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Preface

The document is prepared by M/s Zeeruk International (Pvt.) Ltd. in association with M/s Sustainable Environmental Solutions (Pvt.) Ltd. (hereafter termed as 'the Consultant'; for United Nations Development Programme (UNDP) and UNILEVER, Pakistan (herewith, the Client). This report documents the findings and recommendations of the project titled: "Baseline Assessment of Current Scenario of Plastic Waste Management for Rahim Yar Khan City" (the Project) in compliance with the Terms of Reference (TORs) issued for this project.

The Consultant takes this opportunity to express their gratitude to everyone who contributed to the successful completion of the Project in particular, representatives from Municipal Corporation (MC), Environmental Protection Department (EPD), Khawaja Fareed University of Engineering and Information Technology (KFUEIT), government/private schools, and informal industries. Special thanks to the local administration, school going adolescent children, households' women, and active social members for sharing their experiences and thoughts.

The Consultant would also extend their appreciation to the Client's senior management for their support specifically, in conducting Key Informant Interviews (KIIs) with Additional Deputy Commissioner General (ADCG), Chief Officer (CO, MC), Deputy Director (DD, EPD) and arranging Focus Group Discussions (FGDs) with children during field data collection phase of the project.

Furthermore, the Consultant sincerely hopes that the project's findings and recommendations will be taken in the same spirit and will be implemented by MC for ensuring the effective and sustainable management of plastic waste in nearby future.

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Executive Summary

Solid Waste Management (SWM) has been a long-lasting issue in both rural and urban settings of Pakistan, as it is overwhelmed by a wide variety of social, cultural, legislatives, and economic issues. Unsustainable solid waste management practices lead to a spread of wide variety of waste related diseases, and it is estimated that more than 5 million people die each year¹ across Pakistan. Solid waste generation rate in Pakistan ranges from 0.283 to 0.612 kg/capita/day² and plastic waste accounts for the 2nd highest proportion of MSW, amounting to 6.41 million tons of plastic waste annually³ after the organic fraction. Pakistan is among those few countries that have scarce plastic waste recycling plants to cope with plastic pollution. Additionally, the root cause of the accumulation of single use and non-recyclable plastic is the absence of effective plastic waste management system in the country.

Extensive usage of plastic on one hand has brough comfort in life but at the same time its massive production is a serious management concern. The plastic generation rate in 2019 was reported to be 100 g/capita/day⁴ and it is still increasing at an alarming rate. The safe disposal of plastic waste has become a major issue due to the existence of traditional plastic management i.e., linear economy of plastic⁵ (production-use-disposal). Consequently, more than 3.3 million tons of plastic waste (per annum) ends-up in the landfills, open burning, unmanaged dumps or strewn on land and water bodies across the country⁶. Unfortunately, limited work has been done regarding plastic waste management in Pakistan, thereby in order to address plastic pollution and the need to shift towards circular economy, the UNDP and UNILEVER-Pakistan have designed the titled study "Baseline Assessment of Current Scenario of Plastic Waste Management for Rahim Yar Khan (RYK) City". The project aims to conduct a baseline study in order to identify the gaps and ways to improve the plastic waste management system and to identify the approaches for shifting towards circular economy for plastic – so that to make the RYK city (the Study Area) as "Zero Plastic Waste City".

Keeping in view the project scope and objectives, quantitative and qualitative data was collected from the Study Area. Quantitative data included collection of commingled municipal solid waste (MSW), its transportation, segregation, and weighing of different plastic components originating from targeted residential, commercial, and institutional solid waste streams. While qualitative data was collected by conducting Key Informant Interviews (KIIs) with the relevant stakeholders and by arranging Focus Group Discussions (FGDs) with potential groups of the society in order to assess the behavioral component for managing plastic waste, in particular.

Modes

Results of the qualitative data showed that 82% of the recyclable plastic was generated by commercial stream (shops and hotels), whereas 38% of recyclable plastic was calculated from the domestic stream. The possible reason for the low percentage of recyclable plastic from the HHs could be the involvement of home-maids and residents in segregating the recyclable components from the MSW. Results revealed that a maximum recyclable plastic waste generation rate per Household (HH) came out to be 37.29 g/HH/day in high income area. While a minimum of 24.86 g/HH/day in middle income area because of relatively bigger HH size in comparison with the HH size of low income area. Moreover, a maximum of 6.6 g/kg of PET recyclable plastic waste was separated from a communal point (secondary point) near Railway Station because of high consumption of soft drinks and water bottles by passengers at Railway Station. Apart from this, a maximum of 15.25 g/kg of non-recyclable plastic waste (mostly comprised of disposable plates, spoons, and single-use plastic) was found from a communal point (adjacent to Al-Yageen Language Model School) because of the presence of hotels/restaurants, and shops nearby. One sample was also collected from dumpsite (Mou Mubarak Dumpsite near Madina Colony) in order to know the plastic composition and to quantify how much plastic waste ends up at dumpsite. It was found that a maximum of 21.75 g/kg of non-recyclable plastic waste was observed because of maximum recyclable plastic waste separation from primary and secondary sources. The field team has also observed that a few scavengers were scavenging at a time of sampling at dumpsite relative to scavenging activity within the Study Area and in particular, at communal points because of presence of more recyclable plastic at primary and secondary sources. The findings of the qualitative data highlighted the coordination gap among the municipality, academic

institutes, industries, and INGOs/NGOs for ensuring the effective plastic waste management within the Study Area. It was also found that the municipality lacks dedicated budget under "Awareness or Behavioral Change Component" in Annual Development Plans (ADPs) thereby stressing and limits the municipality to conduct door-to-door awareness. Moreover, it was found that almost 87% of the total expenditure dedicated for SWM during fiscal year 2019-20 was spent in salaries and remaining in fuel, maintenance, and repairing of equipment. Regarding the recovery of post-consumer plastic, it was found that approximately 80% of recyclable plastic was collected by the scavengers, 5% by sanitary workers, and 15% by housemaids/inhabitants of the Study Area. The recovered sorted plastic waste is then sold to street hawkers/itinerant buyers and small scrap dealing shops. It was also noted that approx. 70% of the respondents sell the collected recyclable waste as "Mixed Plastic" at a rate of PKR 30-35/kg, whereas remaining as separate component⁷ (PET Bottles at the rate of PKR 55/kg, Soft Plastic at the rate of PKR 50/kg, and Hard Plastic at the rate of PKR 12/kg) to scrap dealers. Apart from this, it was also observed that the municipality lacks enough equipment like handcarts, brooms, etc., for MSW collection and street sweeping, respectively. One handcart is available for five sanitary workers, and one broom is provided to three sanitary workers and thus hampering the collection efficiency within the Study Area.

Based on quantitative and qualitative data analysis and an extensive literature review, an implementable business model canvas of circular economy for plastic waste has been proposed for effective and sustainable management of plastic waste within the Study Area. Following are the necessary components of the proposed business model canvas:

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¹ Solid Waste Management – The Nation [Online] Available at: https" //nation.com.pk/26-Mar-2020/letters-to-the-editor? Show=preview) [Accessed on 05 January 2021].

² Environmental Protection Department - Solid Waste - [Online] Available at: https://epd.punjab.gov.pk/solid_waste) [Accessed on 05 January 2021].

³ Plastic Pollution by Country 2021. [Online] Available at:

https://worldpopulationreview.com/country-rankings/plastic-pollution-by-country [Accessed 29 April 2021].

⁴ Who is making Pakistan a plastic-stan? [Online] Available at:

https://archive.pakistantoday.com.pk/2019/08/30/who-is-making-pakistan-a-plastic-stan/) [Accessed on 05 January 2021].

⁵ Linear economy: A linear economy traditionally follows the "take-make-dispose" step-by-step plan. This means that raw materials are collected, and then transformed into products that are used until they are finally discarded as waste.

⁶The good, the bad and the ugly of plastic in Pakistan | UNDP in Pakistan [Online] Available at:

https://www.pk.undp.org/content/pakistan/en/home/blog/2020/the-good--the-bad-and-the-ugly-of-plastic-in-pakistan.ht ml#:~:text=More%20than%203.3%20million%20tonnes,water%20bodies%20across%20the%20country) [Accessed on 05 January 2021].

⁷**PET**: Water bottles, soft drinks, juice, mouthwash, sports drinks, and condiments.

Soft Plastic: Shampoo bottles, cosmetic products, automobile cans, samika shoppers, shevel pipes (wiring), PVC pipes, etc. **Hard Plastic**: Geometry boxes, tubs, baby pots, broken chairs, tables, charger casings, TV casings, etc.

Key Partnerships/Partners: Key partners include, local/provincial government, Tehsil Municipal Authority (TMA), INGOs/NGOs, plastic manufacturing industries, educational institutes, informal/private sector, and consumers/public.

Key Activities & Key Resources: Key activities include source segregation (collection and segregation of recyclables and non-recyclables), recycling of segregated plastic waste, and disposal of non-recyclable plastic waste. While key resources include installation of waste bank for source segregation, installation of recycling units using solar energy, implementation of polluter's pay principal (PPP) and ecotax via mandating Environmental Protection Department (EPD) for effective disposal of non-recyclable plastic waste.

Value Proposition: It includes the environmental benefits (by reducing use of virgin raw material, resulting in less pollution and clean environment, and reducing the health problems); social benefits (for improving quality of life via educating child labor involved in scavenging activities); Economic benefits (by increasing aesthetic value through effective management of solid waste, in particular plastic waste as it will result in increased tourism and increased job opportunities within the Study Area).

Customer Relation: Government and industries relationship can be maintained through regulations and policies for long-term including incentives and penalties; consumer relation could be maintained through policies/regulations specifically targeting consumers and by educating them, and by developing linkage between industries and academia for research and development.

Distribution Channel and Customer Segment: It includes an experimental model targeting small industries to produce recycled products using recycled plastic for local distribution and by creating awareness among the locals to use recycled products.

Cost Structure & Revenue Stream: It includes cost which is being required for research and development (R&D), for installing Waste Banks, recycling units, for conducting baseline studies such as pilot tests, and for developing new technology in order to treat non-recyclable plastic waste. Whereas revenue can be generated through the installation and regular operation of recycling units and via imposing taxes/fees to industries against their production using non-recyclable plastic coverings.

Recommendations for Government Departments: Following are the recommendations for the government departments based on the findings of collected qualitative and quantitative data, literature review and observations:

- a. Installation of weigh bridge at dumping site is highly recommended in order to know the daily collection efficiency of MSW.
- b. Tracking devices on vehicles should be installed on priority basis for monitoring the routes (from loading point to disposal site) and to minimize the illegal selling of MSW to brick kilns.
- **c.** Provincial government should devise and implement a legislative framework for the management and/or treatment of non-recyclable portion of MSW along with the strategy for promoting the reuse/recycle concept.
- **d.** It is highly recommended that the provincial government should give permission/authority to the local government/TMA for hiring the staff (in particular supervisor and sanitary staff) against the vacant positions for improving the collection efficiency of MSW within the Study Area.

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- **e.** To conduct a baseline survey incorporating seasonal variations for investigating the current situation of SWM in the Study Area along with the upgradation and digitalization of existing assets management mechanism within the municipality.
- f. TMA should develop an implementation plan for the collection of service fee from waste producers in order to limit/reduce the SW generation rates as it will ultimately reduce financial burden of local/provincial government.
- **g.** TMA should engage, support, and promote informal sector for enhancing/improving the collection efficiency and sustainable management of solid waste, in particular plastic waste via effective engagement of scavengers and street waste pickers within the Study Area.
- **h.** TMA should take appropriate steps for establishing centralized and/or decentralized plastic waste recovery units at various locations within the Study Area for revenue generation.
- i. It is highly recommended that local government should purchase a processing unit under Public Private Partnership (PPP) mode, for converting recyclable plastic waste into plastic flakes (shredded form) or in pellets which can be sold directly to potential plastic recycling industries for revenue generation.
- **j.** Basic training sessions and counseling programs should be arranged by local government to improve environmental knowledge and for improving community's attitude towards plastic waste and to aware them in reducing and managing their household waste by their own.
- **k.** TMA should promote 3R's (reduce, reuse, and recycle) concept in collaboration with educational institutions and other stakeholders at community level with an aim to significantly reduce the amount of waste to be disposed of at final disposal sites and for reducing the public health and environmental risks.
- I. Two-bin concept for recyclables and non-recyclables waste collection systems should be promoted among children and women for the management of recyclable materials, in particular plastic waste.

Recommendations for INGOs/NGOs & Industries: Following are the recommendations for the INGOs/NGOs and industries for ensuring sustainable plastic waste management within the Study Area.

- a. To conduct baseline and assessment studies to bridge the existing information gap, facilitates in developing policies, and in building/enhancing institutional capacity within governmental departments. Most importantly, INGOs/NGOs should assist the educational institutes in carrying out research to find a suitable and sustainable alternative to replace the non-recyclable plastic packaging and to propose a suitable technology for treating the non-recyclable plastic waste.
- b. As there is no landfill site in the Study Area, the major portion of the collected waste is being dumped rather than properly landfilled. Thus, INGOs/NGOs should technically and financially aid the municipality in constructing an engineered landfill site. As it allows the safe disposal of non-recyclable waste by protecting the public health, preserving the key environmental resources and reduces the green-house gas (GHG) emissions.
- c. For developing awareness, environmental INGOs/NGOs should support the local government for organizing awareness sessions, door-to-door awareness programs, seminars, etc. in spreading awareness among the citizens and by educating children at schools and reaching out to corporate offices and households.

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- **d.** It is highly recommended that INGOs/NGOs should provide motorized equipment's /fast moving machinery/vehicles as an alternative to hand driven trolleys for improving the collection efficiency of MSW within the Study Area.
- e. Different training sessions like technical training of sanitary and supervisory staff by including TMA's top management followed by refresher trainings and Training of Trainers (TOTs) on regular basis are highly recommended to be arranged and sponsored by INGOs/NGOs for capacity building among human resources.
- f. Also, industrial units in particular plastic products manufacturers', should play their role in providing financial assistance to educational institutes under Corporate Social Responsibility (CSR) for conducting the goal-oriented research projects for proposing a low-cost and eco-friendly solutions to the problems associate with the single-use and non-recyclable plastic waste.
- For synergy development among different stakeholders i.e., educational institutes (for conducting research on non-recyclable plastic fraction), health department (for highlighting hotspot areas⁸), and the municipality, it is highly recommended that industries should assist TMA financially in order to cope the prevailing problems and pollution being caused by an ineffective management of MSW within the Study Area.



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List of Acronyms:

ADCG

, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	Additional Deputy Commissioner Centeral
ADP	Annual Development Plan
AP	Assistant Professor
ASTM	American Society for Testing and Materials
BCA	Benefit Cost Analysis
BCR	Benefit Cost Ratio
BMC	Business Model Canvas
C2C	Cradle to Cradle
CAPEX	Capital Expenditure
CBR	Cost Benefit Ratio
CO	Chief Officer
CPET	Crystallized polyethylene Terephthalate
CSR	Corporate Social Responsibility
DC	Deputy Commissioner
DD	Deputy Director
DVD	Digital Video Disk
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EPD	Environmental Protection Department
EPS	Expanded Polystyrene
EU	European Union
EXEN	Executive Engineer
FGD	Focus Group Discussion
GHG	Green House Gases
GIS	Geographic Information System
HDPE	High Density Polyethylene
HH	Household
IAL	Industry-Academia Linkage
IEE	Initial Environmental Examination
INGO	International Non-Profit Governmental Organization
ISO	International Organization for Standardization
ISWM	Integrated Solid Waste Management
IWB	Itinerant Waste Buyers
KFUEIT	Khawaja Fareed University of Engineering & Information Technology
	formant Interview
LDPE	Low Density Polyethylene

Additional Deputy Commissioner General

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List of Acronyms:

WEEE

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LOC	Lovel of Confidence
MC	Municipal Corporation
MOE	Margin of Error
MRF	Materials Recovery Facility
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NGO	Non-Profit Governmental Organization
FT-NIR	Fourier Transform Near Infrared Spectroscopy
OPEX	Operational Expenditure
PEPA	Pakistan Environmental Protection Act
PET	Polyethylene Terephthalate
PKR	Pakistani Rupees
POPs	Persistent Organic Pollutants
PP	Poly Propylene
PPE	Personal Protective Equipment
PPP	Public Private Partnership
PS	Polystyrene
PVC	Polyvinyl Chloride
RDF	Refuse Derived Fuel
RYK	Rahim Yar Khan
SDGs	Sustainable Development Goals
SDO	Sub Divisional Officer
SW	Solid Waste
SWM	Solid Waste Management
SWMC	Solid Waste Management Company
SWMS	Solid Waste Management System
TMA	Tehsil Municipal Authority
TMO	Tehsil Municipal Officer
TOR	Term of Reference
TOT	Training of Trainers
UCs	Union Councils
UNDP	United Nations Development Programme
UNEG	United Nations Evaluation Group
VOCs	Volatile Organic Compounds

Waste Electrical and Electronic Equipment



Chapter 01: Introduction

Introduction

Significant surge in solid waste generation rate has been reported due to substantial increase in population and rapid industrialization at global level. For managing it properly, an efficient and sustainable solid waste management system (SWMS) is required. In developing countries, SWM is one of the expensive urban service and due to increase in per capita waste generation rate, it is further worsening the situation. The collected municipal waste is mostly dumped and openly burned; thus, threatening the environment and human life. In 2016 alone, a total of 2.01 billion metric tons (approx.) of municipal solid waste (MSW) was produced worldwide and plastic waste accounted for 12% i.e., 242 million metric tons¹⁰. Details regarding global treatment and disposal of generated MSW is shown in Figure 1 and it reflects that only 13.5% of the collected waste is recycled whereas, 33% of the waste is dispose of to open dump sites. It has been estimated that global waste generation volume will increase to 3.40 billion metric tons by 2050, while daily per capita waste generation is projected to increase by 19% in developed countries compared to approx. 40% or more increase in developing countries¹¹.

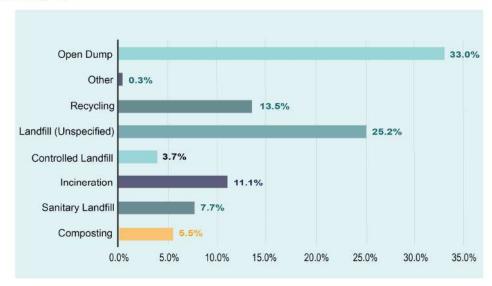


Figure 1: Percentage of Global treatment and disposal of municipal solid waste¹²

Pakistan, being a developing country is a home to over 207.8 million¹³ people and is posing a severe threat to the climate due to the limited existing infrastructure for managing MSW and thus ending up mostly in empty plots, roadsides, and in drains causing blockages in sewage system. Studies revealed

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that the solid waste generation rates in Pakistan range in between 0.283 to 0.612 kg/capita/day and the waste generation growth rate is 2.4% per year¹⁴, as Pakistan produces 85,444 metric tons of MSW each day¹⁵ and plastic waste accounts 6.41 million metric tons annually¹⁶.

Plastic waste accounts the 2nd highest proportion of MSW after the "organic fraction" as shown in Figure 2. Among plastic waste generators, Pakistan ranks 6th in the world and 3rd in Asia¹⁷. Despite the fact that solid waste services are the highest budget consuming function of municipalities in Pakistan, less than 50% of the generated waste is collected due to lack of resources, regulations, and awareness.

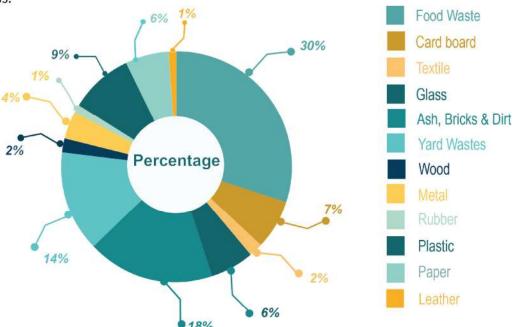


Figure 2: Composition of municipal solid waste in Pakistan¹⁸

Pakistan is currently facing health and other hazards due to extensive and widespread use of plastic because of existing ineffective and inefficient SWM practices. Poorly handled plastic waste ends up directly into the environment, specifically through open dumping, open burning, or disposal in waterways. Plastic, specifically single use plastic, on the one hand has brought easy comforts in our daily life; while on the other hand, its safe disposal has become a major issue that is leading to environmental pollution.

Traditional management of plastic remains linear¹⁹ i.e., production-use-disposal,whereas more attention is given to the circular economy, nowadays. The circular economy²⁰ emphasizes the value in waste and is supported by technological innovations for recycling and reprocessing plastic.

⁹ In developing countries local governments spend 20 to 50 per cent of their budget on solid waste management. (Solid Waste Management Baseline Survey - Kon Tum Vietnam, April 2011 by United Nations Economic and Social Commission for Asia and the Pacific (ESCAP))

 $^{^{10}}$ Kaza, et al., 2018. "What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050." Overview booklet. World Bank, Washington, DC.

¹¹ Ellis, C., 2018. World Bank: Global waste generation could increase 70% by 2050. [Online] Available at: https://www.wastedive.com/news/world-bank-global-waste-generation-2050/533031/#:~:text=Global%20waste%20production%20accounted%20for,billion%20metric%20tons%20by%202050 [Accessed on 5 January 2021].

¹² Kaza, et al, 2018. "What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050." Overview booklet. World Bank, Washington, DC.

¹³ Pakistan Bureau of Statistics - Census of Pakistan 2017

¹⁴ Environmental Protection Department. Solid Waste. [Online] Available at: https://epd.punjab.gov.pk/solid_waste [Accessed 5 January 2021].

¹⁵ Kaza, Silpa, Lisa Yao, Perinaz Bhada-Tata, and Frank Van Woerden. 2018. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Urban Development Series. Washington, DC: World Bank. doi:10.1596/978-1-4648 -1329-0.

¹⁶ Plastic Pollution by Country 2021. [Online] Available at:

https://worldpopulationreview.com/country-rankings/plastic-pollution-by-country [Accessed 29 April 2021].

¹⁷ Kouser, S. et al., 2019, Plastic Pollution in Pakistan and Plastic-Bag Free Initiative.

¹⁸ Expert Group Meeting on Sustainable Application of Waste-to-Energy in Asian Region, February 2018, United Nations Environment Program

¹⁹ Linear economy: A linear economy traditionally follows the "take-make-dispose" step-by-step plan. This means that raw materials are collected, and then transformed into products that are used until they are finally discarded as waste.

²⁰ Circular economy: A circular economy is a closed-loop economic system aimed encourage the continual use of resources and to minimize the use of resource inputs and the creation of waste, pollution, and carbon emissions.

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Because of current plastic waste generation rates are higher than technological advancements, pressure on disposal sites, such as temporary disposal stations and oceans, is increasing²¹. Informal waste pickers play an important role in plastic waste management, in parallel to the formal waste collectors (sanitary workers). The roots cause of the accumulation of plastic waste is the absence of effective plastic waste management system and unfortunately, limited work has been done regarding plastic waste management. Thus, there is a dire need to address the existing gaps and to devise a strategy/plan for improving the current scenario of plastic waste at national level.

1.1 Significance of the Study

With the aim to ensure plastic never become waste, the United Nations Development Programme (UNDP) has been working with the local innovators, industry, and government to develop systemic solutions to identify approaches to transition towards a circular economy for plastic waste. In order to explore the journey of plastic waste in Pakistan particularly in Rahim Yar Khan (RYK) City (herewith termed as the "Study Area"), the UNDP along with Unilever Pakistan (hereafter termed as the "Client"), have entered into a partnership to make the Study Area as a 'Zero Plastic Waste City'. In order to delineate a baseline assessment on the diverse use & users of plastic, present regulatory mechanisms and practices followed, and present scenario in Plastic Waste Management in terms of waste generation, and recycling in Study Area, the Client has designed the project, titled "Baseline Assessment of Current Scenario of Plastic Waste Management for Rahim Yar Khan City". The reason for selection of RYK as Study Area was due to the presence of commercial, and industrial hub comprised of many manufacturing, processing & packaging industries. Therefore, the Client has decided to acquire services of M/s Zeeruk International (Pvt.) Ltd. in association with M/s Sustainable Environmental Solutions (Pvt.) Ltd (herewith termed as Consultant), to conduct a baseline study in this regard. Detailed scope of work is attached as Annexure A.

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1.2 Study Area

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RYK is one of the main cities in the southern Punjab situated in the alluvium plain between Indus River and Cholistan desert. The city is situated/bound on the north by Muzaffargarh district, on the east by Bahawalpur district, on the south by Jaisalmer (India) and Ghotki district of Sindh province and on the west by Rajanpur district.

The city is strategically located at the tripod of three provinces (Punjab, Sindh, and Baluchistan) of Pakistan. This geographical location makes the RYK city, the center of not only the health & education but for business, trade, and agriculture as well. The city lies between 28°-15' longitudes and 70°-22' latitude, accommodating more than 420,419²² people with the population growth rate of 2.3%²³. The city itself administratively subdivided into nine (09) Union Councils (UCs). Figure 3 shows the map of Study Area which was provided by Municipal Corporation (MC), RYK.

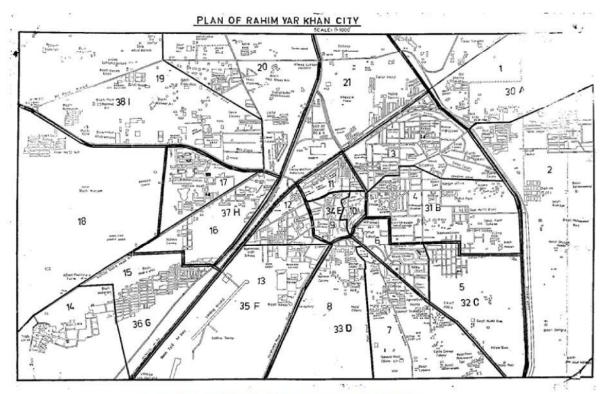


Figure 3: Map of Study Area (Courtesy: MC RYK City)

1.3 Project Objectives

The prime study objectives were:

- To conduct a baseline study in order to establish the benchmark regarding the curren practices of waste management in the Study Area.
- To deeply assess the current mechanism of solid waste management in the Study Area.
- To identify the gaps and ways to improve the waste management system, particularly plastic waste, within the city.
- To identify the approaches to shift towards a circular economy for plastic waste and minimize their leakage into the environment.

1.4 Deliverables

Detail of deliverables as per Terms of References (TORs) is presented in Table 1.

Table 1: Project deliverables with proposed timeline





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2 Background

Solid Waste Management (SWM) has always been a neglected sector in Pakistan due to lack of sufficient resources, inter- and intra-departmental coordination, and institutional capacities. Currently, due to exponential increase in population, rapid urbanization, scarce resources, social inequality, communal perceptions, and insufficient regulations have not only elevated the waste generation rates but also escalated the complexity within the existing SWM system. Composition of solid waste generally comprises of organic waste, plastic waste, rubber waste, metal waste, paper, and cardboard waste, textile waste, glass, bones, wood, and stones. Typical composition of MSW in Pakistan is shown in Figure 2.

As the existing solid waste management capabilities and systems vary from province to province²⁴ and even at city levels, in Pakistan. While the waste collection fleet typically consists of handcarts and donkey pull-carts for primary collection; then open trucks, tractor/trolley systems, and arm roll containers/trucks for secondary collection and transport to transfer station or landfill sites. Most municipal waste is either burned, dumped, or buried on vacant lots, threatening the health and welfare of the general population. Solid waste generation in major cities of Pakistan on the basis of population is shown in Table 2.



Table 2: Solid waste generation in major cities of Pakistan²⁵

Domestic waste in the Study Area is currently not being collected, transported, or disposed of in an appropriate and efficient manner, regardless of the size of the city. About 60-70% of solid waste is collected by the municipal authorities²⁶ and ends up in open spaces, empty plots or at transfer stations/landfill sites as practiced in major cities of Punjab besides Lahore, where a dedicated landfill site with weighting facility has been constructed.

To handle un-attended waste, the informal actors especially scavengers, and street waste pickers play an important role as they recover the recyclable fraction at various steps of existing solid waste management. Hazardous hospital and industrial wastes are being simply treated as ordinary waste.

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Open burning of waste especially non-degradable components like plastic bags, polystyrene packaging etc. are contributing to air pollution. Municipalities have been shown to spend a large portion of their budgets on solid waste management but receive almost nothing in return (no tax) from the residents being served²⁷.

2.1 Existing Solid Waste Management System within Study Area

The Tehsil Municipal Administration (TMA) is mandated not only to provide water and sanitation services but also to manage solid waste within the Study Area. As in other cities of the Punjab, the TMA is responsible for primary and secondary collection and final disposal of solid waste²⁸. The primary collection is accomplished by sanitary workers who collect MSW from door to door, sweeping of streets and roads, and collection of waste from small heaps with the help of brooms, hand carts and other equipment. The collected waste is temporarily stored at filth depots within the Study Area. From there, the secondary collection is carried out using tractor trollies and loaders. The waste is ultimately disposed at Mau Mubarak dumpsite which is 2 – 3 km away from the city. Currently, the Study Area generates about 170 tons of MSW on daily basis, with the daily waste generation rate of 0.40 kg/capita/day and accounts for a yearly volume of 61762 tons²⁹. It is projected that daily waste generation will rise to about 287.49 tons per day by 2023, primarily due to substantial increase in population growth rate and increased economic activities³⁰. A total of 90% of waste collection and disposal is handled by TMA, while the remaining is private companies³¹. Details regarding the components of MSW (solid waste generation, collection, disposal sites, etc.) are presented in Table 3.



Table 3: Existing solid waste management in Study Area³²

There exists a huge gap between the collection and generation of waste in the Study Area as the collection efficiency ranges between 65 – 75 percent. While the rest remains unattended along roadsides and in drains within the city³³.

2.2 Existing Solid Waste Recycling Practices

During the last several decades, migration has occurred from rural to urban areas of Pakistan. The municipalities do not have sufficient financial resources, technical capacity, and manpower to

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²⁴ Waste Management, 13-10-2019 – Country Commercial Guide - Pakistan, (International Trade Administration) [Online] Available at: https://www.trade.gov/knowledge-product/pakistan-waste-management [Accessed on 10-03-2021]

²⁵ Expert Group Meeting on Sustainable Application of Waste-to-Energy in Asian Region, February 2018, United Nations Environment Program

²⁶ ibid

²⁷ Brief on Solid Waste Management in Pakistan

²⁸ Punjab Cities Improvement Investment Program (Rahim Yar Khan City Profile) - The Urban Unit P & D Department, Punjab

²⁹ Situation Analysis Report for Integrated Solid Waste Management in Rahim Yar Khan - Punjab Municipal Development Fund Company (PMDFC) (2013)

³¹ Scoping Study for PET Waste Management in Pakistan (2020) – WWF Pakistan

³² The Urban Unit, Punjab Cities Improvement Investment Program: Rahim Yar Khan City Profile

³³ Waste Management, 13-10-2019 – Country Commercial Guide - Pakistan, (International Trade Administration) [Online] Available at: https://www.trade.gov/knowledge-product/pakistan-waste-management [Assessed on 10-03-2021]

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accommodate the needs of increasing population. Collection, and sorting of recyclable material are being performed efficiently throughout the city by informal sector. The municipal sanitary workers, and private waste collectors segregate the recyclable material during the collection of commingled MSW from the residential, commercial, and educational institutes. The major problem of the city is the non-recyclable waste, which is only being collected by the municipal authorities. These include plastic sachets, wrappers, polystyrene food boxes, and the prohibited shopping bags (with a thickness less than 50 mm), which are still available in the market and thus they remain unattended. This unattended portion along with organic fraction is being disposed-off at nearby filth depot - a temporary disposal site.

