NEFEJ
Nepal Forum of Environmental Journalists

SOLID WASTE MANAGEMENT

IN SELECTED MUNICIPALITIES

Situation assessment, best practices and opportunities for waste to resource

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Nepal Forum of Environmental Journalists
Lalitpur, Nepal

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The report is an integrated result of field visit, live interactions/discussions and documentations in various level on solid waste management sector several municipalities including Waling and Bheerkot of Shyangja District, Pokhara Metropolitan City of Kaski district, Kathmandu Metropolitan City.

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NEFEJ was established on 1 June 1986. It was later registered as the Nepal Forum of Environmental Communicators (NEFC), a private company, because the laws of the day did not allow individuals to organize freely and, therefore, it was not possible to seek registration as a journalists' organization. However, since it needed a proper bank account to operate, it decided to register as NEFC at the Department of Industry. It was formally registered as NEFEJ on 23 August 1990 (after Nepal became a democracy in April 1990).

Throughout its 28-year existence NEFEJ has served its membership and Nepali society as a forum to debate, report, and influence public policy for sustainable development. NEFEJ's membership has included both journalists and experts in different natural sciences who share the common objective of advocating for environmental protection and sustainable development.

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ACRONYMS

AD	Anaerobic Digestion
AEPC	Alternative Energy Promotion Center
BM	Bheerkot Municipality
EPR	Extended Producers' Responsibility
FPU :	Free press unlimited
FS	Faecal Sludge
FSTP	Faecal Sludge Treatment Plant
ICT	Information and Communication Technology
IOT	Internet of Things
IWW	Informal Waste Workers
KMC	Kathmandu Metropolitan City
LA	Local Authority
LGCDP	Local Governance and Community Development Programme
MBT	Mechanical biological treatment
MOALD	Ministry of Agriculture and Livestock Development
MoFALD	Ministry of Foreign Affairs and Local Development
MOUD	Ministry of Urban Development
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
NEFEJ	Nepal Forum of Environmental Journalists
NGO	Non-governmental Organization
NIMBY	Not in my backyard
OHS	Occupational Safety and Health
PET	Polyethylene Terephthalate
PMC	Pokhara Metropolitan City
PPP	Public Private Partnership
PPP	Polluter's Pay Principal
PPE	Personal Protective Equipments

RDF	Refused Derived Fuel
SOP	Standard operating Procedure
SWM	Solid Waste Management
SWMTSC	Solid Waste Management Technical Support Centre
SWOT	Strength, Weakness, Opportunities and Threats
TPD	Ton per Day
TLO	Tole Lane Organization
WM	Waling Municipality

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1. Summary

Solid waste management is one of the priority areas identified as part of developing clean cities and has been taken into the top priorities of the Local Authorities (LA) as it directly impacts on the public health and environment. Current waste handling practices in Kathmandu Valley are based on a "collect and dump" approach that overlooks significant opportunities for turning waste into resources. There is thus the potential to adopt a paradigm shift from a waste management to a resource management approach.

In Nepal, Solid Waste Management Act, 2068 (2011 AD) and Solid Waste Management Rules, 2070 (2013 AD) are the two regulations that govern the SWM sector in Nepal. Local governments are responsible for the collection, transportation and disposal of waste in an environmentally sustainable manner.

In Kathmandu Metropolitan City, there is no precise figures exist on waste collection coverage, but it is estimated that 30- 40% of the waste generated in the city is collected by municipality itself and rest of the percentage (60-70%) has been informally collected by the private companies/organizations. The ambition of the major local authorities of the Kathmandu Valley are to provide full collection coverage in the city, and go through the process of recycling as much as possible, latter to send it to the sanitary landfill site for safe disposal.

The impact on private sectors increment in waste collection in Kathmandu as the citizens started to pay for the waste collection services more than 2 decades ago, and the private companies association has begun, this has resulted municipal waste collection reduced significantly as of their lack of resources and management in the ground.

This is markedly different from the realities observed in the cities with a similar level of socio-economic development, where the fee tends to considerably based on the volume of waste generation, higher the volume of waste generation higher the price of its management and lower cost for the low generation. This can be applied here in Kathmandu as well.

Other challenges identified to achieve a higher waste collection coverage are the low accessibility of some areas by waste collection trucks, especially in core areas with narrow lanes, and the limited awareness of the population in general to the need of collecting and properly handling waste. Recyclable materials found in solid waste streams are routinely recovered in the landfill site at PMC. whereas, a small recycling rate exists in Waling as a result of the activities of both informal and formal stakeholders. Informal actors include waste pickers, scavengers and individual workers who collect and sell recyclables. Formal participants consist of recycling buying centres, recycling workshops and processing companies, which are legally licensed to operate and conduct profit driven activities with recyclables. Enterprises based on recycling and upcycling are needed to promote equally by the local authorities and give preference with funding supports so they can have continued with sustainable platform.

It is observed, however, that there is limited value-added creation by PMC-based stakeholders along the recyclables value chain, as recovered materials are ultimately processed in recycling facilities located in neighbouring cities or processed materials are sold overseas, in particular India. Yet, the existence of small and medium sized enterprises that partly process recyclables into secondary materials – which are reused as final products or further processed by other recycling facilities downstream – indicates there is a potential for value added creation on the recycling industry in Syangja. There are no adequate policies or regulations, either at the national or city level, in support of waste-to resource approaches or the principles of **Reduce, Reuse, Recycle (3R)**. The major policy barrier that could hinder the deployment of waste-to-resource approaches is not given priority of using compost produced from municipal solid waste in agricultural crops. While the

Figure 1 3R- Reduce Reuse Recycle

Ministry of Agriculture and Livestock Development (MoALD) could facilitate in agriculture to use maximum compost is produced from source segregated waste instead of using the chemical fertilisers which is imported. Policies and regulations that could be considered to support waste-to-resource approaches include, inter alia, the formulation of a city-wide strategy for the management of solid waste, the introduction of "polluter pays principle (PPP)" schemes (e.g. by imposing fines to the entities or individuals that dump their waste or to major generators that do not adopt segregation practices), or extended producer responsibility(EPR) practices to industries utilizing materials that can be reused and recycled.

A number of potential intervention areas for the adoption of waste-to-resource opportunities in visited municipalities were considered and discussed. These include options for biodegradable organic waste (e.g. composting, anaerobic digestion, "animal feeding"), recyclable materials (e.g. the adoption of waste bank concepts), unsegregated waste (e.g. the deployment of material recovery facilities) and undifferentiated waste (e.g. provision of decentralized waste collection services through micro-enterprises). Likewise, the community strengthen activities that have seen both at Waling and Pokhara, which enable the municipality to have source segregated materials and that will definitely reduce the cost, time and efforts for recyclables send to recycling.

As an outcome of field visit to selected municipalities (namely Waling, Bheerkot and Pokhara) conducted in March 2020, the consulting team of NEFEJ shortlisted the following opportunities as those with the highest impact potential in the Nepal context:

1. Distribution of home composting units; training on composting that reduce almost 60-65% of the generated waste at source
2. Decentralized waste composting facilities; for immediate solve the biodegradables waste management in the cities without hassle
3. Decentralized secondary waste collection points with the participation of micro-enterprises;
4. Community-driven waste banks with the organization of waste pickers cooperatives.
5. Promote recycling and upcycling initiatives through providing subsidy and facilities for their continuation
6. Separate Solid waste collection and Transportation services can have contracted and monitored.

The suggested ideas could be piloted in conjunction with the preparation of a solid waste management strategy for several municipalities. In case the experiences of piloting these resource recovery facilities are successful, replication and upscaling will be considered.

2. Introduction

This report is prepared in support of **FPU Strategic Partnership Program** under the project of Countering Fake News of NEFEJ. Aiming to know the best practices and implementable solutions for the Solid Waste Management of the Kathmandu valley, to demonstrate how this concept could be implemented.

Based on a number of consultations with local stakeholders, the project team identified solid waste management as a priority area and aims to identify intervention areas and practical measures that can address issues identified in the sector. These opportunities are expected to be aligned with approaches that are innovative, pragmatic and support the conversion of waste into resources.

Against this backdrop, this report presents situation assessment of the solid waste management at several municipalities and discusses opportunities for the adoption of waste-to-resource approaches. The report was prepared based on both on primary and secondary sources of data. Primary data was obtained in the course of a field visits done at selected municipalities. The visits took place from 15 to 20 March 2020 and included meetings and discussions with stakeholders involved in respective municipality's solid waste management sector. Secondary data was obtained through desk research, with all sources used in the preparation of the report being duly acknowledged throughout.

The report is organized into two main sections and as follows:

The initial section presents an assessment of the SWM services, facilities and provisions of the municipality and characterization of respective municipality's solid waste management sector based on the findings of both the field mission and the desk research. This characterization was structured in relation to the main stages of the solid waste sector value chain. In addition to these, the role of the informal sector, people's participation and a brief account of the policy and institutional framework of the sector are also analysed. This section closes with a discussion of strengths, weaknesses, opportunities and threats of the sector in relation to the potential adoption of waste-to resource approaches.

Second section discusses opportunities for the adoption of waste-to-resource approaches in the several urban municipalities including Kathmandu Metropolitan City (KMC). To this end, potential "intervention areas" were firstly identified based on the findings of the desk research, illustrations by solid waste management specialist, and good practices identified in cities of developing Asian countries with similar characteristics to those found in respective municipality. This initial mapping and the outcomes of the field mission served as a basis to the consulting team. These initiatives are then discussed in relation to the risks associated with their implementation. The findings of this report are expected to form the basis of a follow-up deliverable, consisting in the elaboration of an implementation roadmap for a sustainable and inclusive solid waste sector in Kathmandu valley and other emerging towns which supports to the preparation of project proposals.

Two important implications from this is that, firstly, the analysis presented on this study is restricted to the solid waste management sector and, secondly, potential synergies with closely related areas or topics– e.g. sanitation, wastewater management or integrated approaches in the scope of a local government authorities – have not been researched or actively explored in this report.

3. Situation Assessment of Solid Waste Management in Selected Municipalities:

3.1. Waling Municipality

Waling (वालिङ नगरपालिका(Municipality, the heart of Syangja, is a small valley covered with hills formed on 27 January 1997 by merging of the then three VDCs namely Waling, Dhanubase and Pekhubaaghkhor. It is a town and municipality in the western hilly region of Nepal. It is in the Aadhikhola valley in Syangja District, Gandaki Zone of Nepal. Waling will be the first municipality to have houses all coloured with pink and will be named as Pink City. Waling has grabbed an award for the best municipality of the country.

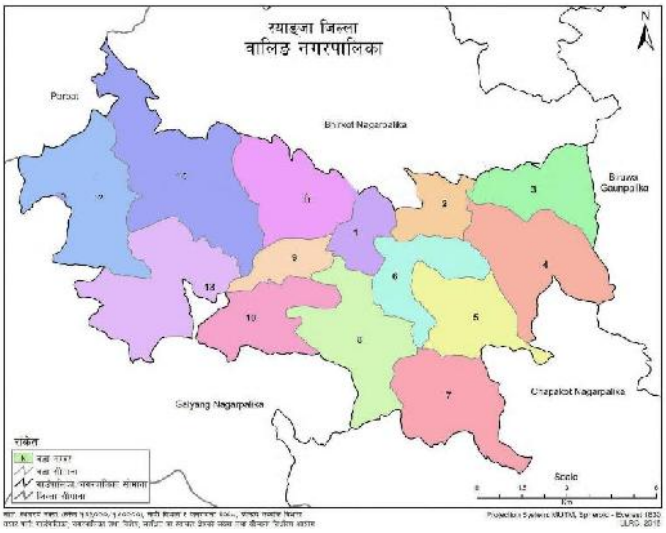


Figure 2 Ward wise map of Waling Municipality

Waling bazaar is at the height of 800 meters from sea level while the municipality's height extends from 731 to 1596 meters. The municipality have two electoral constituencies, 3 DDC ilaka and 14 municipal wards.

The total area of Waling municipality is 128.40 Sq.Km. According to the 2011 national census, the municipality population is 51,243 (which comprised 22580 males and 28663 females) with 1.7 percent population growth rate. The literacy rate is 81.71 percent, however, the municipality have already been declared fully literate. Nepal Government has declared the clean city of Nepal for fiscal year 2073.

Figure 3 Map of Waling Municipality

3.1.1. SWM Value Chain Analysis of Waling Municipality

"Waling Nagarpalikako Sarsafai Kendra" was established in 2012 AD. Waste management Center is built in Land of Purnamrit Higher Secondary School and occupying about 33 ropanies area near Andhikhola River.

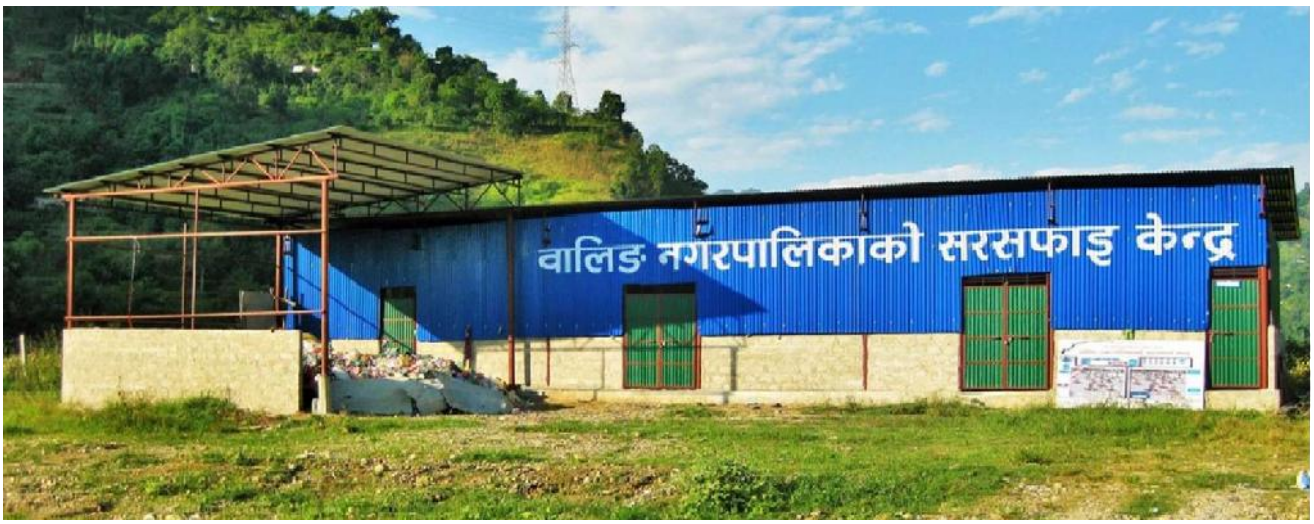


Figure 4 Waling Nagarapalikako Sarsafai Kendra Established by Waling Municipality

Solid waste is generated in the household level. Municipality suggested every household to segregate the 3 different type of waste in different bin Dry Recyclables, Wet Compostable and Glass. Bin should be managed by households themselves. They may be in the form of a sack, plastic drum, or dustbins. It meant municipality motivated to reuse the things.

Waling municipality was awarded by the government of Nepal and also had recently government announced to make it a smart municipality. In Fiscal Year 2015/16, it also won 'the best municipality of the nation' award through Municipal Association of Nepal (MUAN). It was awarded as 'the best municipality of Province 4' this fiscal year and received a cash prize of Rs. 700,000 for becoming 'the best place for solid waste management' in Fiscal Year 2015/16.

Figure 5 Mayor Dilip Pratap Khand, Waling Municipality receiving award as a best place for solid waste management from Municipal Association of Nepal (MUAN)

The municipality have participated community groups and societies for the SWM and have contracted out for SWM of the municipality to "Didi Bahini Tatha Samaj Utthan Sanstha" a women group has been working since the end of 2074 in the field of SWM. And from the last year 2075/76 municipality has started taking over them and managing SWM with detailed planning for the future perspectives. According to "Didi Bahini Tatha Samaj Utthan Sanstha" working group report the net benefit from best the solid waste management is listed below.

Table 1 Income from the solid waste management

Year in B.S.	Income (NRs.)
2071-2072	1,79,000.00
2072-2073	3,49,990.00
2073-2074	7,24,895.00
2074- 2075	4,89,489.00
Total	17,43,298.00

Source: Didi Bahini Tatha Samaj Utthan Sanstha, 2074/2075

3.1.2. Waste generation and handling

The rate of waste generation and its composition depends on level of industrialization/ urbanization, population growth, economic status of residents, seasonal variation and level of enforcement of laws. WM has about 5,952 households and about 51, 234 populations. Mostly non-degradable wastes are collected i.e. plastics, plastic bottles and degradable wastes are comparatively less. The average per capita household waste generation rate in Waling was 0.68 kg/person/day[2]. The total amount of household waste generated in the municipality comes out to be 5.51 tons per day.

Figure 6 Waste collection tipper and its separate day separate waste collection model

[2] SWM in Nepal, ADB 2013

The wastes are separated in the source, collected separately i.e. organic, inorganic, glass bottle in different bins by each and every household and are also treated separately. There are about 40 Tole Bikash Samiti contributing to manage waste in their areas. Annually best 5 active Tole Bikash Samiti are awarded.

Figure 7 Waste segregated collection bin placed at Waling Municipality

Municipality has fixed the charge depending upon the waste generation type and amount of generation by different sectors. The charge fixed by the municipality office were recorded as follows.

Table 2 Charge fixed by the municipality office to the residents

S.N	Description	Charge (NPR/ Month)
1.	Normal houses	50.00
2.	Small restaurant/ Hotel	150.00
3.	Hotel and lodge	500.00
4.	Groceries shop/ Workshop	75.00
5.	Clothes shop/ Stationery	100.00
6.	Clinics	200.00
7.	Meat shop	150.00
8.	Work shop	150.00
9.	Furniture shop	150.00
10.	Hair dressing shop	150.00
11.	Vegetables/ Fruits shop	150.00
12.	Hardware	150.00

Source: (Waling municipality office, 2018)

3.1.3. Waste collection, transfer and transportation

Municipal solid waste is collected every day in city area. Two tripper are mobilized at a time with the respective slogans "Today only organic waste" and "Today only inorganic waste". Respective tripper collected the respective type of waste on daily basis. Glasses and metals are collected once in every month. Female waste collectors go with the vehicle and collect from the door steps of households. Four women are mobilized to collect the waste in two trippers, two women in each. Waste is collected from a common location near the households. Collected waste is then transported to the Waling Nagarpalikako Sarsafai Kendra.

Figure 8 Waste collection and Transfer system of Waling Municipality

3.1.4. Waste processing and treatment

Collected waste is segregated in different categories according to the waste type. For the segregation of waste four women are employed. They are trained by the municipality to segregate the waste. Every day in the office time they come to "Waling Nagarapalikako Sarsafai Kendra" and start to segregate the waste which is collected in daily basis. Four women whom segregate the waste, also work on the practices of reduction, recycling and composting. Organic waste is composted, clothes are used to make bedsheet and other materials. Clothes are bought by such people who need the cloths to made different material from used clothes. Bottles are compacted by the compaction machine (Currently not in use). In the past, bottles and glasses were sold in Butwal but now they are storing it at the side of Waling Nagarpalikako Sarsafai Kendra in order to use them for making a plastic road in and around the city.

