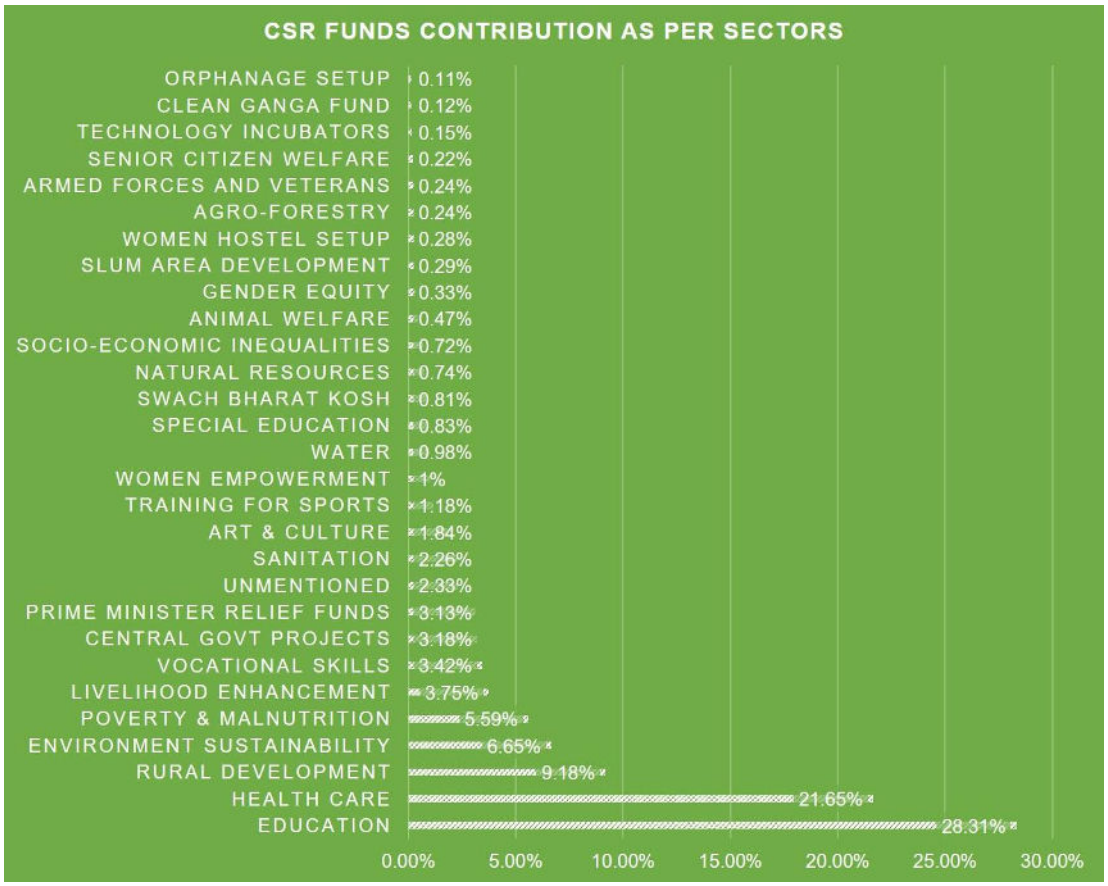

Image 12: Percentage of CSR Fund Distribution across various domains

The following image shares domains that receive CSR funds and to what extent, all across India. Waste Management falls under the third data pointer – Environment and Sustainability – which encompasses air, water, soil, wind pollutions, waste management, biodiversity and ecosystems development etc. A mere 6.65% of CSR funds spent on India is split for multiple causes of environment, all over India.

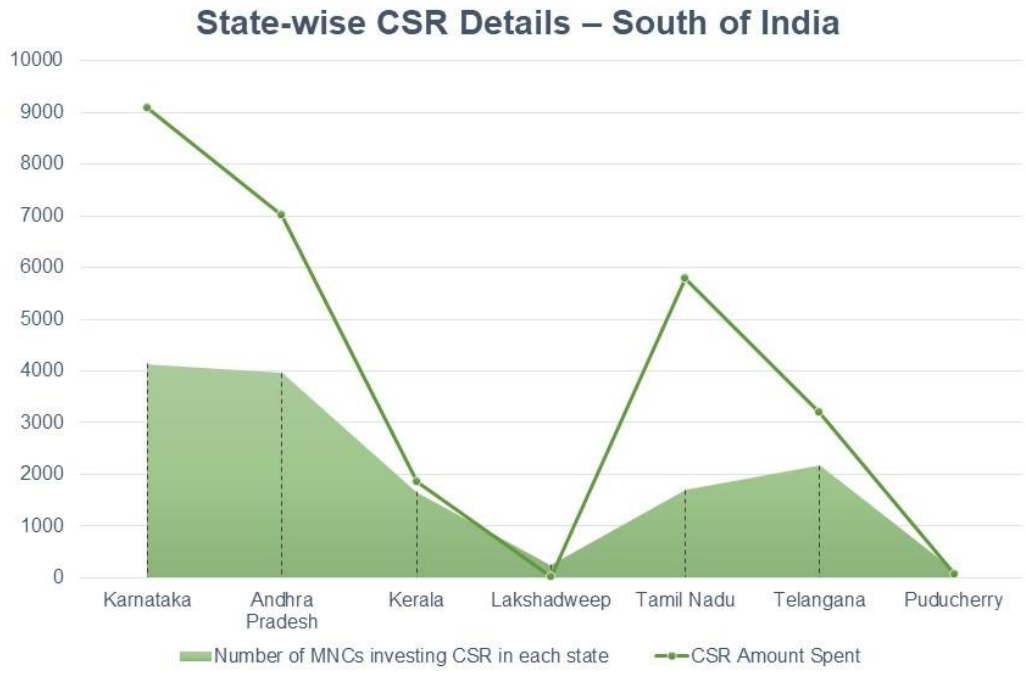

Image 13: State wise CSR Details for the South of India

Sattva's in-depth study regarding CSRs has revealed that Karnataka gets the highest amount of funds in comparison to other South Indian states. However, these funds are not necessarily invested into Bengaluru, but are spent across cities.

Although, the percentage of CSR investments specifically for Bengaluru was not available, there are a couple of MNCs investing CSR funds for SWM in Bengaluru. These range from IKEA Foundation, H&M, Cofresco, Apple India, Wipro Foundation, NSKFDC etc. They have been mentioned in the sections 4.6 Multistakeholder Collaboration and are further elaborated in section 5.5 Public Private Partnerships.

Challenges:

- CSR funds from MNCs are to be utilized on a project basis. This implies that the activities would not be sustainable once the funding is over.