From the filth depots or disposal sites, scavengers and street waste pickers further sort the recyclable materials. After sorting, the high-value recyclables like plastic, metals, rubber, paper, and packaging materials etc. are sold to street hawkers, itinerant buyers, and dealer shops. These informal actors then sell the recyclables at a slightly better price to different junk dealers or junkyards which are operating within the Study Area. It is pertinent to mention here that recyclable plastic includes PET, soft plastic, and hard plastic, while non-recyclable plastic includes styrofoam, single use plastic, ketchup sachets, shampoo sachets, snacks packets, etc. Details of following plastic categories in term of number code 1 to 7 have been included in **Annexure B. Figure 4** shows the flow of recyclable plastic though different informal actors involve in plastic waste management. Most of the small-scale junk dealers involved in this business are uneducated and work either individually or in small groups and do not have direct access to the industries that use recycled materials. Because of above-mentioned reasons, middlemen and large-scale junk dealers exploit small-scale junk dealers, waste pickers, street hawkers and scavengers, and offer them very low prices for the material they collect. This price is very less as compared to the amount that is eventually paid by industry to the middlemen/brokers.



Figure 4: Flow of plastic waste through informal sectors

There exists small-scale informal recycling and manufacturing units (approx. 7 to 10 numbers)³⁴ while the Study Area lacks formal solid waste recycling facilities such as organic composing, glass, or paper recycling plant. The main products of the existing recycling units within Study Area are low grade plastic resin, pellets, and shredded material from PET bottles. Scavengers, community

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members/inhabitants, street itinerant buyers, hawkers, and informal waste collection and handling companies, junk dealers are key players of plastic management within the Study Area.

2.3 Situation of Plastic Waste Management

In Pakistan, plastic production is increasing exponentially, which results in an inevitable rise in waste generation rates. Pakistan has the largest percentage of mismanaged plastic in South Asia, which demands urgent attention³⁵. The plastic waste is an anthropogenic issue that has begun to overload waste management system in both rural and urban settings. The large-scale production and use of non-biodegradable plastic, have also led to plethora of environmental management challenges such as pollution of air, water, and soil. Although, the TMA is responsible for collection, transportation, and disposal of all kinds of waste, however, the plastic waste management is relatively unknown concept for them. The common practices within the city regarding the disposal of non-recyclable plastic waste includes open burning, empty plots, fuel source of brick kilns, and transfer station.

Poor formal waste management is the reason for the contamination of various ecosystems as the management system only focuses on collection of waste from residential and commercial areas and disposal to urban fringes without segregation, material recovery or recycling. Plastic waste recycling and recovery practices are mostly performed by informal sector. Before, plastic waste is sent to recycling plants for processing, it goes through multiple pre-processing stages, such as sorting into different types of plastic, cleaning and washing, drying, and crushing (for reducing the size). As the pre-processing stages add value and ultimately sells at relatively higher price. Many waste dealers have transportation vehicles, which they use to transport plastic to larger junk dealers or recycling plants³⁶.

Because of these above-mentioned reasons, middlemen and large-scale junk dealers exploit small-scale junk dealers, waste pickers, street hawkers and scavengers, and offer them very low prices for the material they collect. This price is very less as compared to the amount that is eventually paid by industry to the middlemen/brokers. Most of the informal actors separate different types of plastic waste before selling, so that reasonable and relatively higher amount can be earned in comparison with selling of mixed plastic. Some of the junk dealers often refuse plastic waste from scavengers and municipal garbage collectors because it is contaminated by wet organic waste, that was put in the garbage bin or disposal site, rendering them smelly and hard to clean.

In recycling plants, the sorted plastic waste is sent to a shredding machine that cuts it into small pieces. These pieces are then cleaned with caustic soda flakes to wash away any dirt followed by drying and packaging. The final products are plastic pellet and plastic crush, which are then sell to potential industries³⁷ which use the recyclable plastic as a raw material as shown in Figure 5.

³⁴ Data based on field observations made by field team.

³⁵The Looming Plastic Pollution Crisis by Nadeem Khurshid, March 2019 - [Online] Available at: https://www.pakistantoday.com.pk/2019/03/14/the-looming-plastic-pollution-crisis/ [Accessed on 14 March 2021]

³⁶ Innovative partnerships with informal workers to recover plastic waste, in an inclusive circular economy approach – Case Study Sai Mai District, Bangkok

³⁷ Innovative partnerships with informal workers to recover plastic waste, in an inclusive circular economy approach – Case Study Sai Mai District, Bangkok

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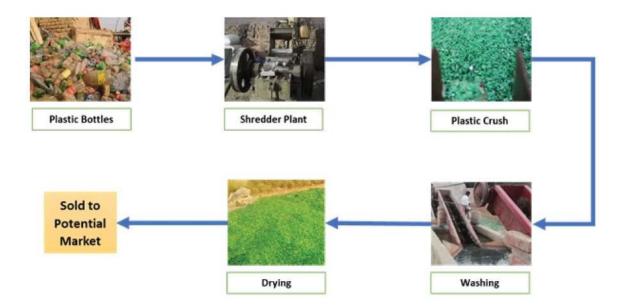


Figure 5: Process flow chart of typical recycling unit

PET bottles, and other plastic of higher economic value get scavenged, whereas single-use non-biodegradable and Styrofoam plastic finds its way to open garbage dumps, communal sites, or municipal sewers, thus choking the sewerage system and adding to the cost of operation and maintenance (O&M) and usually urban flooding as well. Plastic recycling rates vary significantly by the polymer types, as some polymers are more widely recycled than others. Recycling rates for polyethylene terephthalate (PET), high-density polyethylene (HDPE), and polypropylene (PP) are commonly higher than polystyrene (PS) and single use plastic bag. Non-biodegradable polystyrene and plastic bags are not feasible to recycle and/or hard to recycle as the input cost becomes much more than that of the processed material/product³⁸.

2.4 Solid Waste Management Stakeholders

Effectual operation of a SWMS is directly associated with the role of all the relevant stakeholders, which include all the groups or individuals who may affect or be affected, and/or which are directly or indirectly engaged with solid waste generation, collection, handling, sorting, processing, transportation, and its final disposal. Flow of MSW and recyclable plastic waste through formal and informal sector within the Study Area is shown as Figure 6.

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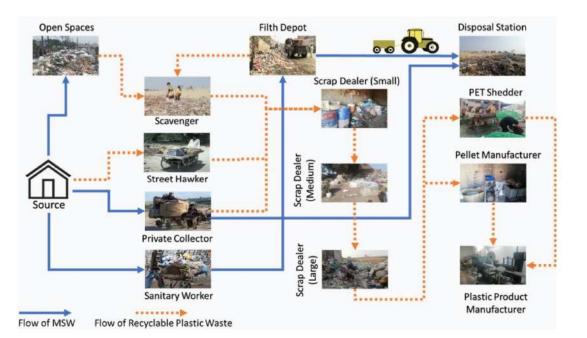


Figure 6: Flow of MSW and recyclable plastic waste through formal and informal sector39

2.4.1 Formal Sector

Infrastructural and organizational system is insufficient for proper solid waste management in Pakistan and thus municipalities and formal service providers are neither providing collection service to all households, nor guarantee an effective recycling and an environmentally sound treatment and disposal of solid waste. In major cities⁴⁰ of Punjab, solid waste management (includes collection, transportation, treatment, and final disposal) is either handled by waste management companies or by TMAs. In cities like Lahore, Rawalpindi, Multan, Bahawalpur, etc., where dedicated solid waste management companies⁴¹ are operational, solid waste collection efficiencies are relatively much better than that of those areas/cities where TMAs are mandated to manage MSW. Possible reasons may include 1) insufficient budget allocation and its timely release (financial constraints), 2) lack of technical expertise, 3) missing of proper institutional and legal arrangements, 4) insufficient collection vehicles and equipment's, and 5) ban on hiring of human resources by provincial government are the major issues being faced by TMA. For the collection and transportation of MSW in Study Area, sanitary workers and drivers are directly involved whereas, supervisory staff (includes Chief Officer (CO), Executive Engineer (XEN), Sub Divisional Officer (SDO), Sub Engineers, Sanitary Inspectors, and Sanitary Supervisors) are being deployed for ensuring effective management of MSW. But unfortunately, at present, waste collection and handling services are inadequate due to limited workforce42.

³⁸Single-Use Plastic Bags & Styrofoam Containers Law (FAQ) - [Online] Available at: https://www.hastingsgov.org/conservation-commission/pages/single-use-plastic-bags-styrofoam-containers-law-faq/[Accessed on 14 March 2021]

³⁹ Based on finding of KIIs, FGDs, and quantitative data collected during field visit.

⁴⁰ Lahore, Faisalabad, Gujranwala, Sialkot, Rawalpindi, Multan, and Bahawalpur

⁴¹Local Government & Community Development (LG&CD) Department Punjab - [Online] Available at: https://lgcd.punjab.gov.pk/ [Assessed on 11-03-2021]

⁴² Information based on data collected during KII with Chief Officer Rahim Yar Khan

2.4.2 Informal Sector

Waste management systems in Pakistan is incomplete in an absence of informal sector which includes scavengers, waste pickers, junk dealers, and recyclers/recycling industries. Besides, informal sector contributes significantly to waste management and resource recovery via collecting, sorting, recycling, and processing the recyclable waste materials. Informal private sector has also been involved in primary and secondary collection of domestic and non-hazardous industrial waste from the localities where municipalities services are not enough and/or absence. The collection of commingled recyclable waste from the factories, offices, stores, schools, and residential areas, and dump site is mostly done by male scavengers, whereas primary sorting or handling of the recyclable material is mostly performed by engaging women and children. Men and children are more likely to be involved in the collection, and transportation, and selling of recovered items, and/or materials to junk dealers. Mostly informal segregation activities take place at every stage of the solid waste management cycle, from the source to the disposal site.

Informal sector activities are highly adaptable, flexible, and able to respond quickly to demand-driven forces. Informal waste collectors, scavengers and recyclers constantly come up with adaptive strategies to access more recyclable plastic while at the same time integrating new systems as they emerge. Even though the income and living conditions of informal waste workers differ significantly according to their main activities, the majority of informal waste workers (scavengers and street waste pickers) are confronted with extremely hazardous working and living conditions. In general, the informal sector is performing their activities in both, as individuals (street hawkers, Itinerant buyers & small-scale junk dealers), as well as in groups (plastic recycling unit, large scale junk dealers & local manufacturing units). The organization and structure of these recovery activities is generally opaque to outsiders. In general waste work is done by religious or ethnic minorities, low castes, or rural immigrants, who are looking for a way to generate subsistence income in an urban context.



Chapter 03: Literature Review

3 Literature Review

A detailed and comprehensive literature review/desk studies have been performed by the Consultant's team keeping in view the objective and scope of the study.

3.1 Plastic Waste: An Environmental Hazard

In Pakistan, plastic pollution is one of the most pressing environmental issue due to rapid increase in plastic products production, non-existence of formal setup and an inefficient informal plastic waste management system. As plastic is composed of toxic pollutants, it has the potential to cause various direct and indirect environmental impacts including disturbance to food chain, human health, tourism, and significant harm to the environment in the form of water, air, and land pollution, which eventually contributes to climate change⁴³ as shown in Figure 7.



Figure 7: Environmental Impacts of Plastic Pollution

3.1.1 Impact on Human Health

Plastic poses distinct risks to human health, if they are exposed to a large variety of toxic chemicals and microplastic through inhalation, ingestion, and direct skin contact, all along the plastic lifecycle⁴⁴ as shown in Figure 8.



Figure 8: Impact of Plastic on Human Health

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3.1.2 Disturbance to the Food Chain

Plastic waste ultimately ends up in ocean basin (if not manages properly) and breaks down into small particles called microplastic due to various factors such as sunlight, wind, waves, microbes, and elevated temperatures. Size of microplastic is often less than one-fifth of an inch and hence consumes by marine animals in particular fish. In this way, small marine animals become poisoned due to plastic ingestion and thus causing problems for larger animals that depend on smaller animals for food and the cycle continues along the food chain. In this way, it enters in our food chain and it is evident that the plastic present in the seafood is eaten by many people every day.

3.1.3 Land Pollution

Dumping of plastic waste on landfill leads to biotic and abiotic degradation⁴⁵ of the plastic, where plastic additives can leach and eventually percolate into various aspects of the environment, causing soil and water contamination.

3.1.4 Air Pollution

Open burning of the plastic waste leads to air pollution due to the release of toxic chemicals into the air such as Persistent Organic Pollutants (POPs), heavy metals etc. POPs can travel to long distances especially via wind currents, and ultimately deposit into the ocean and polar ice caps. There they can adsorb onto other plastic marine debris and microplastic, bioaccumulating up the food chain, and subsequently threatening marine life and human health. The breakdown of biodegradable plastic releases methane, a very powerful greenhouse gas that contributes significantly to global warming. Moreover, the polluted air, when inhaled by humans and animals, affects their health, and can cause many diseases like respiratory problems and heart disease (in humans).

3.1.5 Groundwater Pollution

Water conservation is already a concern in Pakistan due to leaking plastic and waste in the environment which degrade the water quality⁴⁶. Chlorinated plastic can release harmful chemicals into the surrounding soil, which can then seep into groundwater or other surrounding water sources, and also the ecosystem. Another source of water pollution are the discarded plastic bags that mostly end up blocking storm drains and culverts, and consequently impeding the flow of water and worsening bank erosion. This can cause a range of potentially harmful effect to human and animal

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⁴³Conserve Energy Future, (2021). What is Plastic Pollution?. [Online] Available a https://www.conserve-energy-future.com/causes-effects-solutions-of-plastic-pollution.php [Accessed 2 February 2021].

⁴⁴ Azoulay, D. et al., (2019). Plastic & Health: The hidden costs of a plastic planet.

⁴⁵ **Degradation** is the process by which a chemical substance is broken down to smaller molecules by biotic means (biodegradability) or abiotic means (hydrolysis, photolysis, or oxidization).

⁴⁶ Mukheed M, Khan A (2020) Plastic Pollution in Pakistan: Environmental and Health Implications. J Pollut Eff Cont 8:251. doi: 10.35248/2375-4397.20.8.251.

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3.1.6 Impact on Animals

Nearly every species of seabirds and land-based animals eats plastic that cause most of the deaths due to entanglement and starvation. Stomachs containing plastic reduce the urge to eat, causing starvation. It also causes liver and cell-damage and disruptions to reproductive systems, prompting some species to produce fewer eggs, such as oysters. Microplastic can also blocked digestive tracts or pierced organs, and thus causing animal deaths.

3.1.7 Impact on Tourism

Plastic waste damages the aesthetic value of tourist destinations, leading to decreased tourism and in lower incomes/revenue generation by the country. Moreover, in addition to the operational cost, cleaning and maintenance cost of the sites is required for the restoration of tourism.

3.1.8 Microplastic Pollution in the Soil Environment

There are diverse sources of plastic that contaminate environment. These include domestic sewage, microplastic beads from personal care products, biosolids, fertilizers, landfills, irrigation with wastewater, lake water flooding, littering roads and illegal waste dumping, tire abrasion, and atmospheric particles transported over long distances. These various types of plastic contaminate the environment by entering in the soil environment, settling on the surface, and penetrating into subsoil, resulting in pollution.

Draft Laws and Regulations on Solid Waste Management

For tackling the problems which are being associated with inefficient SWM (in particularly plastic waste management), legal arrangements are mandatory and of prime importance. Therefore, the Government of Pakistan has enacted the Pakistan Environmental Protection Act (PEPA) in 1997, which is the most recent and updated legislation on environment. The Pakistan Environmental Protection Agency (Pak-EPA) and provincial Environmental Protection Agencies (EPAs) are the main regulatory bodies for the implementation of PEPA 1997. One of the functions of Pak-EPA is to assist the local councils, local authorities, government agencies, and other department/institutions to implement schemes for the proper disposal of wastes so as to ensure compliance with the standards established by it.

Unfortunately, Pakistan lacks legal framework on SWM and the policy framework regarding plastic waste management which is non-existent at both federal and provincial levels; however, the legislation regarding use of polyethylene bags exists but implementation issues prevail. Presently, the legal rules and institutional framework dealing with solid waste and plastic waste management in Punjab and specifically in Study Area are presented in Table 4.

Laws	Year	Scope
Cantonment Act ¹	1924	Section 132 deals with Deposits and disposal of rubbish etc. as it states every [Board] shall provide or appoint, in proper and convenient situations, public receptacles, depots or places for the temporary deposit or disposal of household rubbish, offensive matter, carcasses of dead animals and sewage.

Table 4: Laws and Regulations on Solid/Plastic Waste Management

Transition of the Control of the Con	Voor	Conne
Laws	Year	Scope
Punjab Environmental Protection Act ⁴⁸	1997	Section 11 prohibits discharge of waste in an amount, concentration or level that violates the Punjab Environmental Quality Standards. Section 13 prohibits the import of hazardous waste into Punjab. Section 16 deals with actions taken by Provincial Agency against the responsible person to restore the environment to the condition existing prior to discharge and disposal of waste.
Pakistan Environment Protection Agency (IEE and EIA Reviews) Regulations	2000	The regulation was put into effect by Pakistan Environment Protection Agency in year 2000, with the purpose of providing "Initial Environmental Examination (IEE)" and "Environmental Impact Assessment (EIA)" for facilities which cause environmental pollution. Solid waste disposal facilities classified in Appendix-1 requires IEE and whereas the facilities listed in Appendix-2 are required to prepare EIA. Appendix-1 H. Disposal of waste Waste disposal facilities with an annual capacity of less than 10,000 cubic meters, for the disposal of domestic and industrial waste Appendix-2 G. Disposal of waste 1. Disposal of waste and/or storage of hazardous or toxic waste (including garbage collection areas for toxic waste from hospitals, garbage incinerators) 2. Waste disposal facilities with an annual capacity of more than 10,000 cubic meters, for the disposal of domestic and industrial waste"
Punjab Local Government Ordinance ⁴⁹	2001	It contains provisions regarding effective solid waste collection, management, and disposal along with the functions and powers of TMA and Tehsil Municipal Officer (TMO).
Punjab Prohibition on Manufacture, Sale, Use and Import of Polythene Bags (black or any other polythene bag below 15 microns thickness) Ordinance	2002	The Ordinance provides that no person shall manufacture, sell, use, or import black polythene bags or any polythene bag below fifteen-micron thickness or offer any eatable and non-eatable goods in any black polythene bag or any polythene bag below fifteen-micron thickness.
Punjab Prohibition on Manufacture, Sale, Use and Import of Polythene	2004	The governor of Punjab has set rules for Prohibition on Manufacture, Sale, Use and Import of Polythene Bags

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⁴⁷ The Cantonments Act, 1924. [Online] Available at: http://lcb.gov.pk/assets/media/cantonments-act-1924.pdf

⁴⁸ Punjab Environmental Protection Act, 1997. [Online] Available at: http://punjablaws.gov.pk/laws/2192a.html ⁴⁹ The Punjab Local Government Ordinance, 2001. [Online] Available at:

https://lgcd.punjab.gov.pk/system/files/PLGO,%202001%20Amended%20upto%2010-11-2014.pdf

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Laws	Year	Scope
Bags (black or any other polythene bag below 15 microns thickness) Rules		(black or any other polythene bag below 15 microns thickness).
Draft Solid Waste Management Regulations	2005	It provides guidelines regarding solid waste collection, treatment, disposal, recycling, administrative sanctions, and expenditure on SWM.
National Environmental Policy	2005	The National Environment Policy was promulgated in year 2005 by Pakistan's Ministry of Environment. It defines general principles of waste management on the basis of globally accepted pillars of clean production technologies, 3Rs, integrated perspective on waste management, and subsidy mechanisms for waste management as described in section 3.3.
Solid Waste Management Directives of the Municipality of Punjab	2007	The Directives serves as a general manual for provincial government departments, local governments, private enterprises, and other agencies that initiate or operate solid waste management activities in urban areas. The directives cover only wastes concerning the municipality. Therefore, hazardous wastes including but not limited to medical and industrial waste, are not subject to the abovementioned directives. Various elements of Solid Waste Management, such as waste collection, waste transfer, recycling, waste burning, composting, biogas generation, and sanitary landfills are included within the framework of this directive, and technical assistance is provided to perform such procedures with a minimal impact on the environment.
Punjab Environmental Policy	2015	Section 7.6 provides guidelines for the municipal, industrial, hazardous and hospital waste management at provincial and local levels. ¹
Handling, Manufacture, Storage, Import of Hazardous Waste and Hazardous Substances Rules	2016	The Rules regarding Hazardous Materials regulate the licensing requirements for the collection, shipment, transportation, processing, disposal, or importation of hazardous waste. It also deals with packaging and labelling issues regarding the management of hazardous wastes, requirements for facilities, general safety measures, safety

3.3 Fate of Plastic Waste

The plastic waste management hierarchy, describes the hierarchical approach for disposal of plastic from most preferred to least preferred option, as devised by EU directives⁵¹ and shown in

Prevention and reduction

Reduction of single-use and unnecessary plastics and packaging

Production of reusable-plastic containers
Design of long life and increased utilization

Chemical recycling or plastic regeneration

Chemical recycling or plastic regeneration

Prevention of reusable-plastic containers
Chemical recycling or plastic regeneration

Prevention of reusable-plastic containers
Chemical recycling or plastic regeneration

Prevention of reusable-plastic containers
Prevention of reusable-plastic vertical containers
Prevention of reusable-plastic v

PYRAMID OF PLASTIC WASTE MANAGEMENT

3.3.1 Landfill

Landfill is the conventional approach to plastic waste management and the least desirable option due to several adverse impacts. A well-managed landfill site, results in limited immediate environmental consequences beyond the impacts of collection and transportation of waste to the landfill. The most serious impact is the production and release of methane – a greenhouse gas, which is 25 times more potent than carbon dioxide. Methane can build up in the landfill mass and cause explosions. In addition to methane, there are long-term risks of contamination of soil and groundwater by some additives and breakdown of by-products in plastic, which can become POPs. Another major drawback of landfills, from a sustainability aspect, is that none of the material resources used to produce the plastic is recovered, thus making material flow linear rather than cyclic.

3.3.2 Incineration (Energy Recovery)

Incineration reduces the need for landfill as it can be used to recover some of the energy content present in the plastic and can be used as fuel in certain industrial processes. The useful energy recovery may vary considerably depending on whether it is used for electricity generation, combined heat, and power, or as a solid refuse derived fuel (RDF) for co-fueling of blast furnaces or cement

⁵⁰ Government of Punjab, Environmental Protection Agency (2015). Punjab Environmental Policy. [Online] Available at: http://www.irispunjab.gov.pk/chartsShowing.aspx?lnk=http://www.irispunjab.gov.pk:8088/Items/Law/Draft%20Punjab %20Environment%20Policy%202015.pdf

⁵¹ Rubel, H. et al. (2019). A Circular Solution to Plastic Waste. [Online] Available at: https://www.bcg.com/publications/2019/plastic-waste-circular-solution [Accessed 15 February 2021].

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In incinerators, poor or incomplete burning of waste materials can result in environmental and health problems through the release of hazardous chemicals, including dioxins and acid gases. To ensure that the hazardous substances are completely destroyed, incineration plants need to burn waste under controlled conditions and at sufficiently high temperatures. Where the emissions of hazardous substances cannot be prevented, additional measures must be taken to reduce the releases into the environment. For instance, PVC and halogenated additives are typically present in mixed plastic

As a consequence, primarily of this perceived pollution risk, incinerating plastic is less common and mechanical recycling of plastic is relatively much acceptable as an alternative plastic waste-management strategy.

leading to the risk of dioxins, polychlorinated biphenyls and furans being released into the

3.3.3 Plastic Recycling

environment.

Recycling reduces the amount of waste that ends up in landfill sites, while cutting down on the amount of material needed from the natural environment and also promotes circular economy for plastic waste. Plastic recycling includes four categories which are presented in **Table 5**.

ASTM D5033⁵³ Definitions ISO 15720⁵⁴ Definitions Other Equivalent Terms

Primary Recycling Mechanical Recycling Closed-loop recycling

Secondary Recycling Mechanical Recycling Downgrading

Tertiary Recycling Chemical Recycling Feedstock Recycling

Quaternary Recycling Energy Recovery Volarization

Table 5: Terminology used in Different Types of Plastic Recycling and Recovery⁵²

3.3.3.1 Primary Recycling

Primary recycling is mechanical reprocessing of plastic which turns it into a product with equivalent properties. Primary recycling is often referred to as closed-loop recycling and considered as the most practical option when the polymer constituents can be (i) effectively separated from contamination, and (ii) stabilized against degradation during reprocessing and subsequent use.

3.3.3.2 Secondary Recycling

Secondary recycling – a mechanical reprocessing of plastic into products with a relatively low quality (of plastic) in comparison with raw plastic's quality. It is referred as downgrading, as the recovered plastic is put into an application that would not typically use virgin polymer e.g., 'plastic lumber', as an alternative to higher cost and relatively shorter lifetime timber.

3.3.3.3 Tertiary Recycling

Tertiary recycling makes the recovery of chemical constituents' possible. It is either described as chemical or feedstock recycling and applies when the polymer is de-polymerized to its chemical constituents. Biodegradable plastic can also be composted, a further example of tertiary recycling, and is also described as organic or biological recycling.

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3.3.3.4 Quaternary Recycling

In quaternary recycling, energy is recovered from plastic waste by incineration.

3.3.4 Re-Use of Plastic Packaging

Re-use is one of the most effective and inexpensive way to reduce the environmental impact of plastic packaging. Post-consumer packaging in the form of glass bottles and jars can be re-used. Take-back and refilling schemes also promote reuse of plastic packaging which mostly includes PET bottles as well as glass. A shift away from single-use plastic carrier bags to reusable bags is also one of the options. However, it can be possible only via conducting voluntary behavior change programmes at household (HH) level, by imposing penalties/fines to offenders through strict legislations, and by giving sustainable alternative such as the plastic bag levy or the banning of lightweight carrier bags.

3.3.5 Downgauging

Downgauging includes reducing the amount of packaging used per item, which will ultimately reduce waste volume. Manufacturers need to use minimum required material necessary for a given application. However, the manufacturers over-use the packaging for some products for marketing purposes and better aesthetics.

3.3.6 Alternative Materials

Alternative materials include use of such materials that can be used for longer time and can be easily recycled multiple times. One of the options is biodegradable plastic because they have the potential to solve various issues pertinent to MSW, especially for disposable packaging that cannot be easily separated from organic waste. It is possible to include biodegradable plastic in aerobic composting, or by anaerobic digestion with methane capture for energy use. However, biodegradable plastic also has the potential to complicate waste management when introduced without appropriate technical attributes, handling systems and consumers' education.

3.4 Stages in Post-Consumer Plastic Recycling

Post-consumer plastic recycling comprises of six (06) key steps: Collection, Sorting, Washing, Shredding or Resizing, Identification and Classification of Plastic and lastly Compounding or Extruding as shown in Figure 10.

⁵² Hopewell, J. et al, 2009. Plastic recycling: Challenges and Opportunities. Philos Trans R Soc Lond B Biol Sci., 364(1526),

³American Society for Testing Materials (ASTM) D5033: Standards relating to recycling and use of recycled plastic ISO 15270:2008 Plastic – Guidelines for the recovery and recycling of plastic waste.

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Figure 10: Stages in Plastic Recycling

3.4.1 Collection

First step of the post-consumer plastic recycling is the collection of plastic waste, which can be done either through 'bring-schemes' or curbside collection. Bring-schemes tend to result in low plastic collection rates in the absence of highly committed public behavior and deposit-refund schemes that impose a direct incentive to participate. Contrary to it, recyclable plastic waste is generally collected alongside in curbside collection of plastic. To maximize the cost efficiency of curbside collection, plastic recyclables are collected along with other commingled recyclables i.e., paper/board, glass, aluminum, steel etc.

3.4.2 Sorting

Sorting of commingled rigid recyclable can be done by both automatic and manual methods in material recovery facilities (MRFs). Manual sorting involves identification by shape, color, quality, and trademark of the plastic that distinguishes it through visual identification by the operators. It is economical but labor-intensive job and can involve human error. Automatic sorting separates plastic materials from recyclables stream (includes glass, metal, paper, cardboard, etc.). Moreover, it is broadly classified into dry, wet, and chemical sorting as shown in **Figure 11**. Few examples of automatic sorting of plastic waste are given below:

 Sink/float separation in water can effectively separate polyolefins (PP, HDPE, LDPE) from PVC, PET and PS.

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- Use of different media can allow separation of PS from PET, but PVC cannot be removed from PET by this technique as their density ranges overlap.
- Other separation techniques such as air elutriation can also be used for removing low-density films from denser ground plastic e.g., in removing labels from PET flakes.
- For separating PET flakes from PVC impurities, thermal kilns can be used to selectively degrade minor amounts of PVC impurities, as PVC turns black on heating, enabling color sorting.
- Other technologies for reducing PVC contaminants in PET flake include froth flotation,
 Fourier transform near-infrared spectroscopy (FT-NIR) or Raman emission spectroscopic detectors to enable flake ejection by varying electrostatic properties.
- The most advanced type is 'Laser-sorting' that uses emission spectroscopy to differentiate polymer types. These systems have the capability to separate complex mixtures as they can perform up to 860,000 spectra s-1 and can scan each individual flake. They have the advantage that they can be used to sort different plastic that are black, which is mostly a problem with traditional automatic systems. The laser-sorting systems are mostly used for separation of Waste Electrical and Electronic Equipment (WEEE) and automotive plastic. These systems also have the ability to separate polymer by type or grade and can also separate polyolefin materials such as PP from HDPE.

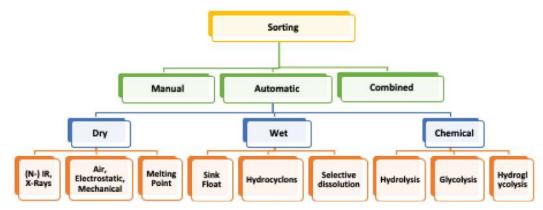


Figure 11: Types of Sorting55

3.4.3 Washing

The sorted plastic waste is then washed to remove impurities such as labels and adhesives. It enhances the quality of the finished product. If the non-plastic waste is not removed, it can result in a final product with poor structural integrity.

