



RAPID ASSESSMENT ON POTENTIAL WASTE AND ITS BUSINESS VALUE FOR TILOTTAMA MUNICIPALITY

(A Rapid Assessment Report)



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Abbreviations

3Rs	Reduce, Reuse, Recycle
ISWM	Integrated Solid Waste Management
MSW	Municipal Solid Waste
PET	Polyethylene Terephthalate
RDF	Refuse Derived Fuel
SDG	Sustainable Development Goals
FGD	Focus Group Discussion

gm	gram
hr	hour
kg	kilogram
Rs	Rupees
sq.km	square kilometres

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Mr. Deepesh Raj Sharma
Team Leader
29 April 2022

Executive summary

A rapid assessment on potential municipal solid waste (MSW) and its business value for Tilottama Municipality was conducted by Centre for Energy and Environment Nepal (CEEN) in March 2022. The existing solid waste management system in Tilottama Municipality was studied in this rapid assessment. The waste generated here is looked after and managed by three different service holders Wash Cooperative, Sundar Nepal and Ward No 2. The amount and nature of MSW in Tilottama was studied. The total amount waste brought to the disposal sites by the service providers was found to be 28 kgs. Analysis of solid waste composition shows that the amount of organic waste was higher as compared to other inorganic waste in household and commercial business whereas in institutions the amount of inorganic waste mostly paper and textile was higher. In the operating areas of WASH Cooperative and Sundar Nepal, the MSW was supposed to be segregated to some extent, but the composition results show that 45% (6.3 tons) and 48 % (4.8 tons) waste collected by WASH Cooperative and Sundar Nepal respectively still consists of organic waste, showing that only partial segregation is accomplished. The per day average waste composition of Tilottama Municipality suggest that 47% (about 13tons) of biodegradable, 26 % (6tons) of plastics, 9% (2.5tons) of textile, 6% (1.68tons) paper, could easily be recovered for recycling before sending it to final disposal.

Comparative study of the current waste management by service providers shows that WASH Cooperative among the three service providers is in a better position for the proper management of the MSW in Tilottama. From the total waste of 28 tons per day brought to the disposal sites, 26 tons of it can be recovered and WASH Cooperative can do this job well as it has adequate infrastructure, technical facilities such as conveyor belt, etc. and trained manpower with proper knowledge of health and hygiene for segregation of MSW. It has been earning money through resource recovery and selling of waste plastics and metals after segregation using conveyor belt in its processing centre. Lately, a wide range of materials like beer, PET water, medical bottles, carton boxes, metal items (tin and aluminium), plastics items (shopping bags, MLP, colored plastics, PP sacks), etc. recovered. The amount earned from the sales of the recovered materials after processing for last month (March) was NRs 126947.

Sundar Nepal does not have any infrastructure (building, sheds, etc.). It conducts door to door collections and road pick up system of waste and transportation to Shankharnagar community forest site. But more often it is dumped and burnt on the banks of Tinau River causing severe pollution. It does not have trained manpower for segregation, resource recovery and recycling.

Ward No 2 was said to fall under the jurisdiction of Sundar Nepal, but during the assessment work it found that Ward No 2 was operating independently and using the same dumping site as Sundar Nepal. The Service provider working in Ward No 2 has very little machinery/equipment facilities (one tractor) and inadequate manpower for door to door collection and for road pick up system.

The main reason behind the enhancement of recyclable waste collection business is the market imbalance and market imperfection. Lack of proper information management system is creating gap for effective collection and management system of recyclable waste.

It was observed that waste segregation at source was missing with all three service providers. The service providers were using different dumping sites. There was uncontrolled disposal of MSW near river banks by Sundar Nepal and open burning of MSW was also noticed at these sites. Resource recovery and recycling activities were also lacking especially with within Sundar Nepal and Ward No 2. During a visit to the only hospital, it was found that it did not have an incinerator and the hospital waste was also managed by one service provider. Hence the hospital and medical waste was found mixed in the MSW mainstream.

The management of MSW could be better managed by introducing activities such as waste segregation at source both at household and institutional/commercial levels, distribution of plastics bags/sacks, distribution of simple metallic hooks (Suiro) for plastics waste, opening of waste buying counters, etc. An integrated solid waste management system with such activities has been proposed, where one service provider with good infrastructure, adequate technical facilities, trained manpower and strong support of Tilottama municipality could very well take care of the solid waste management of the municipality.

1. Introduction

1.1 Background

Under the direct supervision of the UNDP Accelerator Lab and Promoting Green Recovery Project (PGRP) a rapid assessment on potential municipal solid waste (MSW) and its business value for Tilottama Municipality has been conducted. Tilottama Municipality so far does not have both the qualitative as well as the quantitative data of the MSW. This assessment work will be able to determine the total amount of waste generated daily, its composition and show how much of the waste is recyclable and how much non-recyclable. The recyclable portion should be able to determine the direct business value through resource recovery and recycling, whereas some portion of the non-recyclable part will have indirect business value after some processing.

Centre for Energy and Environment Nepal (CEEN) had an opportunity to meet the representatives of Tilottama Municipality in the UNDP office on 30 November 2021 to interact on the possibilities of producing Refuse derived fuel (RDF) from MSW. During the interaction they had shown keen interest in the RDF production technology which can help to some extent in the management of MSW by reducing the waste going to the landfill as well as producing an alternative fuel, which can replace traditional fuels such as fuelwood, coal and other fossil fuels in the industrial sector.

So it is necessary to know the amount of MSW generated by Tilottama which will be available as raw material for resource recovery/recycling and non-recyclable combustible waste for RDF production unit which CEEN has proposed. Hence, it was necessary to assess the data and establish the composition of the waste and the tentative amount of waste that is generated in Tilottama. It was in this connection that the rapid assessment of the MSW of Tilottama was conceived. The outcome of the rapid assessment will definitely give a picture of the nature of the waste and the quantity or volume of waste that is generated in one day. It will show how much waste can be recovered and recycled and how much can be used for producing RDF. Besides resource recovery from business through recycling, RDF can be an alternative solution to management issues created by the non-recyclable plastic waste and combustible waste, which goes mainly to the landfill every day.

1.2. Solid Waste Management

The world today faces many environmental and economic challenges with population growth, urbanization and market expansion. More energy, food and other basic services are constantly required to fulfill the needs of the growing population. The need for energy and dependency on

fossil fuels lead to serious environmental problems such as Greenhouse gases, global warming and climate change. Increasing trade, commercial activities and consumerism lead to increased waste generations creating problems in waste management in all cities and municipalities.

To support and assist the Local Government in the proper management of MSW, the government of Nepal established the Solid Waste Management Act 2068. As per the provisions made in the Solid Waste Management Act 2068, local level authorities are responsible for infrastructures like transfer station, landfill site, processing plant, compost and biogas plant including waste collection, processing, and disposal¹. The new constitution 2072 (2015) made provisions to involve local government institutions and has reorganized the local governments as rural municipalities and municipalities. It has also mentioned the fundamental right of the people to live in healthy and clean environment. Hence, Local Governance Operation Act 2074 (2017) has given responsibilities of municipal waste management to local government. In the process of waste management, local government can also engage different companies, organizations, and agencies in the management of MSW in different levels. It can be in segregation and management of MSW based on the principle of 3 Rs – reduce, reuse and recycle in mobilizing different organizations for creating awareness and trainings in MSW management.

To ensure proper management of MSW source segregation is a must and Nepal has introduced a mandatory policy for waste segregation but has not been followed most of the time. The Solid Waste Management Act 2068 and Rules 2070 require source segregation of waste, separate collection and processing. Also the Environmental Protection Act 2019 and Environmental Protection Regulations 2020 and Nepal's climate commitments says Nepal will adopt source segregation and management of degradable and non-degradable waste as well as recycling of waste.