- Commitment of citizens to participate in CSR funded projects is reduced if they become aware that the project is temporary.

- The process for project implementers to obtain CSR funds from MNCs is a long-drawn process – sometimes taking 6 to 12 months.

Opportunities:

- MNCs have become more conscious about the long-term sustenance of the projects and now request how the exit strategy will be implemented.

- Citizens may take pride that a company wishes to work on solutions relevant to them and become more committed to a project.

- Sattva was explicit about the fact that major organizations are very aware that they can have larger impact through providing funds to incubators. That way multiple organizations with intent of positive impact will be able to implement their projects and develop the society.

- Given that Sattva has shared the top funding companies for CSR (although it encompasses all the domains), the image 13 can be used opportunistically. CKIC can approach the said organizations for incubation.

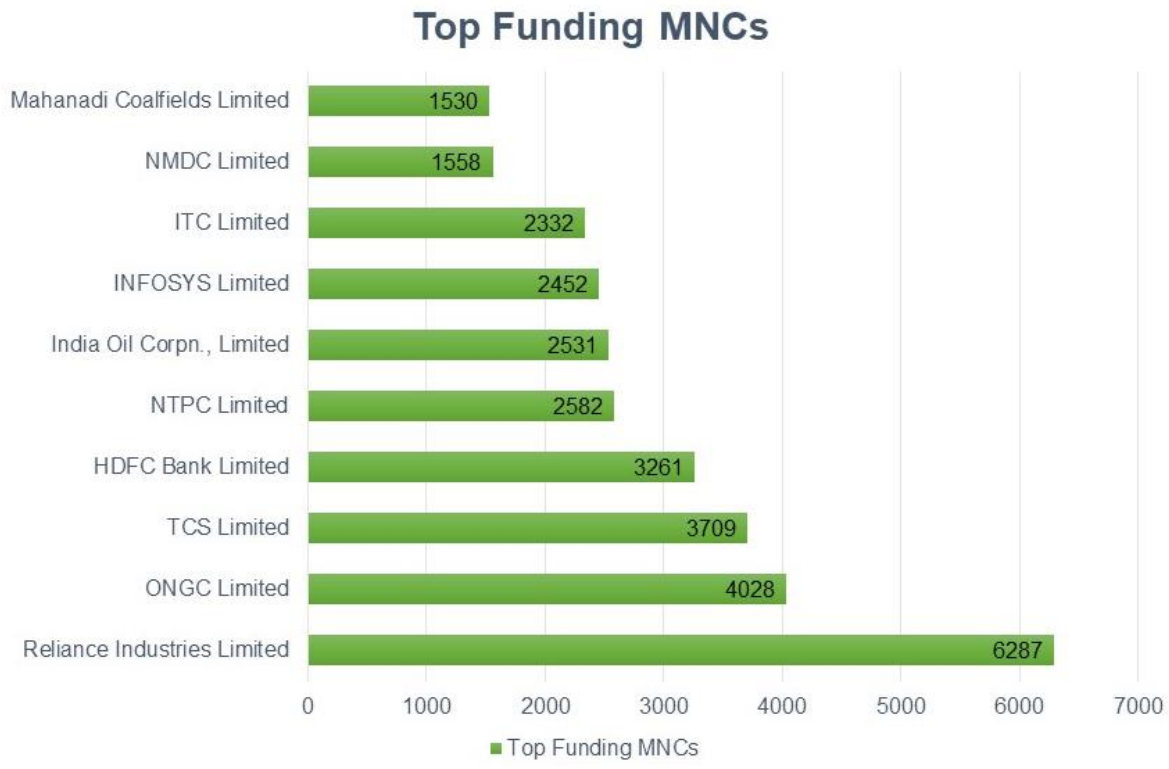

Image 14: Top funding companies for CSR activities in India

5.3.2 Start-Ups

A key stakeholder for startups to pilot and expand their solutions, are the citizens. Circular business models require effective segregated waste and/or the acceptance of new behaviour and consumption patterns.

Table 14 provides an overview of different business models divided into organic and inorganic waste streams:

ORGANIC WASTE			**INORGANIC WASTE**	
#	CIRCULAR BUSINESS MODELS		**#**	CIRCULAR BUSINESS MODELS
1	Waste to Product/ Value		**1**	Circular Supply Chain
2	System Change		**2**	Product as a Service
3	Circular Supply Chain		**3**	Product Life Extension
			4	Sharing & Leasing Model
			5	Resource Recovery and Recycling

Table 14: List of Circular Business Models in the Organic and Inorganic waste management

Organic Waste Startups:

The following table elaborates examples of startups in Bengaluru that work on organic waste management from different approaches and categorizes them into the circular business models in the system.

#	Name	Overview	Business Model
1	Carbon Masters	Making waste into Bio-CNG (a form of methane)	Waste to Value
2	Vyuuham Sustainability	Cutting down organic waste and making compost through black soldier fly in a decentralized structure	Waste to Value
3	Eco Protein	Making protein and feed from organic waste	Waste to Value
4	Gold Composter	Composting for Bulk Waste Generators (BWGs)(in 8 hours)	Waste to Value
5	Stonesoup.in	Pioneering Lane Composting Model in communities	Waste to Value
6	Foodifice	Focus on Food Waste Management (connection of organization to customers and dieticians)	Circular Supply Chain
7	Daily Dump	Selling compost bins of multiple models for household composting	Waste to Value

Table 15: Organic Waste Startups and the corresponding circular business models

All of the listed start-ups in Bengaluru in the organic waste sector are connected directly to the citizens. As most of the major stakeholders of the waste supply chain (like aggregators, recyclers and other processors) do not operate in organic waste; these startups are directly dependent on the citizens of the city. They reach out to Residential Welfare Associations (RWAs), BWGs, to assimilate the organic waste for processing.

As part of a Swaccha Graha movement, Bengaluru had a composting Fair in 2017, where multiple startups in wet waste management and zero waste initiative organizations came together to exhibit their services. (Wirth K, 2017)

Inorganic Waste Startups:

Inorganic waste startups can be found across multiple waste streams of plastics, textiles, e-waste and other micro elements from the e-waste. Table 16 shows examples of inorganic waste management start-ups in Bengaluru categorized into different circular business models:

#	Name	Overview	Business Model
1	Reti Ecotech	Textile waste transformed to Building Materials	Product Life Extension
2	Ecokaari	Upcycling – Creating new products from MLPs	Product Life Extension
3	Saahas Zero Waste	Support in Collection/ Sorting of Waste, Recycling	Circular Supply Chain, Product as Service, Resource Recovery and Recycling

4	Hasiru Dala	Support in Collection/ Sorting of Waste, Recycling	Circular Supply Chain, Product as Service, Resource Recovery and Recycling
5	Repurpose Global	Plastic Recycling	Resource Recovery and Recycling
6	SweepSmart	Sorting & Recycling	Resource Recovery and Recycling
7	SellTrash	Purchase trash from citizens through incentives and provide to respective recyclers	Product as Service
8	ChainFlux	Blockchain technology for the supply chain	Circular Supply Chain
9	Bhuyantra Waste Management Pvt. Ltd .	Dry waste recycling	Resource Recovery and Recycling

Table 16: Inorganic Waste Startups and the corresponding circular business models

Most of the startups work on sourcing their feedstock from aggregators as they work on recycling. Some of them act as aggregators themselves. Only few start-ups like SellTrash work with citizens directly. They collect the segregate inorganic waste from the residents of Bengaluru by incentivizing them. This model is seen in other cities of India as well.