3.4.4 Shredding or Resizing

The washed plastic waste is then loaded into different conveyor belts that run the waste through the different shredders. These shredders tear up the plastic into small pellets or flakes, thus increasing its surface area. Plastic pellets or flakes are easy to process and reshape. Metal detectors or magnets are often used to remove any leftover metal in the mixture.

⁵⁵ Ruj, B. et al, 2015. Sorting of plastic waste for effective recycling. Int. Journal of Applied Sciences and Engineering Research, 4(4), pp. 564-571.

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3.4.5 Identification and Classification of Plastic

In this step, the small plastic particles are tested to determine their quality and class. First test is to check the density. The particles are put in a large tank of water, denser particles sink and less dense one's float. Next test is air classification, which determines how thin or thick the particle is. The particles are dropped into a small wind tunnel, the bigger ones remain low, and the smaller ones fly up higher. Additionally, the sample particles from each batch are collected and analyzed to test their melting point and color.

3.4.6 Compounding or Extruding

In compounding process, the small particles are smashed and melted together into plastic pellets. In this state, the plastic pellets are ready for reuse or be redesigned into new plastic products. Plastic pellets are then delivered to plastic manufacturing facilities to make new forms of plastic products.

3.5 Different Types of Plastic, their Properties, Usage and Effectiveness and Recycling

Properties and usage of each plastic type and their efficiency during recycling process is presented in **Table 6**.

Table 6: Different Types of Plastic and their Properties, Usage and Effectiveness in Recycling

Symbol/ Type of Plastic	Properties	Common Uses	Recycled in	Effectiveness in Recycling Process
PET Polyethylene Terephthalate	Clear, tough, solvent resistant, barrier to gas and moisture, softens at 80°	Soft drinks, water, ketchup, and beer bottles; mouthwash bottles; peanut butter containers; salad dressing and vegetable oil containers.	Polar fleece, fiber, tote bags, furniture, carpet, paneling, straps, bottles, and food containers.	High with clear PET from bottles. Colored PET is mostly used for fiber; Additional issues with Crystallized polyethylene terephthalate (CPET) trays and Polyethylene terephthalate glycol (PET-G).
HDPE High Density Polyethylene	Hard to semi- flexible, resistant to chemicals and moisture, waxy surface, opaque, softens at 75°C easily colored, processed, and formed.	Milk jugs; juice bottles; bleach, detergent, and other household cleaner bottles; shampoo bottles; some trash and shopping bags; motor oil bottles; butter and yogurt tubs; cereal box liners.	Laundry detergent bottles, oil bottles, pens, recycling containers, floor tile, drainage pipe, lumber, benches, doghouses, picnic tables, fencing, shampoo bottles.	High with natural HDPE bottles, but more complex for opaque bottles and trays because of wide variety of grades and color and mixtures with LDPE and PP.

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Symbol/Type of Plastic	Properties	Common Uses	Recycled in	Effectiveness in Recycling Process
PVC Polyvinyl Chloride	Strong, tough, can be clear, can be solvent welded, soften at 80°.	Shampoo and cooking oil bottles, blister packaging, wire jacketing, siding, windows, piping.	Decks, paneling, mudflaps, roadway gutters, flooring, cables, speed bumps, mats	Poor recovery because of cross- contamination with PET. PVC packages and labels present a major issue with PET bottle and mixed plastic recycling.
LDPE Low density Polyethylene	Soft, flexible, waxy surface, translucent, soften at 70 C, scratches easily.	Squeezable bottles; bread, frozen food, dry cleaning, and shopping bags; tote bags; furniture.	Trash can liners and cans, compost bins, shipping envelopes, paneling, landscaping ties, floor tile.	Poor recovery rates, mostly as mixed polyolefins that can have sufficient properties for some applications.
PP Polypropylene	Hard but still flexible, waxy surface, softens at 140 C, translucent, withstands solvents, versatile.	Some yogurt containers, syrup and medicine bottles, caps, straws.	Signal lights, battery cables, brooms, brushes, auto battery cases, ice scrapers, bicycle racks, bins, pallets, trays.	Not widely recycled from post-consumer yet but has potential. Needs action on sorting and separation, plus need for development of further methods to recycle PP.
PS Polystyrene	Clear, glassy, rigid, opaque, semi-tough, softens at 95 C, Affected by fat, acids, and solvents, but resistant to alkalis, salt solutions.	Disposable plates and cups, meat trays, egg cartons, carryout containers, aspirin bottles, compact disc cases.	Insulation, light switch plates, egg cartons, vents, rulers, foam packing, carry- out containers.	Poor, extremely difficult to separate from co-mingled waste. Separate collection of industrial packaging and Expanded Polystyrene (EPS) foam can be effective.
Others	Includes all resins and multi materials (e.g., laminates) Properties dependent on plastic or combination of plastic.	Three- and five- gallon water bottles, bullet- proof materials, sunglasses, and computer cases, signs and displays, nylon.	Plastic lumber and custom- made products.	Considerable variability in energy, water, and emissions from recycling processes as it is a developing industry and affected by collection efficiency.

3.6 Linear vs Circular Economy

Detail regarding the liner and circular economy for plastic waste their comparison is mentioned in following sub-sections.

3.6.1 Linear Economy

One of the significant causes of unsustainable plastic waste management is the linear economy i.e., 'take-make-dispose' as shown in **Figure 12**. A linear economy, characterized by the product being discarded at the end of its use, is one of the main causes of natural resources depletion. The linear economy model not only result in inefficient use of scarce natural resources but also yields increasing amounts of plastic waste from the entire value chain including the extraction of resources, manufacturing, transportation, and consumption

Hence, in order to strive towards effective and sustainable plastic waste management, resource conservation and to meet the Sustainable Development Goals (SDGs), **Target 12.4**, **12.5** and **14.1**, there is a dire need to switch from a linear to a circular economy especially through Integrated Solid Waste Management⁵⁶ (ISWM).

SDG Target 12.4: "By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment"

SDG Target 12.5: "By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse".

SDG Target 14.1 "By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution".

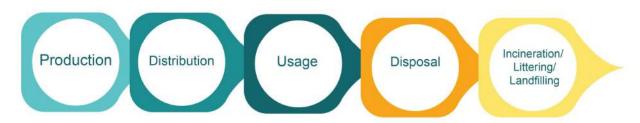


Figure 12: Linear Economy Model

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3.6.2 Circular Economy

The concept of circular economy was developed in 1966 by Boulding⁵⁷. It has ecological roots; the regenerative nature of circular economy is within the regenerative paradigm proposed by Braungart and McDonough of 'cradle to cradle (C2C)' promoting the eco-efficiency to eco-effectiveness⁵⁸. A circular economy is restorative and regenerative by design. This means that materials constantly flow around a 'closed-loop' system, rather than being used once and then discarded as in linear economy. Parameter's detail of linear and circular economy is presented in Table 7.

Circular economy reduces the need of a new raw material by reusing the material, reduces the leakages of plastic into natural systems, and addresses the behavioral change. If applied correctly, the circular economy benefits the society, the environment, and the economy. The basic principles of circular economy are presented in Table 8.

Table 7: Difference between a Linear and a Circular Economy

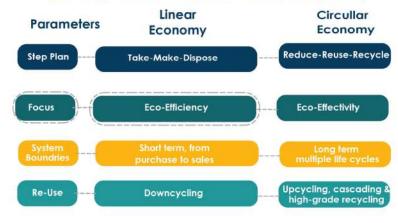
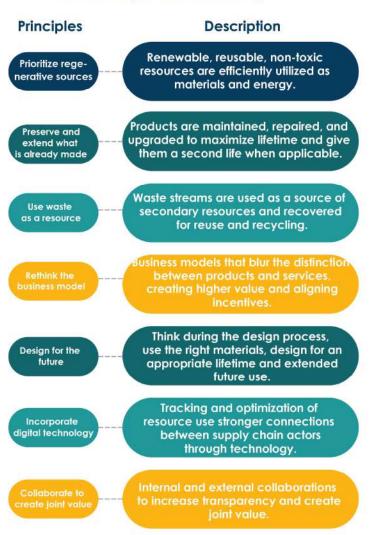


Table 8: Principles of Circular Economy⁵⁹



⁵⁷ RTS, 2019. The circular economy - What is it and why does it matter? [Online]

Available at: https://www.rts.com/blog/the-circular-economy-what-is-it-and-why-does-it

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 $^{^{56}}$ Integrated Solid Waste Management is a complete waste reduction, collection, composting, recycling, and disposal system, as defined by US EPA

Available at: https://www.rts.com/blog/the-circular-economy-what-is-it-and-why-does-it-matter/ [Accessed 25 February 2021].

⁵⁸ Jorgensen S., and Pedersen L.J.T. (2018) The Circular Rather than the Linear Economy. In: RESTART Sustainable Business Model Innovation. Palgrave Studies in Sustainable Business in Association with Future Earth. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-319-91971-3_8

⁵⁹ Circle Economy - The key elements of the circular economy. [Online] Available at: https://www.circle-economy.com/circular-economy/key-elements [Accessed 25 February 2021]

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In a circular economy, plastic never becomes waste or a cause of pollution, rather it protects environment and benefit human financially. It can be achieved through three main actions.

- Eliminate all problematic and unnecessary plastic items and packaging that will reduce the amount of material to be circulated;
- 2. Innovate to ensure that the plastic is reusable, recyclable, or compostable;
- 3. Circulate the used plastic items to keep them in economy. This can be achieved through the development of a dedicated system which includes collection and sorting through physical, chemical, or biological breakdown process, and then the rebuilding of a material that is reintroduced. Material circulation differs from reuse, as the material circulation circulates the packaging material i.e., packaging shape is not maintained and circulation occurs through a breakdown process, however reuse circulates the packaging i.e., packaging shape is maintained, and circulation occurs through washing.

3.6.3 Working of a Circular Economy Model

The circular economy model is shown in **Figure 13** which starts with recycled plastic waste as a source of raw material. The recycled waste is collected either by both public or private solid waste collectors across the city and placed at selected location for the next process. The first and second stage is the collection and transportation of segregated plastic, which is the most difficult and expensive factor due to segmented nature of classification. Plastic waste is mostly sorted into two broad categories: 1) Plastic Recycled Physically, more than 95% pure and segregated plastic waste that can be recycled physically; and 2) Plastic Recycled Chemically, less than 95% pure non-segregated plastic waste that has reached its end of product life that can be recycled chemically only. In physical recycling, plastic can be converted into granules that are the secondary virgin raw materials, while in chemical recycling, products such as industrial diesel, petrochemical products, and lubricants are being manufactured.

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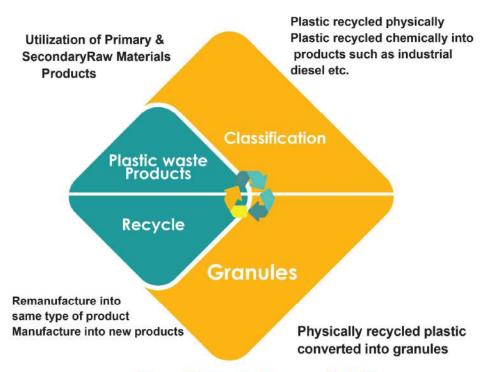


Figure 13: Circular Economy Model⁶⁰

The 95% pureness is essential for certain types of plastic wastes (like HDPE, PE, PP) to be suitable for remolding. At the third stage, granules are physically recycled back to plastic products where the cycle ends but begins again. The recycled granules can be used to remanufacture the same type of product. This enables the product to have multiple life cycles. Similarly, part of the recycled waste can be used to create other products different from those remanufactured, for instance roofing tiles. It is important to stress that a plastic recycling system would face structural deficiencies even with circular circumstances. There would be collection losses and materials unsuitable for recycling anyway.

3.6.4 Opportunities and Challenges in a Circular Economy

A circular economy implies to reduce the waste to a minimum. Shifting the plastic value chain towards this direction would result in improving recycling, redesigning products, and promoting reuse while considering the whole life cycle of the products. There may be some shortcomings in the initial implementation such as high labor cost for the separation process and water contamination that reduces the sustainability of the process but can result in sustainable plastic waste management in the longer run. Transition towards circularity could bring both opportunities and challenges as presented in Table 9.

⁶⁰ Horvath, B. et al, 2018. Designing Business Solutions for Plastic Waste Management to Enhance Circular Transitions in Kenya. Sustainability.

Table 9: Opportunities and Challenges of Circular Economy 61

Opportunities	Challenges		
Enhanced security of supply	Weak economic incentives		
A more circular plastic value chain could mitigate the risks associated with the supply of virgin oil feedstocks, such as price volatility and import dependency.	Low oil prices may act as a disincentive to using secondary raw materials and investing in recycling projects.		
Economic benefits	Technical problems associated with plastic recycling		
Further implementing the waste hierarchy could deliver economic benefits such as increased circularity bears a significantly higher job creation potential than incineration or landfill.	The large number of polymers and the fragmented nature of the plastic market is a constraint. The mixing of different types of polymer and the presence of additives or other contaminants may affect the quality of recycling.		
Reduced pressures on the environment	Finance		
A more circular plastic value chain would reduce greenhouse gas emissions in manufacturing, with a positive impact on the climate. It would also reduce the amount of waste generated, with positive effects on (marine) littering, which would in turn help to limit biodiversity loss.	Financing a transition towards circularity would require substantial investment. Moreover, sometimes the price of recycled plastic is higher than a virgin plastic.		

Although transitioning into a circular economy will be a challenging task but the long-term benefits of taking this route are substantial for our society and natural environment, which will require efforts from all the stakeholders and not just the government to achieve zero plastic waste in Study Area.

⁶¹ European Union, 2017. Plastic in a circular economy. Opportunities and challenges. [Online] Available at: https://www.europarl.europa.eu/RegData/etudes/BRIE/2017/603940/EPRS_BRI(2017)603940_EN.pdf [Accessed 20 February 2021].



Chapter 04: Approach & Methodology

4 Approach & Methodology

An open-ended explanatory methodology was adopted for this study keeping in view the scope and objectives of the study. Figure 14 shows the components of approach that were followed during the study for acquisition of qualitative and quantitative data.



Figure 14: Methodological approach of the study

4.1 Kick-off Meetings

A virtual pre-inception meeting was held on January 04, 2021, which was attended by the higher management of the Client and Consultant (via Zoom app) to avoid in-person gatherings due to COVID-19 pandemic. In this meeting, the Consultant's team have presented the tentative road map for achieving the objectives of the study, in particular. Also, identification of potential waste streams along with number of sampling from residential areas, commercial areas, clinics, institutions, communal points, and disposal site were also finalized.

4.2 Quantitative Data Acquisition

Quantitative data was collected to scrutinize the existing practices of plastic waste management within the Study Area. The Consultants' team had considered various waste streams to calculate plastic generation rates (kg/person/day and/or kg/Household/day) from socio-economic residential classes as well as from commercial areas, hospitals/clinics, and government/private institutions (kg/day) for getting the complete and clear picture of the prevailing conditions of plastic waste within the Study Area. The collected primary data has been triangulated and validated via available secondary data (information/data obtained via extensive literature review/desk studies). Figure 15 shows different solid waste streams which were targeted for quantifying the plastic waste.

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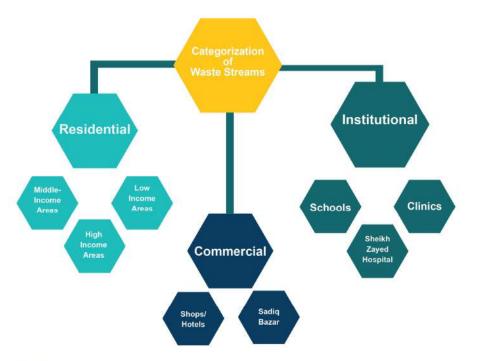


Figure 15: Categorization of waste streams as per residential, commercial, and institutional sources

4.2.1 Plastic Waste Sampling Mechanism

According to Dahlen and Lagervist⁶² (2008), there are almost twenty methods available which are used in estimating solid waste generation rates and its composition. Therefore, it is pertinent to mention here that the solid waste samples were collected, transported, stored, sorted in various plastic components, weighed, and recorded for a period of eight days by using labor-intensive manual process⁶³ and by following the guidelines of Environmental Protection Agency (EPA), Ireland⁶⁴. Figure 16 shows the methodological approach for knowing the plastic components along with plastic quantification within the Study Area.

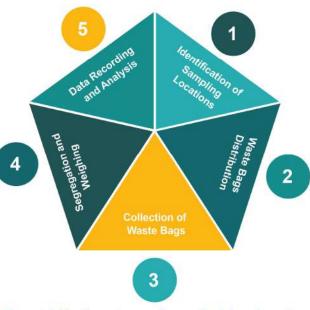


Figure 16: Plastic waste sampling methodology from the Study Area

4.2.1.1 Sample Size Consideration

Sampling size is considered as an integral component of sampling mechanism and for sampling size calculation, the Consultants' team has used the following Cochran's formula which considers 95% level of confidence (LOC) - and assumes maximum variance and expected proportion of interventions for

⁶² Lisa & Anders, 2008, Methods for household waste composition studies, Waste Management 28 (2008) 1100-1112

⁶³ Bernache-Pérez, G., et al., Solid waste characterization study in the Guadalajara Metropolitan Zone, Mexico. Waste Management & Research, 2001, 19(5): p. 413-424.

⁶⁴ https://www.epa.ie/pubs/reports/waste/wastecharacterisation/EPA_municipal_waste_characterisation.pdf

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getting representable samples from the target zones/areas⁶⁵. Details of other factors which were considered in calculating samples number is presented in **Table 10**.

The Study Area had been divided into three socio-economic zones i.e., high income (Abbasia Town⁶⁸), medium income zone (Basti Amanat Ali⁶⁹), and low income (Mastan Shah Colony⁷⁰) for a representative waste sample. These potential socio-economic areas were finalized after due consultation CO, EXEN, SDO. with Each the sub-engineers. of sub-economic zone was further subdivided into sub-areas distinguished by housing type. Moreover, the selection of households, shops, schools, clinics, communal points/filth depots and disposal site were also done after consultation with respective Sub-Engineer of the UC. Distribution of samples that were collected from each socio-economic

4.2.1.2 Sample Collection and Storage

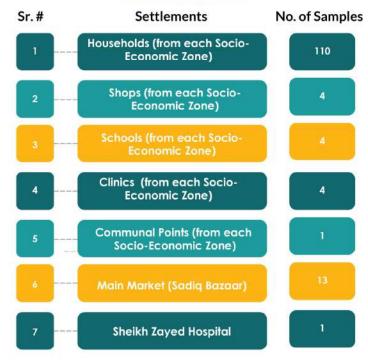
Sampling was done for a period of eight days for evaluating the quantity and composition of plastic waste, which was generated by each targeted waste streams. For getting actual data from the waste streams, waste bags were provided to each of the selected households, shops, hotels, clinics, and

Table 10: Indicators for sample size calculations⁶⁶



Number of samples (N)⁶⁷ = ($\mathbb{C}(LOC)$ ^2× Ind ×0.5)/ $\mathbb{C}(MOE)$ ^2 = 384 samples

Table 11: Distribution of collective samples from each soical-economic zone



⁶⁵ An investigation on effect of bias on determination of sample size on the basis of data related to the students at schools of Guwahati - International Journal of Applied Mathematics and Statistical Sciences Vol. 2, Issue 1, 2013

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schools by engaging sanitary workers and in the presence of sanitary supervisor and/or male enumerator – a day prior to the start of sampling activity. The respondents of the households were asked to store their commingled solid waste over a period of 24 hours in the provided waste bags. And the next day, the filled waste bags were collected, and a new bag was provided to the respondents for next day solid waste collection. Later on, all the collected waste bags were transported through loader rickshaws to a dedicated location provided by TMA in each socio-economic zone for sorting, weighing, and recording of plastic waste components on daily basis. The same activity was repeated for a period of eight days. Besides, the distributed waste bags and sampling locations were also assigned a particular code/number for the ease of maintaining the database. Pictorial view of solid waste sampling and categorization is attached as **Annexure C**.

4.2.1.3 Plastic Waste Categorization, and Estimation

Post collection and transportation of collected waste bags, total numbers on waste bags were noted down⁷² during unloading time. A tarpaulin was spread on the ground and the waste bags were emptied on it one by one. Then manually sorting of recyclable and non-recyclable plastic waste was done by sanitary workers⁷³. Personal Protective Equipment's' (PPE) like surgical gloves, masks, and hand sanitizer were also provided to sanitary workers. Finally, the segregated plastic components were weighed using an electronic weighing balance and the readings were recorded by enumerator on the provided performa. Findings of the plastic waste generation and composition have been explained in sub section 5.1.

Solid waste samples from different communal points and transfer station were also collected and assessed for quantifying the various plastic components and to know how much plastic waste ends-up in dumpsite. (for details see **Table 11**). Thereby, three samples were collected from communal points (each from separate socio-economic zone) and one from communal point near Sheikh Zayed Hospital during night-time. Also, one sample was collected from dumpsite (Madina Colony Disposal Point) during daytime. For the assessment and quantification of plastic waste ASTM Method (D5231- 92)⁷⁴ was followed i.e., a sample of 160 kg of commingled MSW was considered, which was reduced to 40 kg using coning and quartering technique⁷⁵. Different types of plastic wastes components were then segregated and quantified from the reduced 40 kg of mixed MSW for getting the quantities of different plastic waste. Pictures taken during waste sampling and quantification from communal points and dumpsite have been included as **Annexure D & Annexure E**.

4.3 Qualitative Data Acquisition

Purposive Sampling Principles i.e., convenience, judgmental, and authoritative for identification and selection of stakeholders were used for qualitative data collection. Open ended questionnaires for both KIIs and FGDs were developed in line with United Nations

It was observed by field team that most of HHs separated the recyclable materials at source and provided only trash to field team. Therefore, it was requested to provide all the generated solid waste so that actual data can be collected.

⁶⁶ innovation Research and Feasibilities: Design Waste Bank Model for Mardan City – Sustainable Environmental Solutions 2019

⁶⁷ Cochran's Formula used for determination of sample size of unknown population proportion.

⁶⁸ Low Density Residential Zone

⁶⁹ Medium Density Residential Zone

⁷⁰ High Density Residential Zone

⁷¹ Clinic is an organized medical service offering diagnostic, therapeutic, or preventive outpatient services. Clinics can be privately operated or publicly managed and funded.

⁷² In order to get number of exact samples collected against targeted samples from each target area.

⁷³ PET Bottle, Hard Plastic, Soft Plastic, Shopping bags, and Plastic Rappers

⁷⁴ ASTM – American Society for Testing and Materials - Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste - D5231–92-2008); Retrieved from (http://www.astm.org/Standards/D5231.htm)

⁷⁵ In coning and quartering technique, the sample was placed on the floor and thoroughly mixed by shovel, manually. Then the sample was divided into four quarters; the two quarters which sit opposite one another were discarded, while the other two were combined.

Chapter 04: Approach & Methodology

Evaluation Group (UNEG) Ethical Guidelines⁷⁶ and other International Standards of Qualitative Research. The qualitative methods (KIIs/FGDs and observations) had generated enough information on each aspect of the subject matter to the degree of 'saturation' which is the general acceptable standard for defining

the scope of the qualitative work⁷⁷.

Primary qualitative data was collected via performing Key Informant Interviews (KIIs), Focus Group Discussions (FGDs) with stakeholders. field observations. Figure 17 shows the detail of potential KIIs and groups which were consulted for acquiring the required qualitative data. Moreover, the required data was collected by the Consultant's field team, comprised of field coordinator, field officer, and field staff (comprised of sanitary workers, male, and female enumerators). A mandatory training session on "Preventing COVID19 Spread & Safety Protocol" was organized by Consultants' team and attended by field team prior to their field visits for data collection.

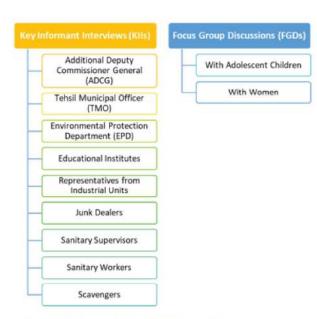


Figure 17: Potential Stakeholders of the study

4.3.1 Key Informant Interviews (KIIs)

Detailed questionnaires were designed with an aim to extract information from the representatives of relevant stakeholders in line with the specific objectives of the study. Moreover, questionnaires/survey forms have been attached as Annexure. Pictures taken during KIIs with waste management stakeholders has been included in Annexure F and the details of KIIs with different

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stakeholders along with the number of representatives that were interviewed is presented in Table 12.

Sr. No. **Key Informants** Number⁷⁸ Annexures Additional Deputy Commissione General (ADCG) Annexure G Tehsil Municipal Officer (TMO) Annexure H Environmental Protection
Department (EPD) Annexure I presentatives from Industria using recyclable plastic Annexure K Sanitary Supervisors Annexure M Annexure O Scavengers

Table 12: Details regarding number of KIIs from various stakeholders

4.3.2 Focus Group Discussions (FGDs)

The FGDs⁷⁹ conducted were qualitative in-depth discussions among group participants about their perceptions, attitudes, beliefs, opinions, or ideas on multiple aspects of solid waste in particular plastic waste generation, handling, segregation, and recycling (in term of circular economy). The main purpose of FGDs was to understand the concerns of targeted groups/stakeholders regarding the existing status of plastic waste management and their opinions how the circular economy for plastic can be implemented within the Study Area. Thereby, a semi-structured questionnaire comprising of open-ended, closed-ended, and probing questions were used for data extraction.

A group of five to twelve respondents were targeted from each stakeholder and their responses against a specific asked question were collected till the point of 'saturation⁸⁰' arose. The adopted approach⁸¹ is considered as optimum scope of qualitative data collection through FGDs. A total of 06 FGDs⁸² were undertaken with women and adolescent children separately. Detailed questionnaire performas that were used for conducting FGDs with women and school going adolescents along with the pictures which were taken during the sessions are included as **Annexure P**, **Annexure Q**, **and Annexure R**, **and Annexure S**, respectively.

 $^{^{76}}$ UNEG Ethical Guidelines for Evaluation - Retrieved from United Nation Evaluation Group: (http://www.unevaluation.org/document/download/3625)

⁷⁷ Saunders B, Sim J, Kingstone T, et al. Saturation in qualitative research: exploring its conceptualization and operationalization. Qual Quant. 2018;52(4):1893-1907. doi:10.1007/s11135-017-0574-8

⁷⁸ By targeting two sanitary workers/UC, two scavengers/UC, and each sanitary supervisor & junk dealer/UC (total UCs in Study Area = 09)

⁷⁹ A focus group discussion involves gathering of people from similar background or experiences for discussing a specific topic of interest. It is a form of qualitative research.

 $https://www.herd.org.np/uploads/frontend/Publications/PublicationsAttachments 1/1485497050-Focus\%20 Group\%20 Discussion_0.pd \\ f$

⁸⁰ "Saturation" word refers to a point when an interviewer gets a repeated information i.e., the information that has already been collected from the respondents of a group).

4.4 Data Compilation, Processing, and Analysis

A parallel and mixed⁸³ approach was applied, and the quantitative and qualitative data was transformed, processed, and analyzed simultaneously, yet separately for comparison and interpretation to draw findings. Following steps were followed for critical analysis of the collected data.

4.4.1 Data Compilation

At the first stage, the quantitative and qualitative data which was obtained through the solid waste sampling (for plastic waste quantification), interviews with key informants, and FGDs (with women and children) were transformed into soft form. Then the transformed data was arranged keeping in view the objectives and scope of the study. Moreover, the data was cross-checked for errors and omissions during the data compilation stage.

4.4.2 Data Validation

Validity, quality, and reliability of the collected data was ensured through pre-set standards⁸⁴ and triangulation⁸⁵ of findings. The objectivity, neutrality and independence of the Consultant's team have guided the data analysis at each step. The possible 'bias' was avoided through an adoption of mixed methodological approach.

4.4.3 Data Analysis

In last step, the compiled data was processed via most widely used statistical tools i.e., MS Excel and ArcGIS. The process had entailed an in-depth manual review (on the Excel sheet) of the collected data and summarized the unstructured textual content into a manageable data.

A descriptive statistical analysis technique was applied like graphical analysis and frequency distribution graphs, circular statistical graphs, and framed tables on the complied data. Finally, the triangulation of both qualitative and quantitative data as well as the relevant information from secondary sources was also extracted. Hence the study findings, valid judgments and recommendations were synthesized.

4.5 Preparation of Short Video Documentary & Finalization

With an aim to give the viewer a realistic and accurate portrait of existing plastic waste situation as well as to highlight the challenges and hurdles in the way to execute circular economy system for plastic within the Study Area, a short documentary of 3-5 minutes has been prepared. As the documentary has covered all the aspects and stages like collection of plastic waste, its transportation, manual segregation/sorting, recycling, and its final disposal. Apart from this, awareness component among stakeholders related to the fate of non-recyclable plastic was also included in the video documentary.

⁸³ The term "mixed methods" refers to an emergent methodology of research that advances the systematic integration, or "mixing," of quantitative and qualitative data within a single investigation or sustained program of inquiry or mixed approach consists of a quantitative, qualitative, and participatory methods and tools and their combinations.

⁸⁴ It includes fraud, screening, procedure, and completeness.

⁸⁵ In the social sciences, triangulation refers to the application and combination of several research methods in the study of the same phenomenon.



Chapter 05: Findings and Analysis

5 Findings and Analysis

This chapter envisages the findings and analysis of collected quantitative and qualitative data. Detail of stakeholders that were engaged for data collection is shown in Figure 17.

5.1 Quantitative Data: Existing & Predicted Plastic Waste Generation in Study Area

With due consultation with relevant stakeholders (in particular EXEN, SDO, and Sub-Engineers), different socio-economic UCs were identified for corelating the recyclable and non-recyclable plastic waste generation rates with different income levels/UCs. In order to understand the prevailing situation of plastic waste along with its daily generation rate and ultimate disposal, solid waste sampling from the targeted waste streams were performed by engaging the sanitary supervisors and sanitary workers along with the Consultant's field team. Figure 18 shows the percentages of plastic waste components against the targeted waste streams.