Figure 9 Waste processing and treatment model of waling Municipality

WM has already installed plastic PET shredding machine which can be used to mix with bitumen for the purpose of making road. Also municipality have built its own aerobic composting plant and is almost ready to operate.

3.1.5. Waste disposal

There was no proper sanitary land fill site because of lack of appropriate place. Lack of appropriate place for the landfilling site provided an opportunity for the Waling Municipality to start the campaign for the waste management at source. It means they started to segregate the waste, separate day separate waste collection and most of the households manage their organic waste at their own place and make compost to use in their agriculture land and recyclables will come in the regular waste collection campaign conducted by the municipality, which is then sorted and send for the recycling and reducing practices. There were about 3-4 tons of rejected materials accumulated at the site of "Waling Nagarpalikako Sarsafai Kendra" of the municipality.

Figure 10 Broken glasses and other rejected materials are lying at the side of Waling Nagarapalikako Sarsafai Kendra

3.1.6. Informal Sector Participation

"Didi Bahini Tatha Samaj Utthan Sanstha" recorded the municipal solid waste generation quantity. The record of 2074/2075 from the organization is tabulated below.

Table 3 Generation of municipal Solid waste of Waling Municipality

Description of waste	Yearly generation of waste (Tonnes)	Percentage by waste (%)
Bio-degradable		
Agriculture related	2550	38.25
Paper	500	7.5
Clothes	100	1.5
Wood related	100	1.5
Others	1000	15
Sub-total	**4250**	**63.76**
Non degradable waste		
Plastic	500	7.5
Rubber	100	1.5
Glass related	300	4.5
Other	1000	15
Sub-total	**1900**	**28.5**
Hazardous and poisonous	5	0.07
Chemical waste	10	0.15
Hospital related waste	500	7.5
Grand total	**6665**	**100**

Source: *Didi Bahini Tatha Samaj Utthan Sanstha,*, 2074/2075

3.1.7. Policy and Institutional framework for solid waste management

With regards to the policy framework, municipality, Waling Municipality in line with the SWM Act and Rules has enacted 'Local SWM Rules ', 2074 (2017 AD). The key provisions of the national SWM Act are:

- Local governments are responsible for the collection, transportation and disposal of waste in an environmentally sustainable manner
- An SWM Council must be formed in the city to frame local policies, set up SWM charges, etc.
- Waste reduction and segregation is the responsibility of the waste generators, and collection and transportation of the waste is the responsibility of the municipality. The municipality needs to prepare and comply with a schedule for collection
- Waste needs to be processed, and maximise it as a resourceful material instead of just taking it to dispose and have plan to recover as much as possible before it is to be taken into safe disposal in the sanitary landfill site

Figure 11 Field visit team with Mayor Dilip Pratap Khand, at Waling Innovation Center

- Polluter's pay principal
- Educating the people about the source segregation, separate collection, income generation and proper handling of solid waste

In particular, there is a framework in place to support the adoption of waste-to-resource approaches. In fact, there is a regulation that promote the use of compost produced from solid waste in agriculture, however, the city has to establish its central processing of suitable approaches for converting waste into resources – composting.

The policy and regulatory framework in Waling Municipality is also notorious for the absence of restrictions or penalties to littering and open dumping, as well as the lack of mechanisms to promote the segregation of waste at the source, the cornerstone of any sustainable waste-to-resource approach.

3.1.8. Summary of Findings

Table 4 Overview of solid waste management sector at Waling Municipality

Solid waste generation	- **Estimated 8-10 ton per day**
Solid waste collection coverage	- Est. at 70-75% of the total waste generated has been collected leaving the houses of the rural areas.
Solid waste Composition	- Limited reliable estimates exist, and the share of the different fractions can significantly vary depending on the type of generator (e.g. hotel, household, market). - Biodegradable organics are estimated to account for the highest share of the total (approx. 63-67% according to data shared from the municipality). - Recovery of recyclable materials like plastics, metals, glass, rubber, papers etc. from the established "Waling Nagarpalikako Sarsafai Kendra".
Collection and Transportation	- Waste is collected by municipality itself and approx. 75% of the total waste collected leaving the houses and business of rural areas. - A transfer station and resource recovery centre has been operating since 2069, currently processing an average of 8-10TPD. - Recyclable materials are also partly collected at the source of generation by informal workers but mainly comes at the resource recovery center. They are also recovered in other points of the value chain (e.g. at the waste segregation area). - Relatively Very low high collection rates charged to end users (50 NPR/month to households for a weekly collection service)
Treatment and processing	- Waste that is formally collected by 2 municipal vehicles which has its 75% coverage of 1500 households. Earlier years it was managed by the Didi Bahini tatha samaj utthan sanstha (3 years) does not undergo any type of treatment. - Recyclables recovered by waste segregation centre are sold to recycling buying centers and ultimately to recycling facilities, mostly located in India. - A value chain thus exists for recyclables as the municipality has been generating good revenue out of the sales. - A few recycling facilities exist in Syangja as well. Most of these employ relatively simple techniques which process recyclables into final products (e.g. Polyethylene processing). These products are subsequently sold and utilized as raw materials in other industries.
Solid waste Disposal	- Municipality has no landfill site developed yet, however there is around 3-5 tonne of rejected materials after segregation is lying and are required to find out the solutions.

Others if any	Municipality has started its young team to educate and innovate various adoptable technologies like smart public light system, GPS based informative system, robotics units for the young children where they can have learned practical knowledge at the regular classes, ICT and IOT productions through the mobilization of the young people. It is expected that this will be integrated in the solid waste management system also in near future.

In order to better understand the present status of the sector and the potential for the introduction of waste-to-resource approaches, it is useful to map out strengths (S), weaknesses (W), opportunities (O) and threats (T). In this connection, the SWOT analysis below attempts to synthesize the main features of the sector:

3.1.9. SWOT analysis:

3.1.9.1. Strengths:

In Walling Municipality people are made aware from different organizations, clubs conducted various awareness program related to waste management, so people are themselves aware and active in managing and reducing waste at the source and cleaning their surrounding areas, e.g. roadside, rivers, open places etc. Wastes are separated at the source i.e. bio-degradable and non-biodegradable wastes using different collection Vehicle (truck) in different days. Waste collected are treated differently in the "Waling Nagarpalikako Sarsafai Kendra".

Figure 12 Aadhikhola River Cleaning by the community of Waling Municipality

The concept of developing a particular locality with the active engagement of local inhabitants in the form of 'Tole Bikash Samiti' has been effective for managing waste of their areas. Door to door waste collection and transportation, and landfill site and conducting awareness programs are found satisfactory as it is the main strengths of the Waling Municipality regarding SWM.

Solid Waste management 2073 has been enacted as aligned with the SWM Act 2068 and SWM rules 2071 of the Nepal Government. With this execution, municipality has been able to generate revenue of 8.2 million including the sales of its reclaimed waste after segregation.

With the formulation and establishment of Waling Innovation Center at the Municipality's own building, the team had started Smart Waling Mobile Application

Municipality had already purchased a plastic shredder machine and have installed at the separate shed developed on its own expenses. The aim of developing that unit is to shred all the plastics and use them to mix it in bitumen and make the plastic road in and around the city. Mayor and the members of the municipality has been consulting with the young team of Pokhara – "Green Road Waste Management" and so have been coordinating for the same project in coming years.

Also for the composting station has been developed at the lateral side of the waste segregation facility, this will be operating soon with the collection of separate organic waste collection. Most of the organic waste coming from Restaurants, Hotels and other business are going for the animal feeding in the city and the remaining of the materials will be taken into the composting unit and make composting.

3.1.9.2. Weakness:

- Lack of efficient technical and trained manpower, increased in volume of waste with increase in population.
- Proper guidance for the staffs is lacking and use of proper safety equipments
-

Unmanaged and damaged the PET bottle and Paper Bailing Unit

Unmanaged rejected waste at the side of Waling Nagarapalikako Sarsafai Kendra

Organic waste pit and unmanaged garbage lying at the side of Sarasafai Kendra

Figure 13 Waste management problems started in Waling municipality

3.1.9.3. Opportunities:

Since the municipality is urbanizing, more houses will be erected and so more waste will be produced in coming years, and hence this establishment of the waste recovery is required to expanded and at the same time municipality can have increase their revenue.

Municipality has its own ICT innovation center and so can have used the local resources on making efficient waste collection, transfer and management which can have monitor the team members remotely as well.

Plastic PET bottles shredding machine has already been installed at the Waling Nagarpalika Sarsafai Kendra and with few study and analysis, municipality can have started to use the shredded unwanted plastics in making blocks for the development of pedestrian lane and also used to mix with bitumen for paving durable green road. This again leveraged Municipality to utilise waste plastics as a resource to develop the city itself.

Figure 14Yogmaya Pangeni, Coordinator, Solid waste Management Committee, explaining about the plan for utilizing plastic and other waste for the city development

Municipality has already built the organic waste management unit alongside Waling Nagarapalika Sarsafai Kendra. After taking a technical team member, municipality can have start making aerobic compost and generate more income by selling that compost to the farmers inside the municipality. Mayor has expressed to start Vermi-Composting and also shared the plan of Faecal Sludge treatment plant (FSTP), which in undergoing design for the upcoming year.

Figure 15 Aerobic Composting chambers at Waling Municipality

Municipality had contracted with AEPC for the establishment of Waste to Energy Plant at November 2018 and that project will be materialised very soon (as per the Mayor Dilip Pratap Khand's conversation). So there will be efficient waste management technology get established for bio-methanation utilising FS and other biodegradable waste generating from the city.

It is required that many municipalities have been gone through for poor database system, which can have utilised here with the locally made software and hardware system. And that will significantly help municipality to upgrade the services facilities and execution of the planned project inside the municipality area.

3.1.9.4. Threats:

WM have seen only two threats for the solid waste management of the municipality

1. In case the water flow level of the river increase during monsoon, the waste segregation, composting and other activities will be halted and the accumulated materials can have taken away by the flood.
2. Local people like to go outside the city, or capital city Kathmandu for their better jobs and opportunities, so young trained people are lacking there and so the management is getting slower.

Sukmaya Thapa, Shopkeeper, Walling Municipality:

"Previously waste of this municipality was not managed properly. We didn't use to collect waste separately . The vehicle collecting waste used not to be in good condition. After the municipality handed the solid waste mangement to private sector i.e. Didi Bahini Samaj Utthan Sanstha it has improved a lot. Waste is collected seperately i.e. organic and inorganic in different bins. Waste is collected regularly. Glass waste is collected once in a month. I have to pay Rs 75 per month and the price is different accoring to waste generation. We are made aware by municipality about the waste managemnt. Before there used to be bicscuits covers, plastics along the road side but now we don't do so we clean our sorrounding by ourselves. Roads are clean we don't throw wastes we collect it and give it to the waste collector. They don't take waste if we mix plastic waste with organic waste. In beginning we felt difficut to keep the waste separately but now it has been as our habit. We are happy that our city has been cleanest city by our act and awareness level."

Figure 16 Locals sharing the progress happening on waste collection and cooperation

Bheerkot Municipality

3.2.1. City Overview

Bheerkot Municipality (भीरकोट नगरपालिका, स्याङजा (was established on 18 September 2015 as a local government of Nepal. The new municipality was formed by merging four existing villages—Banethok Deurali, Darsing Dahathum, Dhapuk Simal Bhanjyang and Khilung Deurali—on 18 September 2015 The office of the municipality is that of the former Darsing Dahathum village development committee's Bayarghari Bazaar. Bheerkot Municipality is surrounded by Biruwa Rural Municipality and Putalibazar Municipality on the East, Parbat district on the West, Arjun Chaupari Rural Municipality, Putalibazar Municipality on the North and Waling Municipality on the South.

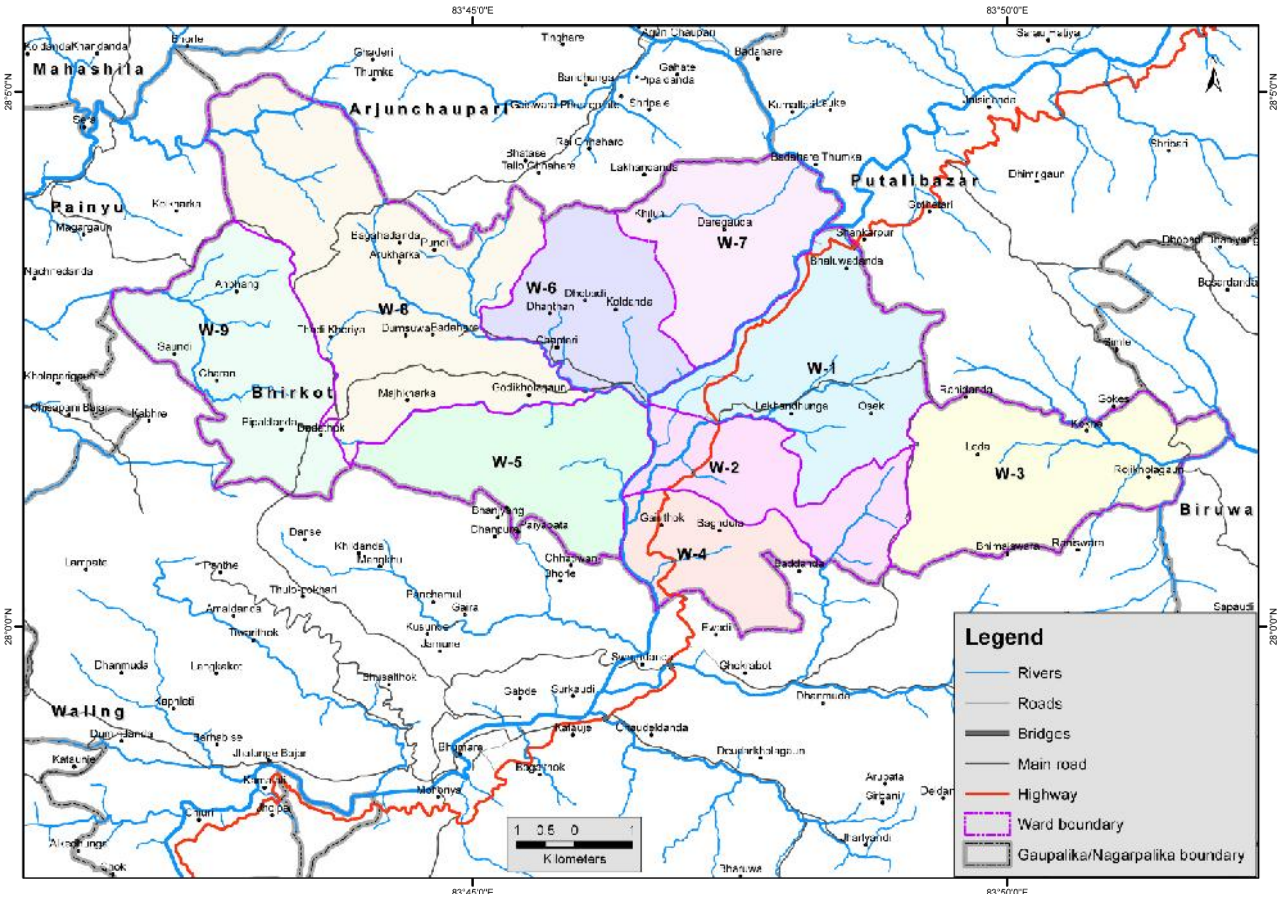


Figure 17 Map of Bheerkot Municipality

The total area of this Municipality is 34 km² (13 sq. mi) and the total population of the municipality is according to 2011 (2068 BS) Nepal census is 18,134 individuals. The density of this municipality is 530/km2 (1400/sq. mi). This municipality is divided into 9 wards. The elevation of this municipality is 730 to 1735 meters' altitude from sea level.

3.2.2. SWM Value Chain Analysis of Bheerkot Municipality

Bheerkot municipality waste management center was established in 2018 AD. Waste management is built in Guthi Land. Waste management center is situated in more than 120 Ropani.

Recyclables like Shoes/Slippers which are still required to segregate plastics, rubbers, leather etc. as it contains multiple items, they used to sale it in Rs 4-5 per KG, and once it is segregated the value will be increase as of the respective materials of plastics, rubbers, metals, leather accordingly. In similar way, they used to segregate the electronic and other items and sale them separately. All the

segregation is being done manually using few simple devices. The cost is relatively small as for the low grade plastics (Kachara) goes with Rs 8-9 per KG.[3]

Municipality has a plant and allocated 150L budget for the development of infrastructure in order to manage wet waste via composting with using waste converters. The tender has been already out for the same. It has been planned to established as an industry model. The details of rates that BM has been paying for the citizens at the time of collection are as mentioned in the below table.

Table 5 Price of Recyclables materials (Bheerkot Municipality SWM Committee)

क्र.सं.	खरिद योग्य सामग्री विवरण	एकाई	खरीद दर (सरदर)	बिक्री दर (सरदर)	केफियत
१	**शिशा**				
१.१	सेतो फुटेका शिशा	किलो	२.०० (रु.१ देखि रु. ३ सम्म)	८.०० (रु. ६देखि रु. ११ सम्म)	
१.२	रंगीन फुटेका शिशा	किलो	१.०० (रु.१ देखि रु. ३ सम्म)	४.०० (रु. ३देखि रु. ५ सम्म)	
१.३	सग्लो शिशा	गोटा	२.०० (रु.१ देखि रु. ३ सम्म)	५.०० (रु. ३ देखि रु. १३ सम्म) ब्राण्ड अनुसार फरक हुने	ब्राण्ड अनुसार दर रेट अलग अलग हुने
२	**कागज**				
२.१	गत्ता/ कार्टुन	किलो	४.०० (रु.३ देखि रु. ७ सम्म)	९.०० (रु. ७ देखि रु. १५ सम्म)	
२.२	कपि	किलो	१०.०० (रु.८ देखि रु. १२ सम्म)	१५.०० (रु. १२ देखि रु. १८ सम्म)	
२.३	किताब	किलो	८.०० (रु.६ देखि रु. १० सम्म)	१२.०० (रु. १० देखि रु. १६ सम्म)	
२.४	डुप्लेक्स (झुरा)	किलो	३.०० (रु.२ देखि रु. ४ सम्म)	८.०० (रु. ६ देखि रु. १० सम्म)	
२.५	सेतो कागज	किलो	८ (रु.६ देखि रु. १० सम्म)	१२.०० (रु. १० देखि रु. १८ सम्म)	
३	प्लाष्टिक				
३.१	एल.डि.,एच.एम.	किलो	१५.००	२५.०० (रु. २५ देखि रु. ५८ सम्म)	
३.२	पि.पि.	किलो	१०.००	२०.०० (रु. २० देखि रु. ३० सम्म)	
३.३	पि.भि.सी	किलो	१८.००	२५.०० (रु. २० देखि रु. ३० सम्म)	
३.४	गुडिया	किलो	२०.००	३०.०० (रु. २५ देखि रु. ४५ सम्म)	
४	धातु				
४.१	फलाम	किलो	१०.००	१५.०० (रु. १२ देखि रु. ३५ सम्म)	
४.२	आल्मुनियम	किलो	५०.००	७५.०० (रु. ६० देखि रु. १३० सम्म)	
४.३	टीन	किलो	६.००	८.०० (रु. ८ देखि रु. १२ सम्म)	
५	कपडा	किलो	६.००	९.०० (रु. ८ देखि रु. १२ सम्म)	
६	रबर (टायर, सोल)	किलो		ब्राण्ड, अवस्था र मात्रा हेरी	वस्तुको अवस्था हेरी

[3] As per the conversation with Krishna Bhandari, Contractor and Consultant from the Municipality

3.2.3. Waste generation and Handling

Municipality generates approx. 4-5 tons of solid waste and have been able to collect 2-3 tons per day in regular basis. It has one tipper and have focussed on the collection of dry waste collection, giving emphasis on the source segregated collection. Since the dry recyclables comes with big volume, municipality does collection 2-3 trips a day depends of the coverage in the urban areas. Collection of recyclables is scheduled for Wednesday- and Saturday generally goes once a month to the purchase of recyclables especially plastics, papers, shoes, glass, metals etc. from rural areas, whereas in the urban areas (goes week wise), and used to collect dry and wet waste separately in alternative days. However, from some places, they get mixed waste also and accumulated at the recovery center, so they started to develop a pit for making the compost.