Challenges for Startups:

- Lack of early-stage funding. Incubators provide majorly non-financial benefits and only small-scale funding. The amounts start-ups can raise in an early-stage often cover only a (part of a) pilot. This implies the need to raise funds from multiple sources.

- Most startups focus on downstream solutions, specifically on recycling business models in waste management (for quicker profits) instead of upstream solutions in waste prevention (reuse, repair, refurbishment, product as service etc.).

- Start-ups struggle to obtain high quality segregated waste for producing valuable waste to products.

Opportunities:

- There is a need to combine incubation services with start-up funding and an increase in funding available.

- Organic waste startups are needed as wet waste constitutes at least 60% of domestic waste and other stakeholders are neglecting organic waste.

- Improved awareness creation and campaigns to obtain segregated waste at source.

- Support for upstream innovations that design out waste before it becomes an issue.

5.3.3 Incubators

Incubators play a key role in supporting start-ups with the skills and tools to build and scale circular businesses that address waste management issues. As part of our report methodology, we spoke with five out of 21 incubators located in Bengaluru to understand their role, challenges start-ups face, trends in solutions and their collaborations with MNCs/industries. Only five of the incubators worked on waste directly, while others focused on robotics and tech primarily.

All the interviewed incubators, located physically within Bengaluru, mentioned that they actively support startups building circular business models. Each of them had a Sustainability/ Climate Action portfolio within which they created cohorts of startups working on pollution, air, water, soil and waste. Four out of the five collaborated with MNCs and larger development agencies (like Agency of French Development, Prio etc.) to incubate startups while one of them has connections to High-Net-worth Individuals (HNIs) to donate and invest on those companies.

The priorities for choosing the startups to invest in or incubate varied among the incubators. Three focused on circular business models, one focused more on livelihoods overlapping with the waste sector and the other focused on deep tech. The incubator focusing on deep tech suggested they wish to explore unique methods of recycling and the technology involved for the same. They are willing to risk the time taken to identify niche space/ research to incubate. They are willing to focus on unique technological projects across India.

All incubators interviewed have an open application process for startups to apply. These applications are vetted, assessed how well the startups fit into the purpose and priority of the cohort that is created.

Through conversations with consultants in this field such as Sattva, it was deduced that incubators with effective plans of what they wish as outcome, must develop a project outcome to the cohort they intend to create. It is vital to define what the outcome would be and accordingly incubate/ accelerate the startups that can contribute to the outcome of the cohort. For instance: catering to an MNC as a demand owner and aligning to their mission, would allow CKIC to select startups to incubate or accelerate. This will facilitate incubators or accelerators to raise funds more easily.

It was suggested by the incubators that some startups needed longer gestation period than the others depending upon their focus areas. Startups focusing on waste to value and behavioural change took time to show output in comparison to those that worked in upcycling etc. For example, Carbon Masters struggles with availing bank loans as their machinery to process organic waste is not viewed as assets yet because they don't have a proof-of-concept at large scale yet. As mentioned above, this is due to the quality of poor segregation.

Only one incubator interviewed personally facilitates connections for start-ups, helping them secure contracts and projects from ULBs to accelerate the startups pace for expansion, while others connect start-ups with their contacts in the public sector, empowering them to progress independently.

Regardless of the approach, all incubators empower startups to raise funds beyond the amount received through incubation. They also enhance start-ups credentials by ensuring alignment with flagship initiatives like Swachch Bharat Mission.

Apart from this, it was identified that incubators are willing to collaborate and open to create a common platform for greater outreach, however, it is unclear how a partnership can be brought about. Furthermore, there was unanimous suggestion that if Climate-KiC had to intervene in

the space of post-consumer waste, they would have to specialize. However, if they were to focus on demand owners like MNCs or the government bodies, then they could explore other types of waste.

Challenges:

- The incubators suggested that funds given to each startup in the cohorts ranges from Rs. 10 Lakhs to 15 Lakhs (1 Million to 1.5 Million INR) which is not sufficient for them.
- Startups need to fundraise simultaneously along with being incubated – which is an extra task.
- There is a lack of 'Polluter pays' policy, leading to nonchalance towards segregation of citizens, affecting the quality of processing and by-products of the startups.
- After a cohort is incubated, implementation is still largely in silos and there is a lack of support of each other.

Opportunities:

- Create a platform with multiple incubators to raise a larger pool of funds for cohorts jointly implemented.
- Develop a project and defined outcome for the incubation to facilitate effective selection of cohort.
- Select and enable the cohort of startups to complement each other in the supply chain during implementation.
- Collaborate with government consultants to push for 'Polluter pays' policy for effective segregation of waste by the citizens.

5.3.4 NGOs, Consultants and Support Organizations

Category	NGOs	Support Organizations	Consultants
Examples	Saahas, Hasiru Dala, Samarthanam Trust, Parvaah (National), Makkala Jaagriti, The Ugly Indian, India Rising Trust, etc.	Sahas Zero Waste, ISWA, Hasiru Dala, Repurpose Global, Recircle	Ernst & Young Sattva
Role	Support ULBs in the services of SWM System. These services range from creation of awareness among people, avoidance of littering, manage DWCCs, aggregate feedstock and recycle waste.	These organizations are large data collectors regarding waste trends all over India, while equally participating on ground implementation of holistic SWM System. While ISWA is focused on collecting data and bringing multiple stakeholders together, the others are active on ground.	The Consultants are focused on aiding the BBMP and the other government bodies from restructuring their system, developing policies and identifying effective partnerships for an integrated system – across the supply chain.

Table 17: Examples of NGOs, supporting organizations and Consultants and roles played by them

Challenges:

- There are arguments stating NGOs must maintain a role of supporting the ULB and not take up the responsibility of managing waste from BBMP. The balance of roles of NGOs are still being decided and debated.