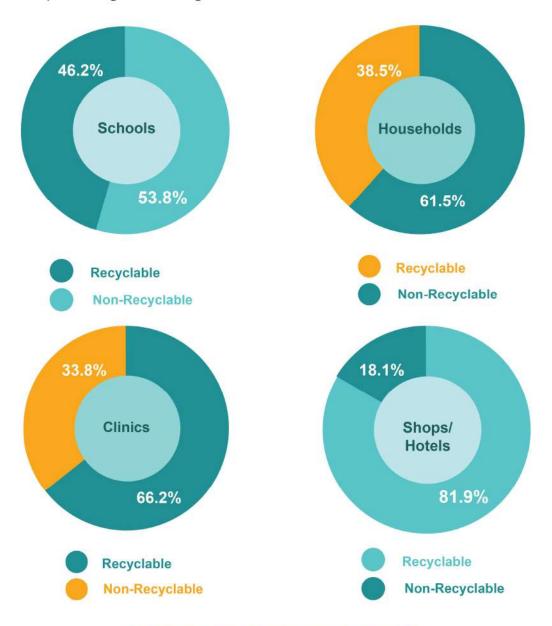


Figure 18: Plastic waste composition within Study Area

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Data reflects that a maximum of 82% of recyclable plastic waste was generated from shops/hotels due to relatively more usage of bottled water (PET), whereas a minimum of 39% recyclable plastic from residential area. Following are the details of PET, soft, and hard plastic.

PET: Water bottles, soft drinks, juice, mouthwash, sports drinks, and condiments

Soft Plastic: Shampoo bottles, cosmetic products, automobile cans, samika shoppers, shevel pipes (wiring), PVC pipes, etc.

Hard Plastic: Geometry boxes, tubs, baby pots, broken chairs, tables, charger casings, TV casings, etc. Furthermore, predicted recyclable and non-recyclable plastic waste generation rates were calculated by considering a population of 420,419 individuals as per 2017 Census and an annual growth rate of 2.5% for next 10 years. Figure 19 shows the predicted plastic quantification which will be generated in 2025 and 2030.

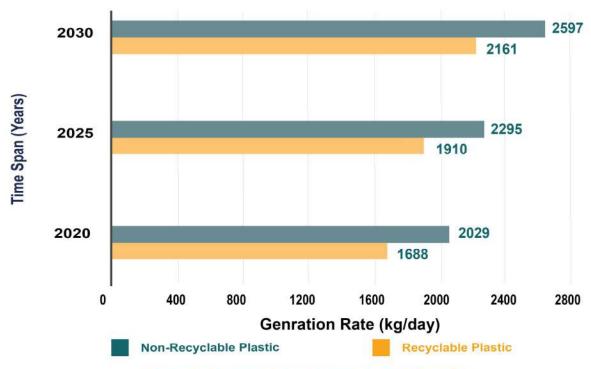


Figure 19: Estimated plastic generation rate in RYK City

5.1.1 Residential Area

Results revealed that a maximum of 37.29 g/HH/day of recyclable plastic were produced in high income UCs whereas a minimum of 24.86 g/HH/day in middle income area of RYK City. It was due to relatively small house size and lesser

A maximum of 37.29 g/HH/day of recyclable plastic waste was generated by high-income areas/UCs, while 24.86 g/HH/day and 26.50 g/HH/day from middle- and low-income areas/UCs, respectively.

persons residing in middle income areas in comparison with low-income areas. Also, variation in plastic waste generation rate among various socio-economic zones were due to difference in buying power and per capita income of residents. Apart from this, an average of 29.55 g/HH/day and 35.61 g/HH/day of recyclable and non-recyclable plastic have been produced in Study Area as shown in

Chapter 05: Findings and Analysis

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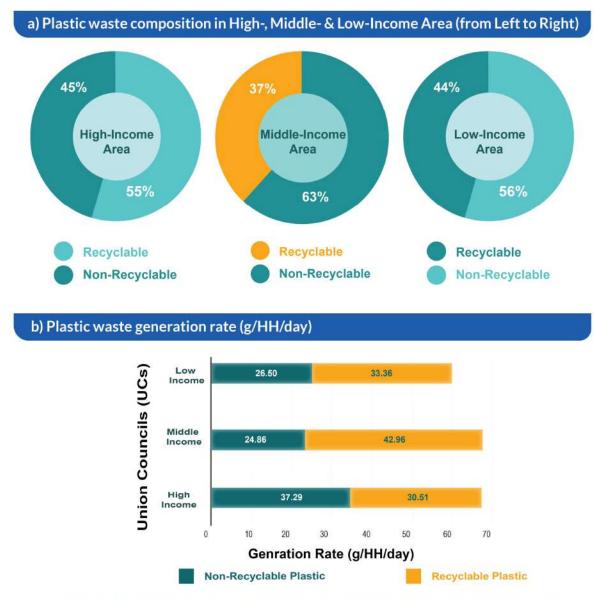


Figure 20: a) Plastic waste composition (%ages) and b) plastic waste generation rates (g/day) of residential area

5.1.2 Commercial Area

A total of eight shops were targeted in each socio-economic zone for knowing the potential rates of recyclable and non-recyclable plastic. **Figure 21** show that a maximum of 76 g/shop of hard plastic, 58 g/shop of soft plastic, and 49 g/shop of PET was

A maximum of 2820 g of PET and 480 g of single use plastic were generated by hotels on daily basis and a total of two hotels were targeted for primary data collection.

high-income UC, whereas a minimum of 70 g/shop of non-recyclable plastic in middle income UC. The possible reason for more plastic generation rate in high income areas is relatively more buying power of customers for keeping their living standards high. Apart from it, 2820 g of PET and 480 g of single use plastic were also generated by hotels on daily basis and a total of two hotels were targeted for data collection.

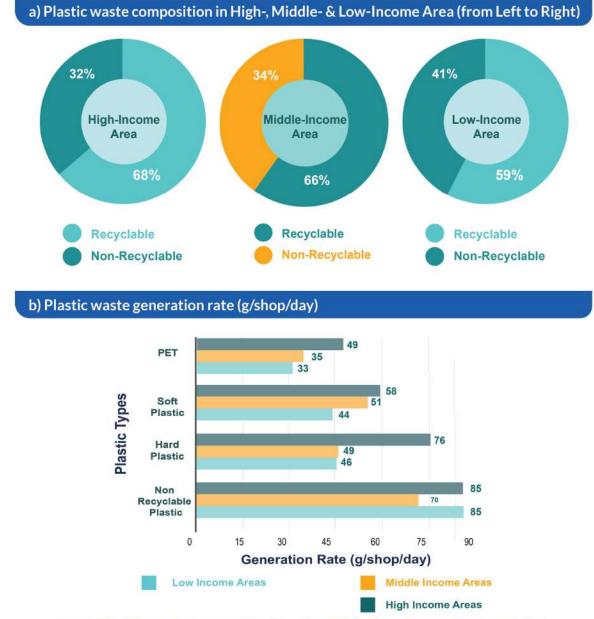


Figure 21: a) Plastic waste composition (%ages) and b) plastic waste generation rates (g/day)

5.1.3 Institutional Category

of shops within the Study Area

For quantification of various plastic types, a total of eight institutes comprised of clinics and schools were targeted in each socio-economic UC for getting daily plastic generation rate.

5.1.3.1 Hospital/Clinics

A total of four clinics were highlighted and targeted in high-, middle-, and low-income areas for plastic quantification. Results showed that more plastic were produced in high income UC in comparison with low-income UC and a maximum of 285 g/day of non-recyclables which mostly comprised of single use plastic (snack wrappers,injection plastic coverings, etc.). Whereas a minimum of 1.23 g/kg and a maximum of 14.8 g/kg of non-recyclable plastic were found from a sample of 120 kg from Sheikh Zaid Hospital as shown

A maximum of 14.8 g/kg of non-recyclable plastic was present in a sample taken from Sheikh Zaid Hospital. Whereas around 60% to 70% of generated plastic waste from clinics comprised of recyclable plastic components i.e., feeding bottles for babies, PET bottles, broken toys, disposable plastic plates/spoons, glasses, straws,

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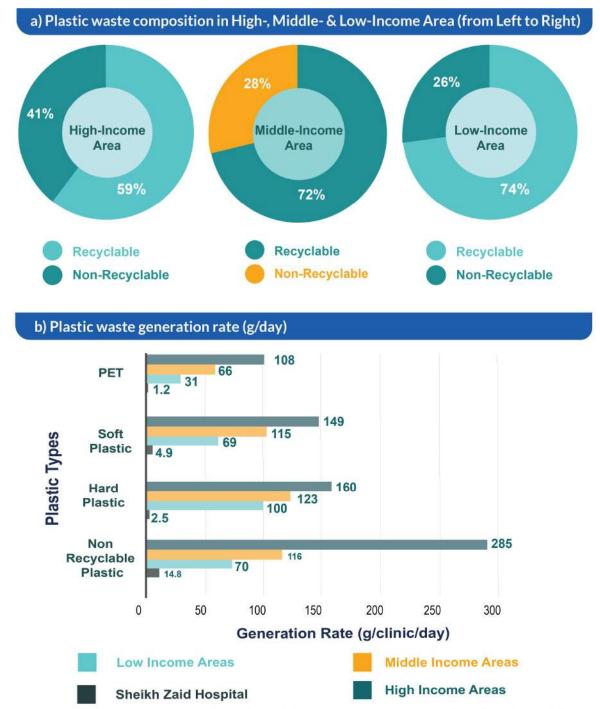


Figure 22: a) Plastic waste composition (%ages) and b) plastic waste generation rates (g/day) of clinics within the Study Area

5.1.3.2 Educational Institutes

For analyzing the plastic generation rate from schools, a total of six schools were targeted in such a way that both government and private schools can be covered. One government and one private school/UC were selected for getting an overall and generic picture of plastic generation within the Study Area. Results showed that a maximum of 475 g/day of non-recyclable plastic comprised of mostly snacks wrappers, juice bottles, and water bottles

Recyclable plastic waste within the commingled solid waste being produced by educational institutions mostly comprised of PET, water bottles, white board pen casings, stationary items, recyclable plastic packaging (lunch box plastic wrapping) etc.

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were produced in schools situated in high income areas due to relatively more consumption of snacks and soft drinks from the children during break and off-times. Figure 23 shows the plastic composition (in %age) and the plastic waste generation rate (g/day) in schools which are being present in various socio-economic UCs of the Study Area.

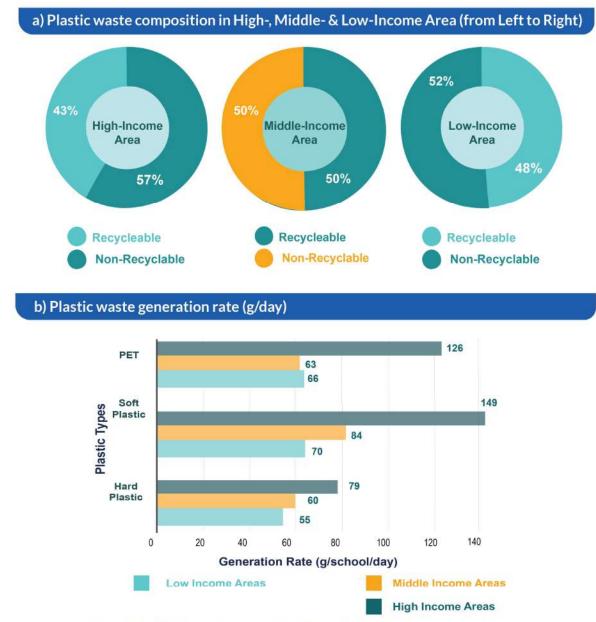


Figure 23: a) Plastic waste composition (%ages) and b) plastic waste generation rates (g/day) of schools within the Study Area

5.1.4 Communal Points

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Three communal points were targeted for getting plastic characterization by analyzing a sample size of 100 - 120 kg as per standard method for composition analysis (ASTM-D5231-92). Locations of targeted communal points are as under:

Collected solid waste sample from communal points depict that almost 80% to 90% of plastic waste fraction comprised of non-recyclable portion primarily due to continuous scavenging by informal

1. First Communal Point: Opposite to Tailoring & Clothing Store, Faisal Road;

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- 2. Second Communal Point: Adjacent to Al-Yaqeen Language Model School; and
- 3. Third Communal Point: Near Railway Station, Railway Road.

Results depict that a maximum of 6.5 g/kg of PET recyclable plastic waste was found at third communal point because of more consumption of soft drinks and water bottles by passengers at Railway Station. While a maximum of 15.25g/kg of non-recyclable fraction was found at second communal point and it mostly comprised of disposable plates, spoons, and single use plastic bags because of the presence of hotels, restaurants, and shops nearby. It was also observed that at late night, workers of these shops came and dispose-off their waste before closing the set-ups. Figure 24 shows the overall plastic generation rate of different plastic type from communal points within the

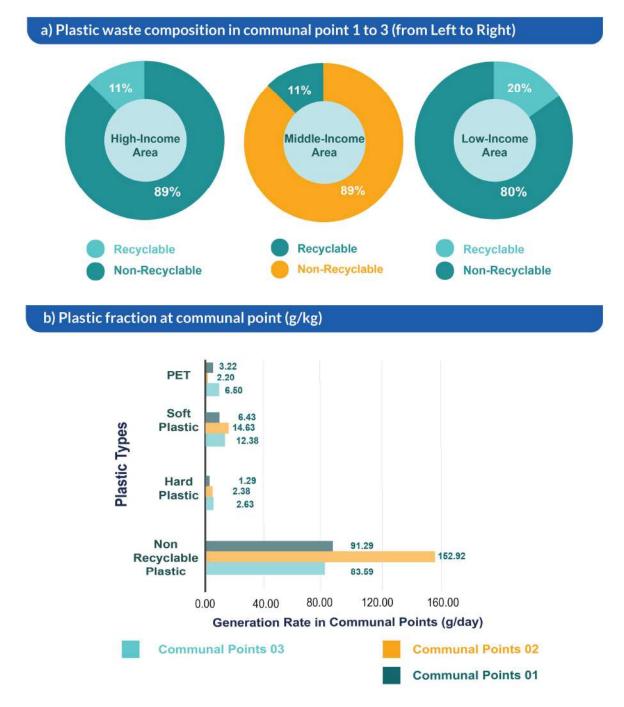


Figure 24: a) Plastic waste composition (%ages) and b) Plastic fraction at dumpsite (g/kg) in communal points

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5.1.5 Landfill Site/ Dump Site

For getting complete picture of plastic waste characterization and how plastic components percentages vary from source of generation to the disposal stage in order to quantify the plastic leakage into the environment. Figure 25 reflects that approx. 6% of recyclable plastic was present making it 1.35 g/kg within MSW present in Mou Mubarak Dumpsite. It was also observed during solid waste sampling that relatively much lesser number of

A maximum of 1.35 g/kg of recyclable plastic component was found to be present in a solid waste sample which was collected from Mou Mubarak Dumpsite. It was also observed that relatively much lesser number of scavengers were scavenging at dumpsite due to presence of relatively much lesser recyclable plastic fraction in comparison with communal points and dedicated filth depots within the Study Area.

scavengers were scavenging at dumpsite due to lesser recyclable plastic fraction in with the scavenging activity at communal points, and filth depots within the Study Area.

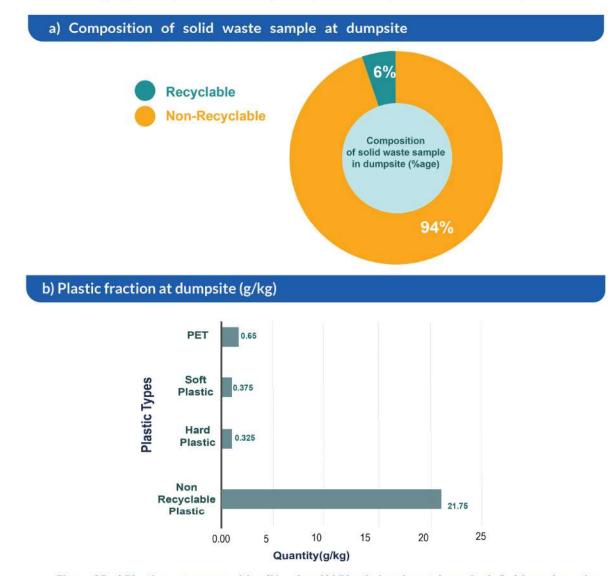


Figure 25: a) Plastic waste composition (%age) and b) Plastic fraction at dumpsite (g/kg) from dumpsite

Based on the collected quantitative data, actual pathways of plastic waste were also recognized along with the possible leakage at each point. The calculated plastic waste generation rate (g/c/day) was then multiplied with the total population⁸⁶ of the Study Area for estimating the approx. generation rate of recyclable plastic waste (in tons/day). Figure 26 illustrated the recyclable plastic flow leakage at different stages, starting from the point of generation to secondary point (filth depots and communal points), and then finally to disposal point (Dumpsite) within the Study Area.

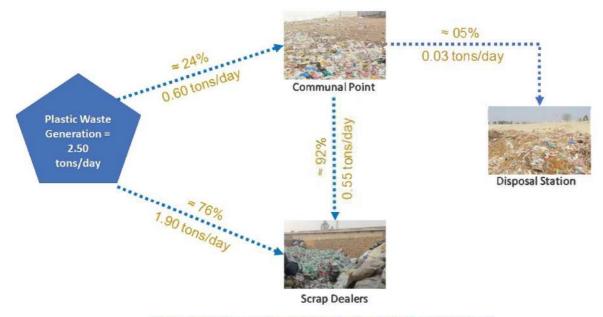


Figure 26: Pathways of recyclable plastic within the Study Area⁸⁷

Note: It was observed during field visit that solid waste management within the Study Area is mostly managed by male workers.

5.2 Qualitative Data Analysis

Qualitative data was collected through KIIs with relevant stakeholders and FGDs with potential groups of society (refer sub-section 4.3, for details). Findings and analysis of the collected qualitative data has been included in following sub-sections. Moreover, GIS map highlighting the locations of targeted communal points, disposal station for quantitative data collection and informal actors consulted during qualitative data collection is shown in Figure 27.

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Chapter 05: Findings and Analysis

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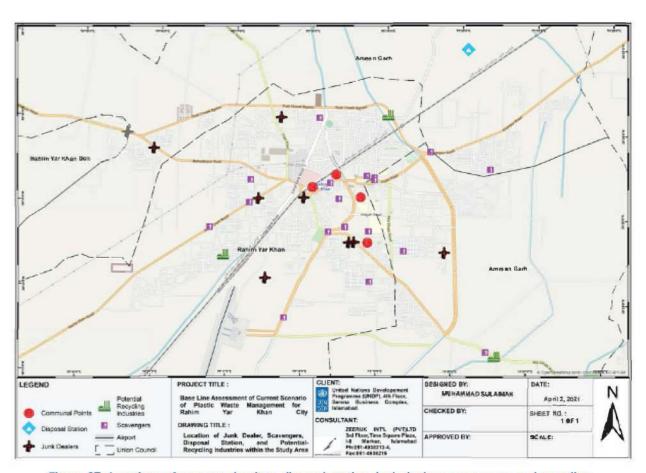


Figure 27: Locations of communal points, disposal station, junk dealers, scavengers, and recycling industries within the Study Area

⁸⁶As per the data provided by municipality of 2017 census and by considering growth factor as 2.5% for four years in order to know approx. population of the Study Area in 2021.

⁸⁷Data based on finding during plastic waste sampling from residential, communal and dumpsite

5.2.1 KIIs with Representatives of Government Institutions/Departments

Provincial governments in Pakistan are responsible for solid waste management. But in 2001, the responsibility of service delivery pertinent to solid waste collection, transportation, and disposal was handed over to local governments. Currently solid waste management companies (SWMCs) are working in Lahore, Faisalabad, Gujranwala, Sialkot, Rawalpindi, Multan, and Bahawalpur with the required necessary assets and staff⁸⁸. Finding of KIIs with different stakeholders has been discussed in sub-sections below:

5.2.1.1 KII with Additional Deputy Commissioner General (ADCG)

Additional Deputy Commissioner (General), RYK has not only appreciated the step being taken by the Client to conduct this baseline study but in order to correlate the plastic waste generation rates with that of various seasons, it was iterated to extend this study so that summer season can be covered. Based on seasonal variation data, the administration and the municipality will be then, in a position, to take necessary steps for ensuring effective management of solid waste and in particular, plastic waste. Moreover, ADCG has stressed on the importance of industries-academia linkage to step out research projects on plastic waste recycling, organic composting, waste to energy projects, and in particular on single use plastic. Keeping in view the ban of single use polyethylene bags by provincial government and for its successful implementation, it is important to give a suitable and sustainable alternative to the community. Thus, for achieving it, local administration is ready to act as a bridge for connecting industries and academia, so that low-cost and eco-friendly alternative to single use plastic can be proposed at earliest.

5.2.1.2 KII with Environmental Protection Department

During the KII with Deputy Director (DD), EPD, RYK, it was articulated that the EPD is given a mandate of protection, and conversation of the environment; the prevention and control of pollution; and enforcement of the Environmental Quality Standards. Moreover, EPD is responsible for ensuring safe disposal of industrial solid waste by following the section 11 of Pakistan Environmental Protection Act (PEPA), which states that "no person shall discharge or emit or allow the discharge or emission of any effluent or waste or air pollutant or noise in an amount, concentration or level which is in excess of the Environmental Quality Standards or, where applicable, the standards established." As far as the management of municipal solid waste is concerned, it is sole responsibility of the municipality to collect, transport, treat, and dispose, whereas EPD has the guidelines for the approval of transfer station and landfill design, but the department lacks design guidelines/protocols to be followed during the construction and operation of the facilities

Besides, it was conveyed that EPD is a major stakeholder in organizing public awareness campaigns regarding the management of solid waste (in particular plastic waste). Several walks, seminars, awareness campaigns were also organized by EPD with support of TMA and Health Department.

EPD being a major stakeholder has showed their willing to act as a bridge for filling the gap between academia and industry for conducting outcome-oriented research projects so that low-cost and sustainable alternative to single use plastics can be proposed.

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5.2.1.3 KII with Municipal Corporation (MC)/Tehsil Municipal Authority (TMA)

In the Study Area, TMA/MC is responsible for the municipal solid waste management which is being carried out via primary and secondary waste collection, transportation, and disposal at transfer station (Mou Mubarak Dump site). Primary solid waste is collected from houses, streets, hotels/restaurants/shops, offices, and educational institutions by sanitary workers with the help of brooms and hand carts. The collected waste is temporarily stored at designated filth depots and at various communal points within the Study Area. Details regarding locations of filth depots is

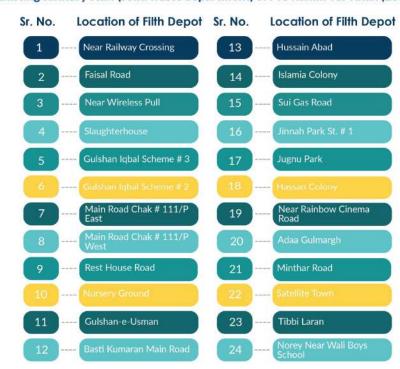


Table 13: Existing sanitary staff (solid waste department) of MC Rahim Yar Khan (2019 to 2021)90

Afterwards, the solid waste at filth depots/communal points/open spaces are transported to a Madina Colony Dumpsite (having an area of 2 to 2.5 Acres) by using tractor trolleys and loaders. It was also informed by the CO that the Government of Punjab (GoP) has approved a permanent landfill site spread over an area of 400 Kanals near Pattan Minara, while keeping in view the current population and rapid urbanization within Study Area, it requires a dedicated waste disposal station with an area of minimum 10 to 15 Acres by considering lifespan of 15 years.

Findings of KII with CO, RYK revealed that that approx. 170 tons per day of MSW is being generated from the Study Area, with an average solid waste generation rate of 2.8 kg/HH. Whereas only 130 tons per day of MSW is being collected and making the collection efficiency of approximately 75%, due to limited available resources (insufficient machinery and staff, in particular). Figure 28

Chief Officer informed that Government of Punjab has already approved 400 kanal land for the construction of landfill near Pattan Minara – a famous historical landmark near RYK City. Whereas a minimum of 10 to 15 acres of land is required by considering landfill lifespan as 15 years.

demonstrates the infographic of available and functional machinery owned by MC for SWM in the Study Area.

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⁸⁸ Local Government & Community Development, Government of The Punjab - Website Accessed on 28-Mar-2021 (https://lgcd.punjab.gov.pk/solid waste management companies)

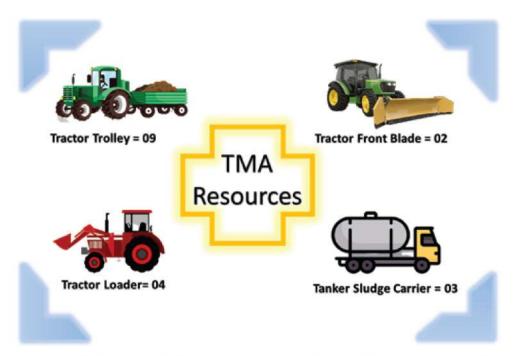
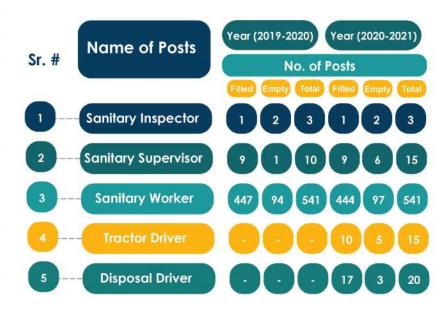


Figure 28: Infographics shows the available and functional solid waste machinery owned by MC, RYK89

Due to limited financial and human resources, the situation related to the management of MSW is worsening by each passing day. As per MC, the available sanitary staff is not enough as the supervisory and sanitary staff are becoming retire at a speedy rate/frequently. In an absence of their alternatives and ban on hiring (despite of vacant positions) by provincial government is further hampering the collection efficiency. Thus, requiring an immediate and clear stance of the provincial government in this regard is prerequisite. Detail regarding the vacant positions in solid waste sector is presented in Table 14.

Despite of the shortage of human resources and ban on hiring, it was also observed that the solid waste sector within the Study Area is facing multiple challenge, specifically insufficient financial resources, timely allocation of funds, and a minimum budget allocated for maintenance and repairing of machinery. Furthermore, as per the figures being shared by shows that municipality had mostly spent under establishment head91 which accounts for 87% of the

Table 14: Existing sanitary staff (solid waste department) of MC Rahim Yar Khan (2019 to 2021)90



⁸⁹ This data was shared by MC, Rahim Yar Khan

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for solid waste management during the financial year 2019-2020 within the Study Area. While other necessary details regarding annual expenditure on MSWM by MC are presented in Table 15.

Table 15: Annual expenditure detail of MC Solid Waste Management (2019-2020)



It was also observed that the informal sector is also facilitating the MC, though indirectly by collecting recyclable fraction of MSW from the Study Area. Talking about the recovery of post-consumer plastic, it was found that almost 80% of recyclable plastic was collected by the scavengers, approximately 5% by sanitary workers, and around 15% by

Recovery of post-consumers plastic was mostly done by scavengers, sanitary workers, housemaids, and inhabitants within the Study Area.

housemaids/inhabitants of the Study Area. The recovered sorted plastic waste is then sold to street hawkers/itinerant buyers and small scrap dealing shops. Whereas the non-recyclable plastic⁹² remained unattended as it mostly ends up in open plots, drains, water bodies, and/or transfer station.

5.2.1.4 KII with Educational Institute

KII with Assistant Professor (AP) Khawaja Fareed University of Engineering and Information Technology (KFUEIT), RYK has highlighted that the institute has enough technical capacity along with dedicated, competent, and research-oriented staff for carrying research pertinent to the non-recyclable and single-use plastic. Thereby, a financial support and/or investment via long term partnership with the industries is the optimum and possible solution for the development of low-cost and eco-friendly prototype for coping plastic pollution, especially. Furthermore, it was also informed by the interviewee that currently, not even a single research project on circular economy for plastic was in progress during the time of visit, thus deeming for imperative and effective engagement of industries and academia for making the Study Area as plastic free in nearby future.

5.2.1.5 KII with Recycling Industries

KII with the representatives of recycling industries revealed that COVID-19 pandemic had severely affected their business due to substantial decline in recycled plastic demand by relevant industries during lock down period. Moreover, restricted physical contact, owing to social distancing, and employees' safety along with staff shortage, had also limited the production of plastic recycling industry. To revive the business, it is a responsibility of the state to support the industry via developing mechanisms related to

Plastic waste recycling units reported a substantial fall in demand of recyclable raw material by the relevant industries due to COVID-19 pandemic. For reviving their business, provision of interest free loan by the provincial government will be much

⁹⁰ ibi

⁹¹ Solid Waste Management Staff

⁹² Commonly, non-recyclable plastic product includes ketchup or shampoo sachets, snack wrappers, polystyrene food boxes, and single use black color shopping bags.

the disbursement of interest free loans and/or by exempting tax (for a period of at least one year) as many families are directly linked with this industry nationwide and in particular within the Study Area.

5.2.2 Klls with Sanitary Supervisor and Sanitary Workers (Formal Sector)

The study findings of KIIs with sanitary supervisor revealed that the supervisory staff have limited number of sanitary workers, equipment's, and machinery which contributes to an inadequate service coverage, collection, and operational inefficiencies in the Study Area.

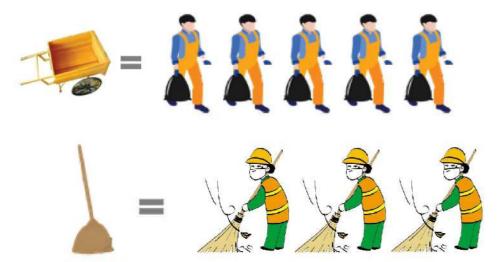


Figure 29: Situation of available resources for solid waste collection93

Figure 29 reflects a clear shortage equipment's and becoming a one possible reason of lesser collection efficiency of MSW. Moreover, it was informed by the respondents (sanitary workers) during KIIs that approximately 4 to 5 kg/HH/day of MSW has been produced from residential areas, 1.5 to 2 g/day from shops, and 5 to 6 g/day from both schools and clinics, separately.

In order to evaluate the understanding of sanitary workers regarding recyclable and non-recyclables plastic, it was also asked during KIIs and documented/noted in respective questionnaires by the Consultant's filed team. Results showed that almost 67% of the sanitary workers were well aware of recyclable and non-recyclable plastic waste. Contrary it was

Almost 27% of sanitary workers collect plastic recyclable during their duty timings, 16% after their duty timing, and remaining 57% do not collect recyclable plastic waste.

found that 27% of sanitary workers collect plastic recyclable during their duty timings i.e., during collection of MSW from primary sources and 16% of them collects recyclable after duty timing, while majorly (57%) did not collect recyclable plastic waste as reflected in **Figure 30**. Based on the observation of sanitary workers, it was also informed that approximately 120 – 150 scavengers are being active in each UC for collecting recyclable plastic within the Study Area.