Figure 18 Composting partition created at Bheerkot Municipality

There are about 44 Waste management committee and 92 Tole Bikash Samiti who are actively working for reducing solid waste in source and managing it effectively. Basically they used to give orientations for the committee and then have source segregated materials collection at each individual households and commercial establishments. With this system they are getting clean recyclables from the sources and required very less segregation efforts.

Figure 19 Separate chambers for segregated recyclables

3.2.4. Waste collection, transfer and transportation

In Bheerkot wastes are collected door to door separately in single truck in alternate days i.e. organic, inorganic, glass. Regular 3 persons for segregation, 2 persons for collection that goes with a driver Driver (1 tipper) and sometime if required they will rent tractor as well especially when goes for the collection from rural areas. According to wastes type, wastes are segregated in 16 different wooden boxes.

Figure 20 Waste collection tipper of Bheerkot Municipality

Regarding Glass waste, Municipality have arranged their households and commercial establishments to have packaged well at their respective place and collect them separately, so that they will just transfer to the vendors without waste their time and fuel for the transportation. With an aim that the people will not openly burn or dispose

haphazard way, municipality has been purchasing plastics and papers only from the villages, where there is no access of vehicle collection. They are planning to collect from urban areas in near future.

Pancha Ratna Plastic Industries Pvt. Ltd,
Helu- Sanokhola, **Bheerkot-1, Syangja**:

Pancha Ratna Plastic Industries P. Ltd was established in 2067 BS and have been regularly giving jobs for about 20 people to produce different grades of polyethene pipes(PVC, LD and HD) through recycle waste plastics. They purchase waste plastics from Bheerkot municipality, scrap collector of Putali bazar municipality, Waling Municipality including informal waste collection sectors of Shyangja and even from Pokhara and Baglung to meet the demand of the production. Rates varies on the quality of the materials but in an average paying out NPR. 30-40 per kg. This industry has a capacity to manage 500 kg of plastic wastes per day regularly buys in an average of 3 TPD of waste plastics from pokhara and Baglung per month.

Team has discussed with Mr.Khyam Bahadur Thapa, Manager, Admin/Account at the site and have collected these informations during the field visit in March 2020.

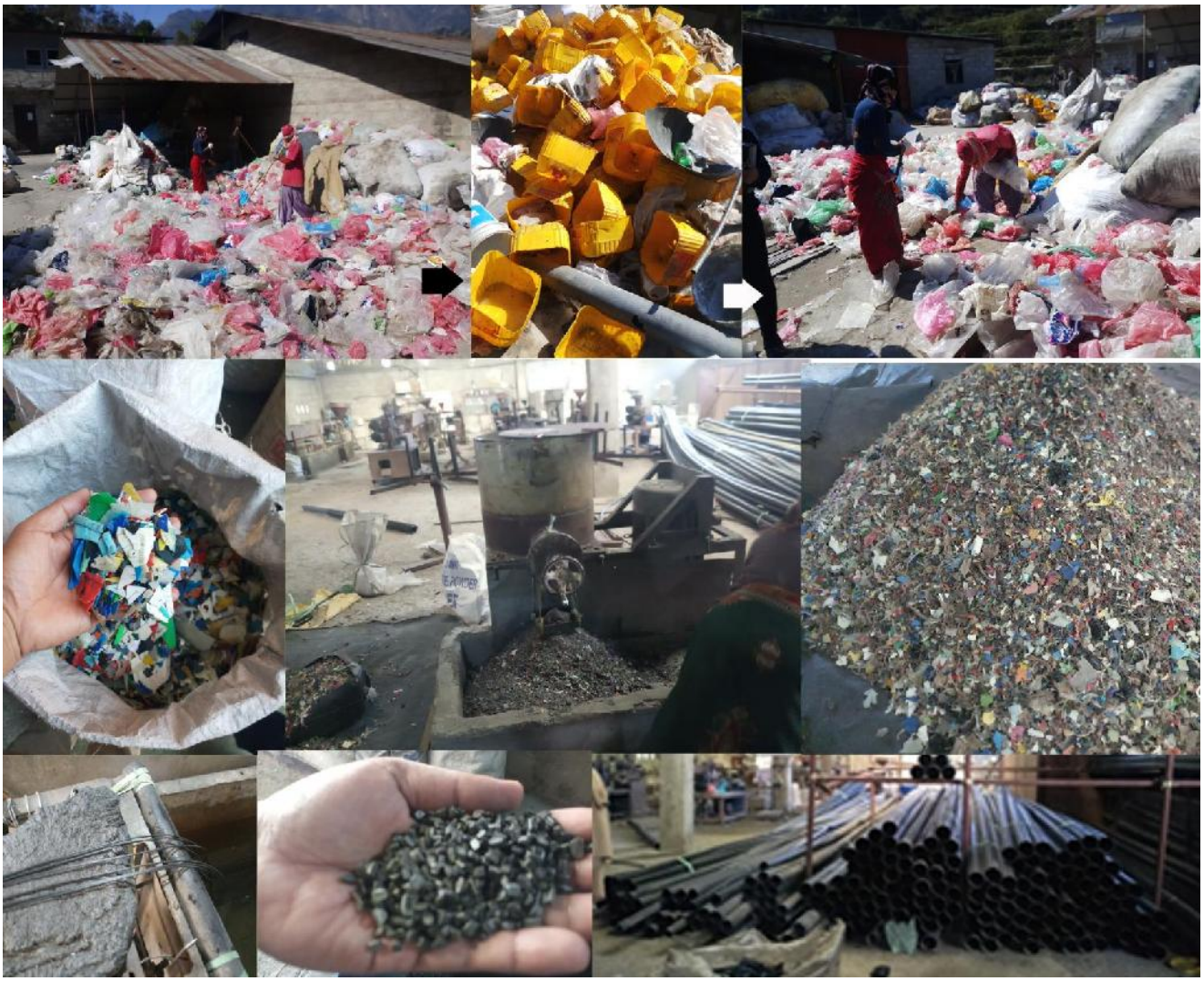


Figure 21 Waste plastic processing at Pancharatna Plastic Industries P. Ltd, Bheerkot-1, Syangja

3.2.5. Waste processing and treatment

Waste is collected at the Material recovery facility- and after the segregation, materials are kept in separate 16 wooden boxes. Municipality has planned to have 100% segregation and make use of proper clean space at the recovery facility. They have started to make park using 120 Ropanies and this waste management facility is a part of that park.

Figure 22 Waste segregation chambers installed at SWM processing center of Bheerkot Municipality

An innovative step with low resource used for the flattening the PET bottles near by the facility. They used to layer down the PET and above that the tipper will be used to drive on, then they do packaging in sacks, so it can receive more numbers.

Currently they have been using the pit system of composting but in the long run municipality is planning to build the separate infrastructure for the establishment of composting plant that can include the waste convertors for quality and efficient management of the composting process.

Bayarghari Cotton Industry, Bheerkot, Syangja:

Khusbu Khatun, 26 yrs, from Parsa district doing this business since 3 years living with his husband with 2 children.

Established in 2016 with investment of about NPR. 4,00,000. The key process of the enterprise are, Collection old/worn out clothes, mannualy Chop/Shred and then send it through processing machine to convert into cottons. Different grades of the cotton will come out from the machine as per the use of the colors, materails and its quality.

Many people bring their old rags and that will be processed taking charge of Rs 20/kg and she also does it sale by making blankets, cushions, dolls etc. As per conversation, she made profit of more than NPR. 80, 000. It is one of the example of SMEs that also process unwanted textiles and make use of valuable resource products reducing waste at source.

Figure 23 Textile factory at Bheerkot Municipality

3.2.6. Waste disposal

BM have not had a sanitary landfill site yet as they have been planning to get 100% of the material recovery through proper segregation and extraction of the materials. Which will be sold to the respective dealers and the recycling factories, mainly goes to Butwal, Birgunj and Hetauda and some even send to overseas mainly in India.

3.2.7. Informal Sector Participation

BM has involved the civil society, Tole wise 44 waste management committee, who are trained for the source segregated collection at their homes and tole areas which is encouraged by purchasing those segregated materials from the waste collection. Since the people in their coverage have a knowledge of the value within their garbage which was sending out, now they are reliant with the concept of source segregation.

3.2.8. Policy and Institutional framework for solid waste management

BM has enacted the similar conditions and rules as of the SWM Act 2068 and SWM rules 2071, which clearly mentioned that SWM starts from home with source segregation, as much as prevention of generation part and then REDUCE REUSE RECYCLE them well. Municipalities has been providing training with the mobilization of consultant who supports and also manage the waste after collection. There is not found a huge impact as of the team could not catch up the details assessment of the municipality on last field visit, but after the visit at the material recovery facility of BM, it is clearly seen that the waste prevention practices are ongoing practically on the ground.

However, as per the policy, municipality have to be carry forward to develop the monitoring guidelines and also need to systematic approach for the penalty for who disobeys the rules and documentation.

3.2.9. Summary of Findings

Table 6 Overview of solid waste management sector at Bheerkot Municipality

Solid waste generation	- Estimated 4-5 ton per day
Solid waste collection coverage	- Estimated at 30-50% of the total waste generated, 1 trips of tipper for the wet waste collection at urban areas and 2-3 trips of tipper for dry recyclables collection. They have also month wise scheduled collection of dry recyclables from the rural areas- on the basis of the value they obtain, municipality have been paying for the same for the people who segregate and give away during collection.
Solid Waste Composition	- Since the collection has been focussed on the dry recyclables and encouraging the generators by paying for the proper segregated materials, there is not exact data available - However, it seems that papers, plastics, are much more than rest of the other materials. Glass bottles are informed to the generating place that they need to keep clean and put separate- so Municipality is collecting directly from their places and sending to the dealers or recycling agents, so that will not be required to bring at the established MRF for further processing. - High potential for the recovery of recyclable materials
Collection and Transportation	- Waste is collected by municipality itself and approx. 60% of the total waste collected. - A transfer station or MRF has been operating since 2018, currently processing an average of 2-3 TPD. - Recyclable materials are collected at the source of generation by generators itself and BM is collecting from there in regular basis.

	They are also recovered in other points of the value chain (e.g. at the MRF). - Relatively high collection rates charged to end users (BM pays against the segregated recyclables at the time of collection)
Treatment and processing	- Waste that is formally collected by 1 Tipper in regular basis or mobilise its staffs for waste segregation and processing. - Recyclables accumulated after collection from customers are re-segregated and storage in the established MRF and then once it is in volume for a trip- sale them to the respective vendors'/ recycling factories. (normally in Butwal, Hetauda, Birgunj and some goes to India as well) - A value chain thus exists for recyclables. - Plastic processing plant is operating by a private entrepreneur and BM supplies the respective materials there. - Textile processing SME is also operating privately as well in the city and all the textile from BM also sends there.
Solid waste Disposal	- Bheerkot has no Landfill development in their plan yet. They have extracted maximum recyclables from the waste and have accumulated some rejected materials-in which they are exploring the best options for its utilization instead of taking it to dump somewhere and pollutes again.
Others if any	Small municipality has this kind of waste management- which is very simple, require less capital investment, less time consuming and promoting recycling through participating the waste generators is found to be a great exemplary model for rest of the all smaller municipalities in Nepal and southeast Asia.

BM has been planning to establish proper wet waste recycling plant at the MRF, that is run with the waste converter machine with 18-25 days composting. Such kind of units has been already in operation at Ilam Municipality, Kirtipur Municipality, Shankharapur Municipality, so being not so ambitious, this kind of model in waste management helps the municipality for efficient waste management in place which is still a big headache for the urban bigger municipalities in the country.

In order to better understand the present status of the sector and the potential for the introduction of waste-to-resource approaches, it is useful to map out strengths (S), weaknesses (W), opportunities (O) and threats (T). In this connection, the SWOT analysis below attempts to synthesize the main features of the sector:

3.2.10. SWOT analysis:

3.2.10.1. Strengths:

BM has a team heading by coordinator, section head and waste collection staffs, who coordinates and supports each other on source segregation of the recyclables at the generation point. After the collection system is introduced the team have fund to get those segregated materials from the customers instantly, which has encouraged many people to join this campaign. Since this is the starting phase, municipality have to invest some funds for the loss that can come in the process of management.

Very less staffs mobilised, 1 driver, 3 segregators, 2 collectors- and altogether 7 staffs found enough to manage the waste collection and management of BM. This is remarkably good model.

Engaging 42 waste management committee and 92 Tole Bikash Samittee were already formed for the development of the community and other development activities in their surroundings and that included waste management and recovery. And the formation of other new committees in different areas are increasing. This is a great example of people's participation for the waste as a resource.

3.2.10.2. Weakness:

Lack of efficient technical and trained manpower so can have plan for the integrated solid waste management system of the municipality.

The increased volume of waste with increase in population. The capacity of the waste management team also need to increase and same time the areas and investments is required.

As the municipality itself buying the recyclables, people will not pay the service fee and if the project goes in loss, municipality have to bear everything and loss the management

Also, the system adopted at Bheerkot Municipality seems to encourage the community for source segregation as of buying their recyclables, but then there will be risk of increasing demand on paying for any social development activities required in the municipality and also might be loss every month in case the cost that is paid to the segregated materials would not overcome on time.

3.2.10.3. Opportunities:

Since people have seen the value on the waste by selling their unwanted recyclables to the municipality, many of them will be more conscious on the material management- which directly impacts the SWM of the city

With this greater participation, municipality have an opportunity to run recycling factories either by their own team or by partnership in return a good value of royalty. In case the city's recyclable materials are not enough, Municipality can have extended its services to the neighbouring municipalities as well.

3.2.10.4. Threats:

Payment to the people who give away the segregated recyclables need a good amount of fund mobilization, and have to provide at the time of collection instantly, so in case of lack of fund with the team, there will be a big problem of communication among the people and the team members of SWM.

3.3. Pokhara Metropolitan City

3.3.1. City Overview

Pokhara, the second largest metropolitan city of Nepal after Kathmandu, is centrally located and is the entry point for the Annapurna trek circuit of the Himalayan range which can be seen on Phewa lake. Among higher Mountains of the world panoramic view of Dhaulagiri, Annapurna and Manaslu can be gazed clearly on Northern side of Pokhara. There are lots of museums, medieval temples and monasteries to visit. Pokhara, city of ten lakes is also the gateway for Annapurna region Trekking. It is the capital of the Gandaki Province which is located 200 KM west from Kathmandu, the capital of Nepal.

It is the largest metropolitan area of Gandaki Province (Pradesh) spread over 464.24 km^2 and houses 414,141 people (Census 2011). The population is increasing tremendously with increment of construction of Roads and other facilities for sustainable development. The city's estimated population as of 2019 is about 500,000 people 4. Pokhara Sub-Metropolitan City was merged with Lekhnath Municipality and a few surrounding villages in 2016 to create PMC. PMC has 33

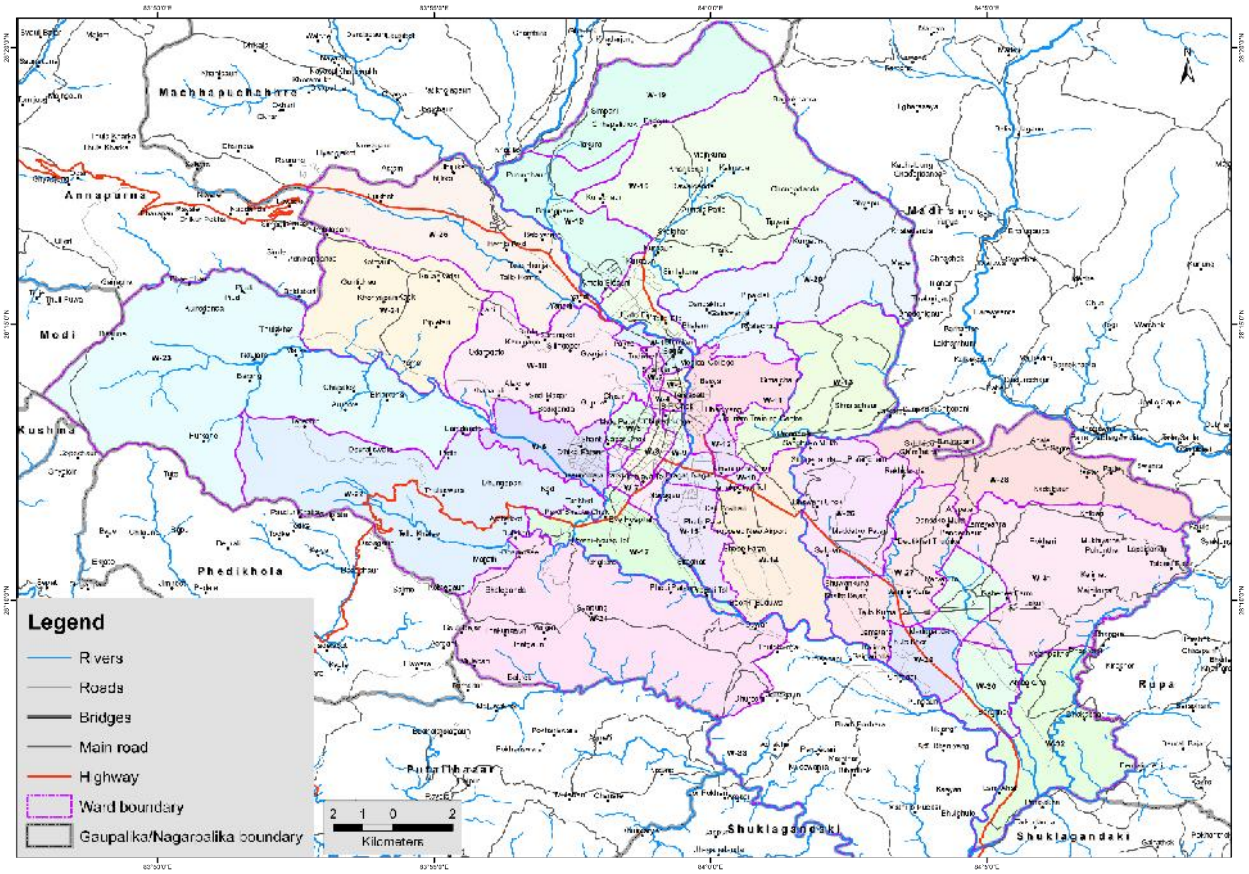


Figure 24 Ward wise map of Pokhara Metropolitan City

administrative wards, classified as core, outer and rural. The estimated population of 514,8905. The rise in population, because of the merger and influx of tourists, has increased the demand for infrastructure and for efficient service delivery.