Opportunities:

- Development of projects with NGOs as well during incubation. They would have in depth knowledge of the community. Startups collaborating with them will facilitate their grassroot reach.

- Align with the new structures of BBMP to be brought out by Sattva towards end of December. This alignment can lead to better collaboration with MNCs

5.4 Recyclers and Aggregators

The recyclers and aggregators within Bengaluru were tight lipped about where they source their material from regardless of the waste streams – plastic, e-waste, textile etc.

They source their feedstock from various traders and organizations. Larger players like Saahas or Hasiru Dala manage their own DWCCs for different waste streams and recycle them (partially) themselves. Saahas has set their own textile DWCC, whereas Hasiru Dala aggregates and recycles e-waste through the entity called E-Hasiru recyclers.

Through conversations with a waste trader, who is a middleman between the individually existing aggregators and recyclers, it was found that there is no particular business model followed except to get their hands on as much as feedstock possible and get profits. There was not much thought given to the quality of the plastic/ e-waste obtained, when it came to

profits. It is the same reason why aggregators and recyclers choose not to reveal their backward linkages to source their materials.

An exception is Visshudh Recyclers – recycling social business set up by Cofresco – who shared that they source their LDPE plastic for recycling mainly from Saahas and Hasiru Dala as ethical sourcing is important to them.

Recyclers also take up the role of PROs to provide EPR certificates to MNCs. Companies like Repurpose Global or Recircle work with MNCs and various players in the supply chain to facilitate the sourcing, aggregation and recycling of plastic waste through digital solutions. They work with MNCs such as Colgate, Burt's Bees, Corona etc.

Challenges identified:

- There is an overlap of informal and formal market in the space of aggregators and recyclers. Not all the players are necessarily registered with CPCB or SPCB.
- Unwillingness to share the backward linkages in the waste supply chain.
- Unregistered recycling companies imply unaccounted effluents that are released into the environment.

Opportunities:

- To work ethically and tap into further networks, there is an opportunity to collaborate with Saahas and Hasiru Dala.
- To give opportunity to other smaller, yet registered recyclers, the cohort that is incubated can be looped with the list of identified and registered recyclers and aggregators to implement a circular supply chain that encompasses of multiple players.

5.5 Public Private Partnership

According to the toolkit of Public Private Partnerships for MSWM, created by GoI and ADB; the role of the private sector in municipal solid waste management has witnessed significant growth across the country.

#	Time Period	Public Private Partnership Trend
1	Mid 1990s	Efforts were taken in metro cities only. The primary aim was to enhance operational efficiency, leveraging the managerial capabilities of the private sector, albeit limited to specific aspects such as collection, transportation, and road sweeping within the broader MSWM value chain.
2	Late 1990s	This realization prompted a surge in initiatives by ULBs, extending beyond metros to tier II cities. Private sector involvement became pivotal in establishing processing facilities and engineered sanitary landfills, addressing technical, financial, and managerial constraints at the ULB level.
3	Mid 2000s	upswing in private sector participation, marked by the successful implementation of Public-Private Participation (PPP) projects encompassing waste processing, sanitary landfill development, and the closure of existing dumpsites
4	Late 2000s	Private sector showing interest in investing and/ or managing projects related to primary collection and transportation. Integrated projects on PPP formats have successfully materialized, covering both processing and disposal aspects. Multiple cities have witnessed integrated systems, and embraced a comprehensive MSWM system, entrusting the entire value chain to a single private operator.

Table 18: Outlining the trends of PPP along a timeline

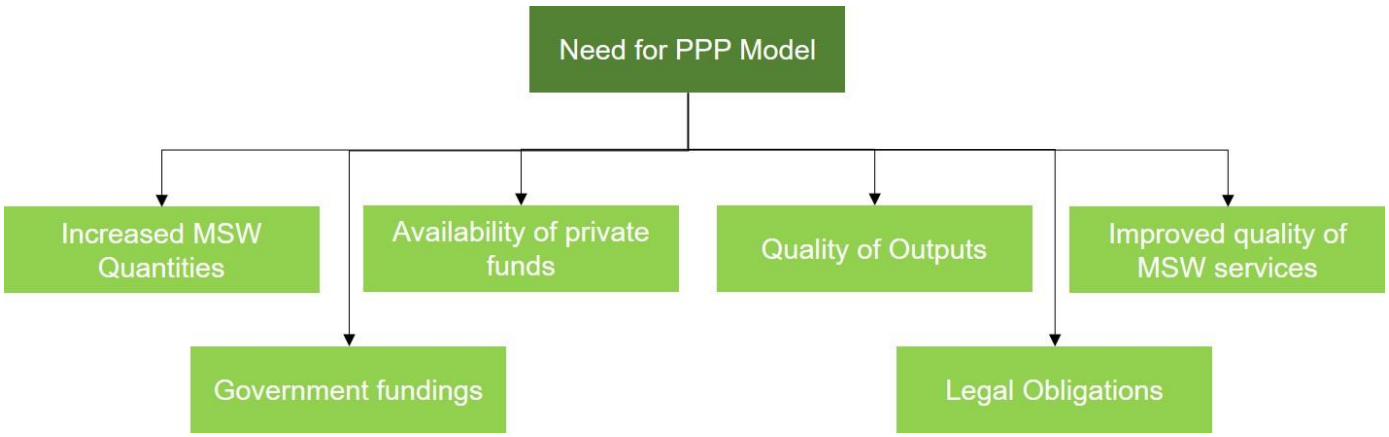

Image 15: The Needs of a PPP Model in MSWM Ecosystem (Preethi Rajesh CSR PDF)

5.5.1 Current Private – Public Partnerships in India

This study will specifically focus on the side of private partnerships that provide investments to the ULB or smaller start–ups that function in the supply chain of MSWM ecosystem. The case studies depicted below are CSR programs implemented on-ground in various states of India to serve as reference and inspiration (CSR Box, 2021).

The most common business model for effective PPP in the space of solid waste management is aptly represented in the following venn diagram. Such collaborations have been supported by the GoI and the States of India as well.