Solid waste management is one of the major environmental issues in cities of many countries including Nepal. In urban Nepal the persistence of traditional attitudes and traditional waste disposal habits in both residential and industrial areas is hampering the efforts by local authorities to collect and dispose of wastes safely and effectively. Minimum community awareness and concern has to be developed towards avoiding such acts as dumping wastes on streets; empty

¹ “Solid Waste Management Act, 2068 (2011) – Nepal Law Commission,” accessed December 10, 2021, <https://www.lawcommission.gov.np/en/archives/category/documents/prevailing-law/statutes-acts/solid-waste-management-act-2068-2011>.

lands, footpaths, streams, rivers, etc.; open and inefficient burning of solid waste; disposal of industrial waste and untreated waste into rivers and open drains; mixing and disposal of hospital and medical waste in the mainstream MSW, etc.²

Urban population growth and economic development will only lead to increasing generation of solid waste. Municipal solid waste (MSW) management in Nepal is largely limited to collection and transportation of waste and its disposal without any treatment or recovery measures. Taking the data from Solid Waste Management in Urban Nepal report of Central Bureau of Statistics 2020³, the estimated waste generation from sub-metropolitan cities is about 3300 kg/day and municipalities is 1440 kg/day. It is estimated that only 50% of the generated waste is being collected. Earlier JICA study report of 2004 mentions that 0.223 kg /capita/ day was an average household waste generation. This study could not take into account the seasonal variation in the generation of MSW. Asian Development Bank (ADB) study of 2013 shows the average per capita waste generation from households is 0.170 kg/capita/day.⁴

The municipalities in Nepal face problems such as lack of technical support, financial constraints, waiting for the government's decision and approval for land acquisition of proposed landfill sites, problems in area selection, and strong opposition from nearby communities. Other geographical problems like flooding, shallow water table, highly permeable soil, and slope instability also exist in the selected area. The characteristic of the generated waste depends on physical factors, such as altitude, temperature, rainfall, and humidity, as well as socioeconomic factors, such as population, economic status, and consumption patterns.

1.3. Types of Solid Waste and Waste Generators

The households, commercial establishments, institutions, industries, health institutions, etc. are the potential waste generators. In general, municipal waste covers the waste generated from households, commercial and institutional establishments. Healthcare and industrial wastes containing hazardous and infectious waste, which should be treated separately, are not included in the municipal waste category.

The municipal waste generally is sorted out as:

- Organic waste (bio-degradable waste)

² Solid Waste Management in Urban Nepal, NPC/IUCN, NCS Implementation Project, 1992

³ Waste Management Baseline Survey of Nepal 2020, Central Bureau of Statistics, Government of Nepal

⁴ Solid waste management in Nepal: Current status and policy recommendations. Asian Development Bank, 2013.

- Plastics (all kind of recyclable and non-recyclable)
- Paper and paper products
- Metals (iron, aluminum, etc.)
- Glass (all kinds of glasses- colored and non-colored)
- Textile – natural as well as synthetic
- Rubber and Leather (synthetic and natural)
- Sanitary pad and diapers
- Others (inert materials etc.)

1.4. Regulatory Framework on Solid Waste Management

The regulatory framework for management of solid waste in Nepal consist of the following acts and rules. Tilottama municipality has also prepared guidelines for management of MSW called “Zero Polythene and Initiation of complete Sanitation within the Tilottama Municipality Guidelines, 2076” (सून्य पोलिथिन तथा पूर्ण सरसफाई युक्त कार्यविधि, २०७६).

Some of the main points in these documents are given in the table below:

S.N	ACT/REGULATION	Points
1.	Solid Waste Management Act 2068 (2011) and	<ul style="list-style-type: none"> • Responsibility of SWM to local government • Segregation of waste at least into biodegradable and non-degradable • Promotion of 3R for minimization and resource recovery • Involvement of private sectors and community on SWM • Sole responsibility of management of hazardous waste by the waste generator
2	Solid Waste Management Rules 2070 (2013)	<ul style="list-style-type: none"> • Segregation and Management of Solid Waste • Discharge of Solid waste • Discharge and Management of Harmful and Chemical Waste • Discharge and Management of Health Institution Related Waste • Transportation of Solid Waste • Operation of the Sanitary Landfill Site • Management after the Closure of the Sanitary Landfill Site
3.	Local Government Operation Act 2074 (2015)	<ul style="list-style-type: none"> • Conservation of environment and control environmental pollution • Management of municipal solid waste • Issue local laws and regulations • Develop and levy service charges

4.	National Health Care Waste Management Standard Operating Procedures, 2020	The national healthcare waste management standard operating procedures (2020) is the revised version of national healthcare waste management guidelines (2014), which clearly provided the ways to deal with healthcare waste. It provides the various ways from waste minimization, waste segregation, handling, collection, transportation, storage, treatment and disposal.
5.	Environment Protection Act 2019 (2076) and Regulation 2020 (2077)	The Act defines how we work with community and industry to minimize risks to human health and the environment from pollution and waste. Environmental regulations attempt to protect public health and the environment from pollution by industry and development.
6.	Zero Polythene and Initiation of complete Sanitation within the Tilottama Municipality Guidelines, 2076 ⁵	<ul style="list-style-type: none"> • Initiate, implement, monitor plans for waste management within the municipality • Formulate awareness programs relating to the waste management and sanitation • Request for the financial support relating SWM from the municipality and ward level • Initiate for the waste segregation at source • Formulate policies to involve private, NGOs/INGOs for the waste management • Use of SWM technologies in the waste management

1.5. Objective and Scope of the Assessment

Under the direct supervision of the UNDP PGRP technical lead and Accelerator Lab in Nepal, and to conduct the rapid assessment of MSW for Tilottama Municipality.

The specific objectives include:

- Identifying (quantify) the major types of municipal waste that includes biodegradable, paper, plastic, glass waste etc. that is generated and disposed (which can be recovered as resources) in the municipality.
- Conducting critical analysis and mapping of the existing businesses and potential ones for the local waste management.
- Identifying the current gaps on municipal waste management at Tilottama.
- Collaborating with municipal officials, representatives from private sector companies, WASH Cooperatives (Sahakari) and other relevant stakeholders to understand the local needs and demand for waste management.

⁵ Municipality Profile, 2075, Tilottama Municipality

- Analyze business value with environmentally friendly, sustainable and adoptive technology in the area of waste management.
- Suggest best possible municipal waste management model suitable for Tilottama Municipality
- Suggest recommendations to UNDP and the local authority on way forwards.
- Conduct and/or support in coordination of 1-2 consultative sessions for the municipality and the stakeholders to share the learnings and findings of the research.

1.6. Limitation

The rapid assessment was conducted in as per the guidance of the UNDP, but had certain limitations which did not allow to encompass all the point noted in the objective portion of the assessment work.

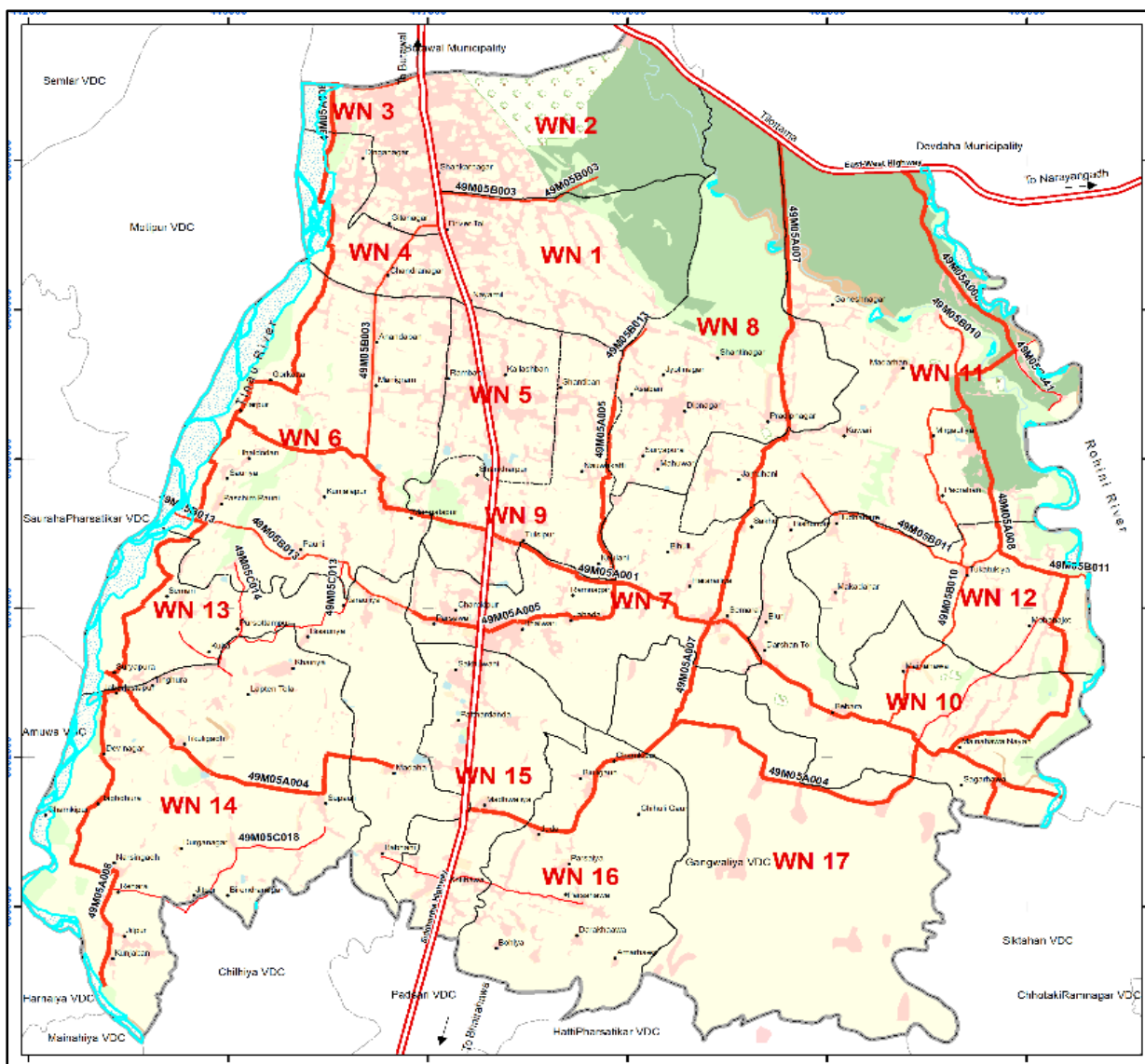
- The budgetary allocation for the works was not sufficient to make more comprehensive approach to the work
- Time limitation was another factor which did not permit to make sufficient surveys, interaction and assessment with the people who were involved in waste management.