PMC has high potential of growing economies in Gandaki Province, has a resource-based economy which is driven by its tourism, agriculture, forestry, and hydropower sectors. Pokhara is generating 182.50 Ton waste per day. About 85% are recyclable waste and 85 TPD are going to the landfill situated

[4] Estimated based on last two-decade population data

[5] City-level assessments and service improvement plans for solid waste management- WB2020

at Bachhebuduwa, ward no.18, Pokhara. About 50,000 litres faecal sludge are collected and is being treated in the specific area allocated by PMC.

Waste management Section falls under the Environment and disaster management, is one of the fifteen main divisions of PMC. The waste management branch has four sub-branches.

The waste management section has 90 personnel to undertake management and on-ground operations. Sanitation branch looking after solid waste operations and management- manned by 1 management staff, 1 office helper, 4-driver, 1-guard and 59 sweepers. Environment branch headed by 2-management staff and 1-helper and has the responsibility of tree plantation, conservation, conduct training and awareness programs.

Landfill branch has 18-personnel with one management staff, 5 drivers, 8 helpers and 4-guards. Vehicle branch has 2 management staff and 1 helper. They are responsible for the operate and manage the vehicles utilized for SWM operations.

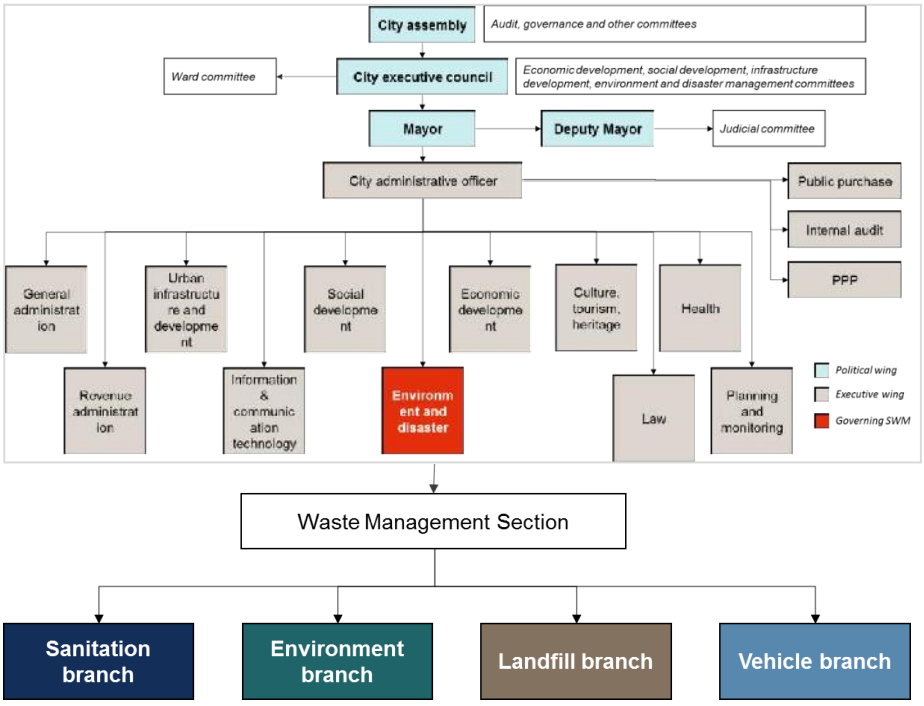


Figure 25 Organization Chart of PMC

Further PMC has engaged separate private operators for biomedical waste handling and septage management.

As of the strategic Assessment done for the City-level assessments and service improvement plans for solid waste management, the waste management branch do not have sufficient technical strength to plan for a comprehensive SWM plan. They do not have required skillsets to plan execute and monitor large scale infrastructure projects and integrate SWM.

Even though PMC is solely responsible for the SWM of the city, it has appointed 7 private contractors to collect and transfer waste from 25 out of 33 wards. Other than these contractors, at neighbourhood level, there are tole lane organizations (TLOs), which has an elected personnel of the ward, work towards awareness raising and conduct local level programs to discuss various issues.

Table 7 Private sectors involved in SWM of PMC and their contract details

SN	Name of private contractors	Agreement date	Contract period	Remarks
1	Pokhara Waste Management Pvt Ltd	2074 Bhadra 2		80% fee goes to private sector and 20% to PMC
2	Brihat Batawaraniya Sundar Nepal Pvt Ltd	2073.Bhadra 17	Until next decision made by PMC	
3	Nepal Public Health and Environment for Development P. ltd	2073 Paush 14	Until next decision made by PMC	
4	Waste Management Recycling Pvt Ltd	2073 Paush 14	2076 Paush	
5	Pragati Sansar Nepal	2074 Chaitra 8	Until next decision made by PMC	80% fee goes to private sector and 20% to PMC
6	Pokhara Greenmart	2073 Baisakh		

7	Green Mart P. Ltd (Septage collection and transport)			
8	Hariyali multi service p. ltd	2073 Falgun 17		Annual 12 L paying to PMC
9	Waste service P. Ltd.	2073 Chaitra	4 years 6 Month	10L per annum paying to PMC
PMC receive Rs 50 thousand for the waste management from the Vegetable market since 2075 Paush month.				

Source: PMC2020

3.3.1.1. Equipments for Solid waste management available with PMC

Table 8 Equipments available with PMC for SWM

SN	Equipments	Total No.s
1	Tipper	8
2	Compactor	4
3	Loader	2
4	Dozer	2
5	Septage Tanker	2
6	Suction cum jetting	2
7	Tractor	2
	Total	**22**

Source: PMC2020

3.3.1.2. Community Awareness programs conducted in 2075/76

Table 9 Community Awareness programs conducted by PMC in 2075/76

SN	Organized by	Theme	Participants/attendees
1	TLOs and women's groups of the ward	Overall waste management practices	Ward 30
2	Machhapuchhre TLO	Waste segregation in classified bins	Ward 12
3	Machhapuchhre Women's Club	Waste segregation in classified bins and market potential for selling recyclables	68 women
4	Women's group	Waste segregation	Ward 11
5	PMC		Ward 21
6	PMC	Segregation of waste and sharing revenue from the sale of recyclables among the TLOs	3 TLOs of ward 29
7	PMC	Reduction and segregation of waste at source	108 women in ward 2
8	Sinhanath Mohariya Tole	Waste segregation	Ward 1
9	PMC	Biogas production from household biodegradable waste	56 attendees representing various toles and women's groups of ward 9
10	PMC		50 attendees representing various toles and women's groups of ward 6

11	PMC		120 people from the ward representing toles and women's groups of ward 10
12	Forest Research Centre	Conducted training program on waste management	All 33 wards

Source: PMC2020

3.3.2. Role of Private Contractors:

Scope of work for the private contractor is to collect and transport waste in closed vehicles in an environmentally sustainable manner. Based on the scope, it is a service contract but the responsibility of procurement of vehicles and other equipment is on the private operator. These contracts are short-term contracts (average 2 years) and thus not conducive for capital investments.

Figure 26 Role of Private Sector in SWM at PMC

Table 10 Private Sector and their waste collection coverage at PMC different wards

Activity	Name of Private operators	Wards served
Waste collection and transportation	Pokhara Waste Management Pvt Ltd	7,17 and 21
	Brihat Batawaraniya Sundar Nepal Pvt Ltd	3, 4, 8, and 9
	Nepal Public Health and Environment for Development	1,2,5,18,23,24 and 25
	Waste Management Recycling Pvt Ltd	10, 14 and 15
	Pragati Sansar Nepal	16,19,26,33
	Just in Time	26-33
Collection—transportation and septage management (sludge collection from septic tanks)	Pokhara Green Mart Pvt Ltd	11,12,13,6 and 20
Reed-bed treatment management	Hariyali Nepal Pvt Ltd	At the dumpsite
Waste segregation and recycling at the dumpsite	Arc D Architectural Engineering Services Pvt Ltd	City wide
Biomedical waste management	Waste Service Pvt Ltd	At the dumpsite and selected hospitals

Source: PMC2020

3.3.3. SWM Value Chain Analysis

PMC does not have material recovery facilities (MRFs), transfer stations or treatment plant within the city. Part of biodegradable/organic waste is segregated by the residents and composted. Recyclable waste is sold to kabadiwalas (informal recyclers). The second level of sorting takes place at the landfill site where PMC has appointed a private contractor. Recyclable/saleable wastes are segregated and sold to large recyclers. The following two sections describe these processes further.

3.3.4. Waste generation and Handling

Table 11 Waste generation and handling by PMC

SN	Item	Quantity (TPD)
A	**Primary Waste Quantification results**	
1	Qty of waste generated by households	145.55
2	Qty of waste generated by bulk generators	4.50
3	Qty of waste generated by commercial establishments	25.53
4	Qty of waste generated by institutions/offices	7.12
B	**Total waste generation (TPD)**	**182.50**
C	**Estimated current Population of PMC**	**514,890**
D	**Estimated generation (GM/capita/day)**	**354**
E	**Average waste quantity received at the dumpsite**	**85**

Source: PMC and analysis by CRIS 2019

3.3.4.1. Waste characterization

Biodegradables consists of 65% of the total waste generation in the city as of the survey done by CRIS December 2019 whereas Plastics 19%, Paper 6%, Glass 4%, textile 2% and Metal 2%.

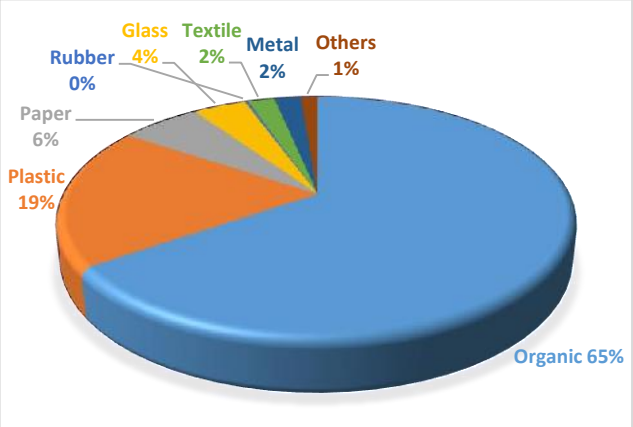


Figure 27 Waste characterization of PMC

3.3.4.2. Waste collection, transfer and transportation

Solid waste collection is outsourced to seven private contractors who provide services in 25 wards (covering 84% i.e. about 88,000 households compared to number of households as per Census 2011). Six wards are served by PMC, covering about 14% i.e. 15000 households, and remaining two wards (3% of the households i.e., 3140 units) being rural in nature are not covered with the waste collection service.

Pokhara practices curb side waste collection wherein the vehicles stop in the main arterial roads, blow their horns and waste generators come to the vehicles to dispose their waste. Waste collection frequency varies from daily (in the core city and commercial areas) to fortnightly in rural areas. It was observed from stakeholder consultations that waste collection vehicles do not follow a fixed time scheduled.

Waste collection fleet comprises four vehicles of PMC and 22 vehicles of private contractors. 170 personnel from the operators and 17 personnel from PMC are engaged in waste collection and transportation activities. The SWM Act mandates waste generators to segregate the waste and dispose it in the waste collection vehicles. However, this has not been followed in PMC. Mixed waste is collected and transported to the dumpsite. Due to very low frequency of waste collection, households in the outer and rural areas tend to segregate the waste in wet and dry fractions and the wet waste is used in agricultural land or as fodder for cattle.

Figure 28 Green painted Closed vehicle used for Waste collection at PMC

An efficient waste collection and transportation system requires complete adherence to the schedule, i.e., day and time of collection need to be fixed and followed daily. This impacts the predictability of the service. Such issues are not monitored, as the existing contracts of the private contractors do not have provisions to penalize contractors if schedules are not prepared and adhered to.

3.3.4.3. Waste processing and treatment

Dry Waste Segregation:

PMC has appointed a private contractor to separate the dry waste from the general waste reaching the landfill site. This contractor has appointed 80-90 rag pickers (60 of them females) to work at the landfill site and extract recyclables from the incoming waste once it is unloaded at the landfill. The segregated waste includes plastic, water bottles, aluminium, copper, tin, spray cans, teddy paper, books, etc. Each worker separates three-four gunny bags of such dry waste and store them in the landfill site itself. Once a week, the segregated waste is sold to the scrap dealer who runs his business in the same premises.

Once a week, the rag pickers sell the recyclable items to the recycling vendor, named Vikas at the disposal site. He has around five employees whom he pays around NPR 15,000 per month. The rag pickers earn NPR 20,000 monthly on average. Buying and selling prices of different items are given below:

Table 12Recyclables market value at PMC

Items	Buying price (NPR/kg)	Selling price (NPR/kg)
Plastics	11	13
Beer bottles	1	1.5
Books/paper	8	12
Iron	13	15
Other metals	70	90

Source: Primary survey by CRIS

This recycler sells PET to Himalayan Plastic Life Pvt Ltd and beer bottles to a beer factory in Narayanghat. This recycler/scrap dealer is from India and he said he worries about losing his livelihood if material recovery centers are set up in the city.

The total waste generation is 182 TPD. Of this, ~35 TPD, or 19%, is plastic and ~20 TPD, 11%, is paper. If this is separated at the source itself, the potential revenue that can be generated from plastic waste is more than NPR 350,000 and from papers is NPR 160,000.

Wet waste Management:

In the core and outer areas, where the frequency of waste collection is more than once a week, residential waste generators tend to segregate their biodegradable waste. In rural areas, organic waste is used as fodder for cattle or used as manure in the kitchen garden or agricultural fields. As per the primary survey results, agricultural waste, mainly generated in outer and rural areas, is used as organic manure (62% of the respondents said this) and to feed cattle (38% of the respondents).

Some TLOs have provided composting bins to households to store and reduce their organic waste. For example, in ward 10, 76 composting bins of approximately 50-liter capacity each were distributed.

Also, small-scale biogas units have been distributed by a private supplier with support from the Alternative Energy Production Council (AEPC) and PMC. Of the units distributed, 42 are for small-scale waste generators in rural areas and 40 are for small-scale waste generators in urban areas (households). The biogas units were distributed based on recommendations from ward chairman. The cost of each unit is NPR 60,000, of which AEPC pays NPR 10,000, PMC NPR 40,000 and the beneficiary NPR 10,000. These domestic bio-digesters can generate 1.0-1.5 cylinders of gas in a four-member family over a month.

Gandaki Urja Pvt Ltd, Pokhara:

Gandaki Urja Pvt. Ltd., is a private company registered in Pokhara. The company has developed and operating a 45 TPD Compressed Bio-gas Bottling plant established in ward 32 of PMC. The capital cost of the project is NPR 25 crore, of which AEPC contributes NPR 5.4 crore under its large biogas plants initiative. The plant is making use of the multiple feed Continuous Stirred Tank Reactor (CSTR) digester to produce biogas from cow/buffaloes dung, pig manure, poultry litter and vegetable/Agricultural wastes. About 20 tons of cow/buffaloes dung, pig manure, poultry litter and vegetable/Agricultural wastes per day is feed into the digester thus it has the capacity of feeding 45 TPD. The bio-gas thus produced is then purified and compressed to form Bio-CNG which shall be compressed and filled into suitable cylinders/cascades and sold as a substitute for LPG. In addition, the plant will also produce enriched organic fertilizer as another valued product which is a key factor on multiplying the agro-productions maintaining the environmental sustainability.

Figure 29Bio gas plant (Gandaki Urja Pvt. Ltd)

Green Road Waste Management Pvt. Ltd, Matepani, Pokhara

The usage of plastic materials is increasing day by day. Roads made of recycled plastics are the future of the world. Plastics are a long chain of polymers that can be moulded into desired shape with the application of heat. In addition, they have an excellent binding property. This allows them to be used in making roads, blocks, and tiles. In roads, plastics can replace bitumen by acting as a binder between aggregates. These roads last longer and are significantly less prone to cracks and potholes unlike conventional asphalt roads.

Figure 30 Plastic Road made by Green Road waste management at Pokhara

Young entrepreneur made the road made of recycled plastics possible in Nepal too. They made a trial road of 100m in Anupam Tole-14, Pokhara using 1,00,000 carry bags and noodles wrappers. They also constructed similar road of 200-meter utilising 600 kgs of rejected composite plastics in Kirtipur, Kathmandu too.

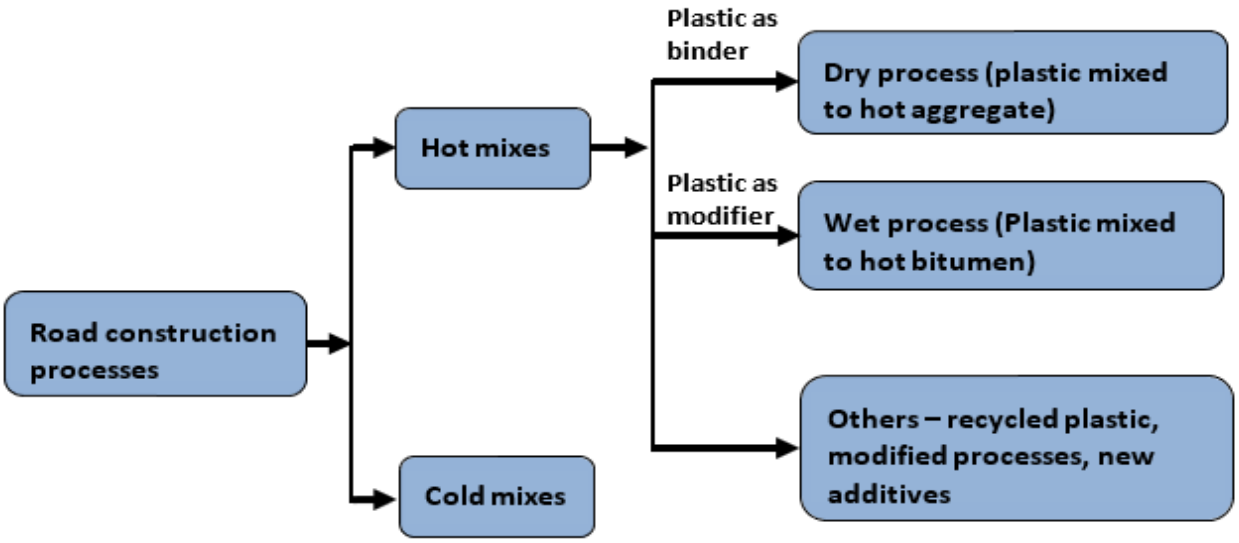


Figure 31 Schematic of the process of Plastic road Construction

The plastic-coated aggregate technique involving the use of plastic waste in road construction offers advantages as mentioned below:

- Surface property of aggregates is enhanced.
- Doubles the binding property of aggregates.
- Bitumen bonding is stronger than normal

Biomedical waste treatment plant operated by the private operator

Waste Services Pvt Ltd, appointed by PMC to collect, treat, and dispose of biomedical waste, has been operating for the past two years. The facility has autoclaving machines located at the dumpsite.