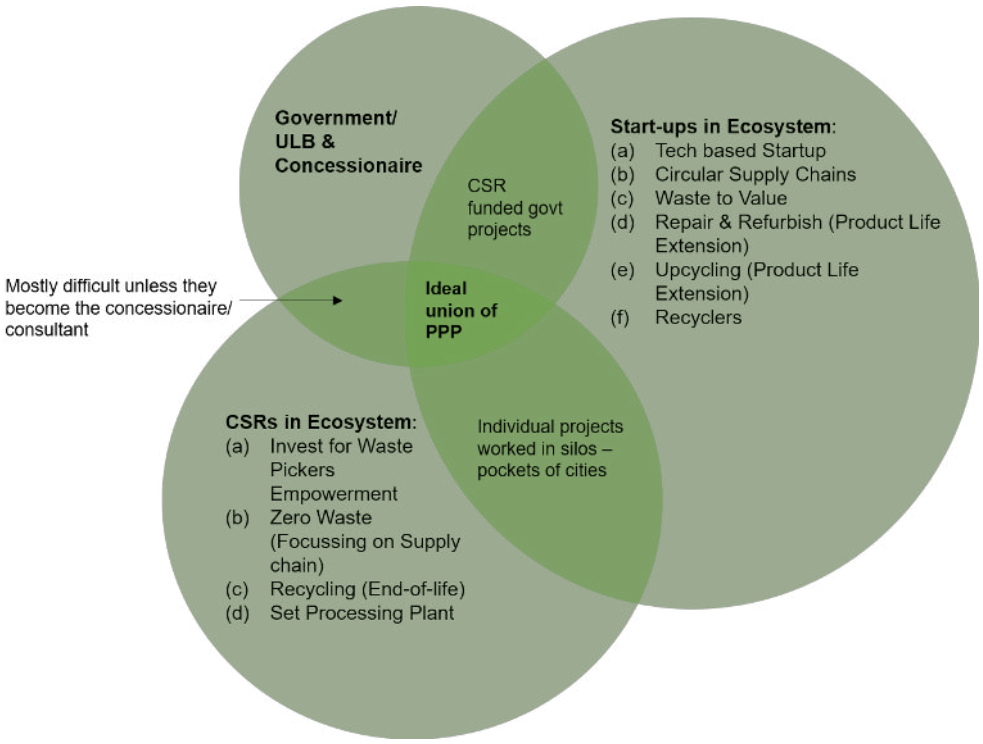

Image 16: Venn Diagram depicting the ideal union of PPP

The ideal union of PPP refers to the effective collaboration of Government/ ULB and concessionaire along with MNCs providing CSR funds and the start-ups for implementation of the MSWM projects on ground.

#	Project	Partners	Value	Implementation
1	**Solid Waste Management and Construction of Sewage Treatment Plant**	REC Limited with Tata Memorial Centre, Skill Council for Green Jobs (SCGJ), Advanced Centre for Treatment, Research and Education in Cancer (ACTREC)	Rs. 2 to 3 crore	(i) Implement comprehensive solid waste management system in 45 villages (ii) REC Limited contributed to the construction of a sewage treatment plant at ACTREC and introduced sustainable energy systems (iii) Played a crucial role in the establishment of mechanized sweeping, collection, and transportation of Municipal Solid Waste in 14 wards in Varanasi
2	**Waste Management Program**	Power Grid Corporation of India Limited with EESL, Agra Nagar Nigam, Jharcraft, and the Government of Jharkhand	Rs. 5.04 crore	(i) Desilting two ponds in Village Riwara, Maihar, Satna district, supply and installation of 10,000 twin-bin dustbins at 92 Indian Railways stations, and the installation of 6,440 out of 8,800 pairs of dustbins at Western Central Railway stations. (ii) Procurement and distribution of dustbins, garbage tippers, and polycotton bags in several municipalities and regions
3	**Clean My Village**	Apollo Tyres Foundation and Harsidhdhi Corporation Pvt. Ltd	Rs. 3.11 crore	(i) Door-to-door waste collection, road and lane cleaning, waste segregation, composting of wet waste, and community awareness initiatives (ii) Constructing "End of Life Tyre" spaces, repurposing waste tires to create five playgrounds in different locations. A total of 290 waste tires were utilized in constructing these play structures, benefitting over 500 individuals
4	**Zero Waste Initiative**	Cummins India Limited with local municipal corporations	Rs. 2.3 Crore	(i) Replicated a successful model of a "Zero Waste Ward" in different wards of Maharashtra. Zero Waste is a holistic philosophy that promotes circularity elements such as the redesign of resource life cycles, emphasizing reuse and eliminates the need for waste to be sent to landfills or incinerators. (ii) An integral aspect of this project revolves around empowering 125 waste pickers, seeking to provide them with enhanced dignity and sustainable sources of income
5	**Recycle and Reuse Program**	Interglobe Aviation Limited with their partner organizations, Nidan and Chintan Environmental Research and Action Group	Rs. 0.39 crore	(i) Pursued a circular waste management approach by recycling old employee uniforms, shoes, bags, aircraft carpets, and seat covers (ii) The proceeds from the sale of these upcycled products provide income-generating opportunities for women residing in slums and villages. (iii) This project involved capacity building for waste pickers, including local communities, and the cleaning of a designated public space in New Delhi

Table 19: PPPs across India in SWM System

5.5.2 Private – Public Partnerships in Bengaluru

Initiative	Implementation
Saahas Zero Waste's Change Matters (Time of implementation is unavailable)	**Project Focus:** - Awareness education regarding bulk waste disposal and side effects - Provide collection services for furniture, e-waste, toys etc. - Engage with RWAs for community engagement to promote reusing culture - Organize repair days, provide Interactive Voice Response System (IVRS) numbers to citizens, set aggregation centres **Project Impact:** Collection of 37,000 kgs of material, serving 9,000 citizens directly, and organizing 14 repair days
Saahas Zero Waste's bE-Responsible and Be Circular	**Project Focus:** - Establish hotline and conduct events at schools, RWAs and other institutions to raise awareness and ensure organized collection for effective e-waste disposal across Bengaluru and National Capital Region. - **Project Impact:** Collected 100 tonnes of e-waste from 1M citizens
NSKFDC Project with Hasirudala	**Project Focus:** - Upgradation of Skills of Waste Pickers and Informal Waste Collectors through creation of training modules to foster entrepreneurial mindset while organizing the waste pickers onto the MSWM System **Project Impact:** Long term impact for waste pickers by facilitating their entrepreneurial transformation with financial literacy, social acceptance and becoming integrated into the MSWM System
Sensing Local with Wipro Foundation (Urban Ecology Small Grant Program) (April 2020 – February 2021)	**Project Focus:** - Enhance the technical knowledge and expertise of ward committees in Solid Waste Management, enabling them to contribute to local area planning, budgeting, and solution implementation - Develop toolkit for scalable and replicable planning to process waste at ward level **Project Impact:** Enhanced knowledge to work on technology selection tool, self-develop planning framework regarding budgeting, land use planning at 15 ward levels by Ward Committees. However, the project has fallen through given the people changing within the system.

Table 20: PPPs across Bengaluru in SWM System

Challenges identified in PPP:

- Bureaucratic system delays the process.
- There is a lack of long-term sustainability. CSR oriented projects' impacts abruptly stops after the project ends.