Nevertheless, major part of the work assessment of MSW and its composition along with major concerns has been covered as far as possible. Besides that the present pandemic conditions have also affect the study so it should also be considered.

2. Methodology

2.1. Study area

Tilottama Municipality is a town in western Nepal. It is named after the local river Tilottama. The municipality lies in Province No. 5 spreading between 27⁰33' to 27⁰39' N latitude and 83⁰25' to 83⁰33'E longitudes. The newly declared Tilottama municipality in Rupandehi district of Lumbini zone has Rohini River and Devdaha municipality in the east, Tinau river and Siyari and Shuddhodhan village in the west, Butwal sub-metropolitan municipality in the north and Omasatiya village and Siddharthnagar municipality in the south. The total area of this municipality is 126.2 sq. Km. It has an average length of 12.5 km and an average width of 10.1 km. Its population has reached 149,657 by the present scenario. There are altogether 17 wards in the municipality.



Photograph 1: Administrative map with all the wards of Tilottama
 (Source: GIS >fjt gS;f | Tilottama Municipality/https://tilottamamun.gov.np/en/content/gis)

Table 1: General information of Tilottama Municipality⁶

Area:	126.2 sq. Km
Households:	25,503
Population:	149,657
Male:	71,700
Female:	77,957

Source: 2021 Nepal Census

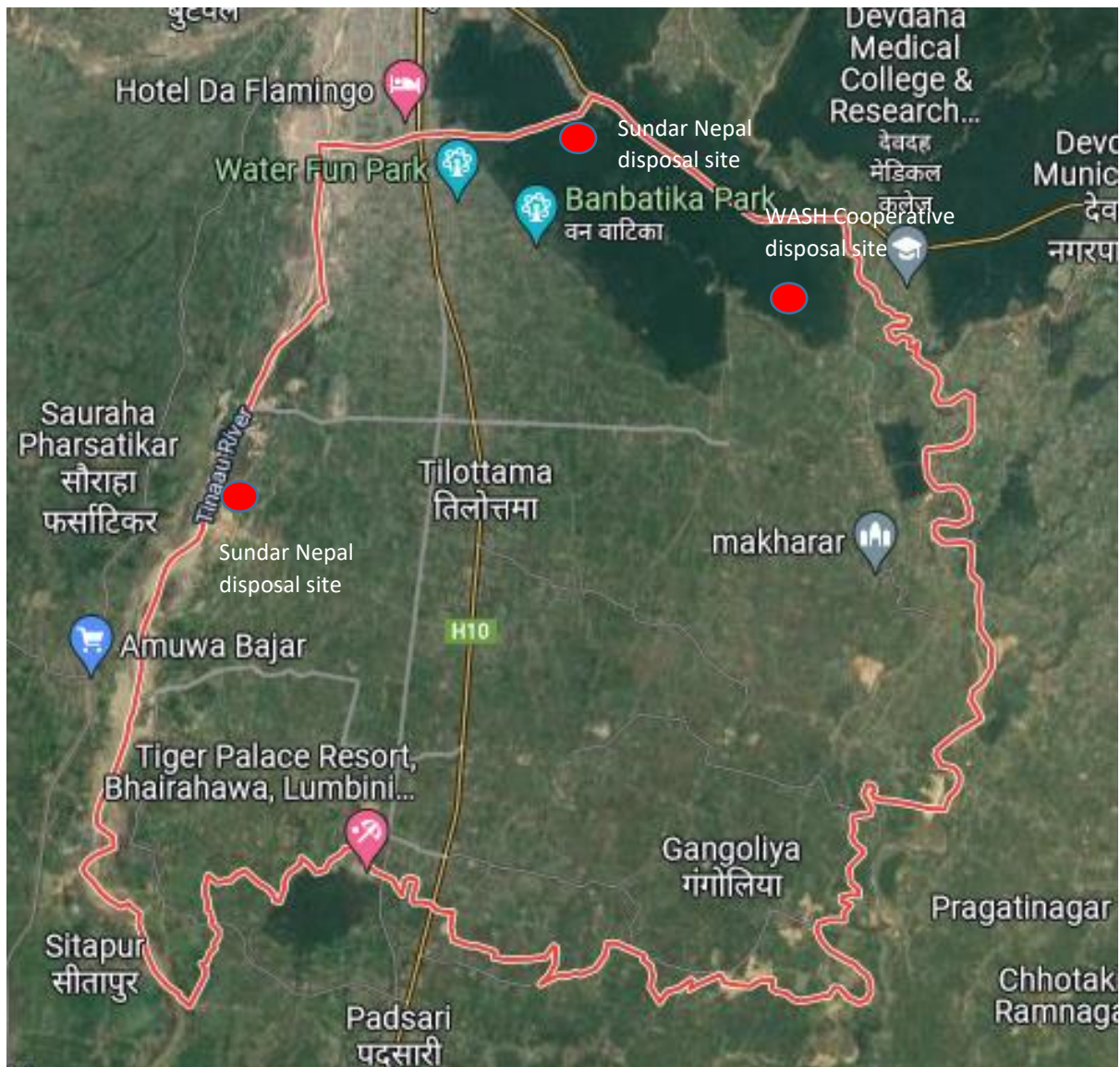
⁶ CBS (2021). Preliminary Report on National Population Census, Central Bureau of Statistics, Thapathali, Nepal

2.2. Data collection

Assessment of MSW, its nature, composition in Tilottama Municipality. Three major dumping site handled by:

Table 2: Service providers and study Area

S.N	SITE (Service holder SWM)	Coordinates of Dumping site
1.	WASH (Jana Sahabagita wash swasthya sahakari sastha Ltd.) Cooperative	27°38'47"N 83°30'34"E 120m
2.	Sundar Nepal private limited, Shankarnagar forest	27°40'0"N 83°29'9"E 160m
3.	Service provider for Ward 2, Tilottama municipality	27°40'0"N 83°29'9"E 160m



Disposal sites of WASH Cooperative and Sundar Nepal Pvt Ltd

Quantitative and qualitative method

The quantitative and qualitative methods were applied during the study. This incorporated questionnaires and interviews, field surveys and data presentation.

▪ Quantitative method

This method was applied through weighing waste generated in all the different waste generators. It was applied through field surveys that were conducted for data collection from households and analysed to address the research objectives.

▪ Qualitative method

A structured questionnaire was used as one of the data collection methods. Sample questionnaires are attached in the annex. This questionnaire was used to collect information from the municipality officials through an interview regarding waste management services and practices for Tilottama Municipality. Detail questionnaires checklist mentioned in annex.