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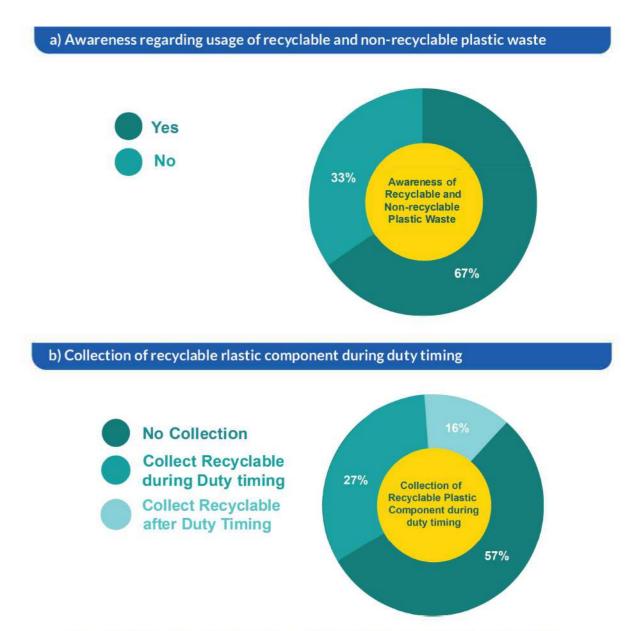


Figure 30: (a) Awareness among sanitary workers regarding recyclable and non-recyclable plastic waste and (b) Collection of recyclable plastic waste during duty timing

5.2.2.1 Klls with Scavengers and Scrap Dealers (Informal Sector)

Results showed that approximately 8 to 10 kg of mixed plastic including PET bottles, soft and hard plastic have been collected by scavengers on daily basis. And almost 70% of scavengers sold the collected recyclable plastic as mixed plastic (as a whole) to junk dealers, whereas only 30% of them sold separate components of plastic and at relatively higher rates. It was found that the selling price of mixed plastic range from 30 – 35 PKR/kg, whereas selling price of PET bottles, soft plastic, and hard plastic was in the order of PKR 55/kg, PKR 50/kg, and PKR 12/kg, respectively. The graphical Figure 31 illustrates the practices followed by informal actors regarding selling of plastic recyclable in the Study Area.

⁹³ It was also found that on average (in the Study Area), one handcart is available for five sanitary workers and one broom is being provided by municipality to three workers

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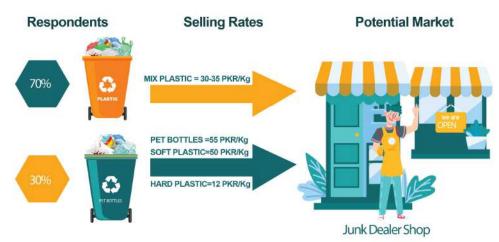
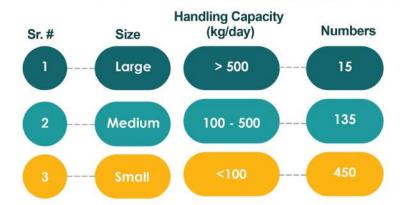


Figure 31: Infographics showing the scavengers' approach towards selling recyclable plastic

Furthermore, the data revealed that a maximum of 50% of scavengers were found to be locals, 35% as Afghan nationals, and remaining 15% came from outside RYK. In order to get information about the plastic inflow (handling capacity of scrap dealers in kg/day), purchasing rate of plastic, and end market of it, different junk dealers were targeted. Locations of the targeted junk dealers' shops is shown in Figure 27. It was found that small and medium scrap dealers get recyclables directly from household members, itinerant buyers, sanitary workers, scavengers, and street pickers. While large scale scrap dealers buy recyclable plastic material from small and medium scrap dealers and sometimes, they process the recyclables instead of direct selling to industries or scrap dealers operating outside the Study Area. Average number of scrap-dealing shops which are operating within the Study Area (as per the knowledge of scavengers and scrap dealers) is presented in Table 16.

Table 16: Tentative number of scrap dealers which are working in Study Area



None of the above-mentioned scrap dealing shops were using any kind of processing machines for transforming the plastic into plastic flakes and/or pellets. Furthermore, most of the scrap dealers usually transport recyclable plastic materials to Lahore, Multan, and Gujranwala for selling purpose, while some dealers have targeted the local

Small scale scrap dealing shops mostly employed daily wage workers, while medium scrap dealers were operating with 2 – 3 workers, and large-scale scrap dealers engaged 10 – 12 workers for handling large plastic influx.

recycling units for transforming the plastic into flakes and pellets. Figure 32 shows the average selling price of different recyclable plastic by scrap dealers to recycling industries.

5.2.3 FGDs with Potential Groups

Two potential groups i.e., women and school going adolescent children were highlighted keeping in view the objectives and scope of the study (refer **sub-section 4.3.2**, for details). Findings of the FGDs with potential groups are documented in following

5.2.3.1 FGDs with Women

Discussions with women which were being carried out by the engagement of female enumerators within the Study Area revealed that each house has been generating a MSW at a rate of 3 – 5 kg/day. Out of the generated MSW, plastic waste accounts for only 10%. Talking about the waste collection services within the Study Area, at most 63% of respondents are getting services, whereas 37% respondents informed that the municipality is not offering their services at all and they are managing by their own as shown in Figure 33. Whereas only 23% of the respondents were found to be satisfied with the municipality services. services,

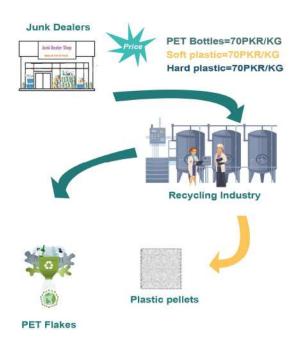


Figure 32: Selling price of different plastic types by the scrap dealers

FGDs data showed that 62% of the Study Area is being served by the municipality whereas 38% of the households are managing their waste by their own or being served by private waste collectors.

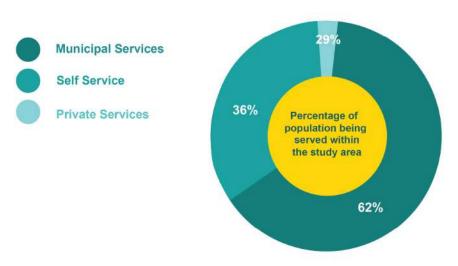


Figure 33: Percentage of population being served within the Study Area

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Figure 34 shows that approximately 45% of women knew about plastic recycling and only 43% of the women were willing to segregate waste at source for reducing the MSW generation rate and for getting monetary benefits from the recovered plastic fraction.

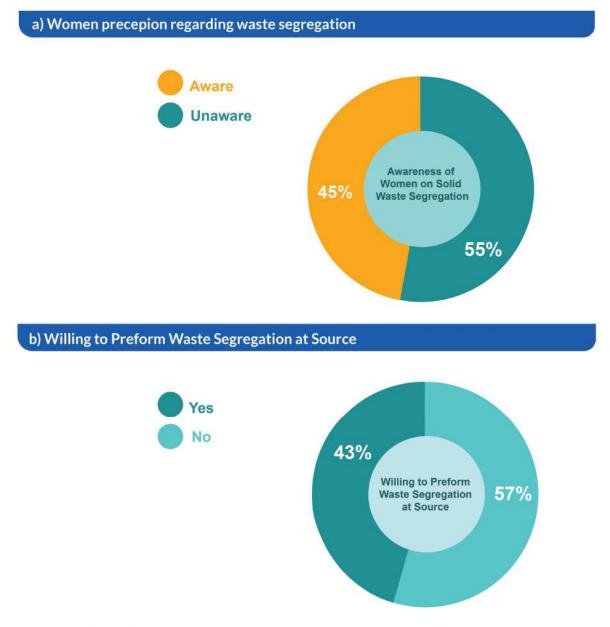


Figure 34: (a) Women perception regarding waste segregation and (b) Willingness of women to perform waste segregation at source

Data reflects that more than 81% of the women were willing to segregate waste at source, if the municipality offers them free collection services. It was also found that around 72% of the respondents had preferred cash incentive and remaining 28% choose bartering of items over cash incentives as shown in Figure 35.

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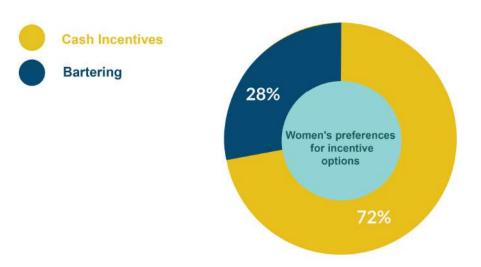


Figure 35: Women's preferences for incentive options

It is important to mention here that only 41% of the respondent were also aware about the ban on the use of polyethylene bags in Punjab.

5.2.3.2 FGDs with Adolescent Children

FGDs with school going adolescent children were conducted in order to extract information related to solid waste management and fate of plastic waste in the Study Area. Moreover, students had showed their interest on plastic waste recycling and acknowledged their responsibility for managing plastic waste at individual level. This indicates that by arranging school campaigns (having a focus on plastic recycling) would ultimately results in positive attitude among children regarding the use of products with no or relatively lesser plastic covering.

Data revealed that 90% of the respondents thought that plastic waste is responsible for pollution in soil, air, and water bodies. Also, more than 70% of the respondents were found to be aware of ban on single-use polyethylene bags in Study Area but all of them were using polythene shopping bags in their daily routine due to unavailability of

Almost 76% of the respondents/targeted adolescent children were willing to sell recycled plastic to junk dealers. Out of this, 27% desired for incentives in the form of books, 16% in the form of cash, and remaining craved for recycled items.

alternative option. Figure 36 shows the respondents' response on banning and imposing fines on usage of polyethylene bags within the campus.

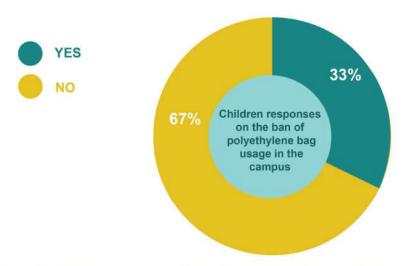


Figure 36: Children responses on the ban of polyethylene bag usage in the campus

Talking about usage of plastic products, it was found that 74% of children were using recyclable plastic products⁹⁴ whereas 26% of the respondents were using non-recyclable plastic products⁹⁵. Figure 37 shows the monthly usage of plastic products by the children.

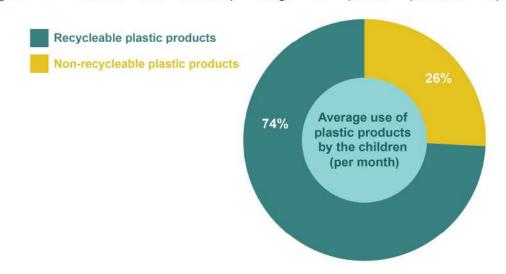


Figure 37: Average use of plastic products by the children (per month)

Finding shows that 76% of respondent were willing to sell recycled plastic to junk dealers, out of this 27% wants incentives in the form of books, 16% needs in cash while remaining were interested in recycled items.

⁹⁴ Recyclable plastic products include soft drinks, disposable straws, disposable cups and plates and pen casings

⁹⁵ Non-recyclable plastic products include polyethylene bags, snack wrappers, disposable straws, cups and plates and sachet packs.



Strategic Action Plan for Effective Plastic Waste Management

Despite being an industrial city, the RYK is struggling to manage its MSW as waste generation rate is increasing on daily basis due to rapid population growth and insufficient available resources. Thus, hampering the collection efficiency of MSW as well. Therefore, an efficient and implementable strategic action plan is required for MSW management, in particular plastic waste. Detail regarding the components of Strategic Action Plan for Study Area is discussed in following sub-sections.

Business Model Canvas of Circular Economy for Plastic Waste

As the plastic waste stream in the Study Area contains considerable number of recyclable materials and thus requiring waste-to-resource initiatives for sustainable plastic waste management. The sustainability of such initiatives depends on multiple factors, such as source segregation, effective engagement of stakeholders, steady and predictable sources of revenue (like recycling plants), public awareness and their participation. The Business Model Canvas (BMC) for plastic waste management for the Study Area is summarized in Table 17 and described below:

PLASTIC RECYCLING

Plastic Recycling Process 1. Inspection 2. Chopping & Washing 6. Filtering to Remove 7. Molten Plastic Extruded into Fine Strands 3. Separation by Flotation 4. Drying 5. Melting by Heat & Pressure 8. Pelletizing

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Table 17: The Business Model Canvas for Plastic Waste Management in Rahim Yar Khan City

Business Model Canvas for Plastic Waste Management

Key Partnerships/ **Partners**

- Local/Provincial Government
- Tehsil Municipal Authority (TMA)
- NGOs/INGOs
- Manufacturing Industries
- Institutes
- Informal/ Private Sector
- Consumers/ Public

Key Activities

- Source segregation (collection and segregation of recyclables and non-recyclables)
- Recycling of segregated plastic
- Disposal of non-recyclables

Key Resources

- Installation of waste bank for source segregation Installation of recycling units
- using solar energy Implementation of polluter's
- pay principal and ecotax via mandating EPD, for effective disposal of non-recyclables

Value Proposition

- Environmental: Reduced use of virgin raw material; Less pollution and clean environment; Reduced health problems
- Social: Improved quality of life; Educating child labor involved in scavenging activities
- Economic: Increased aesthetic value result in Increased opportunities

Customer Relation

- industries relationship can be maintained through regulations and policies for including long-term incentives and penalties.
- Consumer relation could be maintained through policies/regulations specifically targeting consumers and by
- educating them Linkage industries and academia for research development

Channel and **Customer Segment**

nodel targeting small industries to produce recycled products using recycled plastic for local distribution Awareness among

the locals to use

recycled products

between and

Revenue Stream

- Cost saved due to the use of recyclable materials
- Revenue generated through recycling units and waste bank Government support; incentives for industries such as



- Research and Development (R&D) Baseline studies such as pilot tests
- Installation of Waste Bank
- Installation of Recycling Unit
- New technology to treat non-recyclable



6.1.1 Key Partnerships/Partners

Based on the study's findings, it can be concluded that effective partnerships between a diverse range of stakeholders must be designed and encouraged to achieve sustainability in plastic waste management. Figure 38 shows the relevant and core stakeholders/partners whose engagement for devising and implementing a circular business model is incomparable and unmatched.

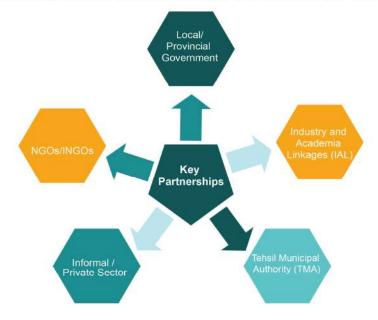


Figure 38: Key Partnerships/Partners in Circular Business Model

TMA, being a lead partner has to play a key role as it is mandated to manage MSW in an efficient way and to raise awareness among locals. In context to plastic waste management, both public (formal) and private (informal) sectors are active in the Study Area. However, activities of the formal and informal sectors are not synchronized, thus leaving huge amount of waste unattended. In order to improve the efficiency of the entire waste management sector, there is a need to develop linkages between formal and informal sectors. Different levels and models of integration are possible, ranging from mere recognition of the informal workers by TMA (e.g., provision of identity cards) to a complete formalization of workers as companies or co-operatives. At first, TMA should devise a system by which it can take maximum advantage from the existing informal setup for enhancing and improving the current collection & disposal mechanisms. Apart from it, TMA can bring down its operational expenditure via engaging the informal sector. In this way, the proposed hybrid system can increase the waste management efficiency via separating recyclable fractions and ultimate disposal of non-recyclables to Madina Colony (dumpsite).

Role of INGOs/NGOs: For the development of close relationship with communities and for gaining a high degree of community trust, role of INGOs/NGOs cannot be underestimated. They can raise awareness through organizing campaigns, educating at schools, reaching out to corporate offices to educate people in the workplace, and providing training and enhancing capacity building of formal and informal sector. Furthermore, they can facilitate and support TMA for launching public

awareness campaigns, source separation programmes and by celebrating an annual "recycling day at school, promoting the use of two-bin system at home and use of biodegradable plastic bags for carrying items etc.

Moreover, NGOs should invest in conducting different baseline research studies, not only to understand the current statistics of plastic waste but also to suggest low-cost and sustainable solutions to cope with non-recyclable portion of MSW by engaging academics and local industries (preferably those who are producing non-recyclable plastic at large scale).

Role of Industries: Another potential partnership is an Industry and Academia Linkage (IAL), as it

promotes innovation in a society that leads to generation of new products and technologies. As a part of Corporate Social Responsibility (CSR), industries in collaboration with academia should invest in productive research with an aim to contribute towards managing the non-recyclable plastic waste in particular. Moreover, they can assist TMA for improving the existing MSW practices by increasing institutional capacity through establishing a model

Example of Industry and Academia Linkages:

The University of Pittsburgh team applies nano engineering to create a recyclable material that can replace complex multi-layered packaging that is unrecyclable.

plastic recycling industry within the Study Area. In this way, the local municipality can not only manage plastic waste but also generate revenue from it. Upon successful operation, this business model can not only be up-scale locally but to the other cities as well.

Role of Provincial Government: In an absence of relevant legislation, plastic waste recycling and its proper management is not possible. Unfortunately, no such legislations, policies, or laws exists in this regard and hence, there is a dire need for comprehensive policies/legislation from the provincial government. It is responsibility of the state/province to formulate such policies that encourage the investment and recycling of plastic waste like tax subsidies for recycling companies and easing the process of acquiring the necessary technology. Moreover, the government not only need to formulate policies but also ensure the enforcement of rules and regulations.

Finally, the consumer of packaged plastic products must be considered as the key player in the circular model. They need to be educated and advised on handling the waste. However, not only education and knowledge influence disposal attitudes, but also local infrastructure and access to convenient disposal systems play a major role.

6.1.2 Key Activities and Resources

There are four main activities that must be fulfilled for the circular economy model to be successful, namely, 3R's (Reduce, Reuse, Recycle,) and disposal. The process begins at the disposal stage, which is usually at the end of product's life cycle. The aim is to minimize the littering and cut off incineration. At the disposal stage, the foremost key activity is the sorting of plastic waste as it determines the quality of secondary virgin raw materials.

Source Segregation: In order to promote and ensure source segregation and to avoid cross contamination of recyclables (segregated plastic components), Waste Bank Model⁹⁶ is considered as a most implementable option within the Study Area for extracting recyclables from a commingled waste stream. The primarily objective of a Waste Bank is to collect recyclable plastic waste at

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⁹⁶ Waste Bank Model is a place for sorting and collecting waste that can be recycled and or reused having economic value

community level, reducing the collection and transportation costs and finally improving the life span of landfills. Initially, the centralized waste bank approach can be implemented in the Study Area as its capital cost is relatively much lower than decentralized Waste Bank. For this, suitable Union Council (UC) must be selected keeping in view the space availability. But for covering the whole city, mobile Waste Bank approach can be integrated with the centralized Waste Bank approach. Mobile Waste Bank can collect waste from different UCs on pre-defined days depending on rate of waste generation and public interest/participation. Schedule of Waste Bank vehicle can be announced by using radio, newspaper and/or TV and also on loudspeakers.

Recycling: The next step is the recycling of the sorted plastic waste to obtain the right micro size by melting it. The melting process releases Volatile Organic Compounds (VOCs) that pose harm to human health and environment. Moreover, the heat required to melt the plastic is often obtained from fossil fuel, that generates carbon emissions and Greenhouse Gases (GHGs). The operational informal recycling units within the Study Area are using diesel generators (in an absence of electricity) and thus causing air pollution.

By switching to alternate and renewable power sources like solar energy, which is considered as highly sustainable and green energy choice, can cause a substantial positive environmental impact by reducing the GHG emissions. Although, this energy alternative is a cost intensive option (in terms of higher capital cost) but having a relatively much lower operating cost, thus will benefit in long term. Therefore, it is suggested that TMA should set up a model recycling unit equipped with solar panels for processing the recyclable plastic in the first stage and upon successful operation should replicate in other parts of the city for generating more revenue along with effective management of plastic.

Disposal of non-recyclable plastic: For effective disposal of non-recyclable plastic, it is important to engage and bound industries by imposing Ecotax or environmental tax via mandating Environmental Protection Department (EPD). By doing so, such industries will not only invest in research for getting eco-friendly and low-cost alternative but also assist in effective management of non-recyclable plastic through Polluters Pay Principle⁹⁷. Finally, for the circular business model to be successful, new technology is required especially for dealing with non-recyclable plastic waste. Having a developing economy, the government is not able to provide financial support, thus requiring NGOs/INGOs to come forward and assist financially for installing recycling center with the technological capability to recycle any plastic code.

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Examples of Implementation of Polluter's Pay Principle:

- The European Union (EU) charge on plastic packaging wastes the charge to be introduced from January 01, 2021, will be calculated on the weight of non-recycled plastic packaging waste "with a call of € 0.80/kg with a mechanism to avoid excessively regressive impact on national contributions".
- In Netherlands, businesses that use more than 50,000 kgs of single-use packaging material must pay a fee. The packaging industry use this money to finances collection and recycling.
- Polluter pays' principle also applies to plastic bags. Since 2016, retailers in the Netherlands are no longer allowed to give away free plastic bags; customers must either pay for one or take along their own bag. Research showed that the waste deriving from plastic bags was reduced by around 70%, after a year. Similarly, in UK, a 5p charge on each plastic bag has led to an 85% waste reduction within six months. In order to prevent plastic litter, taxing the plastic packaging that is most commonly found in the environment could be an effective measure.

The above-mentioned activities do require resources and proper legislation. The government must support investors and facilitate funding where necessary. The initial cost of investment will be higher due to acquiring the right technology, research, and equipping manpower with the right skills. Equally, policies and regulations enacted must be aimed at encouraging investors to embrace the circular model in the plastic industry.

6.1.3 Value Proposition

Adoption of the circular model in the Study Area can result in several positive outcomes ranging from environmental, social to economic benefits including reduction in pollution, conservation of natural resources, less energy consumption, and promoting the economy by creating jobs as shown in Figure 39.

Environmental Value Proposition

The proposed hybrid system of formal and informal waste collectors will aim to increase the plastic collection efficiency and thus reducing the amount of plastic leakage into the environment. Also, the use of recycled plastic reduces reliance on virgin raw materials, leading to reduced extraction of natural resources. In addition, the model ensures that the environment will be cleaner by curtailing the production and incinerating the non-biodegradable plastic in long term. Consequently, health problems associated with inhalation of polluted air (due to incinerating plastic waste) can be addressed. Furthermore, the recycling units which use renewable energy sources will result in clean and healthy environment by reducing emissions of GHGs and other poisonous gases.



Figure 39: Value Proposition of Circular Economy Model

⁹⁷ **Polluter's Pay Principle**: The basis of this principle is that someone is financially responsible for the elimination of the pollution they cause. The principle is used for allocating costs for pollution prevention and control measures to encourage rational use of scarce environmental resources and to avoid distortions in international trade and investment, as described by OECD.

Economic Value Proposition

The use of recycled plastic plays an important role in economy as the country has to spend less money on importation of virgin raw materials. The implementation of government's policies regarding the use of recycled plastic can create an economic incentive for local recyclable industries (which manufacture products from recycled materials). As it creates a closed loop system and thus assist in plastic waste management. Furthermore, the government would improve its revenue streams through taxes for managing non-recyclable plastic and by imposing fines to reluctant industries (those violating regulations and polluters pay principle) as discussed earlier.

TMA can also generate revenue by facilitating the informal sector by permitting and legalizing to collect solid waste from HH level. In this way, more business opportunities for other auxiliary players will be created, from waste pickers to transportation sector and ultimately to recycling industry/recyclers. Improved opportunities will eventually translate into economic growth and improved revenue streams for the municipality.

Social Value Proposition

The main social benefit associated with formal and informal waste recycling activities is the provision of employment or livelihood for poor households in rural and urban areas. It has been observed that children are being involved in scavenging activities in the Study Area. Government and NGOs/INGOs should work together for the betterment of the children involved in scavenging activities. The provision of protective gear among waste pickers combined with awareness raising on health and safety could be an optimum option, among others. NGOs/INGOs can play a key role as they can assist in providing education to child waste pickers. These child waste pickers can also be taught some skills directly related to the waste sector such as recycling techniques or the planning of collection routes. In this way, they can assist in waste management in a better way. Also, measures should be taken to dignify the work of waste pickers and change their status through registration, provision of IDs, badges, uniforms that can have positive effects on child labor, apart from the provision of personal protective equipment's (PPEs). It will increase their access to itinerant waste buyers (IWBs) in high income areas, which usually means an increase in income.

6.1.4 Customer Relation

Creating and maintaining productive relationships among various stakeholders is key to the success of the circular economy model as it involves local government, TMA, formal and informal sector, industries, NGOs/INGOs and the public/consumers.

The government can maintain relationship with other players in the circular model and consumers of plastic products through the formulation of regulations and policies dealing with solid waste management, in particular plastic waste. The government should offer attractive incentives to plastic manufacturers willing to embrace a circular business model. For example, the cost of disposing the waste in landfill or sanctions for illegal dumping needs to be higher than the cost of reusing and recycling in order to encourage optimal recycling.

Equally, policies and regulations should accommodate consumer of plastic products. Punitive legislations such as bans on non-recyclable products, may ultimately have undesired outcomes. It may lead to greater use of alternative that can increase the environmental footprint and still fail to address the root cause of the problem. Instead of banning, the government should introduce the schemes that promote the use of recyclable products such as wooden or reusable cutlery, switching to

water bottles and use of refill detergent/ shampoo bottles etc., and to engage customers' by giving them monetary benefits. Moreover, the legislators should ensure the enforcement/implementation of the policies or regulations. It can be achieved by deciding the type and extent of penalties that will be imposed for violating the ban or law. The penalties could vary from warnings, confiscation of banned products, fines etc. The regulation may further establish minimum and maximum penalties, which can be based on factors such as the nature and severity of the offense (i.e., possession versus production) and the offender (i.e., a small vendor versus a supermarket chain). Additionally, regulations may include a mechanism such as a toll-free phone number to allow the public to report violations of the ban. The model can only be successful if the public is well-educated and willing to participate in the process fully.

The government and plastic manufacturers should implement strategies to educate its customers (those who use plastic products) regarding the disposal of recyclable and non-recyclable plastic products. Also, any fears or concerns regarding the quality of plastic products which are being produced from recycled plastic, should be addressed fully by engaging INGOs/NGOs.

Another equally important relationship is between educational institutes and industries for the acquisition of required skills. The government, plastic industry, and educational institutions must prepare an effective road map for implementing research and development (R&D) in the circular business model.

6.1.5 Distribution Channel and Consumer Segment

Within the Study Area, Plastic manufacturing industries which are using virgin raw materials have their own distribution channels as they have established relationships with suppliers, wholesale dealers, and retail outlets that make their product reach to the consumers. In context to the usage of recycled plastic (as their raw material), the plastic manufacturers have reservations regarding the quality and acceptability by the customers. Besides, they are bound to follow the international standards for meeting the compliance requirement by maintaining the quality and/or standard of the product. Other barriers in its implementation are the lack of legislations/policies for using recycled plastic as alternative to virgin plastic raw materials along with the lack of knowledge about the properties of recycled materials among the manufacturers. Moreover, consumers often perceive that recycled products are of inferior quality and can cause health problems in comparison with the products which are being produced from virgin materials.

With an aim to manufacture a quality product from the recycled plastic instead of virgin raw material, there is a dire need to engage small industry along with local government, academic institutions, and INGOs/NGOs for the development of research-based prototype/solution. Afterwards, these products should be distributed locally (by targeting rural places, low-income areas, and informal settlements) by choosing simple distribution path to make their product reach to customers. For enhancing the acceptability of such products, it requires sustainable marketing techniques like by raising awareness among the customers and to educate them about the importance of the usage of recycled materials and how it could bring less harm to the environment and ultimately less harm to human health. This behavioral change could result in increased demand of such plastic products. If this model becomes successful, it can be adopted by large industries easily via using advanced distribution channels and by targeting large consumer markets.

6.1.6 Cost Structure and Revenue Streams

The proposed circular business model for the Study Area has different cost implications but it can be manageable if the identified stakeholders play their role in plastic waste management by assisting the municipality financially. The model is capital-intensive, but the expected benefits can outweigh the investment cost. Some of the expected costs related to the proposed circular model are stated below:

- 1. Research and Development (R&D) (see sub-section 6.1.1, for details)
- 2. Installation of Waste Bank Model (see sub-section 6.1.2, for details)
- 3. Installation of Recycling units (see sub-section 6.1.2, for details)
- 4. Baseline studies such as pilot tests (see sub-section 6.1.1 and 6.1.5, for details)
- 5. Introduction of new technology to treat non-recyclables (see sub-section 6.1.2, for details)

On the revenue side, the installation of waste bank model and recycling units will reduce the problems and cost associated with plastic waste management and will generate revenue for the municipality. Also, the use of recycled materials would be a cost-saving measure for the industries as otherwise, they have to import virgin raw materials. The detailed Benefit Cost Analysis of the Plastic Recycling Unit (Shredder) is described below:

Plastic Recycling Unit

As it has been mentioned in the previous sections, government and NGOs/INGOs should assist in setting up recycling units in the Study Area. In the proposed recycling unit, used PET bottles will be transformed into plastic flakes by using shredder. The shredder operates at a slower speed than a granulator, and the blade breaks the plastic down into smaller particles (flakes). These pieces are then collected, washed, and dried before being granulated and sent to manufacturers. In order to maintain the constant supply of raw material, colored and transparent PET bottles will be either brought from Waste Bank or from scrap dealers, directly. Details regarding the parameters which should be considered prior to the installation of shredder are presented in Table 18.



Table 18: Parameters of Recycling Unit (Shredder)

Benefit Cost Analysis (BCA)

BCA is the process used to measure the benefits of a decision or acting minus the costs associated with taking that action 98. A BCA involves measurable financial metrics such as revenue earned, or costs saved as a result of the decision to pursue a project. The costs involved in a BCA of the recycling unit includes the following:

Capital Expenditure (CAPEX) includes the cost of purchasing and installation of shredder, and

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Operational Expenditure (OPEX) includes electricity, overhead costs, land rent, utilities bills (electricity bill and water bill), labor charges, and cost associated with purchasing of raw material, drying, and washing of plastic flakes.

Distribution of CAPEX and OPEX along with estimated unit price is presented in Table 19 and summarized in Table 20.

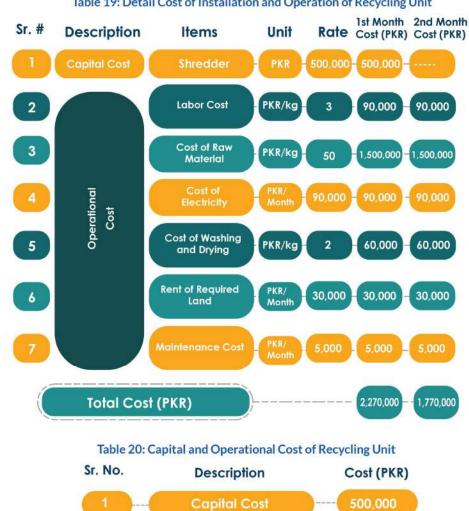


Table 19: Detail Cost of Installation and Operation of Recycling Unit

Revenue generation has also been calculated and projected considering 85% white PET bottles and 15% green PET bottles in one-ton raw material (plastic bottles) as presented in Table 21.