Opportunities identified in PPP:

- Development of risk analyses before project development
- Development of long-term and sustainable plan for prolonged impact, post conclusion of project. For example, by focusing on the creation of (social) business models.

5.6 Academic Institutions and Research

Academic research contributes to circularity from multiple perspectives. Several times latest innovations and tech come through research. Oftentimes, breakthroughs regarding policies, come through extensive research conducted by varied types of institutions. These institutions encompass educational, international support organizations and local social businesses that conduct research, publish the data as reports and as papers.

The plethora of academic research and published papers on Bengaluru's SWM System cover topics of waste segregation, collection, transportation, landfill management, identifications of generic challenges and opportunities and waste processing methodologies. There has also been extensive work done on the informal economy, the supply chain within, financial and social empowerment of waste pickers etc.

These studies have paved paths for organizations like Saahas and Hasiru Dala to suggest amendments to policies to the State and Central governments for the benefits of Waste Pickers.

The reports that have been referred to for this baseline study include published articles from journals like Elzevier, Academia.org, ResearchGate etc. These various studies have been done on done on particular waste stream such as textile, plastic, e-waste, etc. and on the supply chain infrastructure such of DWCCs. These reports suggest extensive ideas and suggestions that foster the integration of the solid waste management from a generic perspective.

These recommendations range from how a DWCC must be structured for providing safe space to the waste workers, the need for public sector bodies to financially invest further, to how a landfill must be bioremediated. Given these suggestions are extremely generic in nature, they have not been enumerated in this report.

Furthermore, support organizations like NSKFDC, GIZ, UNDP etc. have done studies of the waste management system at the national level to analyse the trends within the collection, transportation, processing of waste and the status of informal waste pickers within the system.

Indian Council of Social Science Research (ICSSR) in New Delhi conducts an upcoming study in Bengaluru exploring efficient solutions for management of household waste from a multi-stakeholder approach.

At the same time, there are institutions across India that collaborate with national bodies such as Sathyabama University with National Solid Waste Association of India creating insights that may be relevant for Bengaluru.

The following universities and research institutes have been identified located in Bengaluru that are engaged in waste management and circular economy:

#	Name	Department
1	Bengaluru University	M.Sc in Solid Waste Management
2	Indian Institute of Science	Diploma in Solid Waste Management
3	International Institute of Waste Management	No particular department
4	Bare Necessities Learning	Conducts short online courses.

Table 21: Institutions across India working on SWM System

The universities were unwilling to share the details of the work, project and innovations they were running. They could probably have plans of their inventions/ technology to be patented; hence, they felt the need to maintain their confidentiality. However, the generic course outline that these institutions follow is to provide study materials on the waste supply chain, the current infrastructure, technologies in other countries, the 3Rs, creation of awareness, role of citizens etc.

One of the key challenges faced was the inability to identify and map ongoing research, potential innovations and technology that are worked on, to facilitate a holistic waste management ecosystem.

Opportunities identified:

- CKIC could collaborate with universities (in or outside Bengaluru) to develop relevant projects/technologies.

- Research institutes may support the replication of existing solutions in Bengaluru.

6. Characterize Living and Working Conditions of Waste Pickers

According to UNDP's Baseline Assessment of Socio – Economic Situation of Safai Sathis (waste pickers) in 2021, India is home to an estimated 5 million sanitation workers, encompassing nine distinct categories of sanitation tasks. The term 'waste pickers' encompasses individuals, whether formally employed or not, who undertake the vital responsibilities of cleaning, sorting, collecting, transporting, and delivering recyclables to aggregators and material recovery facilities (MRFs). The waste pickers are found at various stages of the solid waste management (SWM) process, fulfilling roles as itinerant cleaners, waste pickers, workers in domestic, public, and institutional settings, street sweepers, household waste pickers, landfill workers, and municipal contract collectors, among others. Recognized as essential public workers, the Safai Sathis play an indispensable role in bridging critical gaps by recovering recyclables predominantly from urban areas and supplying essential raw materials to the formal recycling chain, thereby contributing to the nation's sanitation efforts.

Despite the pivotal and extensive role played by the Safai Sathis, most of their efforts are within the informal economy, resulting in a lack of legal protections within labour rights frameworks. This informal status obscures their substantial contributions to both the broader economy and the recycling sector. Anecdotal evidence indicates a notable concentration of socially marginalized groups at the lower tiers of the waste management system. With constrained earning potential, Safai Sathis from historically disadvantaged communities are increasingly vulnerable to the threat of slipping into poverty, accompanied by insecurities related to sustenance, income, employment, and livelihood. These observations, underscore the need for improved recognition and support of these essential workers.

From a policy standpoint, the tracking and mapping of employment-related indicators, including enumeration, for these workers has presented an enduring challenge. This challenge is particularly pronounced in the context of India, where a substantial portion of the informal labour force lacks official government identification cards. The absence of such documentation limits the Safai Sathis' eligibility for essential social protection programs, including subsidies for food grains, healthcare, education, and financial benefits, among others. The prevailing dearth of comprehensive data further hampers the formulation and implementation of policies that could significantly enhance the well-being of these workers.

6.1 Scenario in India

In 2020, a comprehensive survey conducted by UNDP India engaged with 9,300 Safai Sathis spanning 14 cities in 10 different Indian states. The ensuing report draws from this cross-sectional cohort, providing a valuable overview of key policy considerations related to Safai Sathis. Notable findings from this survey include the fact that approximately 65% of the respondents had not received any formal education, with a particularly high proportion within socially disadvantaged groups. The average household size stood at four individuals, with variations ranging from 0 to 16 members within the surveyed population.

The majority of respondents were engaged in informal occupations, including itinerant waste pickers, street sweepers, and landfill waste pickers. These informal work categories exhibited a higher concentration of socially disadvantaged individuals and those lacking formal education. Ownership of identification documents varied across the sample, with roughly 90% holding Aadhar cards, around 63% possessing voter ID cards (with a higher representation

among women), and a small 6% reporting ownership of birth certificates. Only 12% held occupation cards, and a mere 0.5% had caste and income certificates.

Economically, approximately 70% of respondents reported a monthly household income below Rs. 10,000, with a mere 4% earning more than Rs. 20,000 monthly. A sizable 67% reported having a bank account, but only 3 in 10 of these individuals had their accounts linked with the Jan Dhan scheme. Half of the surveyed Safai Sathis held beneficiary documents, such as ration cards, which they utilized to access rations, while a mere 4% possessed health cards.

Housing conditions revealed a prevalence of rented or temporary accommodations, with basic utilities like drinking water and electricity generally available. However, only six in 10 individuals reported having access to sanitation facilities. The survey also identified varied cooking fuel sources, with wood-based fuel usage comparable to the use of liquefied petroleum gas and other cleaner alternatives among this resilient group of workers. These comprehensive insights provide valuable baseline data for further policy considerations and interventions to enhance the lives of Safai Sathis.