Key Informant Interview

Different group of Key people who were directly related to solid waste related programs, current solid waste management practices from sampled areas were selected and interviewed. The interview was done with 10 key informants these included representatives from Municipality office, private organizations (SWM service holders, waste collector, driver, waste picker etc.). Questionnaire checklist mentioned in the annex.

Focus Group Discussion

The local as well local government, stakeholders and private company from study area were highly encouraged to participate in closed group discussion about solid waste generation, composition, its segregation and management. The discussion was done between 20 selective participants who represented from Municipality office, SWM service holders of Tilottama Municipality including chairman, Supervisor and other members. The list of participants is added in the annex.

Observation and Photography

Some of the field conditions related to solid waste management and the questionnaire survey were captured in photographs.

Data Processing and analysis

Data collected from the field survey was thoroughly analyzed and represented using appropriate and simple statistical tools such as MS Excel, and presented in charts like bar diagram, pie-chart, etc. Also, figures and tables were shown depending upon the nature of the data.

Method: selection of sampling techniques

For composition of waste in the selected dumping site

Reduction Method of Waste Analysis

- Waste reduction method is of reducing the total collected waste by division of collected waste in to four piles of waste approximately the same volume.
- After division of collected waste in to four piles then removal of two piles at diagonally opposite ends.
- The remaining waste is then thoroughly mixed and again division of waste in to four piles and then removal of two piles.
- Repetition of same process until the intended sampling weight is obtained
- Visual Observation
 - Selected site were observed.
- Citizen Science
 - To collect information and data from relevant stakeholders on SWM and its problems.

3. Current situation on SWM system at Tilottama Municipality

3.1 Waste generation

Based on the study of waste collection by three different service holders of Tilottama Municipality, the municipal solid waste generation was estimated to be 28 tons/day. It excludes the waste generation from those household, commercial or institutes who practices biodegradable waste for animal feeding, biogas production or composting and also those who sell recyclable/reusable waste to scrap shops. As these wastes are not collected by these 3 service holders, the actual Municipal waste generation by household, commercial entrepreneurs and institution in the municipality could be much higher in the municipality. The Municipal solid waste generation was estimated from the vehicle capacity collected by three different service holders of MSW of Tilottama Municipality which shows approximately 28 tons of waste generated per day only.

The Comprehensive Plan on Green recovery⁷ says the total waste generation per day is even more about 39.3 tons. The total municipal waste of Tilottama Municipality comprises 54.34% of biodegradable waste, 29.35% of reusable and recyclables, and 9.65% of inert materials. It also projects that the MSW generation could reach 60 tons per day by the year 2036. This means the

⁷ Comprehensive Plan (Strategy and Action Plan) on Green Recovery focusing on Sustainable Integrated Municipal Waste Management of Tilottama Municipality, Public Relation (WASH) Health Co-op. Ltd /Tilottama Municipality and UNDP Nepal, May 2022.

volume of MSW is only going to increase and the recoverable and recyclable portion will only increase providing better opportunities for recovery and recycling business.

According to the waste collectors, the generation of waste may vary from day to day. On weekend the waste generated maybe twice as much. Similarly, the waste collected in festival seasons is even higher than other time. In addition waste from medical clinics were also found collected mixing with MSW managed by private waste collectors. The existence of sanitary pads, syringes, and other medical waste in the MSW show that the improper management of hospital and medical waste exists in Tilottama.

WASH Cooperative has its own dumping site (Sukhaura River) with adequate infrastructure (building and sheds), technical facilities such as conveyor belt for segregation of MSW, baling machine to bale selective plastic waste, program of compost preparation for degradable wastes, etc. It has been earning money through resource recovery and selling of waste plastics and metals after segregation using conveyor belt. Resource recovery from the conveyor belt is conducted by trained manpower with proper knowledge of health and hygiene with proper protective gears. For door to door collections and road pick up system of waste it uses up to 4 vehicles (2 round).

Sundar Nepal Pvt Ltd. has its dumping site (Shankharnagar community forest) but without any infrastructure (building, sheds, etc.). It uses 4 tractors for door to door collections and as well as road pick up system of waste and transportation to Shankharnagar community forest site. But more often it is dumped and burnt on the banks of Tinau River causing severe pollution. It virtually does not have trained manpower for segregation, resource recovery and recycling. Ward No 2 was said to fall under the jurisdiction of Sundar Nepal, but during the assessment work it was found that Ward No 2 was operating independently and using the same dumping site as Sundar Nepal. Service provider Ward No 2 has very little facilities like one tractor and little manpower. These facilities are not sufficient for door to door collection and for road pick up system of MSW.

3.2 Waste composition (Sample taken from collection vehicle/per day)

3.2.1. Waste Composition of waste collected at disposal site by WASH Cooperative

The waste composition analysis indicates that the highest waste fraction is biodegradable wastes (45%), followed by plastics (23%), textile (11%), paper and paper products (6%), glass (3%) and others (5%). In the case of plastic wastes, it was found that polybags (PP) and polystyrene (PS) were more than other plastic bags and wrappers. Metal, and rubber and leather each accounted for

1% or less. The high organic content indicates a need for frequent collection and removal, as well as good prospects for organic waste resource recovery. The content of major reusable and recyclable materials (i.e., plastic, paper and paper products, metal, glass, rubber and leather, and textiles) comprised 46% on average. The average composition of MSW waste in the eight major waste categories is shown in figure 1 below.

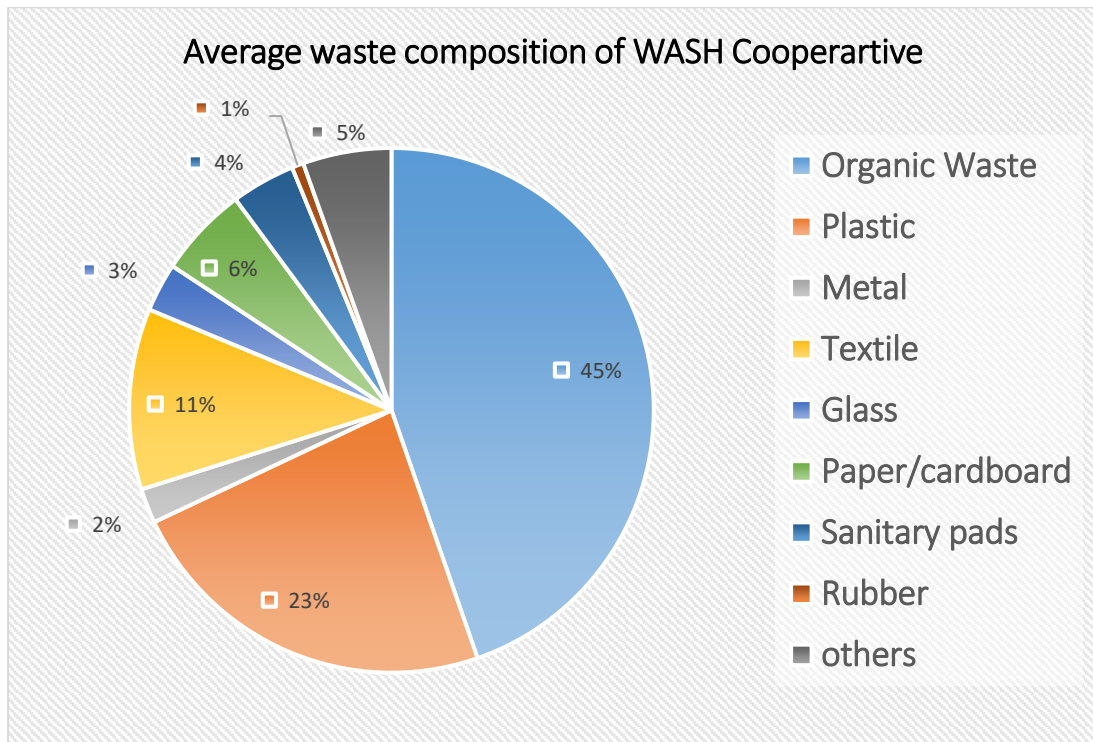


Figure 1. Waste composition of collected waste at disposal site of WASH Cooperative

3.2.2. Waste Composition of waste collected at disposal site by Sundar Nepal

The waste composition analysis indicates that the highest waste fraction is biodegradable wastes (48%), followed by plastics (22%), Textile (10%), paper and paper products (3%), glass (6%) and others (3%). Metal, and rubber and leather each accounted for 3% or less. The high organic content indicates a need for frequent collection and removal, as well as good prospects for organic waste resource recovery. The content of major reusable and recyclable materials (i.e., plastic, paper and paper products, metal, glass, rubber and leather, and textiles) comprised 47 % on average. The average composition of MSW waste in eight major waste categories is shown in figure 2 below.