Operational Cost

1,770,000

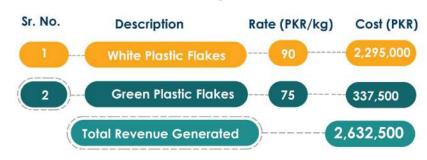


Table 21: Estimated revenue generation of PET bottles

⁹⁸ Hayes, A., (2021) Cost Benefit Analysis. [Online] Available at: https://www.investopedia.com/terms/c/cost-benefitanalysis.asp [Accessed 25 March 2021].

Benefit Cost Ratio (BCR)

BCR is basically the reciprocal of cost to benefit ratio (CBR) and it is important to know as it predicts weather we should go for the opportunity or not, based on numeric digits. Greater the value of BCR ratio, more the profit can be made from the opportunity on which the analysis is performed. Benefit to cost ratio for the proposed recycling unit (shredder) is calculated as:

Benefit to Cost Ratio (BCR)= (Revenue Generated)/(Tentative Total Cost)

BCR for 1st Month= (2,632,500 PKR)/(2,270,000 PKR) = 1.15

BCR for 2nd Month = (2,632,500 PKR)/(1,770,000 PKR) = 1.48

As BCR comes out to be greater than 1, it clearly predicts that the establishment of Recycling Unit within the Study Area is most likely to become a profitable business model.

Payback Period Calculation for the Recycling Unit

The payback period of the invested capital cost against the estimated net profit (PKR/month) has also been calculated which clearly depicts that the investment amount would be recovered after 35 days (by considering the forecasted assumptions as true). The calculations are as under:

Net Profit = Revenue Generated - Total Cost

Net profit generated in 1st Month = 2,632,500 - 2,270,000 = 362,500 PKR/month = 12,083.33 PKR/day

Net Profit Generated in 2nd Month = 2,632,500 - 1,770,000 =862,500 PKR/month = 28,750 PKR/day

Cost Recovered in the 1st month = 362,500 PKR/month

Remaining Cost (to be recovered) = Total Capital Cost - Net Profit Generated in 1st month

= 500,000 PKR - 362,500 PKR

= 137,500 PKR

Payback Period (days) = 30 days + ((137,500 PKR)/(28,750 PKR/Day)) = 30 days + 4.78 days = approx. 35 days

Payback Period = 35 Days



Chapter 07: Recommendations for Improving Existing Waste Management System

7 Recommendations for Improving Existing Waste Management System

For improving the existing solid waste management system, specifically plastic waste along with the implementation of circular economy model for plastic waste and its sustainable operation within the Study Area, following recommendations/suggestions have been formulated for different stakeholders.

7.1 Recommendations for Government and Relevant Institutes

Based on the findings of KIIs with ADCG, CO, and EPA representatives, it has been recommended that provincial government should take appropriate steps for devising guidelines or policies related to the effective management of MSW. Following recommendations have been proposed for provincial and local government to consider upon:

- Sustainable and effective management of MSW within the Study Area subject to presence of transfer station (TF), thus requiring a dedicated space for temporary waste storage and segregation of recyclables.
- Installation of weigh bridge at dumping site is highly recommended in order to know the daily collection efficiency of MSW.
- Tracking devices on vehicles should be installed on priority basis for monitoring the routes (from loading point to disposal site) and to minimize the illegal selling of MSW to brick kilns.
- Provincial government should devise a framework for the management and/or treatment of non-recyclable portion of MSW along with the strategy for promoting the reuse/recycle concept.
- Provincial government should take bold steps to develop legislation and policies related to municipal SWM on urgent basis by focusing how to limit the production of non-recyclable portion of solid waste along with its sustainable treatment strategies for implementation at the provincial and district level.
- 6. Provincial government should give mandate to TMA for hiring and allocating Sub-Divisional Officers (SDOs), and Sub-Engineers against each municipal service i.e., water supply, sanitation, and solid waste for an effective monitoring and sustainable operation of municipal services within the Study Area.
- 7. Provincial government should give authority to the local government or TMA for the hiring of staff (in particular supervisor and sanitary staff) against the vacant positions for improving the collection efficiency of MSW within the Study Area.
- 8. To conduct a baseline survey incorporating seasonal variations for investigating the current situation of SWM in the Study Area along with the upgradation and digitalization of existing assets management mechanism within the municipality.
- 9. It is highly recommended to give mandate to EPD for keeping strict check and balance/compliance regarding the non-recyclable plastic waste producers and to impose fines/penalties or to direct them for managing this waste via installing state-of the art incineration unit at disposal site.
- 10. Provincial government should formulate an effective mechanism and direct local bodies to levy service charges to meet the cost of SWM services and to make them self-sustained.

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Chapter 07: Recommendations for Improving Existing Waste Management System

- 11. TMA should develop an implementation plan for the collection of service fee from waste producers in order to limit/reduce the SW generation rates as it will ultimately reduce financial burden of local/provincial government.
- 12. TMA should engage, support, and promote informal sector for enhancing/improving the collection efficiency and sustainable management of solid waste, in particular plastic waste via effective engagement of scavengers and street waste pickers within the Study Area.
- 13. TMA should conduct basic training sessions and awareness programs for informal actors for the collection of recyclable and non-recyclable plastic waste.
- 14. TMA should educate the informal waste collectors regarding plastic recyclable collection strategies and aware them about potential recyclable plastic components.
- 15. Provincial government should initiate a program for the collection, sorting and selling of recyclable plastic waste by involving informal sectors and to make them as a part of municipality at district level.
- 16. TMA should take appropriate steps for establishing centralized and/or decentralized plastic waste recovery units at various locations within the Study Area for revenue generation.
- 17. It is highly recommended that local government should purchase a processing unit under Public Private Partnership (PPP) mode, for converting recyclable plastic waste into plastic flakes (shredded form) or in pellets which can be sold directly to potential plastic recycling industries for revenue generation.
- 18. Since major fraction of MSW is organic, therefore, in order to reduce the load on disposal sites as well as to consider it as a potential source of revenue generation. In this context, it is recommended to install small and decentralized composting units (as they have relatively simple operation & lesser maintenance requirement) in comparison with centralized and large capacity composting plants.
- Basic training sessions and counseling programs should be arranged by local government to improve environmental knowledge and for improving community's attitude towards plastic waste and to aware them in reducing and managing their household waste by their own.
 - TMA should promote 3R's (reduce, reuse, and recycle) concept in collaboration with educational institutions and other stakeholders at community level with an aim to significantly reduce the amount of waste to be disposed of at final disposal sites and for
- 21. reducing public health and environmental risks.
 - Two-bin concept for recyclables and non-recyclables waste collection systems should be promoted among children and women for the management of recyclable materials, in
- 22. particular plastic waste.

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For improving the prevailing plastic waste management within the Study Area and to make it plastic free by 2030, the municipality/local government should set the targets by 2030 to be achieved. Detail regarding the goals for making RYK as "Zero Free Plastic" is shown in Figure 40.

7.2 Synergy Development

During KIIs it was observed that there exists an inter-coordination gap (within organization) and intra-coordination gap (with other stakeholders, in particular with educational institutes, health department, and formal and informal sector). Hence, it is highly recommended to develop a coordination mechanism so that synergies can be developed among stakeholders for ensuring suitable and sustainable plastic waste management within the Study Area.

Synergy development among different stakeholders i.e., educational institutes (for conducting research on non-recyclable plastic fraction), industrial units (for providing financial assistance) and health department (for highlighting hotspot areas⁹⁹) in order to cope the prevailing problems and pollution being caused by an ineffective management of MSW within the Study Area.

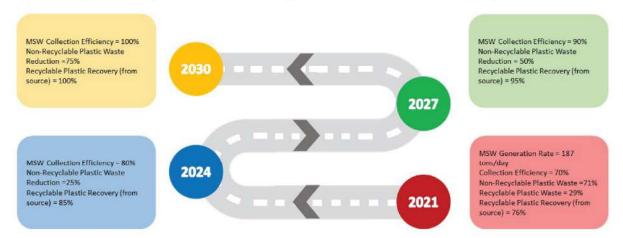


Figure 40: Proposed Roadmap for making RYK as Plastic Free City by 2030

7.2.1 Formal & Informal Sector

It is recommended to Municipality/TMA should engage informal waste pickers under work contract along with formal sanitary staff to carry out waste collection and disposal activities. Moreover, public-private partnerships should be encouraged for ensuring the effective solid waste management through handling, transport, recovery, and disposal of materials. In the Study Area, it was observed that the sanitary staff often separate plastic recyclables during waste collection, but they were not able to achieve high recycling rates (in terms of kg/day) as they have to collect and transport commingled MSW from their working areas/beats. The informal sector, on the contrary, primarily works on recovery and recycling of valuable recyclables (like plastic materials) only and hence collect reasonable number of recyclables (in kg/day) in comparison with sanitary workers. Thus, deeming an efficient coordination between formal and informal sector for recovering maximum valuable plastic material, achieving recycling targets and ultimately can save valuable landfill space.

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7.2.2 Role of Academia and Industries

Educational institutes can play an important role in sustainable management of plastic waste. It was revealed during the study that academic institute (KFUEIT) has enough technical expertise and competent staff for providing low cost and eco-friendly solutions in context to the ban on single-use plastic as well as on non-recyclable plastic waste. In this regard, industrial units in particular, plastic product manufacturers should play their role in providing financial assistance to educational institutes under Corporate Social Responsibility (CSR) program for conducting the above-mentioned goal-oriented research projects.

7.3 Role of INGOs/NGOs

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Based on the study findings, it can be concluded that current plastic waste management system is inefficient and adversely affecting the public, environment, and the economy. Therefore, an effective and sustainable plastic waste management strategy should be formulated at earliest via engaging INGOs/NGOs for providing technical and financial assistance to the local government in following ways:

- To conduct baseline and assessment studies to bridge the existing information gap, facilitates in developing policies, and in building/enhancing institutional capacity within governmental departments. Most importantly, INGOs/NGOs should assist the educational institutes in carrying out research to find a suitable and sustainable alternative to replace the non-recyclable plastic packaging and to propose a suitable technology for treating the non-recyclable plastic waste as well.
- 2. As there is no landfill site in the Study Area, the major portion of the collected waste is being dumped rather than properly landfilled. Thus, INGOs/NGOs should technically and financially aid the municipality in constructing an engineered landfill site. As it allows the safe disposal of non-recyclable waste by protecting the public health, preserving the key environmental resources and reduces the green-house gas (GHG) emissions.
- 3. To assist the local government in devising a framework that integrates the informal sector with formal sector resulting in the increased manpower for the collection of solid waste.
- 4. For developing awareness, environmental INGOs/NGOs should support the local government for organizing awareness sessions, door-to-door awareness programs, seminars, etc. in spreading awareness among the citizens and by educating children at schools and reaching out to corporate offices and households. These awareness campaigns will contribute towards bridging the knowledge gap regarding safe disposal of plastic waste and changing the attitudes and perception of people to minimize the usage of single use plastic items. In order to make the awareness campaigns effective, INGOs/NGOs should also demonstrate the implementation of waste management strategies and via choosing the appropriate mode of communication depending upon target audience as shown in Figure 41.

⁹⁹ Areas having relative a greater number of people suffering from waste related diseases.

Chapter 07: Recommendations for Improving Existing Waste Management System

Figure 41: Means of Communication for raising awareness

- 5. It is highly recommended that INGOs/NGOs should provide motorized equipment's/fast moving machinery/vehicles as an alternative to hand driven trolleys for improving the collection efficiency of MSW within the Study Area.
- 6. Different training sessions like technical training of sanitary and supervisory staff by including TMA's top management followed by refresher trainings and Training of Trainers (TOTs) on regular basis are highly recommended to be arranged and sponsored by INGOs/NGOs for capacity building among human resources.

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Annexure A: Scope of work

Annexure A: Scope of work

The scope of work can be broadly classified into two phases:

Phase I - Design of Research Methodology

The proposed research methodology for the baseline study should comprise of:

- i. Overall approach for measuring the plastic waste generated and methodology with the relevant and statistically appropriate sampling frame
- ii. Collection of qualitative data through key informant interviews (KII) and/or focus group discussions (FGDs) or other available digital tools. Explain the rationale for choosing the specific data collection tool(s)
- iii. In addition to qualitative data, the baseline should also gather quantitative data from primary and secondary research study and surveys which should reveal the following baseline metrics for Rahim Yar Khan:
- a) Total plastic waste generated (tonnage)
- b) Plastic waste collection (tonnage)
- c) Plastic waste collection gap (tonnage)
- d) Type of Plastic Waste generated
- e) Segregation pattern of plastic waste (at source/at time of collection or at the site of trash can etc.)
- f) Need of transfer station in the city
- g) Plastic waste generated (tonnage) by each segment of stakeholders from various socioeconomic categories
- h) Chain of Plastic waste from waste pickers to concerned industries which recycles/reuse plastic waste in one form or other
- i) Plastic waste been dumped at the dump site (tonnage)
- j) Propose a sampling frame
- k) Propose appropriate sample size; the sample will be comprising of all stakeholders from various socio-economic categories such as households, shops; commercial establishments, hospitals, schools, government offices, factories, etc. of all sizes like small, medium, and large
- l) The categorization of various stakeholders along the value chain, small and big ragman/junk dealer; waste pickers; either regulated or un- regulated
- v. The baseline should include:

- a. The categorization, scale, and scope of various recyclers; recycling companies (small or big; to be categorized in terms of recycle plant specifications), especially the plastic waste
- b. What kind of products are being produced by the existing recyclers and what financial model is the most suitable for the city managers.
- c. What factors are to be considered to assess the financial viability of the small-scale recycling plants, keeping in mind the waste generation capacity of the selected locations
- Analyze possible enterprise options for the stakeholders like waste pickers, individually or as group, through interviews, discussions with waste pickers, with particular focus on gender (including third sex) and youth

Annexure A: Scope of work

- Analyze the available solutions of low-cost eco-friendly products such as biodegradable bags and or other products developed from recycled plastic that can be produced on mass scale
- Assess the manufacturer awareness and the availability of the alternates of the polythene bags such as oxy-biodegradable bags
- Provide valuable insights into the nature and effort of recovery of post-consumer plastics
- Develop the sampling frame to include the sampling methodology, tools, and technology to be used for collection of primary and secondary data sources
- v. Implementation guidelines including detailed checklist and detailed questionnaire and ethical concerns in a more stakeholder's participatory manner
- vi. Undertake high quality photography of the existing works undertaken, collection points, recovery centers (if any), landfill sites, disposal methodology and patterns. Small videos and audio interviews of all stakeholders included in value-chain. This will help to draw out conclusions to frame proper collection methods; and
- vii. Detailed work plan and implementation milestones for the baseline study

Phase II - Data Collection and Assessment

The second phase comprises of baseline data collection and analysis, which includes

- i. Research on the availability of recycling plants at local and national level, their specification details, cost details, capacity, and capability efficiency to recycle plastic waste and provide analysis of the most feasible option at each proposed geographic location.
- ii. Baseline measurement for a period of at least 4 weeks in each of the cities/area. The baseline information collection questionnaire will be used after the approval of the Client and would also contain photographic/audio/video evidence.

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Annexure B: Plastic types in term of number code 1 to 7

Annexure B: Plastic types in term of number code 1 to 7

- Code 1: Polyethylene Terephthalate (PETE or PET): Water bottles, soft drinks, juice, handwash, mouthwash, sports drinks, and condiments
- Code 2: High-Density Polyethylene (HDPE): Shampoo bottles, cosmetic products, bleach bottles, automobile cans, detergent bottles, geometry boxes, tubs, baby pots, broken chairs, and tables.
- Code 3: Polyvinyl Chloride (PVC): Shevel pipes (wiring), PVC pipes
- Code 4: Low-Density Polyethylene (LDPE): Samika shoppers, plastic wrappers, bread bags
- Code 5: Polypropylene (PP): Bottle tops, drinking straw

- Code 6: Polystyrene or Styrofoam (PS): Disposable foam cups, take-out food containers, egg cartons, foam packaging, charger casings, and TV casings
- Code 7: Miscellaneous plastics: ketchup and shampoo sachets

Annexure C: Pictorial view of waste sampling and quantification from residential area





Step 1: Marking of houses and distribution of waste bags





Step 2: Collection and transportation of waste bags





Step 3: Unloading of waste bags on trampoline sheet





Step 4: Segregation of recyclable/non-recyclable plastic components





Step 5: Weighing of recyclable/non-recyclable plastic components

Annexure D: Pictorial view of waste sampling and quantification from communal points





Step 1: Collection and weighing of sample





Step 2: Quartering of collected sample on trampoline sheet





Step 3: Segregation of plastic components





Step 4: Weighing of recyclable/non-recyclable plastic components

Annexures E: Pictorial view of waste sampling and quantification from dump site (Madina Colony, Mou e Mubarak)





Step 1: Collection and weighing of sample





Step 2: Quartering of collected sample on trampoline sheet





Step 3: Segregation of plastic components





Step 4: Weighing of recyclable/non-recyclable plastic components

Annexure F: (a) Pictorial view of KIIs with ADCG, CO, DD EPD, and representatives from KFUIET and recycling industrial units (informal sector)



KII with ADCG



KII with CO, MC (RYK)



KII with DD EPD (RYK)



KII with Assist. Prof (KFUEIT)



KII with Plant Manager (UNILEVER)



KII with Recycler Unit Owner



KII with Owner (Recycler Plant)

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KII with Owner (Manufacturer Unit)

Annexure F: (b) Pictorial view of KIIs with sanitary supervisors

















Annexure F: (c) Pictorial view of KIIs with sanitary workers

















Annexure F: (d) Pictorial view of KIIs with junk dealers

















Annexure F: (e) Pictorial view of KIIs with scavengers

















Annexures G: Questionnaire for conducting KII with ADCG

Annexures G: Questionnaire for conducting KII with ADCG

Project Title: "Baseline Assessment of Current Scenarios of Plastic Waste Management for Rahim Yar Khan (RYK) City"

Questionnaire Develor	pment for Additional	Deputy	y Commissioner	General
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1.	Name:				P.	
2.	Contact #	(optional):				
3.	Email Id:					
4.	From how	many yea	rs you are working	as DC in RYK?		
5.	How many	/ planned/	unplanned UCs are	e there in your juris	sdiction?	
		Sr. No.	Planned/Unplan	ned Level	Number	٦
		1.	Planned	District	114111201	-
		2.	Unplanned	District		-
		3.	Planned	RYK City		-
		4.	Unplanned	RYK City		
6.	Are you sa	itisfied wit	n the existing Mun	nicipal Solid Waste	(MSW) services? (Y/N)	
7.	If no, enlis	t the majo	r bottlenecks and	your strategy to ta	ckle these limitations?	
_	D		-1			
8.	Do you ha	ve an idea	about the waste c	ollection and gene	ration of MSW at district	and city level?
8.	Do you ha	ve an idea Leve	-	collection and gene	ration of MSW at district Quantity (kg/day)	and city level?
8.	Do you ha		-	rated/Collected	1	and city level?
8.	Do you ha	Leve	el Gener	rated/Collected red	1	and city level?
8.	Do you ha	Lev e	Generat	rated/Collected red	1	and city level?
8.	Do you ha	Leve District District	Generat Collecte	rated/Collected red d	1	and city level?
		District District RYK City RYK City	Generat Collecte Generat Collecte	rated/Collected red d	Quantity (kg/day)	and city level?
		District District RYK City RYK City	Generat Collecte Generat Collecte	rated/Collected red d red	Quantity (kg/day)	and city level?
9.	How much	District District RYK City RYK City annual bu	Generat Collecte Generat Collecte Collecte udget has been allo	rated/Collected ded d ced d cocated for MSW materials	Quantity (kg/day) anagement?	and city level?
9.	How much	District District RYK City RYK City annual but	Generat Collecte Generat Collecte Collecte udget has been allo	rated/Collected ded d ced d ocated for MSW materials and the sufficient? (Y/N)	Quantity (kg/day) anagement?	and city level?
9.	How much	District District RYK City RYK City annual but	Generat Collecte Generat Collecte Collecte udget has been allo	rated/Collected ded d ced d ocated for MSW materials and the sufficient? (Y/N)	Quantity (kg/day) anagement?	and city level?
9.	How much	District District RYK City RYK City annual but	Generat Collecte Generat Collecte Collecte udget has been allo	rated/Collected ded d ced d ocated for MSW materials and the sufficient? (Y/N)	Quantity (kg/day) anagement?	and city level?
9.	How much Do you th If no, hov	District District RYK City RYK City annual but	Generat Collecte Generat Collecte Collecte udget has been allo ne allocated budge ore budget is requi	rated/Collected ded d ced d ocated for MSW materials and the sufficient? (Y/N)	Quantity (kg/day) anagement? N) the existing services?	and city level?
9. 10 11	How much Do you th If no, hov	District District RYK City RYK City annual but nink that they much mo	Generat Collecte Generat Collecte Collecte udget has been allo ne allocated budge ore budget is requi	rated/Collected ded d ced d ocated for MSW m et is sufficient? (Y/N red for improving t d to municipalities	Quantity (kg/day) anagement? N) the existing services? ? (Y/N)	and city level?
9. 10 11	How much Do you th If no, hov	District District RYK City RYK City annual but nink that they much mo	Generat Collecte Generat Collecte Collecte udget has been allo ne allocated budge ore budget is requi	rated/Collected ded d ced d ocated for MSW materials and the sufficient? (Y/N) red for improving the sufficient of	Quantity (kg/day) anagement? N) the existing services? ? (Y/N)	and city level?
9. 10 11 12	How much Do you th If no, hov Is the allo	District District RYK City RYK City n annual but nink that the v much mo	Generat Collecte Generat Collecte Generat Collecte udget has been allo ne allocated budge ore budget is requi get timely released major reasons? And	rated/Collected ded d ced d ocated for MSW m et is sufficient? (Y/N red for improving t d to municipalities	Quantity (kg/day) anagement? N) the existing services? ? (Y/N) nis situation?	and city level?

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Annexures G: Questionnaire for conducting KII with ADCG

INFORMATION REGARDING LAWS/REGULATION

15. Did the municipality ever requested for regulations or special orders from DC regarding MSW
management? (Y/N) 16. If yes, give the details?
17. Do you have any idea regarding the expense on the collection and transportation of MSW?
18. If yes, tell us about the approx. cost (in PKR/ton)?
19. Have you ever engaged technical personnel for devising a strategy to reduce the incurred cost (for managing MSW)? (Y/N)
20. In your opinion, what are the major constraints in approval of "Draft Guidelines for SWM" and
how it affects the existing system?
21. How the above mentioned "Draft Legislation" would assist them in future?
22. Have your team ever worked or is working in transforming informal stakeholders into formal
sector? (Y/N)
23. If yes, share the details?
24. If no, what are the major reasons?
25. Are you planning to formulate laws/guidelines specifically on solid waste management at district
level? (Y/N)
26. If yes, share the details?
27. If no, what are the major reasons?
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IN ndustries are op Sr. No. 1. 2. 3. 4. 5. 6. dustries use virg Sr. No. 1. 2. 3. er engaged industry (CSR)? (Y/N)	Level District District RYK City RYK City RYK City RYK City Origin Raw mate Both (raw	Category Small Medium Large Small Medium Large d or both material erial + virgin)	Number aterial as the	details Rationale heir raw mat		
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2. 3. 4. 5. 6. Sr. No. 1. 2. 3. er engaged index	District District RYK City RYK City RYK City gin, recycled Type of Virgin Raw mate Both (raw	Medium Large Small Medium Large d or both material erial + virgin)	al r	Number		
3. 4. 5. 6. Sr. No. 1. 2. 3. er engaged index	District RYK City RYK City RYK City gin, recycled Type of Virgin Raw mate Both (raw	Large Small Medium Large d or both material erial + virgin)	al r	Number		
4. 5. 6. Sr. No. 1. 2. 3. er engaged index	RYK City RYK City RYK City gin, recycled Type of Virgin Raw mate Both (raw	Small Medium Large d or both material erial + virgin)	al r	Number		
5. 6. Sr. No. 1. 2. 3. er engaged index	RYK City RYK City gin, recycled Type of Virgin Raw mate Both (raw	Medium Large d or both material erial + virgin)	al r	Number		
6. Sr. No. 1. 2. 3. er engaged inde	RYK City gin, recycled Type of Virgin Raw mate Both (raw	Large d or both material erial + virgin)	al r	Number		
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er engaged indu		1 1-10/1 -10 /10/1-10	research	as a part of		
	ustries for	investing in	research	as a part of		
about it?						
on how importa	57A5 V		inkage is (v	with respect	to managi	ing MSW) and
			5.1 15.1		in your ju	risdiction? Or
our views on circ	ular econoi	my regardin	g plastic w	aste manage	ement (in p	particular)?
		n/incentive	to the in	dustries tha	nt recycle	waste/plastic
eam ensures that	t the indust	tries are foll	owing the	regulations?		
t	kages can be st	kages can be strengthened t plastic waste recycling, he se factors which contribute ur views on circular econor ing any support/relaxations, in which form?	kages can be strengthened? t plastic waste recycling, how can this se factors which contribute the most in ur views on circular economy regardining any support/relaxation/incentives, in which form?	kages can be strengthened? t plastic waste recycling, how can this practice be see factors which contribute the most in this regardur views on circular economy regarding plastic wing any support/relaxation/incentive to the ins, in which form?	kages can be strengthened? t plastic waste recycling, how can this practice be enhanced se factors which contribute the most in this regard? ur views on circular economy regarding plastic waste manage ing any support/relaxation/incentive to the industries thats, in which form?	kages can be strengthened? It plastic waste recycling, how can this practice be enhanced in your justed factors which contribute the most in this regard? The plastic waste recycling in this regard? The plastic waste management (in plastic waste management) The plastic waste management (in plastic waste management)

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Anr	nexures G: Questionnaire for conducting KII with ADCG	
37.	How frequently you monitor that whether industries are complying with the laws?	
38.	What is your policy for those who violates the laws/regulation?	
	Do you have policies for single use plastic product manufacturing industries? (Y/N) If yes, what steps or support are you providing or willing to provide to support these cut short the use of plastics?	industries to
	cut short the use of plastics:	
	INFORMATION REGARDING AWARENESS	
41.	What alternate options are you considering against the polyethylene bags?	
42.	What is public point of view about the ban of using polyethylene bags?	
43.	What are the effective means for creating awareness among local people in this reg	ard?
44.	Apart from the usage of polyethylene bags, what is your opinion regarding source so	egregation?
45.	Do you think, it can be implemented within your jurisdiction? (Y/N)	
46.	If yes, what more resources (in terms on money, time, and resources) are required?	
	If no, what are the major bottlenecks?	
4/.	ii iio, what are the major botherecks:	
48.	Tell us about the budget allocation for the awareness campaigns?	

Tor e	ffective awarer				
Does	your team hav	e plan regarding awareness camp	aign? (Y/N)		
1. If yes	, give details:		.=0 (4042 140		
	Sr. No.	Awareness campaign	Location	Audience	
	1.				
	3.				
	4.				
		CENEDAL COMME	·		
		GENERAL COMME	NIS		
2. In wh	nat ways, waste	e segregation at Household (HH) le	vel can be ensured	1?	
3 In vo	ur oninion wh	at is the most effective strategy fo	r formalizing the in	oformal stakeho	olders
	ui opinion, wii	at is the inost effective strategy to	I TOTTINGITZINE LITE II	HUHHAI STAKEH	Jucis
11100	sing in view the				
(keep	oing in view the	e demographics of RYK City and att			
	Pro-10 De Hinto Salta velos acessos	e demographics of RYK City and att	itude of stakehold		
	Pro-10 De Hinto Salta velos acessos		itude of stakehold		
	Annual State Control of the Control	e demographics of RYK City and att	itude of stakehold		
4. How	to make MSW	e demographics of RYK City and att	itude of stakehold in department?	ers)?	
4. How	to make MSW willing you are	e demographics of RYK City and att	itude of stakehold in department? non-recyclable po	ers)?	
4. How	to make MSW willing you are	e demographics of RYK City and attended to the management a revenue generation to invest on research regarding	itude of stakehold in department? non-recyclable po	ers)?	
4. How	to make MSW willing you are	e demographics of RYK City and attended to the management a revenue generation to invest on research regarding	itude of stakehold in department? non-recyclable po	ers)?	
4. How 5. How parti	to make MSW willing you are cular after cons	e demographics of RYK City and attended to the management a revenue generation to invest on research regarding	itude of stakehold in department? non-recyclable po	ers)?	c waste in Hav
4. How 5. How parti e you	to make MSW willing you are cular after cons	e demographics of RYK City and attended attended and attended and attended attended and attended attend	itude of stakehold in department? non-recyclable po	ers)?	c waste in Hav
4. How 5. How parti e you	to make MSW willing you are cular after cons	e demographics of RYK City and attended to management a revenue generation to invest on research regarding sulting research institutes or university to initiate research.	itude of stakehold in department? non-recyclable po	ers)?	c waste in Hav
4. How 5. How parti e you	to make MSW willing you are cular after cons	e demographics of RYK City and attended to management a revenue generation to invest on research regarding sulting research institutes or university to initiate research.	itude of stakehold in department? non-recyclable po	ers)?	c waste in Hav
4. How parti	to make MSW willing you are cular after cons	e demographics of RYK City and attended to management a revenue generation to invest on research regarding sulting research institutes or university to initiate research.	n department? non-recyclable porsities?	ers)? ortion of plastic	c waste inHav scale up at
4. How parti	to make MSW willing you are cular after cons	e demographics of RYK City and attended to invest on research regarding sulting research institutes or univerthe municipality to initiate research opportunities)?	n department? non-recyclable porsities?	ers)? ortion of plastic	c waste inHav scale up at
4. How 5. How parti e you local for Are y regain	to make MSW willing you are cular after cons	e demographics of RYK City and attended to management a revenue generation to invest on research regarding sulting research institutes or univertient the municipality to initiate research tion opportunities)?	n department? non-recyclable porsities?	ers)? ortion of plastic	c waste inHav scale up at

Annexures G: Questionnaire for conducting KII with ADCG

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Annexures H: Questionnaire for conducting KII with CO

generation rates?