6.2 Scenario in Bengaluru

Informal waste pickers are individuals who are not incorporated into the formal system or have been legally acknowledged. Typically, these waste pickers are migrants or belong to lower castes in India. They often lack the necessary skills and resources to efficiently collect and manage Dry Waste Collection Centres (DWCCs) and conduct waste transactions to maximize their earnings. Operating independently, these waste pickers gather inorganic waste from roads, bins, and railway tracks. They play a crucial role in sustaining the recycling industry by supplying the collected inorganic waste to DWCCs, aggregators, or recyclers in exchange for monetary compensation. It is common for these waste pickers to involve their entire family in the waste picking activities.

On a daily basis, an average of 3,500 Metric Tons of plastic waste is traded, with a notable portion of this material escaping official estimates of waste generation in Bengaluru. This unaccounted-for plastic is diligently collected by a group of unsung environmental heroes – waste pickers. These individuals play a crucial role in the waste management ecosystem, retrieving plastic waste, selling it to scrap dealers, who then pass it on to aggregators and ultimately to re-processors. The informal waste recycling sector employs approximately 95,000 workers, with a significant number of them being women.

Despite their indispensable contribution to environmental sustainability, waste pickers and informal recyclers find subsidize the responsibilities of producers, consumers, and the government. While providing an essential service, waste pickers receive meagre compensation. In Bengaluru, municipal authorities have actively engaged waste pickers and other informal waste collectors in door-to-door collection of dry waste and the operation of Dry Waste Collection Centres at the municipal ward level, thus formalizing them. The ongoing integration of waste pickers is enhancing the existing low-cost informal waste recycling chain, offering valuable solutions, albeit often operating in obscurity (S. Nalini, A. Kabir; IAWP; 2021).

According to BBC Media Action Research (2020), in Bengaluru, the majority of residents lack awareness and acknowledgment of the waste pickers who manage their waste. Despite the visible and concerning presence of waste on the streets, informal waste collectors remain largely ‘invisible’ to the public.

It was observed that people showed sympathy and appreciation towards formal waste collectors and were ignorant to the informal waste collectors. This recognition of formal waste

collectors came from citizens observing them wearing uniforms and interacting with people. However, BBC Media Action India's formative study in 2020 revealed that, when people talked about waste pickers, it was about their poor physical appearance (55%), lack of education (60%), problems with addictions (42%), homelessness (49%) and a fear that they spread disease (56%). It can be said that informal waste pickers were discussed with a feeling of disgust.

Informal waste pickers shared experiences of discrimination from the general population due to the nature of their work. They mentioned occasionally avoiding interactions with people to evade harassment, thereby choosing to remain inconspicuous as a coping mechanism to deal with discrimination, bullying, and concerns for their own safety.

Formal waste collectors at the top of the hierarchy typically hold contractual or government positions, work with different NGOs or organizations that manage DWCCs, receive a fair salary, maintain regular working hours, and frequently engage with the general population. As waste workers are legally recognized, they have their government IDs; which allows them to apply social and financial empowerment schemes. The waste sorters in the formal waste management system, at dry waste collection centres form a part of a comparatively more structured setup, receiving minimum wages and reasonable working hours. In contrast, informal waste sorters at scrap shops and itinerant buyers have infrequent interactions with the general population.

It is the informal waste pickers who are the most marginalized and unnoticed within this ecosystem. They often work during unconventional hours, such as early mornings or late nights to remain inconspicuous and gain access to the most valuable waste materials. Many of them live in fear of harassment, whether from law enforcement or the general population.

According to AICCTU (2021), waste pickers assume a pivotal role in Bengaluru's waste management landscape, serving as the unsung heroes of the city's waste management system. Despite BBMP's waste collection system's intended capacity to handle the daily production of 4,000 – 6,000 tons of solid waste, it is approximated that informal waste workers are responsible for collecting a substantial 1,050 tons of recyclable materials each day, equating to a remarkable one-third of the city's total waste output. A comprehensive study underscores the invaluable contribution of approximately 30,000 waste pickers, which has translated into significant annual savings of more than INR 84 crores for, BBMP, in the realm of waste collection and management. An estimated 60% of waste pickers belong to the community of 42 lakh migrant workers, constituting a substantial 44% of the city's overall population.

The COVID19 lockdowns in India led to the economic pressures and dearth of livelihood opportunities in their native villages, which drove these migrants to seek work in other regions of the country. This migration was primarily prompted by agrarian distress in their home areas, compelling labourers to seek employment elsewhere. Consequently, this phenomenon contributed to the expansion of a 'reserve army' of low-cost labourers, perpetuating the challenges and vulnerabilities faced by these migrant workers.

6.3 Current Initiatives in Bengaluru for Waste Pickers

Numerous organizations in Bengaluru have undertaken various initiatives aimed at fostering the socio-economic development of waste pickers. To foster social economic development for the waste pickers, organizations such as the H&M Foundation, in partnership with ten organizations, has launched the "Saamuhika Shakti" initiative, dedicated to the welfare of

waste pickers citywide. This collaborative effort involves specific objectives assigned to each organization, including BBC Media Action, Hasirudala, Sambhav Foundation, Save the Children, Social Alpha, Wateraid, The/Nudge, Enviru, and Circular Apparel Innovation Foundation. To ensure accountability and measure the impact on the ground, the International Initiative for Impact Evaluation is entrusted with monitoring and evaluating the outcomes of this vital program. These concerted efforts reflect a commitment to enhancing the well-being and prospects of waste pickers in the Bengaluru region.

Furthermore, Hasiru Dala, in partnership with the Alliance of Indian Waste Pickers, has designed training modules to uplift waste pickers as part of a Corporate Social Responsibility (CSR) initiative by the National Safai Karamcharis Finance and Development Corporation (NSKFDC). This initiative is being implemented not only in Bengaluru but also in various other cities (IAWP, 2018).

6.4 Challenges and Vulnerabilities in Informal Waste Recycling Industries

- **Weather Induced Vulnerability**

The rise in material moisture content resulting from rain or floods, coupled with inadequate infrastructure for material storage and limited drying spaces, leads to a decline in material prices during the monsoon season (approximately four months), the post-monsoon period (around three months), and even during summer showers.