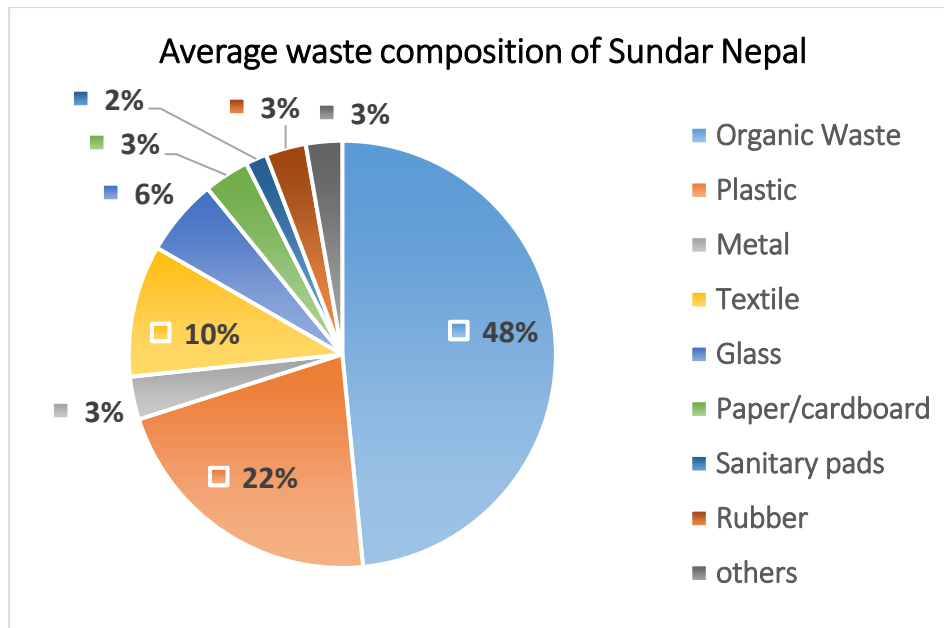


Figure 2. Waste composition of collected waste of Sundar Nepal Pvt. Ltd.

3.2.3. Waste Composition of waste collected by Ward 2

The waste composition analysis indicates that the highest waste fraction is Biodegradable wastes (48%), followed by plastics (20%), Textile (6%), paper and paper products (9%), glass (8%), metal 1% or less and others (2%). The high organic content indicates a need for frequent collection and removal, as well as good prospects for organic waste resource recovery. The content of major reusable and recyclable materials (i.e., plastic, paper and paper products, metal, glass, rubber and leather, and textiles) comprised 44% on average. The average composition of MSW waste in the eight major waste categories is shown in figure 3 below.

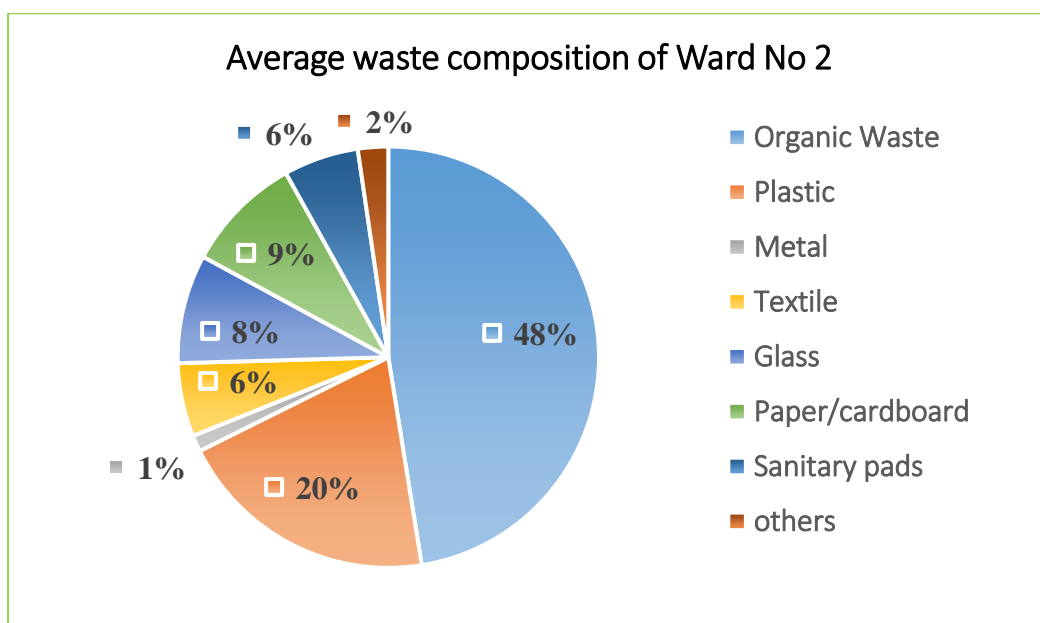


Figure 3. Waste composition of waste collected at disposal site by Ward No 2

Figure 4 shows waste composition of the daily average of the waste collected by the three service providers in Tilottama Municipality. It consists of biodegradable is 47%, plastics 21%, textiles – 9%, paper and card board – 6%, metal – 2%, glass - 6,% medical waste – 4%, rubber - 2 % and others - 3 %.

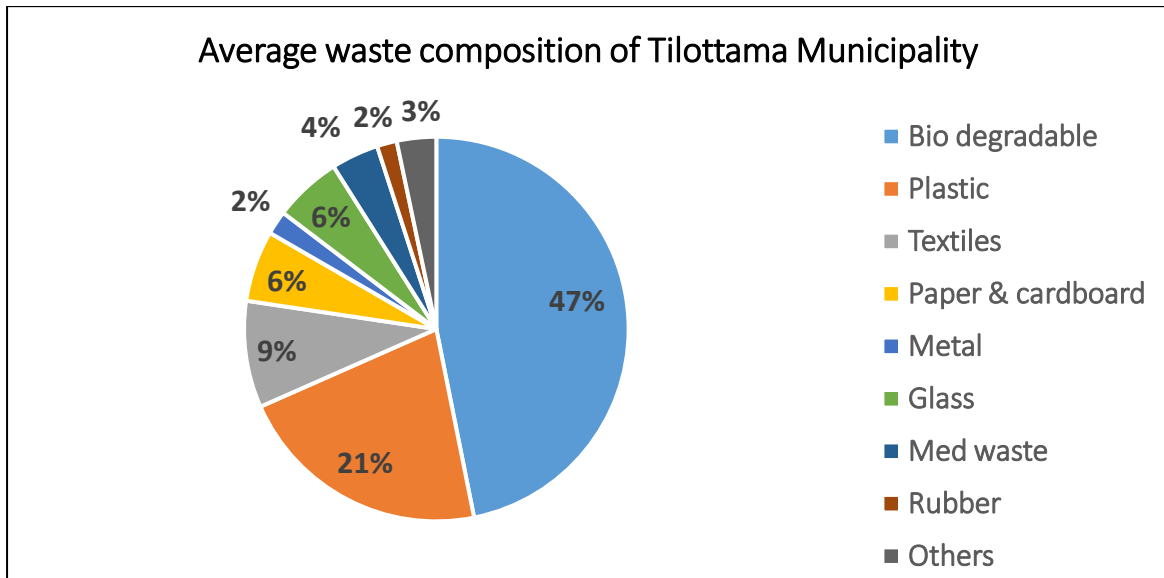


Figure 4. Average waste composition of Tilottama Municipality based on waste collected for disposal

From the daily waste generated by the municipality about 26 tons waste is recoverable or recyclable, whereas 2 tons of the waste is non-recoverable and need to take in sanitary landfill. The biodegradable portion of the waste can either be used to generate biogas or produce compost. Other portions like paper, plastics, glass, metal, etc. can be recycled or sold in the market. The market value of recyclable waste in Tilottama ranges from Rs 15/kg (paper of copy books) to Rs 185/kg (aluminium)⁸. There are more than 10 scrap shops which buy and sell recyclable wastes and provide job to 3-4 people per shop. The report has presented a clear picture of the different waste materials, categorizing them in different groups in paper (newspaper, carton box, copy books), plastics (A, B, C grades) with respective prices of cost and selling prices of these scrap shops. An average of about 50-60 tons of recyclable is bought and sold, indicating good opportunity for recycling business.