Annexures H: Questionnaire for conducting KII with CO, MC (RYK)

Project Title: "Baseline Assessment of Current Scenarios of Plastic Waste Management for Rahim Yar Khan (RYK) City"

Questionnaire Development for CO, MC (RYK)

1.	Name:			
2.	Contact # (if any):	_		
3.	Socio-economic categorization of UCs (of RYK City) based on property prices	or	solid	waste

Sr. No.	UC# /Name	Socio- economic Type	Income Based	Plot Rate Based	Based on SW Generation Rate	Planned/Unplanned
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						

STAFF AND FLEET DETAILS

4. Staff detail which are being deployed for collection & transportation of Municipal Solid Waste (MSW) within RYK City?

Staff Type	Number
Chief Sanitary Supervisor	
Sanitary Supervisor	
Sanitary Workers	
Others	
	Chief Sanitary Supervisor Sanitary Supervisor Sanitary Workers

5. Equipment/Machinery details which are currently used in RYK City?

Sr. No.	Equipment/Machinery	Number	Capacity
1.			
2.			
3.			
4.			
5.			
6.			

Annexures H: Questionnaire for conducting KII with CO

7. Is the public aware about the two-bin concept? (Y/N)

6. How many more HR and equipment are required for improving the services at City Level?

Sr. No.	HR/Equipment	Number
1.		
2.		
3.		
4.		
5.		

DETAILS REGARDING MSW MANAGEMENT

8.	If yes, does the public segregate waste at point of source? (Y/N)
9.	If yes, are the segregated Solid Waste (SW) components collected from the RYK City? (Y/N)

10. If yes, are the segregated bins (wet and dry waste) provided/installed within RYK City?

11.	Is there any campaign conducted by the municipality for the awareness of public in this regard?				
	If yes, at what level, frequency etc.?				
					

12. If segregated waste is collected, then talk about the collection frequency of various components of MSW i.e., plastic, metals, glass, paper, etc.?

Sr. No.	Component of MSW	Collection frequency
1.		
2.		
3.		
4.		
5.		
6.		

13. How much Solid Waste (SW) is being generated and collected at RYK City?

Sr. No.	SW Generation/Collection	Quaintly (kg/day)
1.	Generation	
2.	Collection	
3.	Efficiency (%age)	

14.	How much recyclable and non-recyclable plastic (in % age) is present within commingled MSW

15.	How much amount (in PKR/annum) approx. is being spent against managing SW of RYK City?

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Annexures H: Questionnaire for conducti	ng K	KII with (O
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- 16. Does the municipality charge for SW services? (Y/N)
- 17. If yes, approx. how much the municipality charge at household (HH) level on monthly basis?

18. Has the municipality ever worked in calculating tariff rates for effective management of MSW? (Y/N)

19. If No, then how to improve existing MSW services within RYK without asking for additional subsidiary/amount from provincial government?

20. Are you aware of any private firm(s) providing waste management services or transforming waste (particularly plastic) into useful products within the city:

Sr. No.	Name of the firm	Services offering	For how long they are working?	Address/Location	Licensed/Non- Licensed
1.					
2.					
3.					
4.					
5.					

21. Approx. total number of Streets/Households/Shops/Clinics or Hospitals within RYK City (responsible for):

Sr. No.	Category	Numbers	Approx. quantity of plastic waste generated (kg/day or %age)
1.	Streets		
2.	Households (HHs)		
3.	Shops		
4.	Clinics/Hospitals		
5.	Educational Institutes		
6.	Industries/Factories		
7.			
8.			
9.			

INFORMATION ABOUT SCRAP DEALERS

22. Details regarding Scrap Dealer which are being operational within the RYK City?

Sr. No.	Business Name & Type	Registered (Yes/No)	, , ,	Address/Location	Comment
1.					
2.					

Annexures H: Questionnaire for conducting KII with CO

3.			
4.			
5.			
6.			

INFORMATION ABOUT INDUSTRIES

23. Enlist Industries that use recyclables (particularly plastic) within RYK?

Sr. No.	Type of Industry & Name	Tehsil/City Level	Category (small, medium, large)	Location/Address
1.				
2.				
3.				
4.				
5.				
6.				

24. Which informal commercial units buy recyclables from the scrap dealers for making useful products? (Record their address)

Sr. No.	Commercial Unit Type	Quantity of recyclables purchased	Name of transformed materials/products

INFORMATION ON SCAVENGERS

25. Approx. number of scavengers which are operating within RYK?

Sr No	Number of scavengers	Level		
1.		Tehsil		
2.		City		
3.		Per UC		

26.	Has the municipality ever worked for including scavengers into their existing setup for improving
	MSW services? (Y/N)

27.	If yes,	kindly share the	necessary deta	ils and bottle	enecks for its	s implementation?
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	INFORMATION ON SEGREGATED WASTE COMPONENTS
	Do the sanitary workers segregate recyclables (particularly plastic) during their duty timings? Y/N If yes, then tell us about the main reasons which compel them in doing so?
31.	Does the municipality have the idea about the worth/selling value of segregated components? Sr. No. Type of Segregated Component of MSW Rate
	(PKR/kg)
	INFORMATION ABOUT POLYETHYLENE BAGS
32.	How polyethylene bags effect sanitation system at Tehsil & City Level? And how to overcome this issue?
33.	What steps the municipality has taken for implementing the initiative of "BANNING OF PLASTIC
	BAG"?
34.	What alternatives is the municipality providing against the polyethylene bags?

Annexures H: Questionnaire for conducting KII with CO

Annexures H: Questionnaire for conducting KII with CO

INFORMATION ON COMPLAINT MANAGEMENT SYSTEM

- 37. Does the municipality have a complaint management system (Y/N)?
- 38. Approx. number of complaints received per month

Sr. No.	Platform	Number
1.	Through PM Portal	
2.	General/Direct	

39. D	es the	complaint	resolution	mechanism	exist?	(Y)	/N
-------	--------	-----------	------------	-----------	--------	-----	----

,	, what is the	evinering inter				
12 17			 	 <u> </u>	10) 25 <u>(1)</u>	- 0

41.	. If No, now the municipality solves the lodged complaint?									

42. Generally what type of complaints, the municipality receives and the recommended resolving duration against the complaint type?

Sr. No.	Type of complaint	Resolving duration
1.		
2.		
3.		
4.		

INFORMATION ON TRANSFER STATION/LANDFILL SITE (TS/LF)

43. Total Number of TS at RYK?

Sr. No.	Tehsil/City Level	Number of TS	Location	Capacity/size
1.				
2.				
3.				
4.				

44. For how long the waste is kept at the Transfer stations (TS) and how many fleets are used for transporting waste?

Sr. No.	Name of TS	Location	Duration	Fleet regarding info (HR, Vehicle type and Number)
1.				
2.				
3.				
4.				

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Annexures H	H: Questionnaire	for conducting	KII with CO
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5.										
5. Tot	al number o	f Dumping s	ites (DS)/La	ndfills (LF	:)?					
Sr. No	o. Tehsil/	city Level	Number o	of DS/LF	Loca	tion	Сар	acity/size	Life S	Span (yrs.)
1.								•		
2.										
3.										
4.										
6. Sta	ff and Fleet	operating at	DS/LF and	amount o	f solid	waste	bein	g dumped o	n daily	basis?
Sr.	Name of	Location	Type of	Fleet (S	taff +	Num	ber	Solid was	ite	Boundary
No.	DS/LF		LF/DS	Machin	- 8			dumpe	20	Wall
	101							(ton/day	y)	(Y/N)
1.										
2.										
3.										
4.			<u></u>			,				
5.										
6.										
9. Hov	w much expe	her finances	you need fo	or the ma	nagem	ent of	f TS ar	nd LF?	e for ne	
	Sr. No.	1	S/LF			Locati	ion		Area	
	1.									
	2.									-
	3.									
	4.									
	5.									

Sr. No.	TS/LF	Location	Area
1.			
2.			
3.			
4.			
5.			
6.			

- 51. Does separate compartment/cells exists in TS/LF for segregated waste? (Y/N)
- 52. If yes, in which categories the waste is segregated:

Sr. No.	Categories
1.	
2.	

Annovuros	ш.	Questionnaire	for conductin	a KII with CO
Annexures	н:	Questionnaire	for conductin	g Kii With CO

3.	
4.	
5.	

53.	What issues do the municipality face regarding the management of TS/LF?

INFORMATION ON RECYCLED PRODUCTS

54. Pen down the views of the interviewee about the recovery of post-consumer plastics (shredden)	ers,
vending machines, Refuse Derived Fuel (RDF), etc.)?	
55. How much budget (max.) can the municipality allocate or invest in this regard?	

LEGISLATIVE REGARDING QUESTIONS

ELGISLATIVE REGARDING QUESTIONS
56. Are there any existing laws/regulations for managing the waste management system in the city?
(Y/N)
57. If yes, kindly share the details?
58. Has the municipality ever worked previously or working in making these regulations/laws?
59. Does the municipality require any technical assistance from EPA or any other department or
professionals in this regard? (Y/N)
60. If yes, kindly enlist those requirements?

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Annexure	s H: Questio	nnaire for cor	nducting	KII	with CO					
	there any ations/laws?		faced	by	municipality	in	making	or	implementing	these
62. If yes,	what are th	iose?								
8	11-0-3									
	41 - XX - 40	XI 40 - 51 - 14 - 15 - 15 - 15 - 15 - 15 - 15	20. 05		1 19 10 10	2/	3-7-0:	22	<u> </u>	
			GEN	IER/	AL QUESTIONS	ì				

	GENERAL QUESTIONS	
63. V	What is the ultimate fate of non-recyclables which are present in commingled MSW?	
64. Is	s there any plan for making informal system into formal?	
	Does the Micro-plan/management of sanitary workers exist? Y/N. f yes, kindly share the details:	
	Does the municipality maintain records of the amount of waste being collected and training monthly basis?	nspoi
	s the municipality working or planning to work on waste processing (energy recover, etc.	.) rela
	Which type of technology would be feasible and can easily be implemented in RYK foorocessing in your opinion?	or wa

Annexures H: Questionnaire for conducting KII with CO
70. Is there any resource shortage faced by municipality in collecting and transporting MSW?
71. In what ways, plastic waste recycling can be improved in your area and how to make informal dealers' part of the existing system?
72. Any additional comments or suggestions of interviewee?

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Annexures I: Questionnaire for conducting KII with EPD's representative

Annexures I: Questionnaire for conducting KII with EPD's representative

Project Title: "Baseline Assessment of Current Scenarios of Plastic Waste Management for Rahim Yar Khan (RYK) City"

Questionnaire Development for Environmental Protection Department (EPD)

1.	Name:
2.	Contact # (optional):
3.	Email Id:
4	Designations

INFORMATION REGARDING INDUSTRIES

5. How many licensed and non-licensed industries are operating within study area?

Licensed/Non-Licensed	Number
Licensed	
Non-Licensed	

6. To how many industries have you given NOCs/permit for construction phase (in last year):

Category	Number
(Small, Medium, Large)	
Small	
Medium	
Large	
Others	

7. To how many industries have you given NOCs/permit for operational phase (in last year):

Category	Number
(Small, Medium, Large)	
Small	
Medium	
Large	
Others	

8. Are you aware of different type of industries that generate huge amount of solid waste (particularly plastic)? (Y/N)

Annexures I: Questionnaire for conducting KII with EPD's representative

9. If yes, give details:

Sr. No.	Nature of industry	Type of waste generate	Quantity (kg/month)	Licensed/Non-Licensed
1.				
2.				
3.				
4.				
5.				

10. Are there any laws/regulation/guidelines regarding the solid waste? (Y/N) 11. If yes, give details: 12. If the answer to above is question is 'no', is EPD planning to formulate laws specifically on s waste management? (Y/N) 13. If the answer to above question is yes, share details: 14. If no, what are the constraints? 15. Is EPD giving any incentives to the industries that recycle waste or generates relatively les amount of waste? (Y/N). 16. If yes, in which form and enlist those industries' names and addresses? 17. If no, does EPD impose fines to offenders? (Y/N) 18. If yes, give details: Sr. No. Name of the offender Fine imposed		INFORMATION	REGARDING LA	WS/REGULATIO	N		
12. If the answer to above is question is 'no', is EPD planning to formulate laws specifically on s waste management? (Y/N) 13. If the answer to above question is yes, share details: 14. If no, what are the constraints? 15. Is EPD giving any incentives to the industries that recycle waste or generates relatively less amount of waste? (Y/N). 16. If yes, in which form and enlist those industries' names and addresses? 17. If no, does EPD impose fines to offenders? (Y/N) 18. If yes, give details: Sr. No. Name of the offender Fine imposed 1. 2.	lO. Are there any	laws/regulation/guideli	ines regarding th	ne solid waste? (Y/N)		
waste management? (Y/N) 13. If the answer to above question is yes, share details: 14. If no, what are the constraints? 15. Is EPD giving any incentives to the industries that recycle waste or generates relatively less amount of waste? (Y/N). 16. If yes, in which form and enlist those industries' names and addresses? 17. If no, does EPD impose fines to offenders? (Y/N) 18. If yes, give details: Sr. No. Name of the offender Fine imposed 1. 2.	l1. If yes, give de	tails:					
13. If the answer to above question is yes, share details: 14. If no, what are the constraints? 15. Is EPD giving any incentives to the industries that recycle waste or generates relatively less amount of waste? (Y/N). 16. If yes, in which form and enlist those industries' names and addresses? 17. If no, does EPD impose fines to offenders? (Y/N) 18. If yes, give details: Sr. No. Name of the offender Fine imposed 1. 2.	12. If the answer	to above is question is	'no', is EPD plar	nning to formula	ite laws sp	ecifically	on solid
14. If no, what are the constraints? 15. Is EPD giving any incentives to the industries that recycle waste or generates relatively less amount of waste? (Y/N). 16. If yes, in which form and enlist those industries' names and addresses? 17. If no, does EPD impose fines to offenders? (Y/N) 18. If yes, give details: Sr. No. Name of the offender Fine imposed 1.	waste manag	ement? (Y/N)					
L5. Is EPD giving any incentives to the industries that recycle waste or generates relatively less amount of waste? (Y/N). L6. If yes, in which form and enlist those industries' names and addresses? L7. If no, does EPD impose fines to offenders? (Y/N) L8. If yes, give details: Sr. No. Name of the offender Fine imposed 1. 2.	13. If the answer	to above question is yes	s, share details:				
amount of waste? (Y/N). 16. If yes, in which form and enlist those industries' names and addresses? 17. If no, does EPD impose fines to offenders? (Y/N) 18. If yes, give details: Sr. No. Name of the offender Fine imposed 1. 2.							
Sr. No. Name of the offender Fine imposed 1. 2.	14. If no, what ar	e the constraints?					
Sr. No. Name of the offender Fine imposed 1. 2.	15. Is EPD giving amount of wa	any incentives to the i ste? (Y/N).				s relative	ly lesser
2.	15. Is EPD giving amount of wa 16. If yes, in whic	any incentives to the iste? (Y/N). In form and enlist those D impose fines to offend	industries' name			s relative	ly lesser
	amount of wa 16. If yes, in whic 17. If no, does EP	any incentives to the iste? (Y/N). In form and enlist those D impose fines to offendatalls:	industries' name	es and addresses	s? 	s relative	ly lesser
3.	15. Is EPD giving amount of was 16. If yes, in whice 17. If no, does EP 18. If yes, give de Sr. No	any incentives to the iste? (Y/N). In form and enlist those D impose fines to offendatails: Name of the of	industries' name	es and addresses	s? 	s relative	ly lesser
	15. Is EPD giving amount of was 16. If yes, in whice 17. If no, does EP 18. If yes, give de Sr. No	any incentives to the iste? (Y/N). In form and enlist those D impose fines to offendatails: Name of the of	industries' name	es and addresses	s? 	s relative	ly lesser
19. If no, what are the reasons/pressures?	15. Is EPD giving amount of was 16. If yes, in whice 17. If no, does EP 18. If yes, give de Sr. No	any incentives to the iste? (Y/N). In form and enlist those D impose fines to offendatails: Name of the of	industries' name	es and addresses	s? 	s relative	ly lesse
	15. Is EPD giving amount of was 16. If yes, in whice 17. If no, does EP 18. If yes, give de Sr. No	any incentives to the iste? (Y/N). In form and enlist those D impose fines to offendatails: Name of the of	industries' name	es and addresses	s? 	s relative	ly lesser

21. How often EPD officers monitor/visit industries (functional within their domain compliances?	n) for ensuring the
QUESTIONS RELATED TO BANNED PLASTIC BAGS	
22. Does micro plan exist regarding enforcement of ordinance? (Y/N)	
23. If yes, share details:	
24. If no, then how EPD enforces the ordinance? And what actions have been taken Give details:	against offenders?
25. Is EPD considering any alternate options to polyethylene bags? (Y/N) 26. If yes, share details?	
QUESTIONS RELATED TO MUNICIPAL SOLID WASTE MANAGEMEN	IT
27. Does EPD have any laws about those who litters? (Y/N)	
28. If yes, tell the interviewer about fines?	
29. If no, what is your departmental stance in this regard?	
30. Do you have policies for those industries who are manufacturing single use plate (Y/N)	stic products?
31. If yes, share the details:	
32. If no, what are the constraints regarding it?	

Annexures I: Qu	estionnaire for conducting KII with	h EPD's representative	
	any standard guidelines for the a share the details:	approval of proposed landfill and t	ransfer station? If
34. Did the EPD 35. If yes, please	No. 10 Call No.	construction (in future) by municip	pality? (Y/N)
36. Does EPD ha		truction and O&M of TS/LF? (Y/N	
38. If no, what a	re the reasons for not having the	guidelines:	
39. Did EPD give	22	MANAGEMENT COMPANIES nanagement companies in RYK? ((/N)
40. If yes, share	the details:		
Sr No.	Name of the company	Services offering	
41. How EPD en	sure safe working of these compa	anies? Or which department is res	ponsible for it?
	INFORMATION REG	ARDING AWARENESS	
42. Does EPD de	dicate budget under awareness souch is it?	sub-head? (Y/N)	
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	o, how do you	ı manage the budge for av	vareness?		
par	ticular plastic		aigns regarding the m	anagement of solid was	ste (ir
16. If y	es, share the o		Location	Target audiense	
	1.	Campaign	Location	Target audience	
	2.				
	3.				
	4.				
	5.				
		MEDIATOR LINKAGES	6 (ACADEMIA + INDUST	RIES)	
8. In y	our opinion, c	MEDIATOR LINKAGES			
			academics and industri	es important? (Y/N)	nt of
19. In y		does the linkage between a	academics and industri	es important? (Y/N)	nt of
19. In y	our opinion, h	does the linkage between a	academics and industri	es important? (Y/N)	nt of
19. In y	our opinion, h	does the linkage between a	academics and industri	es important? (Y/N)	nt of
9. In y	our opinion, h	does the linkage between a	academics and industri	es important? (Y/N)	nt of
49. In y soli	our opinion, h	does the linkage between a	academics and industri	es important? (Y/N) the effective manageme	nt of
49. In y soli 50. Is E	rour opinion, h d waste? PD willing to p	does the linkage between a	academics and industri	es important? (Y/N) the effective manageme dustries? (Y/N)	nt of
49. In y soli 50. Is E 51. If y	rour opinion, he distance waste? PD willing to pless, how can the	does the linkage between a now can academics and inc	academics and industri	es important? (Y/N) the effective manageme dustries? (Y/N)	nt of

Annexures I: Questionnaire for conducting KII with EPD's representative	
GENERAL COMMENTS	
54. In what ways, plastic waste recycling can be improved in your area?	
55. What are your views on circular economy regarding the management of plastic stakeholders need to participate for promoting circular economy?	waste and whic
56. Remarks/comments	e .
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Annexures J: Questionnaire for conducting KII with educational institute's representative

Annexures J: Questionnaire for conducting KII with educational institute's representative

Project Title: "Baseline Assessment of Current Scenarios of Plastic Waste Management for Rahim Yar Khan (RYK) City"

Questionnaire Development for Educational Institution

2.
 3.

7.

9.

10.

11.

12.

13. 14.

Name of institute:			
A I I			
STREMPSIONE-ACCIONS II	ee:		
	l):		
Email Id:			
For how many yea	rs are you working in this ins	titute?	
	DETAILS REGARDIN	IG THE INSTITUTE	
Level of education	taught in this institute:		
 Primary 	 Seconda 	ry	Higher
 Bachelors 	 Masters 	,	Ph. D
How many teacher	rs are teaching in this institut	e?	
		. 2	
How many student	ts are studying in your institu		
	Level	Number	
	Primary		
	Secondary		
	Higher		
	Bachelors		
	Masters		
	Ph. D	7.5	
Does your institute	have environmental depart	ment? (Y/N)	
If yes, does that de	partment have experts spec	ifically in the field of so	olid waste? (Y/N)
Is there any resear	ch being carried out regardir	ng the waste to energy	plants? (Y/N)
If ves. kindly share	the details of those topics?		
,,,	The state of the s		
			-

Annexures J: Qu	estionnaire	for conducting KII with e	educational institute's represe	entative	Ann	exures J: Que	estionnaire for conducting KII with educational	institute's representative
15. Is there any your institut		eing carried out regardin	g the treatment of plastic wa	ste management in	25.	If yes, what a	alternative options the institute is providing re	garding it?
16. If yes, what	areas of pla	stic waste management	are being targeted? Can you	share the research				
topics?						15 1 - 1 -		
						ir no, what a	re the reasons for not enforcing the ban?	
17. If no, what a	re the reaso	ons that the topic of plas	tic waste management is still	neglected?	_			
				_	27.	Are there su	fficient bins in your campus, to cater all the wa	ste generated (Y/N)?
					28.	If no, what is	s the reason for having insufficient resources?	
18. Is there any	course bein	g taught regarding the c	ircular economy of plastic wa	— ste in the institute?				
(Y/N)						G41 PERAPPERAPPER	in the institute (students, teachers, other)	er staff etc.) aware of segrega
INFORM	ATION REGA	ARDING THE ACADEMICS	S INDUSTRIAL AND EPA COLLA	ABORATION			parate bins for the collection of segregated wa	ste in your campus? (Y/N)
250 page 1000		CO CO A	ween academics and industrie	es for managing the			ich way, the bins are categorized (e.g., wet vs d	
issue of solid 20. If yes, how o		N) ational institute aid indu	ustries?				een any awareness campaign regarding the soli	d waste management organized by
				_		campus or a	ny other organization? (Y/N) the details:	
				_		Sr. No.	Name of the campaign	Organized by
21. Did any indu	stry contact	you regarding the techn	nical support from your institu	te for managing the		1.	With the second probability and the second proba	
issue of solid	l waste, par	ticularly plastics? (Y/N)				2.		
22. If yes, kindly	share the o	letails:				3.		
	Sr. No.	Name of the industry	Assistance asked from you		34.	If no, what w	vere the reasons for not conducting the aware	ness campaign?
	1. 2.			-		ls the institu	ite doing any activity to promote the concept o	f recycling of plastics? (V/N)
	3.			-			the details of those activities?	recycling of plastics: (1/14)
	4.				36.	ii yes, siiare	the details of those activities?	
23. Do you thinl	that the in	stitute have enough tecl	hnical personnel that can assi	st EPA to formulate	9 .			
laws regardi	ng solid was	ste management? (Y/N)			37.	If no, what a	are the constraints?	
	1	NFORMATION REGARDI	ING THE AWARENESS		_	av 2000 1000 1000 1000 1000 1000 1000 100	rationerange = progressed describitions (Adv.	
24. Is the use of	polyethyler	ne bags in the campus ba	anned? (Y/N)				INFORMATION REGARDING THE	BUDGET

Anı	nexures J: Questionnaire for conducting KII with educational institute's represent	ative
	Does the institute allocate budget for the management of solid waste? (Y/N) If yes, how much budget is allocated and what activities you do with that budget	t?
	Is this budget sufficient? (Y/N) If no, how much more budget your institute requires?	
	GENERAL COMMENTS	
42.	What does your institute do with the waste collected?	
43.	What steps your institute have taken to ensure proper management of solid was plastic)?	aste (particularly
44.	In your opinion, how can you improve the existing SWM system?	
45.	Remarks/comments (if any)	
<u> </u>		

Annexures K: Questionnaire for conducting KII with recyclable industries' representative

Annexures K: Questionnaire for conducting KII with recyclable industries' representative

Project Title: "Baseline Assessment of Current Scenarios of Plastic Waste Management for Rahim Yar Khan (RYK) City"

Questionnaire Development for recyclable industries' representatives

1.	Name of Industry:	
2.	Type of business:	
3.	Established:	
4.	Location:	
5.	Name of Interviewee:	
6.	Designation:	
7.	Contact Number:	
	BUSINESS RELATED INFORMATION	
8.	Size of business (S, M, L):	
9.	Size of business (S, M, L):	
9. 10.	Size of business (S, M, L): Number of Employees:	
9. 10. 11.	Size of business (S, M, L): Number of Employees: Working hours:	
9. 10. 11.	Size of business (S, M, L): Number of Employees: Working hours: Average yearly income (optional):	

13. How much waste do you generate?

Sr. No.	Type of waste	Quantity
-		

14. The interviewee segregates different plastic waste components (as a whole of their duty area)?

Y/N. If Yes, then fill the following table.

Sr #	Type of Plastic material	Quality (contaminated/non- contaminated)	Colored/non- colored	Quantity (kg/day)	Rate (PKR/kg)
1.					

Annexures K: Questionnaire for conducting KII with recyclable industries' representative

2.				
3.				
4.				
5.				
6.				
7.	7	7		

15. Are you willing to receive waste management services from the government/private companies?

If yes, how much would you like to pay?

16. Who segregate the waste for you and how much you pay?

17. What do you do with your waste (recycle, sell or dump)?

18. If the answer to above question is recycle/reuse: then how much amount and for where it is

used:

Sr No	Type of waste	Quantity reused (kg/day)	Purpose

19. If the answer to above question is "sell the waste": then how much and at what price:

Sr No	Type of waste	Quantity sold (kg/day)	Price (PKR/kg)	To whom they sell

DETAILS REGARDING RAW MATERIAL

 $20. \ \ Do\ you\ use\ virgin\ or\ reused/recyclable\ material\ as\ raw\ material\ in\ your\ industry?$

21. What material (recyclables) you use in your industry:

Sr	Raw	Colored/non-	Purchase	Quantity	Raw material supplier's
#	Material	colored	Cost	purchased	name, address, contact # or
			(PKR/kg)	(kg/month)	any other detail

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I	Annevures k	. (Questionnaire f	or cond	ucting KI	Lwith	recyclable	industries'	representative	
r	Alliexules n		Juestionnaire i	OI COHO	UCCIIID N	I WILLI	recyclable	moustnes	representative	

22. How much virgin and recyclable material you buy:

Type of material	Quantity (kg/month)	Price (PKR/kg)
Virgin material		
Recycled material		

23. Do you purchase only from selected vendors or sellers or you can purchase from anyone? And do you have contract agreement with the providers of raw material? (Yes/No). In case of Yes, then what is the duration of existing contract agreement?

Sr No	Providers of raw material	Contract agreement (Yes/No)	Duration

24. How (in which form) are these raw materials supplied? (e.g., compact form, loose form, pallets, or granules form etc.)

Sr No	Form in which the	Quantity	Purchasing Price
	material is supplied	(kg/day)	(PKR/kg)

	25	In current circumstances de	you pre	efer recycled	or virgin material as	your raw material?
--	----	---	---------	---------------	-----------------------	--------------------

26. What are the issues in getting these raw materials?	

27. Are you satisfied with the quality of materials provided by the sellers/vendors? What are you	ır
concerns regarding the raw materials (recyclables)?	

28.	What do you expect from vendors/sellers regarding these raw materials?

INFORMATION ON RECYCLED PRODUCTS

Annexures K: Questionnaire for conducting KII with recyclable industries' representative

29. What recycled product you make:

Sr No	Recycled product	Quantity (kg/month)	Selling price (PKR/kg)
-			

30. How much non-recyclable plastic you generate and what do you do with it?

Sr No	Type of material	Quantity (kg/day)	What you do with it

INFORMATION ABOUT SAVINGS AND EXPENSES

31. Is it profitable to use recycled material?
32. How much money you save by using recycled material?
33. Monthly Expenses and its detail:

Sr No	Type of Expense	Amount (PKR/month)

INFORMATION ON POLYETHYLENE BAGS

ng polyethylene bags in your facility?	_
r to above question is no, what alternate option are you using (e.	— g., biodegradable
	r to above question is no, what alternate option are you using (e.

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7. Did you get any kind of support regarding the polyethylene bags from the local	governme
	-
GENERAL COMMENTS	
8. In what ways management of waste particularly plastic can be improved?	_0
9. General comments or suggestions:	- -
	-0

Annexures L: Questionnaire for conducting KII with junk dealer's representative

Annexures L: Questionnaire for conducting KII with junk dealer's representative

Project Title: "Baseline Assessment of Current Scenarios of Plastic Waste Management for Rahim Yar Khan (RYK) City"

Questionnaire Development for Junk Dealers

1.	Name of Interviewee:
2.	Established:
3.	Location:
4.	Contact Number (optional):

BUSINESS RELATED INFORMATION

- 5. Size of business (S, M, L):
- 6. Number of Employees:
- 7. Average yearly income (optional):
- 8. Have you registered your business (Y/N)?
- 9. Types of business activities:
 - Reuse
 Reclaim
 Repair
 Recycle
 E-waste
 Others:
- 10. What type of recyclables' (other than plastic) the interviewee is dealing with?

Sr. No.	Type of recyclables ¹
1.	
2.	
3.	
4.	
5.	

11. Average profit against the type of recyclable component (without processing):

Sr. No.	Recyclables' type	Purchasing cost (PKR/kg)	Selling cost (PKR/kg)	Potential buyers + Address
1.				
2.		-		
3.				
4.				
5.				

 $^{^{\}rm 1}$ In this question, recyclables include all the material except plastic

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Annexures L: Questionnaire for conducting KII with junk dealer's representative

- 12. Does the interviewee process the recyclables? (Y/N)
- 13. If yes, list downs the number and types of equipment/machinery used for processing the recyclables?

Sr. No.	Type of machinery/equipment	Additional value (PKR/kg)	End product	Selling price (PKR/kg)	Potential buyer/Recycling companies + Address
1.					
2.					
3.					
4.					
5.					

INFORMATION RELATED TO PLASTIC WASTE

- 14. Does the interviewee know about different types of plastic (Yes/No)?
- 15. If yes, fill the following table:

Sr. No.	Type of recyclable plastic	Quality of material (clean/unclean)	Colored/non- colored	Quantity (kg/day)	From whom they receive (sanitary worker, scavenger etc.)	Price at which they buy (PKR/kg)	Potential buyers + Address
1.							
2.							
3.							
4.						0	
5.							
6.							
7.							

- 16. Does the interviewee process the plastic recyclables? (Y/N)
- 17. If yes, list downs the number and types of equipment/machinery used for processing the recyclables?

Sr. No.	Type of machinery/equipment ²	Additional value (PKR/kg)	End product	Selling Price (PKR/kg)	Potential Buyer + Address
1.			19		

² Pen down the details regarding machines specs, associated cost, working capacity, and capability efficiency in observations section.