Except for Western Regional Hospital and Gandaki Hospital, all other healthcare units (around 80) utilize this biomedical waste treatment facility. The agency collects the waste from the hospitals/health facilities, treats it through autoclaving, and segregates it into biomedical waste, recyclables, and disposables. Gloves, pipes, syringes, etc., are put into the autoclaving system. Saline

water bottles, mineral water bottles and plastics are recycled. As per the plant operator's statement, the autoclave runs three-four cycles per day and ~600 kg of waste is treated daily.

Figure 32 Bio-medical waste management center run by Waste Services P. Ltd, Pokhara

According to our interaction with the private operator, the company uses six waste collection vehicles. They have five vehicles (Tata 407) to collect MSW/general waste from the hospital and one Mahindra vehicle (1 MT) for biomedical waste. The biomedical waste-collecting vehicle makes two-three trips daily. Most hospitals give segregated waste to the waste collectors. These serve 22 large healthcare centers, 10 small healthcare centers, and some clinics.

This establishment has seven workers and three drivers. The workers undergo a medical check- up (occupational health check-up) every three months. The capital investment for this plant was done by the private operator. They charge NPR 20 per kg for MSW and NPR 35-40 per kg for biomedical waste collection from the healthcare units. The operator pays NPR 10 lakh per year to the PMC.

3.3.4.4. Waste disposal

PMC has developed a sanitary landfill site constructed over 4-hectare land that has been operational since 2004. However, this is used as a dumpsite i.e., all the waste collected from the city is dumped here without any segregation and processing. A septage management plant was also installed within the dumpsite but is currently non-functional.

Figure 33 Pig farms lying at the bank of seti river (Left) and Landfill Site of PMC

A private agency has been appointed by PMC to segregate the recyclable waste (paper, plastic, glass, etc.) from the waste that is reaching this landfill facility daily and in return the agency pays a royalty to PMC. The agency extracts recyclables daily and sells the same to large scrap dealers. There are approximately 70 big recyclers and 1000 small scale individual recyclers in Pokhara. A private initiative, M/s Three Star Pipe Udyog in Pokhara receives recyclable plastic from small scale recyclers and recycles it to manufacture plastic pipes. Daily plastic waste intake of this unit is 600-700 kg and produces 400 kg of pipes.

Landfill site:

Location:

- Bachhebuduwa Bachhebuduwa, ward no.18,
- near the converging point of near the converging point of Seti river and river and Phurse Khola
- 670m high from MSL
- 9 km away from Prithivi Highway Highway

Area:

- Landfill Area: 80 Ropani
- Treatment area: 30 Ropani
- Buffer zone, Internal Road and other infrastructures composting area: 15 Ropani
- Total: 200 Ropanies
- Volume accommodate =7,20,000.00 cum
- Bounded by earthen dam at southern part for safe disposal of landfill wastage. Vertical cylindrical bolster Gas ventilation (1m dia GI mesh wire, 14 nos.)

Construction:

- Construction started: Poush 2056(Dec 1997)
- Construction completed: Ashad 2060 (June 2003)
- Inauguration date: 24th Magh 2061(Jan 2004)

Septage Settlement tank (SST):

- Capacity: 150.00 Cu.M
- Semi underground septic tank, about 1m below GL

Sand drying bed (SDB)

- Size: 41.15mX41.15m
- Divided in seven compartments
- As a filter material, five different grade of gravel varying large to small from bottom to top
- To settle the solid waste on the sand bed
- To filter the liquid in primary level

Treatment plant

- Horizontal Reed bed (HRB) area: 1105.00 Sq.m
- Vertical Reed Bed (VRB) area: 2203.00 Sq.m
- Treatment Capacity= 75.00 Cu.m/day of septage, 40.00 cum/day of solid waste leachate= 115.00 cu.m/day

Surface water collection basin

Volume: 270.00 cu.m

Municipality uses its own vehicle and human resources for the management of the Landfill, levelling, soil covering time to time after the disposal of the rejected materials at the landfill site.

3.3.5. Informal Sector Participation

There are 450-500 rag-pickers (including women, street children and elders) in the PMC area. They collect the recyclables (that have an economic value) from public areas and sell them to the local kabadiwalas.

Informal boundaries for collection of recyclables are outlined between the different groups of rag- pickers.

Figure 34 Informal Sector participation in recyclables extractions

The rag-pickers generally collect waste during the day as the local police does not allow collection of recyclables at night due to security reasons.

3.3.6. Policy and Institutional framework for solid waste management

Ministry of Federal Affairs and Local Development (MoFALD), Ministry of Urban Development (MoUD), Ministry of Finance (MoF), Ministry of Forests and Environment (MoFE) are the key ministries relevant to solid waste management for technical, operational and financial management and monitoring related guidance to local governments. Investment Board Nepal provides guidance on investments and PPP structuring for infrastructure project including solid waste management (SWM) in developing the larger projects with the investment above NPR 6 Billion.

Solid Waste Management Act, 2068 (2011 AD) and Solid Waste Management Rules, 2070 (2013 AD) are the two regulations that govern the SWM sector in Nepal. PMC, in line with the SWM Act and Rules has enacted 'Local SWM Rules ', 2074 (2017 AD). The key provisions of the national SWM Act are:

- Local governments are responsible for the collection, transportation and disposal of waste in an environmentally sustainable manner
- An SWM Council must be formed in the city to frame local policies, set up SWM charges, etc.
- Waste reduction and segregation is the responsibility of the waste generators, and collection and transportation of the waste is the responsibility of the Local Authority. The LA needs to prepare and comply with a schedule for collection
- Waste needs to be processed and safely disposed in the sanitary landfill site
- PPPs are encouraged to develop SWM infrastructure

Under the Constitution of Nepal (2015), MoFALD is the nodal Ministry guiding local government operations. MoFALD has enacted the Local Government Operations Act, 2074 (LGO Act), which is currently being followed by all the urban local levels (LA) for their day-to-day operations. MoFALD is in process of preparation of a model law for the local bodies to implement the Local Government Operations Act 2074 effectively. MoFALD is also planning to draft new policy for solid waste management.

From the environmental pollution control perspective, currently there are no technical standards developed in Nepal with respect to SWM e.g. there are no regulations/norms/standards for monitoring the quality of the leachate that is being generated in waste treatment facilities. Also there are no norms available to the LA to guide them identify suitable land for development of waste management facilities.

Also, the 'Environment Protection Act' was revised in 2019 and the Ministry of Forests and Environment is currently in the process of formulating 'Environmental Protection Rules' under the provisions of the recently published Environmental Protection Act. However, this Act only covers the requirements of carrying out environmental assessment, initial environmental examination, environmental impact assessment, etc., prior to implementation of SWM projects. This Act does not provide environmental quality standards to be complied with during the operations of waste management facilities. 'Intergovernmental Fiscal Arrangement Act' (2017) and Public Private Partnership and Investment Act (2019) are other relevant regulations impacting financing and project preparation with respect to SWM at local level.

3.3.7. Summary of Findings

In all, the city produces about 182 MT waste daily, of which 47 MT wet waste and 21 MT dry waste is segregated and recovered at source. Recovery means the wet waste is used to produce compost or animal feeding. Dry waste is sold to individual or retail recyclers. The dry waste comprises of plastic, glass, and paper. Thus, disposable waste amounts to 114 MT. As per the primary survey, 85 MT waste is reaching the landfill daily. Hence, 29 MT waste is not collected. Because of the frequency of

collection, the waste is usually stored within the premises. As organic waste is used by the waste generators for household composting, this stored waste will mainly by dry recyclables.

Table 13 Overview of Solid Waste Management Sector at PMC

Solid waste generation	**- Est 182 ton per day**
Solid waste collection coverage	- The frequency of collection varies from daily to once a month. As much as 3% of the households (3,140 out of 105,828) are not covered at all. The daily collection covers 10 out of 12 wards of the core area (42,835 households out of 105,828).
Solid waste Composition	- Limited reliable estimates exist, and the share of the different fractions can significantly vary depending on the type of generator (e.g. hotel, household, market). - At the source, share of organic content is the highest at - ~65%, followed by plastic (~19%), paper (~6%) and glass (~4%). - High potential for the recovery of dry recyclable materials at sanitary landfill only
Collection and Transportation	- Waste collection fleet comprises four vehicles of PMC and 22 vehicles of private contractors. 170 personnel from the operators and 17 personnel from PMC are engaged in waste collection and transportation activities - With the cumulative capacity of waste collection and transportation of about 132 Tons out of 182 tons generated in the city i.e. 73% of the total waste collected - PMC does not have its own MRFs, transfer stations or treatment plant within the city - PMC had its appointed private agency, extract the recyclables at site provided near by the landfill site, daily and sells the same to large scrap dealers. With this service, PMC is receiving royalty from them in regular basis. - Various community or neighbourhood-level IEC activities undertaken by the TLOs to promote segregation at source and that has been sold to the local vendor and informal sectors from them especially dry recyclables
Treatment and processing	- Waste that is formally collected by 7 private agencies and PMC goes to the landfill and the contractor with his team segregate all the recyclables from the landfill site before it is dumped in the site - Rest of the residues remain after the extraction of recyclables like plastics, papers, metals, rubbers, glass etc., will be covered by the soil in regular basis using the excavator and dozers. - PMC is receiving royalties from the contractors for the recyclables extraction in monthly basis - Contractor sale those recovered recyclables to the several large storage vendors who then take them for the recycling factories inside the country and also in India. - A value chain thus exists for recyclables. - Biodegradables from the households are basically used for the animal feeding and composting locally. PMC has been supporting TLOs with the involvement of ward officials in the respected area providing various trainings on home composting, recyclables waste segregation and sell to get recovered maximum recyclables and encourage them by connecting with recyclers.
Solid waste Disposal	- All the waste collected is transported to the sanitary landfill site located in Bacchebuduwa in ward 14 of Pokhara. Although it was designed to be a sanitary landfill site, all unsegregated waste collected from the city reaches

	the site. The site is accessible from the highway (9 km away). The total area is about 10 ha, of which the landfill area is 4 ha. Rest of the area within the premise is used for reed-bed treatment, biomedical waste handling, etc. All the waste reaches the landfill which is 12 meters deep. After collecting waste from generators, no process is undertaken to segregate, reduce, recover, and treat it. Thus, not only inert waste comes to the landfill, all the waste from the city reaches the site. Dry recyclable waste is then segregated and sold to the vendor and ultimately goes to big recycling plants. - The leachate from the disposal site is treated using the reed-bed treatment technology. Treated leachate is disposed in the Seti River, which is around 50 m from the site. However, before the disposal, it is not tested in a laboratory. This plant is 15 years old (commissioned in 2004). Currently, it is not functioning well. The filter depth is 1 m and comprises sand, pebble, bolder, etc. The dumpsite is being used since 2004 and the total leachate generation is estimated at 377,318 m3
Others if any	Since the landfill site is located within 2 km radius of the proposed international airport site and, thus, needs to be scientifically closed by December 2020 and so PMC is required to find an alternative solutions as soon as possible.

PMC has enacted local Solid Waste Management Rules, 2074 (2017) and published in the local gazette in 2075 (2018). The coverage of the rules is as per the SWM Act. Unlike the Act, no major changes have been made in the PMC SWM rules.

Local rules are crucial to implement the national level regulations. From this perspective, this rule needs more elaboration. The key issues in the rules are:

- The rules do not provide any proforma or minimum eligibility criteria to appoint private operators as per the federal law
- They do not mention the requirements and components of developing SWM plan for the city
- There is no elaboration on processing and treatment of waste, environmental standards which are to be complied with
- They do not provide details of cost recovery principles of the municipality
- They stipulate penalty for any violation but do not provide any mechanism for monitoring the acts
- Appointing private contractors for service delivery is allowed, but there are no guidelines on payment modalities

3.3.8. SWOT Analysis

In order to better understand the present status of the sector and the potential for the introduction of waste-to-resource approaches, it is useful to map out strengths (S), weaknesses (W), opportunities (O) and threats (T). In this connection, the SWOT analysis below attempts to synthesize the main features of the sector:

Strengths:

- PMC is generating revenue with deploying private sectors. The private operators are responsible for collecting SWM charges of which 20% is retained by PMC and 80% is given back.

- The contracts are for 2 years and extendable as as per their performance in every 2 years.

- Biomedical waste is collected separately and treated in situ as well as in a centralized system which is operating by the private contractor

- Domestic level segregation is in place, where people have cattle to be fed or use in agricultural fields or kitchen gardens after making compost.

- Scope of work for the private contractor is to collect and transport waste in closed vehicles in an environmentally sustainable manner.

Weakness:

- Lack of efficient technical and trained manpower, the department does not have the technical and management capabilities to manage design-build-operate-transfer contracts

- PMC contracts with private service providers do not have provisions to penalize contractors if not adhered to the schedule of collection. Additionally, there are no set processes or system for contract management and enforcing penalty provisions from the contracts onto contractors.

- There is an inherent risk of revenue leakage.

- Obligations of PMC and the private party are not clearly defined in the contracts. TLOs are third-party in some of the contracts and their roles are also not clearly defined

- Based on the scope, it is a service contract but the responsibility of procurement of vehicles and other equipment is on the private operator.

- These contracts are short-term contracts (average 2 years) and thus not conducive for capital investments.

- Performance standards that are required to be achieved by the private contractor are not mentioned and absent of performance measurement and monitoring in these contracts. Therefore, penalizing private party for non-performance is absent.

- Although the contracts mention that the receipts would be provided by the PMC, database of the actual amount of SWM charges is not available.

Opportunities:

- Less than 30% of the establishments is currently paying SWM charges and so more opportunities to increase the revenue if PMC can have efficiently monitor all the establishment units are charge for SWM services.

- Also the payments to the contractors are not linked to the billing and collection performance. This warrants for improved coverage of levying SWM charges, rationalization of tariffs, and assurance of no leakage in the collection process by improving the procurement.

- PMC can mandate for waste segregation at source; segregation is requirement of the waste generators and can have start developing decentralised waste processing centers.

Threats:

An international airport has been proposed within two km radius of the current landfill site (operationally this site is being used as a dumpsite) for which the construction has already begun. Hence this landfill needs to be scientifically closed by December 2020. Currently the biggest challenge for PMC is closing existing landfill operations in an environmentally sensitive manner, identifying and constructing an alternative landfill site on immediate basis

4. Opportunities for "waste-to-resource" initiatives for Kathmandu

4.1. The Context for waste to resource opportunities

Current solid waste management practices in Kathmandu are primarily based on a "collect and dispose" approach that overlooks the enormous potential for converting waste into resources. Partly the informal sectors that includes private companies, putting their large efforts (almost 60%) in waste collection, segregation and extracting for the recycling of the Kathmandu valley. Since there is no such infrastructure and technology have been built for the recycling and recovering from KMC, there is an enormous opportunity to play on maximum recovery of the recyclables and also have establish the system.

Having said that, KMC also have been facing the challenges to expedite its decision and move forward to the Integrated Solid waste management (ISWM) that was carried forward with international bidding process since 2011 via Investment board of Nepal (IBN) office. The awarded private concessionaire had already cleared with the DPR and have reviewed by the committee formed under the IBN. This has become a bottleneck for the Kathmandu valley and delayed to decide in development of the waste management framework. NEPWASTE and Clean Valley Company (CVC) was awarded for the Package I (consists of 11 Municipalities of Kathmandu district including Kathmandu Metropolitan city excluding Kirtipur), Package II and III (including 9 Municipalities of Lalitpur and Bhaktapur District including Kirtipur Municipality). Since the packaged has been awarded for 20+ years, and under the provision of BOOT contract, the private concessionaire have to be able to bring the investment, technology and execution of the project. Local authorities are to facilitate and support for the management of the ISWM at their respective areas. In Kathmandu (Package I case), the detail documents have been formally handed over to KMC from IBN, as SWM rules apply to have the decision to be made from LA i.e. KMC.

Having as basis the situational analysis and best practices outlined in Chapter 3 above and taking into account the specific economic and social circumstances of respective model of waste management in their areas, this chapter discusses opportunities for "waste-to- resource" initiatives in Kathmandu. These opportunities were identified based on the assumption that initiatives to be prioritized are aligned with the principles of Reduce, Reuse and Recycle (3R), and that they are at the top of the waste management hierarchy pyramid (see figure below).