⁸ A Report on Recyclable Waste Collection System in Tilottama Municipality, Wash Cooperative, February 2022

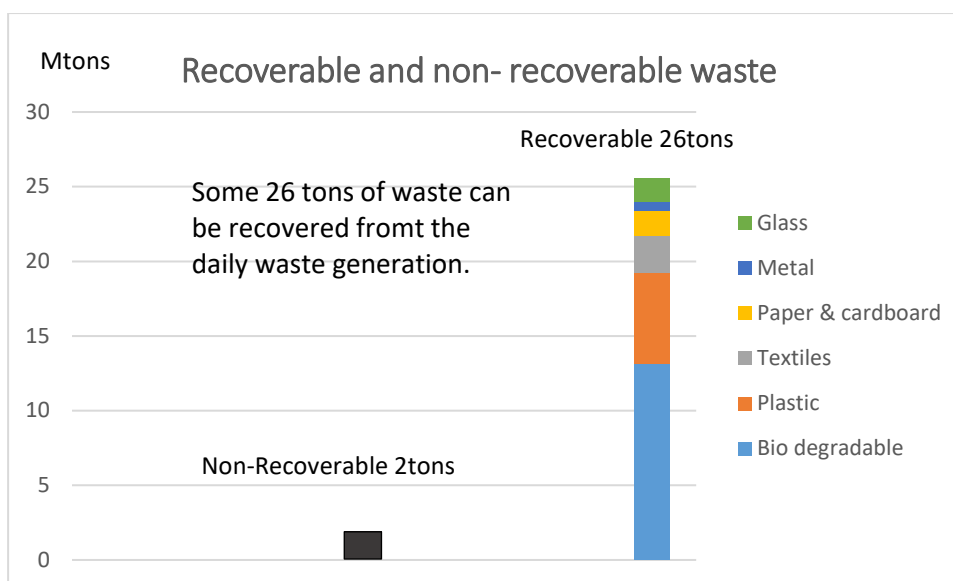


Figure 5. Recoverable waste ~ 26 tons and non-recoverable waste ~ 2tons

The total weight of the municipal solid waste collected by the service providers (WASH Cooperative, Sundar Nepal Pvt. Ltd. and Ward No 2) and its composition is given in table 3 below.

Table 3: Total amount of waste and its composition based on waste collection by 3 service holders of Tilottama Municipality

Waste type	Wash Sahakari	wt (tons)	Sundar Nepal	wt. (tons)	Ward No 2	wt. (tons)	Average (%) by wt	Total per day (tons)
Bio degradable	45 %	6.30	48%	4.80	48%	1.92	47	13.16
Plastic	23%	3.22	22%	2.20	20%	0.80	21.6	6.05
Textiles	11%	1.54	10%	1.00	6%	0.24	9	2.52
Paper & cardboard	6%	0.84	3%	0.30	9%	0.36	6	1.68
Metal	2%	0.28	3%	0.30	1%	0.04	2	0.56
Glass	3%	0.42	6%	0.60	8%	0.32	5.7	1.6
Medical waste including Sanitary pads	4%	0.56	2%	0.20	6%	0.24	4	1.12
Rubber	1%	0.14	3%	0.30	-	-	1.7	0.47
Others	5%	7.00	3%	0.30	2%	0.08	3.33	0.93
Total wt. (tons)		14		10		4		28

From the above table, it can be observed that 47% of the waste consist of biodegradable waste which can go for composting or biogas generation. About 46 % of waste is recyclable waste consisting of plastics, paper textiles, rubber, glass and metals and 7 % non-recyclable waste (medical waste and others) for disposal. Among the recyclable waste, metal and glass together

comes to ~8% that can be recovered after smelting, whereas remaining 38 % can undergo mechanical and thermal recycling. From observations in the field work about 1/3 (8%) of this consist of combustible portion can be used for thermal recycling to get RDF fuel.

3.3 Waste Segregation and collection system

3.3.1 Waste Segregation System

In the Tilottama Municipality, waste segregation system is not well practiced. All biodegradable and non-biodegradable wastes are mixed together and transported to disposal site. On the way to disposal site, the waste collector or the staffs use to segregate the recyclable wastes in the waste collection vehicle and they use to sell them to the scrap collectors (Kawadi). However, biodegradable wastes are sorted and used for either feeding animals or making organic fertilizers using traditional composting methods and vermi composting. WASH Cooperative use waste segregation system in the wards and they are providing some services for composting. They give orientation and trainings to household members to practice pit composting or animal feeding for biodegradable waste.

Under the Promoting Green Recovery Project (PGRP) technically and financially supported by UNDP Nepal, Vermi-composting has been piloted in 260 households to manage organic waste and promote organic farming. This activity was initiated to manage biodegradable waste in the MSW to produce vermi compost. It is especially targeted for the farmers.

Two staffs are allocated in each ward for cleaning public road, parks, playground and public buildings. Three additional staffs are allocated for increasing the greenery around six-lane road, Tilottama ring road. Dustbins are distributed in the municipality's main roads, Haat Bazaar, and office areas through the co-ordination of municipality with other organizations.

3.3.2. Waste Collection and Transportation

Door to door waste collection system is commonly practiced in Tilottama Municipality. Environment Sundar Nepal Pvt. Ltd. is involved for the collection of waste from ward 1, 3, 4, 5, and 6. Public Relation (WASH) Health Co-operative Limited (Wash Cooperative) collect, transport, process and recover (partially) solid waste from wards 7 to 17 (except 12&17). Solid waste from ward no.2 is collected from the households and dumped by the respective ward staff.



Photograph: Municipal waste collection at Tilottama Municipality

A tipper and three tractors are used for collection and disposal of waste from ward 1,3,4,5 and 6 by Environment Sundar Nepal P. Ltd. There are 12 staffs for the management of solid waste in this area. The waste collected by the street sweepers and sanitation staff is transported and disposed through municipality allocated vehicles. WASH Cooperative has allocated 23 staffs for the waste management in it respective area.

The frequency of waste collection, the amount of waste collected in one day, machinery/equipment, manpower used and other details about the waste collections and transportation of the three service providers is given in table 4. The disposal site of Sundar Nepal and Service provider of Ward 2 is the same, whereas of WASH Cooperative is different. For a small municipality like Tilottama, having more than one disposal site is not desirable.

Table No 4. Present status of Waste management in Tilottama Municipality

SWM service holder	Wards No.	Collection Type	Collection frequency	Transfer & Transportation vehicles	Treatment system	Final Disposal	Manpower	Additional support
WASH (Jana sahabhagita wash swasthya sahakari sastha ltd.	7,8,9,10, 11,12, 13, 14, 15, 16,17	Door to Door collection Road pick up system	7-8 tractors per day (roughly) 12-14 tons per day	4 Tractors	35% of recyclable collection is sold whereas 65% of the wastes are openly dumped.	Disposes the collected waste at the abandoned channel of Sukhaura River.	Trained (6 workers) from UNDP project	Municipality UNDP
Sundar Nepal private limited, Shankarnagar forest	1,3,4,5,6	Door to Door collection Road pick up system	(10) tons per day (roughly)	Total 6 vehicles (1 stand by)	Segregation in the vehicles with 3 staffs involved; sold to Kawadis and remaining waste are openly disposed.	disposed either in the bank of Tinahu River or Shankhanagar community forest and either burnt or buried		
Ward 2, Tilottama municipality	2	Road pick up system	3-4 tons per day	1 tractor with 2 collection points	No treatment systems practices	The waste collected from the ward 2 is dumped under the ground of Shankarnagar Community Forest.		

SWM Service Fee Collection and Budget

Certain amount of service charge is being collected by the municipality and the informal sectors regarding the SWM collection from the public. The service charge being collected differs from different clients such as household, commercial organization, etc. During collection of information on service charges, sometimes the information was not disclosed readily. The rate of the average charge/month fixed by the organization are listed in the table 5 below.