- **Policy Induced Vulnerability**

In 2016 and 2017, the informal economy faced significant challenges due to two major policy measures: Demonetization and the introduction of the Goods and Services Tax (GST). The demonetization move involved the withdrawal of INR 1000 and 500 currency denominations, aimed at targeting undisclosed cash reserves. This action rendered 86% of India's currency supply obsolete virtually overnight. Consequently, numerous businesses in the informal recycling sector found themselves in a precarious situation, struggling with a shortage of small change, which in turn had ripple effects throughout the supply chain (Chandran, Arora, Abubaker, Shekar; 2018).

The second policy measure involved the implementation of the Goods and Services Tax (GST). Recyclable plastics and other waste materials were initially subject to a 5.1 percent Value Added Tax (VAT), which was later raised to 18 percent for recyclable plastic, metal, and glass. This higher tax rate was applied at more formalized stages of the informal waste supply chain, such as plastic and glass reprocessing and manufacturing units. In order to prevent price hikes for end consumers, the tax burden was shifted onto the informal waste supply chain to absorb.

- **Social Unacceptance of Waste Aggregation Units**

The 'Not in my backyard' attitude of urban residents has led to the relocation of waste aggregation facilities to the outskirts. An example of this is Nayandahalli, initially situated on the city's periphery, where waste warehouses were established due to its distance from the urban core. Over time, the city expanded and reached Nayandahalli, and it now boasts a major metro train station connecting it to the city centre. The arrival of affluent residents via the metro has created a situation where they prefer not to have these warehouses visible from their apartment balconies. Consequently, what were once facilities on the outskirts have now become an unwanted presence in someone's immediate vicinity.

To adapt and survive, these warehouses must once again move to the newly redefined periphery. As they are pushed beyond the city limits to reduce costs, the homes of waste workers and sorters are now being used as sorting facilities for the materials brought in.

Opportunities identified:

- **Inclusion in the EPR framework as Entrepreneurs:**
  Within the framework of Extended Producer Responsibility (EPR), our aim is to channel financial and intellectual investments into training sessions for organizations of waste pickers and other stakeholders within informal waste supply chains. These sessions will focus on incorporating elements of transparency and traceability, along with providing insights into regulatory regimes. The ultimate goal is to simplify the operations of informal enterprises and enhance their overall efficiency.

- **Inclusion on e-Shram portal:**
  E-shram is a government portal that enlists the labourers in each of the domain – ranging from construction, health, education, rural development domains etc. However, waste workers are categorized as 'Others'. Creating a separate section for them will be one of the ways through which waste pickers can be recognized.

- **Development of Partnerships:**
  There is a chance for more intricate partnerships to be made. Even if Saamuhika Shakti is a collaborative initiative of ten organizations, each of these organizations can facilitate a larger movement by including organizations of their nature to increase the reach to waste pickers. For instance, Hasirudala can include Sensing Local, Repurpose Global, Recircle etc (all organizations that work with waste pickers while recycling plastics and other types of waste)

8. Conclusion

In conclusion, the SWM baseline study sheds light on the challenges and opportunities inherent in Bengaluru's waste management ecosystem. The intricacies of end-of-life processes, marked by machinery breakdowns and operational inefficiencies, emphasize the need for interventions such as collaboration with academic institutions and the implementation of a polluter pay fee. The examination of informal waste pickers reveals vulnerabilities and proposes inclusive measures, including EPR frameworks and partnerships, to integrate these workers into the broader waste management sector. The study further unveils the complexity of multi-stakeholder collaborations, underscoring the gap in a comprehensive partnership loop crucial for effective waste management in Bengaluru.

Despite the insightful recommendations for improving waste management, the study acknowledges methodological challenges, including difficulties in securing interviews with target stakeholders within a short timeline and the elusive nature of accurate waste volume data. Resistance from Municipal Corporations to share data due to litigation concerns and organizations' reluctance to disclose information for fear of competition pose additional obstacles. Limited data on the informal waste sector further complicates the understanding of this critical component of waste management.

Moving forward, the implementation of the proposed recommendations is crucial to empower CKIC in developing a Circular Economic Innovative Cluster. This approach aligns with the GoI's multi-stakeholder and participatory model, fostering collaboration among startups and preventing the formation of exclusive groups while enabling scalable expansion. Despite the challenges, addressing these issues through the recommended interventions is imperative for advancing circularity in Bengaluru's waste management and creating a more inclusive and effective waste management ecosystem.

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10. Appendices

10.1 List of Key Stakeholders

Shared as attachment: Stakeholder List_YEHxCKIC_Final

10.2 Survey Questionnaires

Shared as attachment: Survey Tool_YEHxCKIC_ Final

10.3 List of DWCCs in Bengaluru

Shared as attachment: DWCC List_YEHxCKIC_Final

11. Introduction of Drafting Organizations

This baseline report was commissioned by Climate KIC in partnership with SecondMuse and prepared by Yunus Environment hub.

11.1 Climate KIC

EIT Climate-KIC is Europe's leading climate innovation agency and community, using a systems approach to shape innovation to support cities, regions, countries and industries meet their climate ambitions. Together with partners across the globe, EIT Climate-KIC acts to bridge the gap between climate commitments and current reality by enabling decision makers and investors to act. They find and implement solutions in integrated ways and mobilize finance. They build skills to accelerate learning and explore innovation, opening pathways to shift mindsets and behaviours. Through radical collaboration, EIT Climate-KIC orchestrates large-scale demonstrations that show what is possible when cycles of innovation and learning are deliberately designed to trigger exponential decarbonisation and build resilient communities.

11.2 Yunus Environment Hub

Yunus Environment Hub (YEH) is a global social business network that creates solutions for the environmental crisis. Co-founded by Nobel Peace Prize laureate Prof. Muhammad Yunus, YEH supports and develops social business solutions that solve environmental problems in a financially self-sustainable way and with high socio-economic impact. YEH's vision is to create a world of 3 Zeros: Zero Poverty, Zero Unemployment and Zero Net CO2 Emissions. To achieve this goal, YEH is facilitating social business entrepreneurship as a vehicle to solve the most pressing issues of the planet, to ensure these solutions are financially self-sustainable and socially inclusive. To achieve this YEH, builds partnerships with public and private sector and engages with development cooperation agencies aligned with our mission. YEH purpose manifests in the ambition for YEH to drive systemic change by empowering green social businesses and building an ecosystem that enhances the impact of those entrepreneurs. YEH works to support social business solutions specifically to mitigate climate change and increase climate resilience of local communities.

11.3 SecondMuse

SecondMuse is a global impact and innovation company that works with communities focused on climate, equity, and tech to build resilient economies that benefit people and protect the planet. Our impact-driven methodology prioritizes collaboration and relational infrastructures with key stakeholders to develop market-driven solutions that transform our current systems. Over the last 15 years, we have designed, developed and implemented a mix of innovation programming and investing capital that has reached over 160 countries and territories.