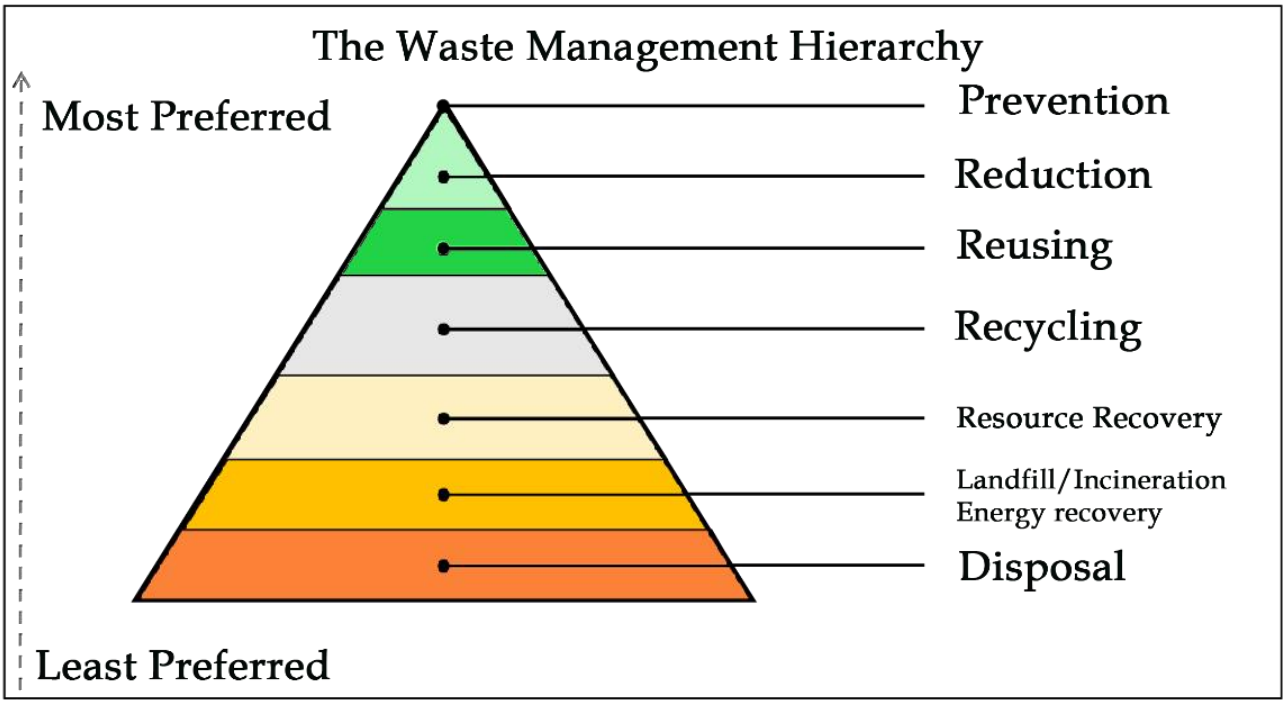


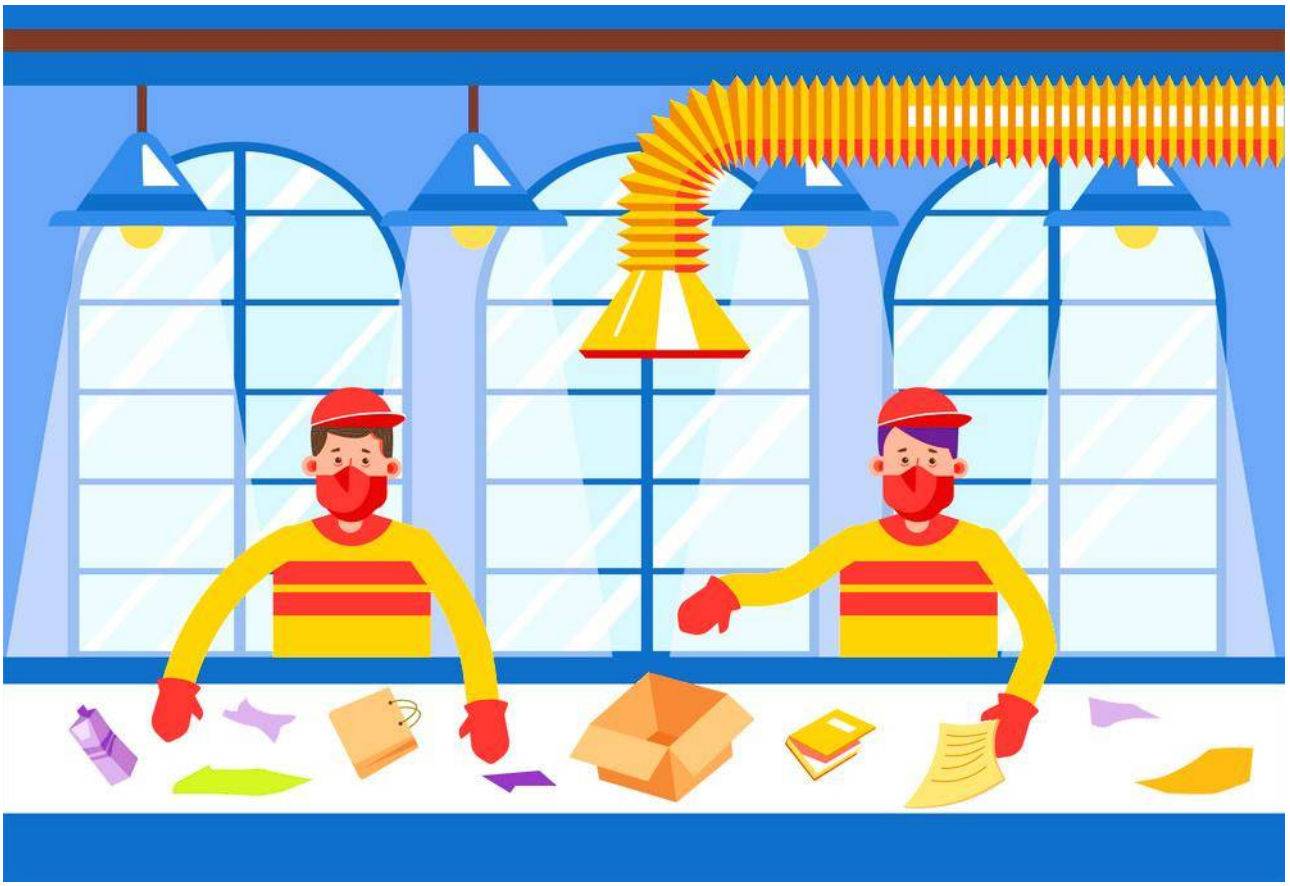
Figure 35 Waste Management Hierarchy

Source: Modified based on Hoornweg and Bhada-Tata (2012) and UNEP (2013)

At the core of any sustainable and long lasting "waste-to-resource" approach is the ability to ensure a certain level of segregation, preferentially at source, of waste streams that can be converted into a product. Taking this into consideration, the ensuing discussion is based on the assumption that approaches requiring some degree of segregation at the source should be preferred and prioritized.

In this context, SWM practices can be implemented in relation to the following waste-to-resource opportunities:

- Waste prevention awareness, less waste less management and resource saving approach
- Recovery and recycling of recyclable materials; send them for recycling
- Give feed to the feed able biodegradables and rest can use for waste to energy conversion through anaerobic digestion.
- The sludge coming out after the bio digestion, could be used to make quality compost fertiliser and use them for healthy agriculture
- Resource recovery options for mixed waste.



It should be noted that waste-to-resource opportunities that could be identified at the end of the solid waste management value chain – e.g. landfill gas recovery or landfill mining – have not been discussed in the scope of this study. Moreover, approaches which are unlikely to be technically and economically feasible in lower-middle income countries just like Nepal, including thermal treatment methods (e.g. incineration, gasification), were not analysed on this study. It has also been excluded the analysis of waste types that require dedicated handling approaches, such as electronic waste.

The section closes with a discussion of specific "intervention areas" that could be adopted in Kathmandu.

4.2. Opportunities for enhancing recovery and recycling of recyclable materials

It was noted in Chapter 3 above, that recyclable materials entering solid waste streams in explored municipalities, such as plastics, paper or glass, are routinely collected and transacted through informal and formal networks.

As depicted below in the flowchart, informal actors include waste pickers, scavengers and private Sector workers who collect and sell recyclables. Formal sectors integrating these networks consist of recycling buying centers, recycling workshops or processing companies, which are formally licensed to operate and conduct profit-driven activities with recyclables.

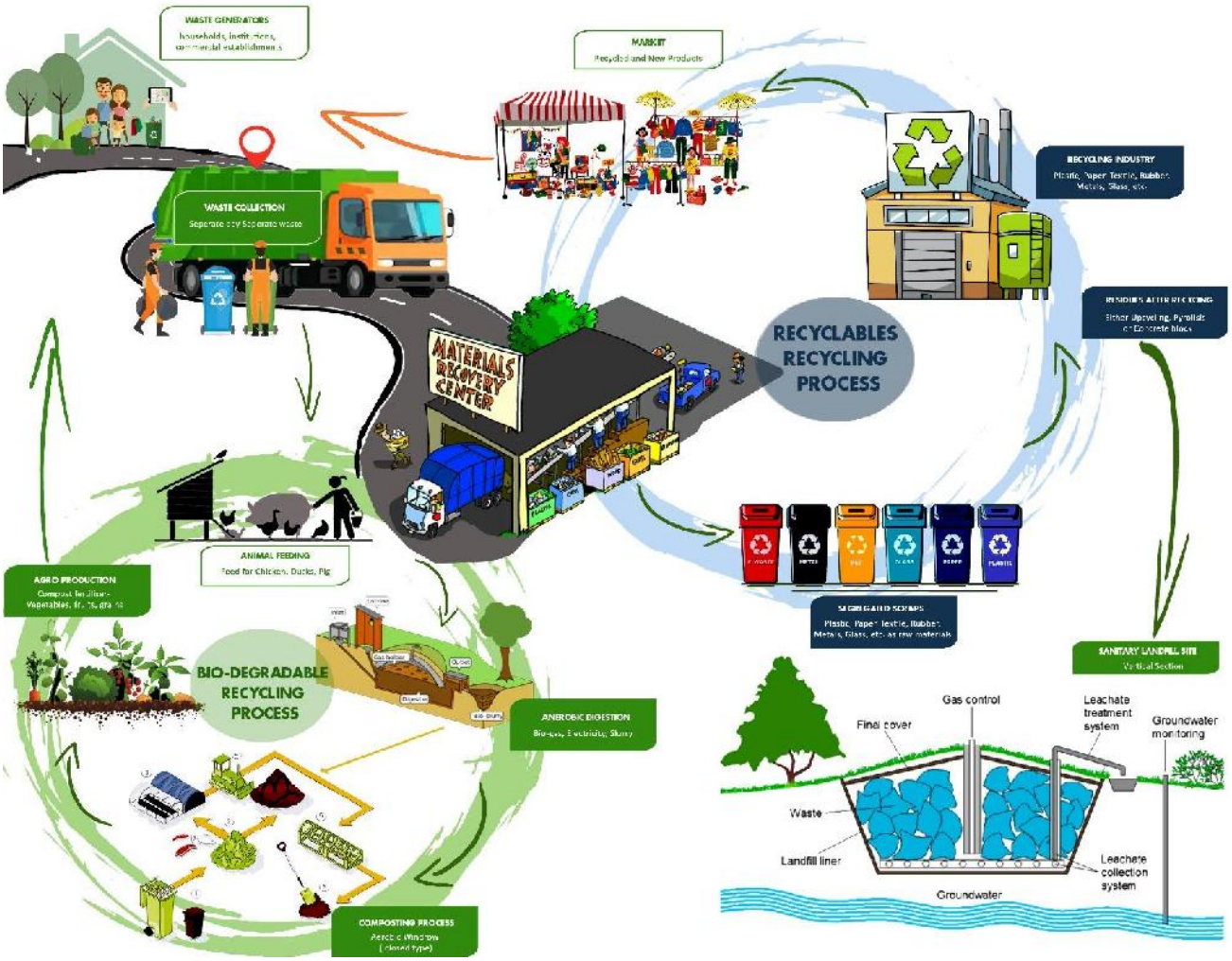


Figure 36 Solid Waste Management flow chart

While a market for recyclables is in place and operates with limited public policy intervention, opportunities do exist to increase collection rates and address some challenges identified along the recyclables value chain. Four challenges are highlighted as follows:

4.2.1. Vulnerability of all stakeholders in the value chain to market price instability.

This is attributed to the fact that the recycling industry has become a truly globalized business since the early 2000s. An implication is that any fluctuation in the price of virgin or secondary materials is quickly disseminated and usually has an immediate impact on recyclable markets globally. This vulnerability is further exacerbated by the low value added of Kathmandu stakeholders in the different stages of the recyclables value chain.

4.2.2. Vulnerability of informal waste sector members.

Informal Waste Workers that press out a living from daily door-to-door collection of recyclables are the most vulnerable actors in the recyclables value chain. They usually work independently, do not benefit from any type of social protection scheme, and are subject to the contingencies of the market by selling any recyclables they collect at the daily rate set by buying centers. Besides, most of them are getting less margin as they also have to buy recyclables from households and business entities especially scrap buyers, or Khalisisiwalas.

4.2.3. Lack of segregation practices.

No formal waste segregation practices exist in Kathmandu. The introduction of such practices could result in an increase in the share of recyclable materials entering the recyclables value chain, as well as a reduction in the disposal of these materials. Since the practice has not been adopted from the city denizens, this will be implicated even though LA enforce it in the city.

4.2.4. Limited infrastructure.

There is limited infrastructure to segregate and store recyclable materials at scale. The transfer station, where a large volume of municipal waste comes for loading into the bigger trucks and dumpers, have to take load immediately as the landfill will be closed by 2:00 P.M. So there is no much time to get it segregated even though IWWs are partly allowed in the transfer station. Currently have a mechanism for material sorting has almost stopped, beyond opportunistic and small-scale activities by operational staff. Recyclables are mainly collected and sorted at the buying centers operated by informal sector members, with poor facilities. Most buying centers are in need of cleaning equipment which would increase the value of recyclables as well as their revenue, but these facilities are absent due to lack of finance and basic infrastructure. As such, much potential waste is not segregated and collected, and revenue is lost.

A number of initiatives could be considered by policymakers and practitioners in Kathmandu with a stake in the sector in order to address these challenges. Among these are, for example, the conduct of awareness campaigns to sensitize populations to the need of segregating waste including recyclables; the introduction of mechanisms (incentives or penalties) to encourage large generators of waste to segregate solid waste; the organization of waste pickers into groups /cooperatives is already there and can have contracted for extracting the recyclables from the transfer station; the piloting of waste bank models to stimulate waste segregation practices at the community level; the introduction of social protection mechanisms to reduce the vulnerability of IWWs to the hazards of their work (e.g. health risks, market price risk); the adoption of policy mechanisms to stimulate private sector investments in recycling industries, etc.

4.3. Opportunities for converting organic waste into compost

Composting is the process of biodegradation of organic matter into a humus like material named compost through the activity of microorganisms that operate in the presence of oxygen. Composting

is a natural decomposition process that takes place under controlled conditions, where the volume of organic waste can be reduced up to 60% of the original.

Several methods exist for composting solid waste, ranging from small to large-scale applications (see Figure 24 below). The smallest plants consist of composting bin that can be adopted by families or individuals at the household level. The largest are industrial-size composting facilities that rely on machinery to process large quantities of solid waste.

The adoption of composting as a solution to treat organic solid waste could be a "win-win" opportunity in the Kathmandu and other urban municipalities context in general and in country like in Nepal in particular. On one hand, it is an approach that addresses a solid waste management issue by treating a certain type of waste – organic waste – into a final product. On the other, the resource obtained can be utilized for agriculture purposes and partly substitute the consumption of chemical fertilizers. This can be of national and strategic relevance as Government of Nepal is a country whose major economic sector and source of employment is agriculture. Agriculture remains Nepal's principal economic activity, employing about 65% of the population and providing 31.7% of GDP. More so if one takes into consideration that the national Government considers agriculture as the basis for economic growth, poverty reduction and food security (FAO, 2011).

Manual windrow composting

Mechanized windrow composting

In-vessel composting

Box composting

Worm composting

Home composting

Community based Composting

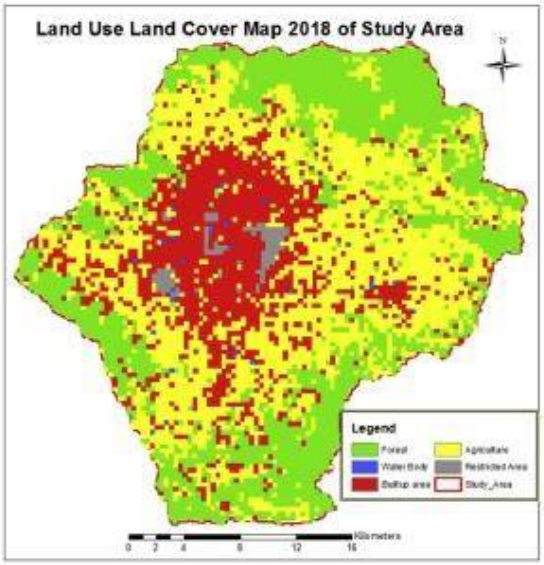
Home Composting

Windrow Composting- Biocomp

Figure 37Illustration of different composting method

The market for compost from solid waste is already exist in Kathmandu and other 42 districts[6] (as of the Biocomp Nepal's own outreach) – in fact, current regulation from the Ministry of Agriculture and Livestock Development (MoALD) forbids the utilization of compost from urban wastes in agricultural crops – opportunities for creating a huge market do exist.

First of all because Nepal exhibits the lower use of fertilizer per hectare of arable land in the region[7], and thus there is a potential for improved crop productivity with more fertilizer made available and utilized. Secondly, compost is an organic fertilizer that brings several benefits to agricultural practices, as it can contribute to a higher retention of nutrients in soils by reducing losses from leaching. Thirdly, all chemical fertilizers consumed in Nepal are fully imported, the dependency that could to an extent be reduced with the application of an indigenous resource in the form of compost. Lastly, the promotion of clean agriculture and organic farming is a national development priority, and the utilization of compost could be an element supporting this strategic direction. To have an idea of the potential of compost as a resource that could be harnessed from solid waste, it may be observed from the figure below that agricultural practice is one of the main land uses in Kathmandu Capital City.



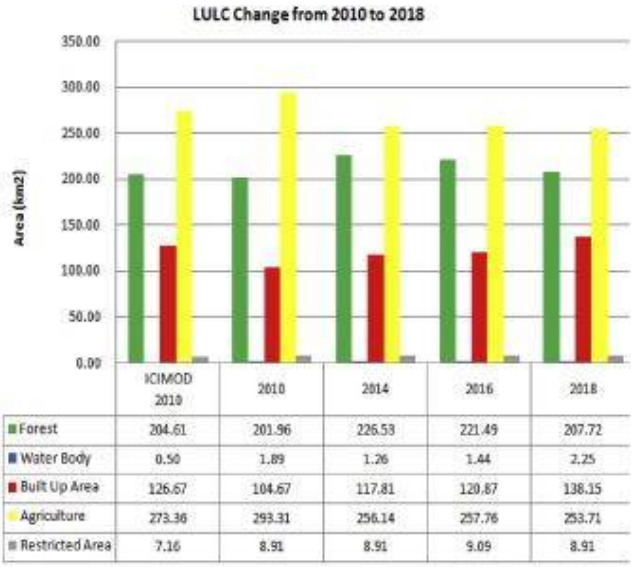


Figure 38 Land-use in Kathmandu Capital City (2018) ICIMOD

Compost produced from solid waste does not necessarily need to be used for agricultural purposes: it can be used in nurseries, public gardens, or even as landfill soil cover (in case the compost produced is low in quality). Findings from the field visit conducted in March 2020 indicate that positive experiences in the production of organic fertilizer in Bheerkot, Kathmandu (Biocomp Nepal, Blue Waste to Value) and Pokhara (Gandaki Urja P. Ltd) exist, and that as long as products meeting high quality parameters can also be produced, there is an opportunity for creating a demand for such product. It was also indicated by SWM Act 2011 and SWM Policy 2013 that the segregation of waste at source would be a necessary condition for proper solid waste management of the city, so that quality compost can be produced which enable market creation and the lifting of any regulatory restrictions in the use of compost produced from solid waste in agriculture.

[6] Biocomp has its fertilizer sales in 42 districts in Nepal

[7] **I**n Nepal, fertilizer consumption is 74.1 kg per hectare of arable land, which compares with 168.8 kg/ha in India and 503.3 kg/ha in China (https://www.theglobaleconomy.com/rankings/fertilizer_use/).

4.4. Opportunities for recovering organic waste as animal feed

The feeding of animals with food waste is a common practice in Nepal Especially for the pigs, chickens and ducks. In this step the food hygiene is required to monitored in regular basis and yes it is a best resourceful for several nutrition for them to grow. Mostly from the hospitality industries, food scraps come with unwanted cooks, leftovers from the parties and restaurants and buffets are cleanly kept in the cold room, which can be utilised to feed animals. Many animal farms used to collect from several hotels, restaurants and eateries every morning and evening- and they even pay as per the volume collection. The value chain can be upgraded if this can have systematically place with the introduction of source segregation and categorical collection system in those business houses which can be regulate the separate collection for the feeding and remaining materials which cannot be used for feeding can be taken for the anaerobic digestion or composting.