Table 5. Service charge collected by service providers from the public

MSW service holder	Client category	Rate of charge(Rs)
WASH Cooperative (Public Relation (WASH) Health Co-operative Limited)	Household	55-60
	Commercial shop	100
	Restaurants	500-5000
	Institutes	55-60
Recovered waste material		1-2 lakh/per month
Sundar Nepal Pvt. Ltd.	Household	80-82
	Commercial shop	75-100
	Restaurants	250-10,000
	Institutes	100-200 (government school) 1000(private school)
	Resort/party palace	500 and above
	Clinic/pharmacy shop	300-400
Recovered waste material		2-2.5 lakh/per month (Kawadi only)

3.4. Waste processing

Informally large amount of dry (recyclable) materials are collected, processed and recovered by many scrap dealers. There are about 10 scrap dealing shops that buy and sell recyclable waste. The average monthly income of a scrap shop is about NRs 25-30 thousand/month. Some scrap dealers (Kawadis) collect small portions of recyclables like plastics, papers, metals from source and sell it to scrap shops. Likewise, some helpers and sweepers also collect recyclable materials like plastics, paper and metals from the disposal sites and sell it to these shops. This was observed during the assessment work at the dumping site of Sundar Nepal. In general, a scrap shop can buy and distribute or sell recyclable waste material of about 50-60 tons per month⁸.

Sunder Nepal Pvt. Ltd and Service provider of Ward No 2 does not have any does not have any facilities for processing of the waste at the disposal site. Both service providers do not practice waste processing and recovery of recyclable wastes. The manpower with these service providers are inadequate and not trained for waste processing.

Among the three service holder; WASH Cooperative is better off in MSW processing facilities. They already have the basic infrastructure for storing, processing and disposal of municipal solid waste. It was constructed with the support of municipality to manage waste from wards 7 to 17 (except 12 & 17). The site is managed by WASH in partnership with municipality and is supported by PGRP/UNDP for the extension of ISWM infrastructures and services. It already has a conveyor belt, where the manual sorting of MSW takes place to separate recoverable/recyclable items and waste for disposal. Wash Cooperative took the initiative to install a Baler machine (hydraulic press), which is used to compact the plastic waste (including PET bottles) to decrease the volume of waste for transportation. They are in the process of installing a shredding machine to shred plastic and paper waste.



Mechanized conveyor belt for sorting waste



Baling machine (Hydraulic press)

They introduced the practice of waste segregation after collection and transfer of the MSW. About 35% of recyclable waste is sorted out which is sold to local recycling industries or local scrap dealers, whereas 65% of the remaining wastes are openly dumped. Recyclable waste includes plastics, glass, metal and pet bottles. Even textile items go for recycling. They sold some waste textiles at Rs 2 per kg to Lumbini Sirak Dasna.

The average cost of some recyclable materials being processed and recovered by WASH Cooperative is Tilottama Municipality is given in Table 6. The cost of these materials maybe not be stable and can change according to the situation in the market. Lately, a wide range of materials are recovered and recycled from processing of the MSW at its processing center. The materials include bottled of different types like beer, PET water, medical bottles, carton boxes, metal items (tin and aluminium), plastics items (shopping bags, MLP, colored plastics, PP sacks), etc. The total amount of materials per month and the cost per kg of these recovered items are given in table 7. The amount earned from the sales of the recovered materials after

processing for last month (March) was NRs 126947. This shows the business value of the waste which can be converted to “Mohar”⁹.

Table 6. The average cost of the recyclable waste

Category of waste	Amount (kg)	Rate (Rs)
Bottles (PET)	Per kg	35-40
Metal (Tama)	Per kg	400
Plastic sack (PP sacks)	1 Bundle (55 Boras)	14/per kg
Torch light	Per kg	400
Beer bottle	Per pieces	1
White glass (grinding)	Per kg	4
Card board/Paper	Per kg	14

Table 7. Amount of recovered and recycled materials of WASH Cooperative

No	Item	Amount per month	Price NRs per kg	Total amount (NRs)	Remarks
1	Water bottles	1222 kg	50	6100	The prices of the materials being recycled will change according to the market situation
2	Beer bottles	3000 pcs	2 per pc	6000	
3	Medical bottles	167 kg	5	835	
4	Carton boxes	366 kg	18	6588	
5	LD plastics (white)	650 kg	25	16250	
6	Plastic shopping bags	857 kg	30	25710	
7	MLP	1210 kg	6	7260	
8	PP sacks	1236 kg	14	17304	
9	Tin	285 kg	20	5700	
10	Aluminium	57 kg	100	5700	
11	Transparent glass	5900 kg	5	29500	
	Total amount NRS earned from sales			126947	

Treatment, recycling and recovery

Local scrap collectors collect some portion of recyclables like plastics, papers, metals from different sources - households, vehicles and even the dumping/disposal sites and sell to the scrap dealers. During the field works it was noticed at the disposable site of Wash Cooperative that scrap collectors often visit the waste disposal site and start collecting the recyclable items, especially plastic wastes.

⁹ Source: Wash Cooperative



Photograph of scrap collector on the way

Informally significant amount of dry materials are collected, processed and recovered. Basic SWM infrastructure for storing, processing and disposal is already constructed by municipality to manage waste from wards 7 to 17 (except 12 & 17). There is a conveyor belt already installed at the site where WASH Sahakari is processing the waste. The unsorted waste is placed on the conveyor belt and the workers sort out the recyclable items. The Baler machine is used to decrease the volume of plastic waste mainly PET bottles. This site is currently managed by WASH in partnership with municipality, which has been also supported by PGRP/UNDP for the extension of ISWM infrastructures and services.

For this **Public Relation (WASH) Health Co-operative Limited** have started door to door collection system. For each household they use to charge Rs. 75/house and the fee varies with the business types. Six tractors are used for collection and disposal of waste from ward 7 to 17 by WASH. There are 23 staffs for the management of solid waste in this area.

3.5 Final Disposal

Waste collected by Sundar Nepal is currently disposed either in the bank of Tinahu River or Shankhanagar community forest and either burnt or buried. Some collection of recyclable

materials is also done in the dumping sites. It was also learnt that the waste disposed at Tinau river by Sundar Nepal waste often burned by the scrap collectors after sorting recyclable materials.

Big sections (see picture below) are dug up using excavators in the forest area and the MSW waste from the transporting vehicles are dumped in these excavated sections. Once they are filled the excavators cover up the waste with soil. The waste collected from the ward 2 is also dumped under the ground of Shankarnagar Community Forest and processed the same way.

Public Relation (WASH) disposes the collected waste at the abandoned channel of Sukhaura River. The waste transported to the processing site is normally loaded onto the conveyor belt for sorting recoverable/recyclable, after which the remaining waste is buried using excavators.

	
<p>Dumping site of WASH Cooperative</p>	<p>Dumping site of Sundar Nepal Pvt. Ltd. & Ward 2</p>

3.6 Social mobilization and public participation

Awareness Campaign

In Tilottama Municipality the local people are actively involved in the waste management system. It seems they are well were aware of the waste they generate and keeping the city clean. At their own initiations various awareness and cleanliness program are organized within the municipality through jingles, programs, and leaflets to keep the inhabitants aware of proper waste management. In each ward the local team and different clubs organize cleanliness programs once in a week. For such cleanliness campaign Municipality or the organizations working on solid waste management system send their vehicles for waste collection. The major public areas like roads are cleaned every 15 days through the program named “Clean Tilottama-Green Tilottama”. Team members

had opportunity to visit cleaning activity near the hotel premises. It was learnt that every last Saturday of the month residents have to clean up their local areas bring own cleaning tools. One representative of each household has to compulsorily come and participate or else be fined. During the work of this assessment the research team had opportunities, formally and informally to interact with local residents about keeping the city clean. The level of responsibility and awareness about solid waste management and cleanliness was found to be very high.

Municipality in collaboration with the organizations working with solid waste management organize different workshops and seminars on waste management system to aware the local people. They have printed and distributed brochures on waste management system. Local Government have their own rules and regulations on waste management and disposal.

3.7 Findings on the perception study

Waste collection and Management

The perception of respondents about the present solid waste collection process was also studied. Respondents were asked about the present management practices. It shows that the 90% household respondents from the assessment area said that the waste collection was fair and remaining 10% of the respondents were not completely satisfied with the management, which also confirms that the solid waste collection process by service holder needs improvement.