Annexures L: Questionnaire for conducting KII with junk dealer's representative

2.	3		
3.			
4.			

- 18. If no, then had an interviewee ever thought about the production of low-cost eco-friendly products (like biodegradable bags) on mass scale? (Y/N)
- 19. If no, what are the major hurdles/obstacles or any other valid reasons behind it?

20. Does the respondent deal with non-recyclable plastic material? If yes, give following details:

Sr. No.	Type of Non-recyclable Plastic	Quantity (kg/day)	Purchasing cost (kg/day)	What interviewee does with it?
1.				
2.				
3.				
4.				
5.				

- 21. The interviewee has contract agreement with the providers of raw material? (Y/N).
- 22. In case of yes, then what is the duration of existing contract agreement?

Sr. No.	Name of individual or firm which provides raw material	Contract agreement (Yes/No)	Duration	Providers' Detail + Address
1.				
2.				
3.				
4.				
5.				

23. Enlist different types of plastic type in descending order based on market demand?

Sr. No.	Type of Plastic recyclables	Potential buyers + Address
1.		
2.		
3.		
4.		
5.		ĺ

INFORMATION ON SCRAP DEALERS

24. Does the respondent know about the number of scrap dealing shops within the below mentioned areas and the type of recyclables they are dealing with?

Sr. No.	Area/Level	Size	Licensed/non-licensed	Number	Dealing recyclable type
1.	RYK city	Large			

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Annexures L: Questionnaire for conducting KII with junk dealer's representative

2.		Medium	
3.		Small	
4.		Large	
5.	UC	Medium	
6.		Small	

GENERAL COMMENTS

25.	What are the issues in getting the raw materials and how it can be improved?	
26.	Does scrap dealer face any issue from their potential clients (industries etc.)?	
27.	What are the major obstacles do you currently face? And what is your expectation from government or concerned department?	om the local
28.	Is this business profitable? (Y/N). Will you continue in future?	
29.	Will you recommend others to come in this business? (Y/N)	
30.	If yes, what will you recommend dealing with (recyclable types and why)?	
31.	If no, what are the major reasons?	
32.	If you are unregistered, and given chance to get license, will you obtain it? (Y/N). Give your answer:	reasons for
33.	Through what stages usually the plastic material passes through (chain) before coming to use" stage? And what financials are required at each stage?	ng to "ready

Anr	nexures L: Questionnaire for conducting KII with junk dealer's representative
34.	In your opinion what are the factors which must be considered for assessing the financial viability of the recycling plants (including your setup)?
35.	General comments or suggestions to improve the recycling of waste in particular plastic
	component?

Annexures M: Questionnaire for conducting KII with sanitary supervisors

Annexures M: Questionnaire for conducting KII with sanitary supervisors

Project Title: "Baseline Assessment of Current Scenarios of Plastic Waste Management for Rahim Yar Khan (RYK) City"

Questionnaire Development for Sanitary Supervisors

1.	Name & Age:
2.	Contact # (if any):
3.	Duty Timings:
4.	UC's Name/Number (responsible for)?
5.	Is your UC planned or unplanned?
6.	What are the major reasons for the selected category?
_	
_	
7.	Is waste segregated at source? (Y/N)

INFORMATION OF STAFF, EQUIPMENT AND FLEET

8. If no, then what steps would you like to take for ensuring waste segregation at source?

9. Number of Sanitary workers under your supervision?

10. Number of resources allocated for your area:

Sr. No.	Resources	Number	Number of trips/day
1.	Mini Dumper		
2.	Compactors (12 m³)		
3.	Compactor (25 m³)		
4.	Arm Rolls		
5.	Truck		
6.	Containers		
7.	Korgan		
8.			

11. Information regarding containers in your area:

Sr. No.	Container's Capacity (m³)	Number	Location	Unloading Frequency (per day)	Target Areas (general)	
------------	---------------------------------	--------	----------	----------------------------------	---------------------------	--

Annexures M: Questionnaire for conducting KII with sanitary supervisors

12. How many more resources are required for improving collection efficiency in your UC?

Sr. No.	Resource Type	Number
1.		
2.		
3.		
4.		
5.		
6.		

INFORMATION REGARDING PLASTIC WASTE SEGREGATION

13. What is an approx. number of open heaps found in your UC(s)?

Sr. No.	UC Name/Number	Number	Location
	1		
		*	

14. How much waste is collected from the following?

Sr. No.	Category	Number	Approx. quantity of MSW generated (kg/day)	Approx. quantity of MSW collected (kg/day)
1.	Streets			
2.	Households (HHs)			
3.	Shops			
4.	Clinics/Hospitals			
5.	Offices			
6.	Schools/Colleges/Universities			
7.	Factories/Industrial Units			
8.	Others			

15. Are you aware about recyclable and non-recyclable plastic waste? (Y/N)

16. If yes, then tell how much (approx.) plastic waste is generated and collected in your jurisdiction?

Recyclable p	lastic waste	Non-recyclable plastic waste		
Generated (kg/day) Collected (kg/day)		Generated (kg/day)	kg/day) Collected (kg/day	
)				

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Annexures M: Questionnaire for conducting KII with sanitary supervisors

17. Approx. quantity of different plastic waste materials which are being generated within your UC(s):

Sr. No.	Type of plastic material	HH (%)	Educational institutions (%)	Shops (%)	Hospital/ Clinics (%)	Factories (%)	Overall (%)
1.							
2.							
3.							
4.							
5.							

18. Does the sanitary workers in your area segregate waste components (in particular plastic waste)? (Y/N)

19.	How	many	sanitary	workers	against	total	deployed	are	collecting	and	selling	recyclables	ir
	parti	cular p	lastic was	te?									

20. What is your opinion regarding the following details of various collected plastic waste components collected by sanitary workers?

Sr. No.	Type of plastic material	Source segregation ³	Quality (contaminated/non- contaminated)	Colored/non- colored	Quantity (kg/day or %)
1.					
2.			-	i de	
3.				ė.	
4.					
5.					
6.					

21. To whom the sanitary workers usually sell the collected recyclables and at which rates?

Sr. No.	Buyers	Rate
1.		
2.		
3.		
4.		
5.		

22. How much non-recyclable plastic waste is collected in your UC(s) and what is its ultimate fate?

Sr. No.	Type of non-recyclable plastic	Quantity (kg/day or %)	Ultimate fate
1.			
2.			
3.			
4.			

³ at source, at time of collection or at Transfer station TS or Landfill LF

5.		

INFORMATION REGARDING SCAVENGERS

- 22. Does the interviewee know about the scavengers who are active in his UC(s)? (Y/N)
- 23. If yes, tell us about the approx. number of scavengers?
- 24. What is your opinion regarding the following details of various collected plastic waste components collected by scavengers?

Sr. No.	Type of plastic material	Source segregation ⁴	Quality (contaminated/non- contaminated)	Colored/non- colored	Quantity (kg/day or %)
1.					
2.					
3.					
4.					
5.					
6.					
7.					

25. To whom the scavengers usually sell the collected recyclables and at which rates?

Sr. No.	Buyers (PKR/kg)	Selling rates (PKR/kg)
1.		
2.		
3.		
4.		
5.		

INFORMATION REGARDING SCRAP DEALERS/INDUSTRIES

26. How many scrap dealing shops are operating (that use recyclables) within UC?

Sr. No.	Level	Size	Number	Rational for selected size	Location
1.	UC	Large			
2.		Medium			
3.		Small			
4.		Large			
5.	RYK city	Medium			
6.		Small			

⁴ at source, at time of collection or at Transfer station TS or Landfill LF

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Annexures M: Questionnaire for conducting KII with sanitary supervisors

27. How many potential industries are operating in the vicinity of your UC?

Sr. No.	Level	Size	Number	Rational for selected size	Location
1.	UC	Large			
2.		Medium			
3.		Small			
4.		Large			
5.	RYK city	Medium			
6.		Small			

26. What kind of plastic waste material/recyclables are in demand by the buyers (scrap dealers or industries)?

Sr. No.	Type of recyclables	Buyers (address)
1.		
2.		
3.		
4.		
5.		

INFORMATION REGARDING COMPLAINTS SYSTEM

27	-				- 17/1/811
21.	Does any	complaint	management	system	exist? (Y/N)

8. If no, how you resolve the lodged complaints?

29. Approx. number of complaints received per month?

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Platform	Number
Through PM Portal	
General/direct	

30. What are the major types of complaints you usually received and what is the resolving duration of the lodged complaint?

Sr. No.	Type of complaint	Resolving duration
1.		
2.		
3.		
4.		
5.		
6.		

Annexures M: Questionnaire for conducting KII with sanitary supervisors

INFORMATION REGARDING TS AND LF

- 31. Does any transfer station (TS) exist within your UC(s)? (Y/N)
- 32. If yes, fill the following table:

Sr. No.	TS Name	Location	Capacity/size	Deployed resources
1.				
2.				
3.				
4.				
5.				
6.				

33. For how long the waste is kept in the Transfer stations (TS) and how many vehicles (along with types) are usually used for transporting waste?

Sr. No.	Name of TS	Location	Duration	Fleet (In) ⁵	Fleet (Out) ⁶

34. Where is the landfill site (LF) or Dumping sites (DS) located for disposing the collected waste from RYK?

Sr. No.	Name of DS/LF	Location	Capacity/size	Lifespan (yrs.)

35. Staff and fleet operating at DS/LF and amount of solid waste being dumped

Sr No	Name of DS/LF	Location	Type of LF/DS	Staff	Fleet Type and Number	Solid waste Dumped (ton/day)

36. Is the waste being dumped in TS/LF in separate compartments or in mixed form: if you segregate, what are the different categories:

Sr. No.	Categories
1.	

⁵ Fleet In refers to number of vehicles that are usually used for bringing collected waste from UC(s) to TS.

125		n .	5		
125	- 1	<i>a.</i> :	2	σi	

Annexures M: Questionnaire for conducting KII with sanitary supervisors

2.	
3.	
4.	
5.	

- 37. Is there any space available or dedicated for construction of new TS and LF for future? (Y/N)
- 38. If yes, please fill the following:

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Sr. No.	TS/LF	Location	Area
1.			
2.			
3.			
4.			

GENERAL COMMENTS

35.	Shortage of any resources or other difficulties faced by the interviewee for perduties:	orming his
36.	In what ways, plastic waste recycling can be improved in your area?	-
37.	What is your opinion about the chain of waste material particularly plastic was where the waste is collected, from which stages it passes through, and the ultim	
38.	If given chance, which initiatives would you had taken for improving the existin management:	- g waste -
39.	Complaints or issued faced by the sanitary workers:	-
40.	Does micro-plan/management of sanitary workers exist? Y/N.	

⁶ Fleet Out refers to number of vehicles that are usually used for transporting collected waste from TS to LF.

Annexures M: Questionnaire for conducting KII with sanitary supervisors	
41. If no, then how you keep check and balance on your resources?	_
42. What steps should the municipality take for binding the inhabitants for waste source?	– – segregation at
43. General Remarks/comments (if any)	-
	_

Annexures N: Questionnaire for conducting KII with sanitary workers

Annexures N: Questionnaire for conducting KII with sanitary workers

Project Title: "Baseline Assessment of Current Scenarios of Plastic Waste Management for Rahim Yar Khan (RYK) City"

Questionnaire Development for Sanitary Workers

	Name:
2.	Age:
3.	Contact # (if any):
4.	City from which they belong:
5.	Duty Timings:
6.	Deployed UC Name/Number:
7.	Monthly Income:
8.	What tools/equipment are provided to you for the collection of waste:
9.	Is personal protective equipment (PPE) provided by the municipality? (Y/N)

INFORMATION ABOUT THE WASTE GENERATION AND COLLECTION

10. Number of Streets/Households/Shops/Clinics or Hospitals (responsible for):

Sr. No.	Category	No.	Approx. Quantity of MSW Generated (kg/day)	Approx. Quantity of MSW Collected (kg/day)
1.	Streets			
2.	Households (HHs)			
3.	Shops			
4.	Clinics/Hospitals			
5.	Offices			
6.	Schools/Colleges/Universities			
7.	Factories/Industrial Units			
8.	Others			

8.	3. Others				
1. Wh	at is the typical weigh	t (approx.) of MS	SW that is be	ing collected fror	n HH?
§ 					
2. Ave	erage size of HH (peop	le/house)?			
1.					
.3. Ave	rage number of story	(s) of house in yo	our UC?		
_					

Annexures N: Questionnaire for conducting KII with sanitary workers

14. What is the typical composition of MSW?

Sr. No.	Component	% age of total
1.	Food	
2.	Plastic	
3.	Shoppers/Disposables Plates/Spoons, Packing Materials	
4.	Metals	
5.	Glass	
6.	Packing material	
7.		

- 15. Are you aware about recyclable and non-recyclable plastic waste and its types? (Y/N)
- 16. Estimated plastic waste generated and collected (kg/day or %age) in your UC:

	Non-recyclable plastic waste		
ollected (kg/day)	Generated (kg/day)	Collected (kg/day)	
,	llected (kg/day)	llected (kg/day) Generated (kg/day)	

17. Approx. quantity of different plastic material generated from different sources:

Sr. No.	Type of plastic material	HH (%)	Educational institutions (%)	Shops (%)	Hospital/ Clinics (%)	Factories (%)	Overall (%)
1.							
2.							
3.							
4.							
5.							

18. Enlist types of non-recyclables plastic waste and what is their ultimate fate?

Sr. No.	Type of material	Quantity (kg/day)	What is its ultimate fate?
1.			
2.			
3.			
4.			
5.			

INFORMATION REGARDING PLASTIC WASTE RECYCLABLES

19. Either the interviewee segregates different plastic waste components during their duty? (Y/N)

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Annexures N: Questionnaire for conducting KII with sanitary workers

20. If yes, then fill the following table.

Sr. No.	Type of plastic material	Source segregation ⁷	Quality (contaminated/non- contaminated)	Colored/non- colored	Quantity (kg/day or %)
1.					
2.					
3.					
4.					
5.					
6.					
7.					

22.	Does the interviewee	collect recyclables	(within study area) after duty timing	s? (Y/N)
-----	----------------------	---------------------	--------------------	---------------------	----------

23. If yes, kindly fill the details:

Sr. No.	Type of Plastic material	Place of Segregation ¹	Quality (contaminated/non- contaminated)	Colored/non- colored	Quantity (kg/day)	Rate (PKR/kg)	To Whom They Sell?
1.							
2.							
3.							
4.							
5.							
	Other Than Plastic						
1.							
2.							
3.							
4.							

INFORMATION ON SCAVENGERS

24. Does the interviewee know any scavenger who is very active in plastic waste collection and selling it? If yes, then share necessary details?

Number

⁷ at source, at time of collection or at Transfer station TS or Landfill LF

Annexures N: Questionnaire for conducting KII with sanitary workers

RYK City	
UC	

25. What is the average amount at which scavenger sell plastic waste?

Sr. No.	Type of plastic waste	Amount of waste collected (kg/day)	Selling price (PKR/day)	To whom they sell

INFORMATION ON SCRAP DEALERS OR POTENTIAL INDUSTRIES

26. What kind of plastic waste material/recyclables are in demand by the buyers (scrap dealers or industries)?

Sr. No.	Type of recyclables	Buyers along with address	Product Type
1.			
2.			
3.			
4.			
5.			

27. How many scrap dealing shops are operating in the area?

Sr. No.	Level	Size	Number	Rational for selected size	Location
1.		Large			
2.	UC	Medium			
3.		Small			
4.		Large			
5.	RYK city	Medium			
6.		Small	1		

28. Enlist potential industries which reuse or recycle plastic waste?

Sr. No.	Level	Size	Number	Rational for selected size	Location
1.		Large			
2.	UC	Medium			
3.		Small			
4.		Large			
5.	RYK city	Medium			
6.		Small			

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Annexures N: Questionnaire for conducting KII with sanitary workers

		Number	Collection frequency (if applicable)	Location	How many more req
Container Size (0.	.8 m3)				
Container ()				
Container ()				
Hand Carts					
Workers					
Others					
	issue fa	ced during	their duty timings/area	1?	

Annexures O: Questionnaire for conducting KII with scavengers

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Annexures O: Questionnaire for conducting KII with scavengers

Project Title: "Baseline Assessment of Current Scenarios of Plastic Waste Management for Rahim Yar Khan (RYK) City"

Questionnaire Developn	nent for Scavengers
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1.	Name & Age:
2.	Contact Number (if any):
3.	Nationality:
4.	Qualification (if any)?
5.	Do you live in RYK? Or outsider?
6.	Working hours:
7.	Are you working independently? (Y/N)
8.	If no, then talk about your employer and detail regarding wages and targeted type of waste
	component on which you are agreed to work?
_	
_	
, <u> </u>	
9.	What about your daily working hours (in case of employee)?
_	
10.	What is your target area(s)/UCs and any specific reason for it (in case of "NO" to question 7)?
_	
_	
11.	How much do you earn on daily or monthly basis (in case of working independently)?
_	
12.	How are your potential buyers? (Scrap Dealers or Industries or some other buyers). In case of
	some other buyers, inform about their business and business type?
	INFORMATION ON WASTE SITUATION
13.	What tools you usually use for segregating waste?
14.	Do you wear Personal Protective Equipment's PPEs' (gloves, masks etc.) while collecting or
	segregating waste? (Y/N)
15.	Estimated plastic recyclable waste collected (kg/day)?
7-	

Annexures O: Questionnaire for conducting KII with scavengers

16	07	- 8V	ferred area for co	0.7		e., Housel	nold, conta	ainer, ope	en du	mps,
17	7. Approx. he		ich you collect (%	or kg/d	ay) different ty	pes of pla	stic mate	rial from t	he be	elow
Sr. No.	Type of Plastic material	НН	Educational institutions	Shops	Hospital/Clin	nics Fac	tories T	S/Open heaps	LF	Overall
		11	NFORMATION ON	SEGRE	GATION OF WA	ASTE COM	IPONENTS	S		
			(IN PARTICU	LAR PLA	ASTIC WASTE R	ECYCLAB	LES)			
18.	Do the sani	tary w	orkers segregate	recyclal	bles (particular	ly plastic v	waste) in y	our work	ing a	rea?
	(Y/N)	or.							.	
	2-4500 tests		nitary workers fa following table:	cilitate	you or sell you	the collec	ted recycl	lables? (Y	/N)	
	Sr. No.		of plastic waste	Qualit	ty Quantity (k	(g/day)	Selling pr	ice (PKR/	day)	1
										-
21.	Either the i	ntervi	ewee segregates (differen	t types of recyc	lables ba	sed on qua	ality? Y/N		
22.	If yes, then	fill the	following table.							
Sr. No.	Recyclak materia	ole	Quality (contaminated/ contaminated	non-	Colored/non- colored	Quantit (kg/day	5 100 to	e	tentia + Ado	al buyer dress
1. 2.	v									
3.										

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Annexures O: Questionnaire for conducting KII with scavengers

4.			
5.			
6.			
7.			

23.	What type of issues you usually face in collecting and selling of segregated rec	yclables
-		

24. How much an interviewee collects recyclables (kg/day) along with recyclable types, selling rates and to whom they sell it (also try to extract addressed of potential buyers)?

Sr. No.	Type of plastic	Quality	Quantity (kg/day)	Potential buyers + location	Selling price (PKR/kg)
1.					
2.					
3.					
4.					
5.					
6.					

25. What kind of plastic waste material/recyclables are in demand by the buyers (scrap dealers or industries)?

Sr. No.	Type of recyclables	Potential buyers	End product
1.			
2.			
3.			
4.			
5.			

INFORMATION ON SCRAP DEALERS & INDUSTRIES

26. Do you have an idea about the number of scraps dealing shops within the below mentioned levels/areas?

Sr. No.	Level	Size	Number	Rational for selected size	Location
1.		Large			
2.	UC	Medium			
3.		Small			
4.		Large	-11		
5.	RYK city	Medium			
6.		Small			

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Annexures O: Questionnaire for conducting KII with scavengers

27. How many industries are working at below mentioned areas that use recyclables as their raw materials?

Sr. No.	Level	Size	Number	Rational for selected size	Location
1.		Large			
2.	UC	Medium			
3.		Small			
4.		Large			
5.	RYK city	Medium			
6.		Small			

GENERAL COMMENTS

28.	What is your perception about the waste in general?	
_		
29.	Would you like to get yourself registered and work for the local govern cooperation? (Y/N)	ment or municipal
30.	If yes, what will be your expectations?	
31.	If no, what are the major reasons behind it? And on which conditions you will	agree?
32.	What is your opinion about the chain of waste material particularly plastic was the waste is collected, from which stages it passes through, and the ultimate	100 (E.S.
33.	In your opinion, what is the ultimate fate of non-recyclable portion of MSW?	

Ann	exures O: Questionnaire for conducting KII with scavengers	
34.	What is the ultimate and optimum solution of these components for effective	e management?
	If asked to improve the existing MSW management system or to make it a what will be your suggestions?	profitable practice,
_	General comments regarding the collection, selling of plastic waste (if any):	
_		

Annexures P: Questionnaire for conducting FGD with women

Annexures P: Questionnaire for conducting FGD with women

Project Title: "Baseline Assessment of Current Scenarios of Plastic Waste Management for Rahim Yar Khan (RYK) City"

Questionnaire Development for Women

1.	Respondent Name:
2.	Education & Profession:
3.	Age (optional):
4.	Contact No. or NIC (optional):
5.	Location/Address where FGD is conducted:

PERSONAL INFORMATION

- 6. No. of family members:
- 7. To which age group they belong:

Age Group (years)	Family members
Less than 5	
Between 5 and 30	
Greater than 30	

- 8. Average family income per month:
- 9. Average size/area of house:

INFORMATION ON WASTE SITUATION

10.	How much solid waste your family generates (kg/day):	

11. Approx. how much each component of commingled Municipal Solid Waste (MSW) is produced?

Sr. No.	Component Type	Quantity (kg/day)
1.	Plastics	
2.	Paper/cardboard	
3.	Glass	
4.	Metals	
5.	Food Waste/Kitchen Waste	
6.		
7.		

12. Are you of aware of recycling of waste? (Y/N)

Annavuras	D.	Questionnaire	for	conducting	ECD	with	women
Annexures	Ρ:	Questionnaire	tor	conducting	FGD	with	women

13. Had there been any awareness campaign regarding the recycling of waste from the government or any other organization?

14. What do you recycle and for what purpose?

Sr. No.	Material that is recycled	Purpose
1.		
2.		
3.		
4.		
5.		

15. Do you sell plastic recyclables and at what price?

Sr. No.	Type of plastic recyclables	Quantity (kg/day)	Selling price (PKR/kg)	To whom they sell
1.				7
2.				
3.				
4.				
5.				

16. If you do not recycle and if incentive is given, will you do recycling?

17. In which form will you like the incentive to be given (monetary/recycled items etc.)?

18. How much non-recyclable plastic you generate and what do you do with it?

Sr. No.	Type of material	Quantity (kg/day)	What you do with it
1.			
2.			
3.			
4.			
5.			

- 19. Do you segregate your waste at household level (Y/N)?
- 20. If yes, into how many components, their approx. weight and ultimate fate?

Sr. No.	Type of material	Quantity (kg/day)	What you do with it
1.			
2.			
3.			
4.			
5.			

21. If no, what are the major reasons? And what if asked to segregate waste at Household (HH) level by the govt. (via passing relevant legislation), will you do it? (Y/N)

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	3	
f no, what are t	ne reasons?	

23. How often the following plastic products are used by you and your family?

Annexures P: Questionnaire for conducting FGD with women

Sr. No.	Product	Frequency (daily, weekly, monthly)	Number generated per month
1.	Polyethylene bags		
2.	Shampoo bottle		
3.	Cosmetic products		
4.	Razors		
5.	Soft drinks		
6.	Snack's wrapper		
7.	Disposable straws		
8.	Disposable cups and plates		
9.	Pen casings		
10.	Brushes		
11.	Sachet packs		
12.			
13.			

24.	From the above products, the use of which products, you can minimize?	
		-:
		20

- 25. Are you aware of different type of plastic waste? (Y/N)
- 26. If yes, give the following details:

Sr. No.	Type of plastic waste	Quality	Quantity (kg/day)	Fate (Dispose of/Sell) ⁸	Selling rate (PKR/kg)
1.					
2.					
3.					
4.					
5.					
6.					
7.					

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⁸ In case the respondent sells the recyclables, pen down the rate at which they sell.

Annexures P: Questionnaire for conducting FGD with women

INFORMATION ON COLLECTION OF WASTE

27.	How you managed your solid waste (either by yourself or by services provided by the government/private)?
28.	Where the respondent disposed of the waste (in case of managing the waste by their own)? How frequently you dispose of solid waste?
	Does the respondent pay in case of acquiring services from private waste collectors? (Y/N) If yes, how much they pay on monthly basis? How frequently they collect waste?
31.	If no, on what terms and conditions the waste collector agrees?
	Does the respondent pay in case of acquiring services from municipality? (Y/N) If yes, how much they pay on monthly basis? How frequently they collect waste?
34.	If no, on what terms and conditions the waste collector agrees?
35.	What you do with your waste when the sanitary worker (of municipality) does not visit your house?
	Does the municipality provide services during public holidays? (Y/N) If no, then what you do with your waste?
	Are you satisfied with the current services provided by the municipality? (Y/N) If no, what are your expectations from the municipality in this regard?

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Annexures P: Questionnaire for conducting FGD with women
40. If the municipality offers you to provide free services, would you segregate waste at source? (Y/N)41. If no, what are the major constraints? And if municipality imposes fines against the reluctance of source segregation, then would be your approach?
42. If the waste management services are provided, what services are offered?
43. Is there any provision of bins or waste containers near your residence? And how far are they located from your place?
44. How frequently the waste from those bins/containers is being emptied?
INFORMATION ON SEGREGATION OF WASTE
45. Are you aware of two-bin (wet and dry waste)/color coded bins concept? (Y/N) 46. If yes, does municipality provide you separate bags for wet and dry waste storage? (Y/N)

- 47. If yes, how frequently they provide it?
- 48. Are there separate bins placed in your area? (Y/N)
- 49. Has there been any awareness campaign regarding the segregation of waste from the government or any other organization? (Y/N)

INFORMATION REGARDING COMPLAINTS

- 50. Is there any complaint cell from the waste management services provider? (Y/N)
- 51. If yes, have you ever complained regarding the waste management services? (Y/N)
- 52. If yes, were you satisfied with the resolution of complaint? (Y/N)
- 53. If answer to question. 52 is no, how do you complaint the municipality regarding MSW?

Annexures P: Questionnaire for conducting FGD with women				_	
	Annexures	P: Questionnaire	for con	ducting FG	D with wome

54. If answer to question 53 is yes, then give the following information?

Sr. No.	Type of complaint	Resolved (Yes/No)	Duration
1.			
2.			
3.			
4.			

INFORMATION ON POLYETHYLENE BAGS

55	Are you aware about the ban on the use of polyethylene bags? (Y/N)	
56.		
57.	If yes, what are the major reasons for this?	
P		
58.	If no, what alternate options are you using (e.g., biodegradable bags)?	
59.	Did you get any kind of awareness or support regarding the polyethylene bags	s from the local
	government? (Y/N)	
60.	If yes, share the details?	
_		
	GENERAL COMMENTS	

61.	In your opinion what steps the municipality should take to promote the segregared commingled MSW at source?	ition of
— 62.	What will be your stance regarding the fines which will be posed by the municion offenders (which generate waste more than the specified quantity in future)?	pality against the

63. What will be your stance regarding the incentives which will be posed by the municipality against those who produce segregated or less amount of waste?

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Annexures P: Qu	uestionnaire for conducting FGD with women	
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64. If given char	nce, how would you like to manage the solid waste?	
de.		
775		
55. In your opin	nion how to make money from the MSW management?	
66. How manag	gement of waste particularly plastic can be improved?	
67. General con	nments (if any)?	
		_

Annexures Q: Pictorial view of FGDs with adolescent children

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Annexures Q: Questionnaire for conducting FGD with children

Project Title: "Baseline Assessment of Current Scenarios of Plastic Waste Management for Rahim Yar Khan (RYK) City"

Questionnaire Development for Children

1.	Name of school:	-
2.	Address:	
3.	Name of contact person:	-
4.	Age:	-
5.	Class:	-
6.	Contact # (optional):	-
	INFORMATION REGARDING THE AWARENESS	
7.	Are you aware of plastic pollution? (Y/N)	
8.	In your opinion, how is plastic affecting the environment?	
9.	Are you willing to work on mitigation of plastic pollution? (Y/N)	
10.	Is the use of polyethylene bags in the campus banned? (Y/N)	
11.	If yes, what alternative options the institute is providing regarding it?	
12.	Do you use polyethylene bags? (Y/N)	
13.	If no, what other alternative option do you use?	
	Are there sufficient bins in your campus, to cater all the waste generated (Y/N)?	
	Are you aware of segregation (recyclables/non-recyclables etc.) of waste? (Y/N)	
	If yes, do you segregate waste at school or home? (Y/N)	
17.	Are there separate bins for the collection of segregated waste in your campus of (Y/N)	or at your home?
18.	If yes, in which way, the bins are categorized (e.g., wet vs dry, packing vs glass vs	s plastics etc.)?

Annexures Q: Pictorial view of FGDs with adolescent children

- 19. Had there been any awareness campaign regarding the solid waste management organized by the campus or any other organization? (Y/N)
- 20. If yes, share the details:

Sr. No.	Name of the campaign	Organized by
1.		
2.		
3.		
4.		

INFORMATION REGARDING THE RECYCLING OF WASTE

21. Do you recycle waste? (Y/N)	
22. If yes, what do you recycle and what do you make out of recycled material?	
23. If no, what are the reasons for not doing it?	
 24. If incentive (in terms of monetary or toys) is provided to you, will you provide the with recyclable material? (Y/N) 25. Is the institute doing any activity to promote the concept of recycling of plastics? 26. If yes, share the details of those activities? 	
	-
GENERAL COMMENTS	
27. Do you have any idea, who collects waste from your school and home?	

Annexures Q: Pictorial view of FGDs with adolescent children

28. How often the following plastic products are used by you?

Sr. No.	Product	Frequency (daily, weekly, monthly)	Number generated per month
1.	Polyethylene bags		
2.	Shampoo bottle		
3.	Cosmetic products		
4.	Razors		
5.	Soft drinks		
6.	Snack's wrapper		
7.	Disposable straws		
8.	Disposable cups and plates		
9.	Pen casings		
10.	Brushes		
11.	Sachet packs		
12.			
13.			

From the above products, the use of which products, you can minimize?
Any ideas regarding how to recycle plastic waste/material?
Remarks/comments (if any)

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Annexures R: Pictorial view of FGDs with women

Annexures R: Pictorial view of FGDs with women













Annexures S: Pictorial view of FGDs with adolescent children

















"Waste not, want not."
-Ben Franklin

Zeeruk International (Pvt.) Ltd.
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