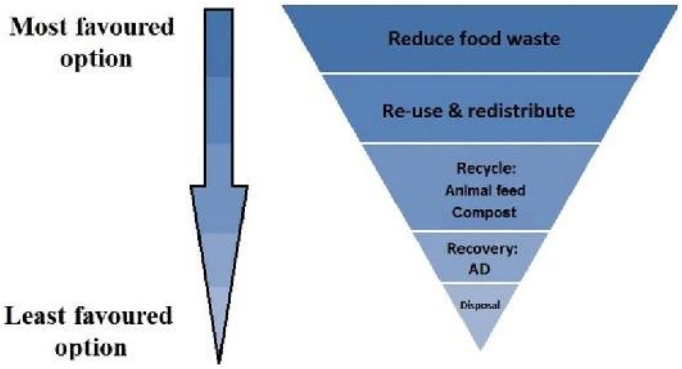


Figure 39 Biodegradable waste management hierarchy

Feeding to household livestock is relatively low-risk in terms of health hazards, such risks are higher in case food scraps are routinely provided in commercial or industrial facilities. A foot-and-mouth disease outbreak in the UK in 2001 was attributed to swill feeding[8]. These hazards to animal health could be reduced with the introduction of regulatory, certification and standardization measures. Countries like Japan or the Republic of Korea recycle approx. 40% of their food waste as animal feed (AAF, 2016). Yet, in these countries such practices are tightly regulated, with food scraps having to undergo a standardized heat treatment and a sterilization process before being provided to animals. Thailand is another country where these industries are reported to exist.

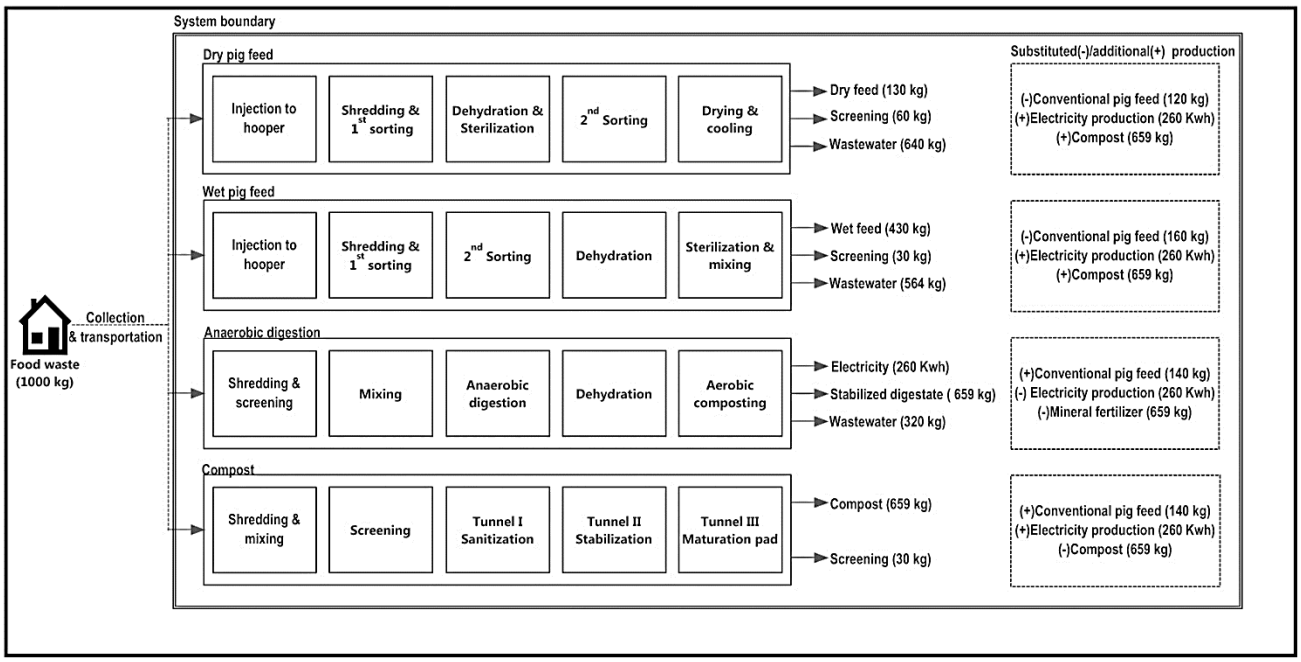


Figure 40 Schematic diagram for waste to resource applicable for Kathmandu and other urban municipalities

This waste-to-resource opportunity may be considered in the context of Kathmandu solid waste sector. Nonetheless, the actual potential of the approach is unknown, and the conduct of a baseline

[8] A report by FAO (2011) indicates a relatively high incidence of foot-and-mouth disease in Kathmandu. However, no evidence is available to establish a linkage between the disease and the practice of swill feeding.

study would be an important step in order to properly understand the value chain, business models, and volumes of organic waste that are processed this way.

4.5. Waste-to-energy opportunities through anaerobic digestion

Among the opportunities for converting solid waste into energy, the anaerobic digestion (AD) route is, in principle, the most suitable to the Nepal context. AD is a biological treatment method whereby the organic fraction of waste is decomposed into biogas due to the activity of anaerobic bacteria. The biogas generated can be used as a heating fuel or converted into electricity. The deployment of AD approaches in Kathmandu could therefore increase the supply of an indigenous, clean and renewable energy source. It could also support the access of local populations to cleaner forms of energy.

KMC has already installed a prototype bio-methanation plant in 2017 with the support of the European Union with the capacity to engulf 3 TPD of organic waste which can produce 96 kg gas, 300 kg bio-organic fertilizer, and 13,500 litres of purified water daily. It was aimed to produce 14KW electricity and use it for the office station at Teku transfer station and Environment Management Department of KMC but soon then the load shedding in the country is lifted and this unit is just used to produce gas- which is not operated now. With this available resources, KMC can have install such plant in several areas and take maximum benefits of waste to resource which can have reduce 2500 tonnes of carbon dioxide emission annually.

Figure 41 Waste to energy (WTE) Plant installed at Teku Transfer station by KMC with the support of the EU

These opportunities appear to be more significant in the case of heating fuel supply rather than electricity supply, as 65% of the country's urban population still relies on traditional biomass for their heating and cooking needs, while access to electricity in urban areas is 97% (IEA, 2016).

The AD processing of urban solid waste is still a relatively novel and fairly untested approach in most developing Asian urban areas. One of the main challenges associated with the technology is the need to ensure a relatively high level of segregation of the organic fraction to be treated, otherwise the AD process can be significantly hampered and eventually fail. In this context, in the short to medium run it may be reasonably expected that AD approaches could only be deployed in relatively small-scale settings in Kathmandu, with the assumption that any biogas generated would be consumed locally and in proximity to the waste treatment facility.

Nonetheless, it was reported during the field visit at Gandaki Urja, Pokhara was operating the large scale which show highly feasible of deploying AD facilities for processing organic waste collected from hotels, restaurants and markets.

4.6. Processing and treatment options for mixed waste

A brief overview of three options that could be deployed to treat unsegregated waste streams is discussed below. These consist in the deployment of material recovery facilities, the production of refuse- derived fuel, and mechanical biological treatment.

Material recovery facilities (MRFs) are processing units where incoming waste streams are sorted out for the recovery of valuable materials. Fractions with market value that are recovered can be sold to end- users and/or dispatched to recycling facilities for further processing. On its most simple designs, MRFs can consist of a sorting table and a weighing scale, with its operation relying on manual labor. Larger MRFs are automated and more complex in design, usually involving the operation of pay loaders and fork lifts, as well as equipment such as conveyor belts, magnetic separators, trommel screens or balers. MRFs tend to be associated with high capital and operational costs, and it is usually advised the preparation of a business feasibility study prior to any investment decision (ADB, 2011).

Refuse-derived fuel (RDF) is produced through the processes of shredding, drying and densifying solid waste streams into a pelletized fuel. On a typical RDF production plant, input waste is separated into its combustible and non-combustible components. The combustibles are crushed and shredded into a uniform size, dried and compacted into the final RDF product. RDF can be used as a fuel in industrial boilers, such as cement factories or brick kilns. The harnessing of solid waste for RDF production has been assessed in Kathmandu by CEEN, but the outcomes of such study has not been publicly disclosed.

Mechanical biological treatment (MBT) designates several methods of pre-treating waste which are usually carried out prior to landfill disposal. In general, an MBT system includes manual and/or mechanical sorting facilities where large inorganic items such as recyclables and hazardous materials are separated, while the organic fraction is partly decomposed through composting. MBT can reduce the volume of waste disposed to landfills and facilitate the recovery of recyclable materials, even if these are soiled/unclean recyclables. MBT facilities are usually large-scale and installed in close proximity to disposal grounds. Due to the scale of these plants and the mechanization involved, MBT tends to be associated with high capital and operational costs.

4.7. Summary and discussion of potential intervention areas for waste-to-resource opportunities in Kathmandu

The matrix presented below is specific to the "intervention areas" for waste-to- resource opportunities that could be adopted in KMC. These intervention areas, in case implemented, would result in tangible changes – i.e. they lead to "on the ground" interventions – to the way solid waste is currently handled and/or managed in Kathmandu valley.

The matrix characterizes and briefly discusses each intervention area proposed, whereby:

- Each area was organized in relation to four main types of waste:

  i) biodegradable organic;
  ii) recyclable materials;
  iii) unsegregated waste; and
  iv) undifferentiated waste.

  The latter pertains to opportunities that can be pursued regardless of the type of waste considered.

- Expected impacts of each intervention area were considered along the solid waste sector value chain, with three main stages considered for this purpose[9]: i) waste generation & handling; ii) waste treatment/processing; and iii) marketing of the resources recovered or generated from waste.

- Since KMC have a direct role in the development and/or implementation of any of these intervention areas, and so it was not indicated in the stakeholders' column.

- A number of actors whose presence in Kathmandu Valley could not be confirmed were either not mentioned in the stakeholders' column (e.g. technology providers) or were stated in a generic manner (e.g. NGOs, Private Companies, waste transportation companies, etc.).

- Benefits and challenges from harnessing the opportunity(ies) associated with each intervention area were indicated in the table.

- The overall impact potential of each intervention was considered either as marginal, incremental or transformational.

It needs to be noted that the intervention areas identified should not be considered in an isolated or mutually exclusive manner, and in fact they could be combined or streamlined as part of an ISWM plan or approach.

[9] This is, in effect, a simplification of the value chain that was used in Chapter 1 to characterize KMC's solid waste sector. As here it is taken a "waste-to-resource" perspective, the disposal stage is replaced by the marketing of the resources recovered or generated from waste, regardless of whether the demand for such product already exists or needs to be created.

4.8. Potential intervention areas for KMC's solid waste management sector

Table 14 Potential intervention areas for KMC's SWM sector

Waste Type	Intervention area	Description and rationale for the intervention	Stakeholders	Benefits/Challenges expected in development and implementation
BIODEGRADABLE ORGANIC	Maximize the use of home composting units	Fully-decentralized option for treating solid waste, where home-composters are used to process organic waste generated in households. The compost produced would be utilized by households themselves.	Local communities and residential households Community Based Organizations (CBOs), NGOs	- Cost savings in the collection, transportation and disposal of waste. - Waste treatment and utilization of the resource would be fully addressed upstream - Several households in Kathmandu already recover organic waste (e.g. for animal feed) - Many discrete composting units necessary to achieve a transformational change
	Deployment of small/ medium scale composting facilities	Decentralized solid waste management approach whereby the organic fraction of waste is segregated, collected and transported to small and/or medium-sized composting facilities. The compost produced could be utilized in agricultural crops, plant nurseries or purchased by KMC for utilization in the city's public gardens and also encourage its citizens	Sources of waste generation: households, public buildings, markets, hotels, small businesses, etc. Waste collection companies, MoALD, Wholesale and retail sellers of fertilizers Farmers	- Leveraging of a locally available resource in the form of fertilizer, - Relatively simple technology for treating the organic fraction of waste - Technology already tested and applicable even in city areas - Easily manageable and goes with current development of value chain, from waste generation to compost use - Use of compost produced from solid waste in urban agriculture is already adopted by many citizens in Kathmandu.
	Formalize and streamline the recovery of organic waste as animal feed	Reports indicate that organic waste is, to some extent, already recovered in Kathmandu, although informally, for use as animal feed. This intervention would aim at improving and maximizing these opportunities, for instance by increasing collection rates, fostering business opportunities and certifying feed products produced.	Sources of waste generation: communities, households, public buildings, markets, hotels, small businesses MoALD Animal feed companies and business associations	- Option for harnessing the organic fraction of waste which appears to already exist, even if through informal networks - Good experience and practices found in Kathmandu and other urban areas of Nepal on this "waste-to-resource" option
	Harnessing opportunities for waste-to-energy conversion through AD treatment	Decentralized waste management intervention where organic waste is segregated and converted into biogas through AD processing, with the biogas generated used as a heating fuel or electricity.	Local communities and residential households CBOs	- From a technical standpoint, AD is the most feasible "waste-to-energy" approach for solid waste in the developing country context - The AD process requires as input a very well segregated organic fraction of waste - Demand for the energy generated required to be located relatively close to the treatment facility but also had proven technology of

				Gandaki Urja, Pokhara- KMC can have bottling station and supply everywhere.
RECYCLABLE MATERIALS	Testing and deployment of the "waste bank" model targeting both informal sector members and local communities	Waste banks consist of banks that accept waste – mainly inorganic waste – as a deposit. A community focused concept, encourages households to segregate waste and exchange it for cash or a deposit in a savings account. IWWs could also play a role in the implementation of such model by for examples, DOKO recyclers, Khalishisi etc	Local communities and residential households, Informal waste sector members, CBOs Recycling companies Local banks	- High potential for improved livelihoods of IWWs, - Promotes waste segregation and the collection of clean recyclable materials, - Potential for developing innovative business models, such as micro-finance schemes, - Potential resistance to formalization by IWWs, - Risk that IWWs may be bypassed with the adoption of the approach in case communities sell recyclables directly to recyclable buying centers through waste banks
	Strengthening existing recyclables value chains through technical and financial assistance	Conducting an integrated approach throughout the value chain, with the introduction of targeted measures along the recyclables value chain. A "package" of measures could include, for example, the introduction of EPR models, support to the establishment of waste pickers cooperatives, awareness programmes to promote the segregation of waste at source, policies to attract "value- added" recycling industries to the country, etc.	IWWs, NGOs, Companies producing materials that can be recycled' Business associations, Recycling companies	- Limited disruption to a value chain that appears to already function with limited public support, - Potential for enhancing the recovery of recyclable materials and livelihood improvement, - Reduced potential for transformational impact as the focus is on small interventions along the recyclables value chain, - Potential resistance to formalization by IWWs.
	Implementation of a system of collection points for recyclable materials	Intervention area where households, small business and other actors generating solid waste segregate recyclables and bring them to secondary collection points in the city. Informal sector participation, integration and formalization could be explored through the creation of opportunities for the establishment of micro-enterprises for recyclable collection and/or other roles.	Sources of waste generation: communities, residential households, public buildings, markets, hotels, small businesses, etc. CBOs and NGOs Waste collection companies Recycling companies	- Potential to significantly increase the collection of source segregated recyclable materials - Risk of interference in informal sector networks, raising issues about waste ownership - High investment and operational costs associated with the development of an infrastructure of waste collection points for different recyclable materials and a dedicated collection and transfer system - Long lead times for implementation in view of the number of stakeholders involved, investment requirements, community participation, etc.

UNSEGREGATED WASTE	Deployment of MRFs to increase the recovery of recyclables	Implementation of one – or more – MRFs to enhance the recovery of recyclable materials from unsegregated waste, with possible sites being the location adjacent to the transfer station.	Waste collection & transportation companies Recycling companies	- Enhanced opportunities for the recovery of recyclable materials - Limited deployment of MRF facilities in South Asian Countries due to high investment and operational costs, and the risk that the most valuable recyclables are collected upstream by IWWs - Not in support of transformational "waste- to-resource" measures whereby a higher value from resources is to be obtained from source segregated waste
	Deployment of opportunities for the production and utilization of refuse derived fuel (RDF)	RDF could be produced from unrecyclable waste fractions that are combustible (e.g. textiles, paper, wood), with the fuel generated used in industrial boilers (e.g. cement /brick kilns) or for electricity production. Waste could be collected from the landfill site, and the RDF production facility deployed in tandem with MBT of mixed waste.	Industrial facilities using industrial boilers (e.g. cement kilns)	- Option for harnessing waste in the form of energy - Potential for toxic emissions in case materials such as PVC are not removed from the waste fraction recovered for RDF production - Limited "pro-poor" impact of the intervention - Limited impact along the whole waste sector value chain
UNDIFFERENTIATED WASTE	Increasing waste collection rates by decentralizing collection services through small-scale operators (micro-privatization of waste collection)	This intervention would aim at fostering opportunities for the establishment of small-scale operators, such as micro-level enterprises or CBOs, in order to extend waste collection coverage to the whole city. It would support the achievement of two goals: full waste collection coverage, and savings in collection costs. This intervention area could be articulated with initiatives supporting the segregation of waste at source.	Communities, residential households, public buildings, markets, hotels, small businesses, CBOs, NGOs, Informal Waste sector members	- Two major challenges currently identified in the city could be addressed simultaneously: low waste collection coverage and low levels of waste segregation at source - Strong pro-poor component, in light of the opportunities to formalize IWWs activities, job creation among the urban poor and provision of collection services to low-income settlements - Opportunities for introducing "polluter pays" principles through the creation of business models where communities served pay directly to the companies providing the collection service. - The intervention area in itself falls short of a "waste-to-resource" component and would need to be combined with complementary measures - Unwillingness of communities or participants to pay for the services provided
	Implementation of measures to minimize waste generation rates at source	Implementation of measures to minimize waste generation rates at the source (e.g. reduction in the consumption of plastic bags) through education and sensitization programs, including reward and penalty schemes.	Communities, residential households, public buildings, markets, hotels, small businesses, CBOs	- Reduced costs incurred with collection, transportation and disposal of waste - Difficult to set a baseline and the specific contribution of the measures adopted to the reduction of solid waste generated - Intervention only focused in the initial stage of the solid waste value chain, with the potential to only alleviate – and not fully address – major issues identified in the sector.

OTHERS	Overall waste management information and documentations	Documentation of the every step of the activities carried out in SWM would ultimately supports on the efficient planning and decision making without losing the time and efforts of the available resources	Municipality itself or the contracted private sector who manage waste in the municipality	- Software development/ application tools will reduce the time of data entry, and have also support the reduction of expenditures in the long run - Database is made available at any time. If the real-time data management is made available, that lead no hassle to face the media and upcoming researchers in the municipality - GPS tracking of the vehicle, routine dissemination/ with updates can be made visible for the citizens, so they can have plan accordingly to provide their generated waste in proper coordination - This will reduce the right information dissemination to the public and also for the planning team useful for decision making. - Digital payment gateways integration will help people to pay the fee easily on time and also reduce other expenses that create if followed in manual system.

4.9. Proposed waste to resource initiatives for Kathmandu

This is concluded that two types of initiatives would be prioritized: i) the development of a solid waste management strategy for Kathmandu, and ii) the deployment of resource recovery facilities. With regards to the latter, the following opportunities were shortlisted by the consultant as those associated with a more visible and potentially higher tangible impact:

- Promotion of home composting units;
- Decentralized waste composting facilities;
- Decentralized secondary waste collection points with the participation of micro- enterprises (SMEs, MSMEs);
- Community-driven waste banks, in coordination with organization of waste pickers cooperatives.
- Establishment of Recycling and Reprocessing

Home composting units which has been initiated a decade ago (Since July 2002 subsiding for its citizens aimed to reduce waste from the source) from KMC and SWMTSC to the rest of the other Municipalities in Nepal. The consultant had derived this aerobic composting bins himself and worked out the best way to manage the composting, is strongly advising to use in household level. Reasons for this are, inter alia, the infrequent or non-existent provision of municipal waste collection services, which prompt many households to separately handle the biodegradable fraction (e.g. for animal feed or by simply burying it in households' backyards), which tends to quickly decompose in the context of Kathmandu's warm temperate climate. It can thus be hypothesized that the adoption of this approach would not require a major behavioural change to current waste handling practices of households.

Figure 42 Home composting bins

The deployment of decentralized waste composting facilities is, in principle, a particularly well-suited solution to treat organic waste generated in large facilities or buildings (e.g. restaurants, hotels, markets, government offices, schools) or even households that are unwilling to adopt home composting units. By "decentralized" it is meant that these facilities would be located in relative proximity to the sources

Figure 43 Decentralized Community based aerobic compost plant of Kirtipur Fohar Byawasthapan Sewa P. Ltd. running at Kirtipur, Panga, Kathmandu

of waste generation, thereby saving costs incurred with the collection/transport of waste and its proper management. However, several challenges can be identified with respect to the deployment of this approach. Kirtipur, Shankharapur, Chobhar had its already proven examples and running with low capital investment.

Among these the need to ensure that the organic fraction of waste meets certain segregation standards, and that waste collection and transport procedures are in place in order to ensure that the segregated fractions reach the composting facility without being mixed up with other waste streams. Another noteworthy challenge concerns the creation of a market or demand for the compost produced, including the processes of having it tested in laboratory and certified by an official certification body. In this

Figure 44Branded Compost of Nepal through decomposition of biodegradable waste materials

regard, it needs to be emphasized the regulation of MoALD that need to promote the use of compost in agriculture. Against this setting, it is recommended as a first step that a small-scale (e.g. a facility with a processing capacity of 1-2 TPD) decentralized waste composting unit could be piloted and tested for treating waste generated from business entities. Upscaling and replication would subsequently be decided based on the outcomes and lessons learned from piloting activities.

Implementing decentralized secondary waste collection points with the participation of micro-enterprises is an option that could be trialled in order to simultaneously address two major challenges in Kathmandu: low waste collection coverage and low waste separation rates at source. One of the root causes for the low collection rates observed in Kathmandu limited resources of KMC and formal contractual process for the private parties to have their support on the waste collection in the city.

A proper set up facility of the MRF is urgently required for the dry recyclables segregation. This can be developed at the existing transfer stations as a city center and some can have establish outside the ring road. If considered in tandem with "waste-to-resource" approaches, decentralized collection could be conceptualized from the beginning alongside methods to collect segregated waste at the source. Decentralized collection has been adopted with considerable success in several cities in developing countries, especially in suburban areas and low-income settlements. A key success factor for waste management concepts such as these to effectively work is the need to ensure a reliable source of income to the micro-enterprises providing these services, which could be in the form of direct payments from payment gateway (e-sewa, khalti, fonepay etc), or an indirect charge to households through the water or electricity bill.

Community-driven waste banks with organization of waste pickers cooperatives is an option that could be pursed in order to enhance the collection of clean recyclables while seeking ways of improving the livelihoods of informal waste pickers. Several experiences exist in developing Asian countries in the

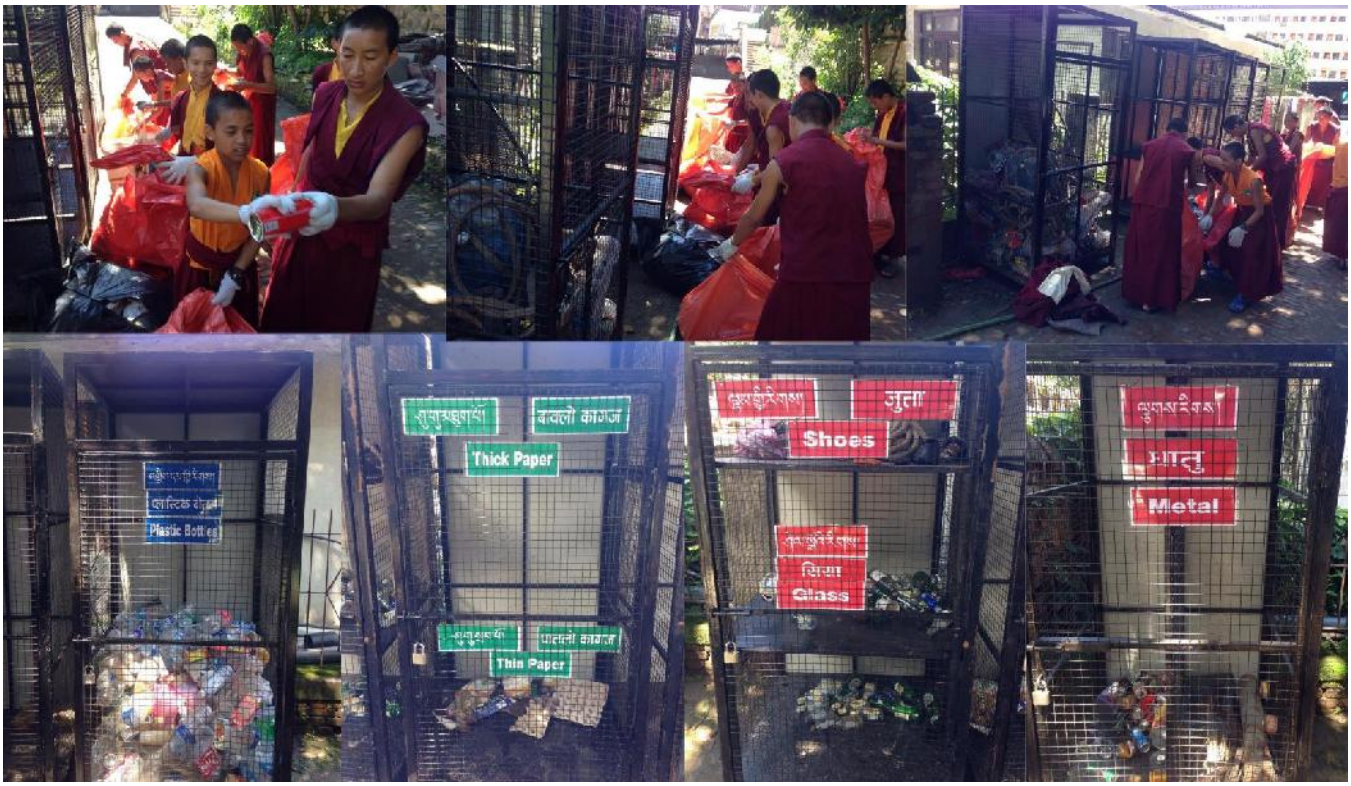


Figure 45 Community Waste bank established at Rangjung Yeshe Institute, Baudha, Kathmandu

adoption of waste bank concepts, but few have been as successful as those in Indonesia (so-called "bank sampah"). Waste banks are grassroots, community-run facilities that accept recyclables (and, in some cases, organic waste) in exchange for cash or a bank deposit. Models such as this, or similar, could be tested in Kathmandu, either operated by communities themselves or informal waste sector groups. In case informal sector members are organized into cooperatives, waste banks could increase their bargaining power in relation to buying centres, or even enable these to be bypassed altogether. This concept could be first piloted, for example, in the communities that were part of the Local Governance and Community Development Programme (LGCDP), in case such experiences are considered positive.

Table 15 Indication of the main target groups of the four shortlisted initiatives and discusses risks associated with their adoption.

SN	Initiative	Main target groups	Main risks identified
1	Home composting units	Households	- Unwillingness of households to adopt home composting units. - Unwillingness of households to mobilize their own resources to purchase home-composting units. - Potential competition from other approaches currently adopted by households (e.g. organic waste being utilized as animal feed).
2	Decentralized waste composting facilities	Medium-sized generators of waste, such as hotels, restaurants, markets, public buildings, schools, etc. Pilot districts where decentralized collection points will be established.	- Unknown uptake of waste segregation attempts in a city with limited experience on these practices. - Large quantities of segregated organic waste (e.g. from hotels or markets) could be diverted to purposes (e.g. by animal feed companies) other than composting, thereby affecting the processing capacity of a given composting plant. - Business model of composting plants is not expected to be financially sustainable without some form of public support (e.g. a share of the waste collection fee charged would need to

			revert to the operation of the facility).
3	Decentralized secondary waste collection points with the participation of micro-enterprises	Households, small shops/businesses Micro-enterprises Informal sector members	- Already introduced in many places but again the unwillingness of communities or households to pay for door-to-door collection services, even if these are cheaper and more frequently provided than those through KMC itself. - Lack of leadership at the community level for the development of a decentralized waste collection approach. - Unwillingness or resistance of village leaders to assign waste collection services to micro-enterprises. - The establishment of micro-enterprises at the grassroots level cannot be guaranteed (e.g. due to the lack of interest on such ventures, lack of seed capital, lack of access to finance, etc.). - The activity of micro-enterprises may be hindered by the lack of regulation. - The successful adoption of an initiative along these lines could imperil the current business model for waste collection services of existing stakeholders and KMC.
4	Community-driven waste banks with organization of waste pickers cooperatives	Communities Households Informal sector members	- Lack of leadership or interest at the community level to the establishment of waste banks. - No benefit perceived by informal waste sector members regarding their organization into groups or cooperatives. - Lack of funding and operating capital to initiate the activities of a waste bank. - Bargaining power of buying centers could squeeze out of business grassroots initiatives such as waste bank models.
5	Proper set up of MRF at the city center and surrounding areas	Municipality own and privately own MRF could be installed	- Lack of man power and other input services for the set up and operation - Surrounding neighbors can have complained about its sound, environment etc. - If contracted for short period of time, this cannot be operated under the full swing setup because of the risk in capital investment.

5. Conclusion

The assessment conducted indicates that there is a significant potential for the adoption of waste-to-resource initiatives in Kathmandu. As the approaches prioritized by the consultant team are relatively novel in the Kathmandu context and imply a change in the way solid waste is conceived (i.e. a transition from a waste management to a resource management approach), it is recommended to first pilot such approaches in small-scale settings (taking either in the best wards) prior to making a decision of advancing into upscaling and replication. Some are already exiting and needed to replicate only. It is also recommended that the proposed approaches are implemented in the context of an integrated and holistic framework, whereby interventions in one end of the value chain (e.g. segregation of waste at the source) have correspondence with similar interventions in other points of the waste handling process as a whole (e.g. ensure that segregated waste streams are collected and processed in a separate manner).

In addition, it is suggested that the implementation of any of the four shortlisted initiatives can be complemented with a portfolio of measures to support addressing issues of a more strategic and cross-cutting nature. The most salient of these has, in fact, already been identified as a priority by consultant team: the preparation of a solid waste management strategy for Kathmandu. Other options that could be considered:

Provide technical assistance to improve the sector's policy and regulatory framework, including mechanisms for enforcing compliance and monitoring implementation of "waste-to-resource" approaches. Policies and regulations that could be considered include, inter alia, the introduction of "polluter pays" schemes (e.g. by imposing fines to entities or individuals that dump their waste or to major waste generators that do not segregate waste), or extended producer responsibility (EPR) practices to industries utilizing materials that can be reused and recycled.

Preparation of a city-wide waste segregation program, which could include options for the collection and treatment of the waste streams recovered. Separate day separate waste collection is already proven methods for the Kathmandu valley and other urban areas of Nepal.

Conduct of a financial-economic assessment with the aim of: i) obtaining a thorough understanding of costs currently incurred in handling solid waste; ii) estimating benefits/costs from the adoption of "waste-to-resource" and "pro- poor" approaches, including co-benefits and costs of inaction; and iii) coming up with financially sustainable models, including economic instruments, to support the deployment of these approaches.

Provide technical assistance in the establishment of partnership modalities for service-delivery (e.g. public-private partnerships, NGO-public partnerships, concessions, open tenders, etc.).

Provide technical assistance in the design and implementation of "social" instruments to reach out to communities and businesses, such as communication campaigns, education programs and capacity building training sessions.

Set-up a program to support the creation of a market for compost generated from solid waste, which could include, for example, maximise the use in agriculture and restrict the use of imported chemical fertilisers, a trial program for farmers, and the certification and testing of the final product.

Design of a financial plan to assist local stakeholders raising funds from financial institutions, in particular multilateral development banks, to support large-scale investments in Kathmandu solid waste sectoral management like recycling, upcycling, composting etc.

As a final remark, even though this report had a specific focus on the solid waste sector, it is recommended that consultant team considers potential synergies between this and other sectors, in particular sanitation and hygiene, where opportunities for integrated approaches could be leveraged and jointly pursued. Also, further assessment on waste-to-energy project at the landfill site which KMC Environment Management Department has signed consortium will be required in order to avoid duplication but to create synergies with the proposal on decentralized composting facilities. It is also recommended to make further efforts to assess potential options for landfill improvement such as landfill gas recovery and landfill mining in conjunction with waste-to- resource initiatives proposed in this report.

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7. Photographs:

Municipality Building

Waste collection system at Waling Municipality

Two separate vehicle goes for dry and wet waste collection at Waling Municipality

SWM management committee formed by Waling municipality

Source segregated waste waiting for collection

Mayor Dilip Pratap Khand, Waling Municipality

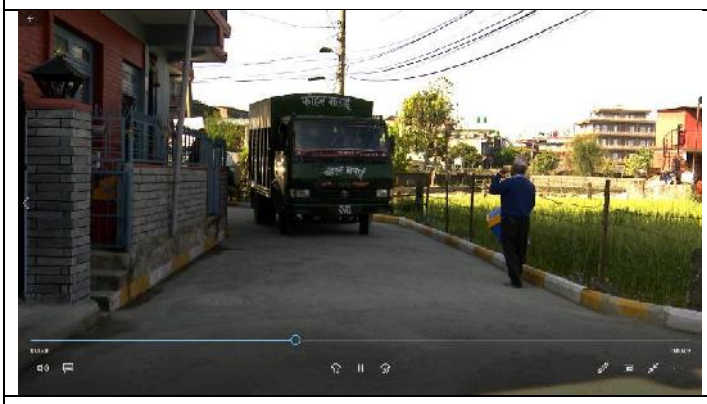
Mrs. Yugmaya Pangeni, Coordinator, SWM management committee of Waling Municipality

New composting plant established at Waling Municipality

	
Plastic Shredder at Waling Nagarapalika Sarsafai Kendra	Recyclables and rejected waste piled up outside the waling Nagarpalika Sarsafai Kendra.
	
Citizens started putting pink colour at their houses at Waling Municipality	Vendors also manufacturing poly tanks in pink colour to sell them at Waling Municipality
	
Mr. Krishna Bhandari, SWM consultant, of Bheerkot Municipality showing MRF with segregation containers made out of waste wood blocks	Plastic Storage after the segregation. This will be selling out to recycling centers at and neighbouring municipalities.
	

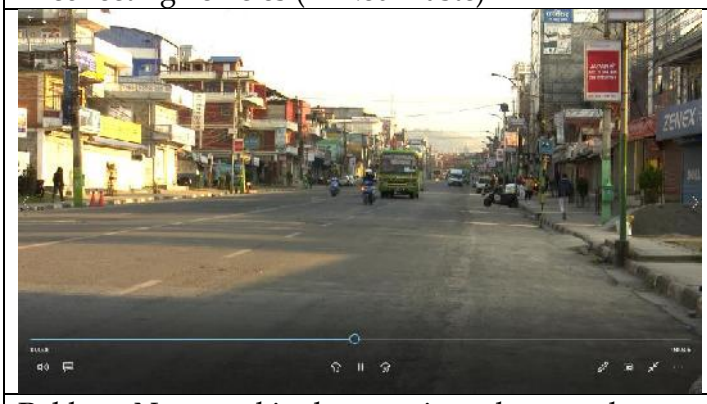
Separate waste collection at MRF of Bheerkot Municipality	Park development alongside the MRF of Bheerkot Municipality
	
Used glass bottles collection at source of waste generation (Hotels/Restaurants/Banquets etc.	Direct cash payment to the separate collector of glass bottle by the municipality
	
Bayarghari Cotton factory (SMEs that recycle Cotton)	Cotton recycling Enterprise at Bheerkot Municipality
	
Plastic drying & making ready for recycling at Panchakanya Plastic at Bheerkot Municipality	Plastic thresher using for cutting and removing dusts/mud in the waste plastic

	
Heating and melting station of Plastics	Plastic Extruder machines for different types/sizes of plastics granules making line.
	
Granules of waste plastics ready to use as raw materials	Different sizes of pipe production area
	
Signages at Putalibazar lane, Syangja and its bazar area without litterings	Pedestrian was collection containers at PMC
	

Waste collection from households, people brings up to the road	Waste Collecting vehicle visibility of Private operators
	
Household waste sergregation bin provided by ward on subsidized rate at PMC-13 ward	Community women brought segregated plastics from their home for selling to the vendor at ward 13
	
Darshan Lama, Ward 13 Chairman, PMC explaing about the waste to zero campaign.	Mrs. Krishna Kumari Gurung Coordinator, of Zero waste campaign at Milan Marg TDC, ward 13-witnessing the payment done by vendor to the members against the recyclable materials sale
	
Clean surrounding neighborhood and waste collection vehicle maintaining cleanliness as example at ward 13, Milan marg, Rakshya Marga and Kmapokari marg tole development area.	Community members waiting for the central collection of their segregated recyclables to sale them out to waste collection vendor.

People bring the waste to the street send them out in collecting vehicles (mixed waste)

Dry recyclables materials packaging at the street to ease in giving away for collection vehicle



Pokhara New road in the morning- clean road

Collected garbage taken to the Landfill

Informal waste workers (IWWs) extracting recyclables from the garbage at the Landfill

Mr. Resham GC, Site Incharge, Lanfill Site, explaining about the management of landfill at PMC

Ms. Kalpana Baral, Head, Sanitation Section, PMC and her team member

Mayor Man Bahadur GC, PMC explaining about the waste management and upcoming plans

Road Sweeping staff of PMC and their equipments

Gas bottling station at Gandaki Urja P. Ltd, Pokhara

Panoramic view of Gandaki Urja P. Ltd (Anerobic Digestion, CNG and compost Fertilisers production)

Composting Station of Gandaki Urja P. Ltd

Customer of Gas explaining the quality

Compost Seiving and Packaging station

Demo farm established at Gandaki Urja P. Ltd

	
Biomedical waste segregation at Waste services P. Ltd, Pokhara	Mr. Santosh Poudel and his colleques with the autoclave unit for disinfection of biomedical waste
	
First Plastic road developed by Green Road waste management P. Ltd, Pokhara	Plastic raod at Anupam tole, Pokhara, Almost 1Lakh composite wrappers and single used plastics has been used

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