Storage of waste

Regarding the storage of waste, majority of the respondents used plastic bags and the remaining used sacks and dustbin. The study showed that 60% of the respondents stored their waste in plastic bag and 20% of the respondents used sacks and 20% used dustbin to store the waste

Solid waste management practice

Regarding the storage of waste management practice, majority of respondents manage their waste through the door to door waste collecting system.

3.8 SWOT Analysis

Strength	Weakness (Gap)
<ul style="list-style-type: none"> • Strong awareness among the common people for maintaining a clean city • Public participation in Saturday and other cleaning programs • Capable and committed leadership in the municipality • Image of two times award winning municipality • MSW management is an integral part of Municipality program • Sufficient budgetary allocation for MSW management • WASH Cooperative in cooperation Municipality already has project support from UNDP in which they have established waste collection and processing center. They have started waste recovering and started Business on Waste. • The municipality has its own guidelines for the SWM and sanitation under Zero Polythene, 2076 	<ul style="list-style-type: none"> • Unavailability of reliable data on solid waste generation and resources recovery • Lack of waste segregation at source by all three service providers • Multiple disposal sites for a small city • Uncontrolled disposal of MSW near river banks by Sundar Nepal • Open burning of MSW by service providers and recyclers causing pollution • Lack of reward and punishment • Poor resource recovery and recycling activities within Sundar Nepal and Ward No 2 • No incinerator in Hospital and lack of separate hospital waste management • Hospital and hazardous waste being mixed in the MSW mainstream • Within WASH Cooperative and Municipality there exist some rivalry among coworkers • Lack of Use of SWM technologies in the waste management
Opportunity	Threat
<ul style="list-style-type: none"> • 48 % or 13.2 tons/day of Biodegradable waste for biogas (small and large) • Resource recovery of 6.22 tons plastics, 9 tons textiles, 6 tons paper, 2 tons metal and 5.7 tons glass from waste. Its nearly 50 to 60% including wet and dry wastes. • Already existing recycling industries (mat industry, plastic granule, shopping bags, ropes, etc.) in the vicinities of Tilottama is a big market for recyclable items • Energy intensive Glass and metal recovery through smelting in case of power surplus • WASH Cooperative having technical facilities (baling machine, conveyor belt for segregation of MSW, etc.) and trained manpower is already operating successfully in partnership with the municipality • Strong and visionary leadership within WASH Cooperative and adequate financial resources • Future program of Wash for source segregation of MSW and RDF production as alternative fuel • Job opportunities. • Woman empowerment. 	<ul style="list-style-type: none"> • Change in leadership within the municipality after local elections • Only WASH Cooperative is working with waste processing and recovery facilities so municipality should start working with other service providers as well. • Change in leadership of WASH Cooperative • Lack of technical expertise in operation of waste processing center of WASH Cooperative with business model • Unhealthy and hostile environment between three waste management service providers • Public health impacts in the absence of proper solid waste management or waste services. • Health impacts on those living near open dumps. • Health and illness costs due to solid waste related pollution. • Health impacts on waste workers. • Groundwater pollution or negative impacts on natural environment.

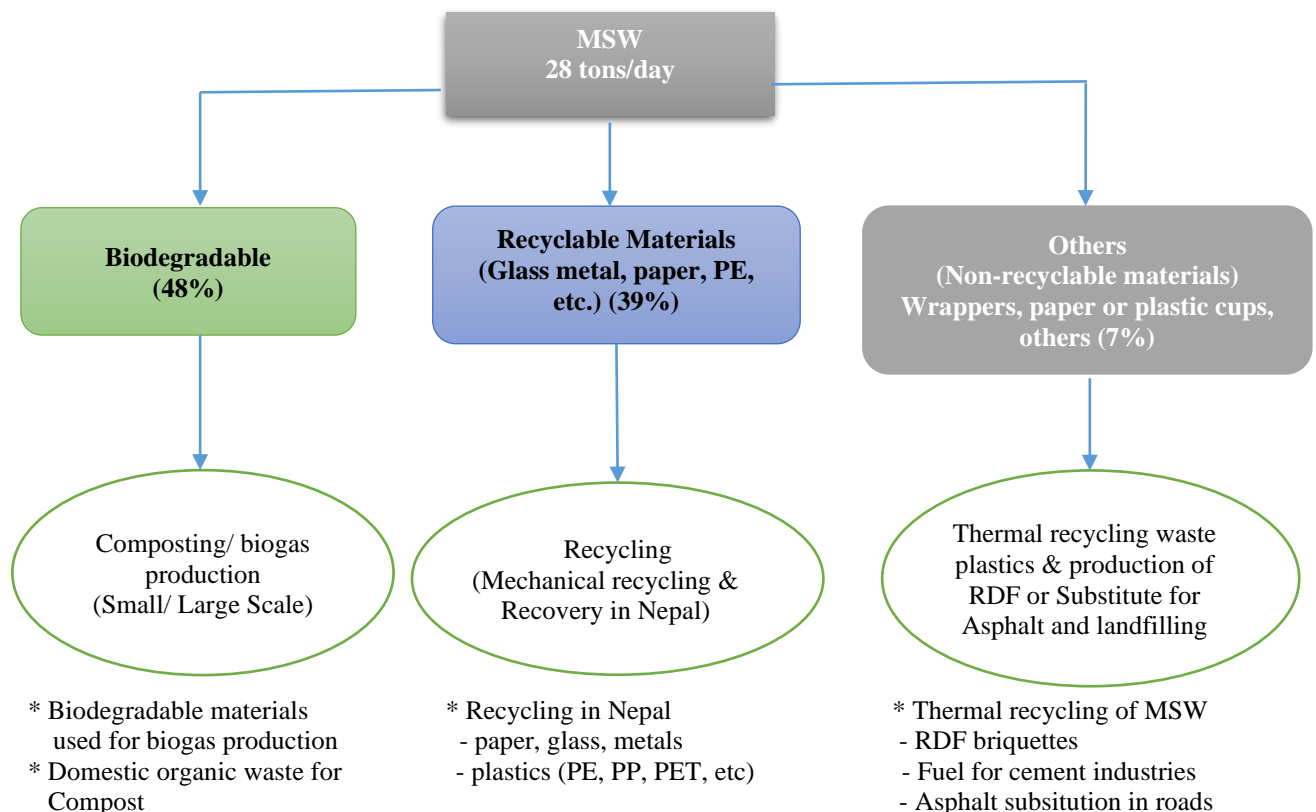
The SWOT analysis and given assessment work gives a clear picture of the situation of the management of MSW in Tilottama municipality. Among the three service providers WASH Cooperative has most of the prerequisites and a sound base to manage the total waste of the city.

- Waste processing and disposal center with adequate infrastructure (office, building and sheds, etc.)
- Technical facilities (baling machine, conveyor belt, etc.) and trained manpower to handle and process MSW
- Highly devoted, competent and committed leadership with future vision
- Good financial status of cooperative as well as support from municipality
- Good relationship with the leadership of Tilottama Municipality and the staff
- Good relationship and project support from UNDP
- Good concept of waste recovery and recycling
- Already effective running programs on composting and recycling business

4. Recommendations for Integrated waste management system

4.1 Potential Waste Management Model

Conceptual framework of recovery, recycling and landfilling of MSW materials in integrated solid waste management, where the segregated waste will be used.



Earlier waste was looked at as a nuisance and dumped mainly in landfill areas. Now it is looked as a valuable resource. Waste materials are no longer end of supply chain but rather beginning of another chain. Products can be recycled again and again to get new products.

- If earlier degradable portion (47%) of MSW was used for composting alone, now besides composting biogas generation in small as well as large digesters to produce CNG are well developed.
- If recycling of waste (plastics waste, glass, metals, etc.) was earlier sold to neighboring countries (India), now recycling within Nepal is coming up very fast. Recycling of glass and recovery of metals are energy intensive industries that can use the surplus energy which will be available in the country. Around 30 % of the waste including plastic paper , etc. can be recycled within the country now.
- Non-recyclable combustible waste (about 8 %) has high energy value, so energy recovery from such materials in the form of RDF can not only be an inexhaustible form of Renewable energy but also be a safe, economic waste disposal of residual waste, resulting in Greenhouse gas reduction. Non-recyclable plastics can be also used as fuel in cement and other industries as substitute of coal and fuelwood. Recent research of CEEN with support of UNDP has shown that RDF used in kilns in Thimi were resource and time saving as well emitting low emissions during use as substitute of fuelwood.¹⁰

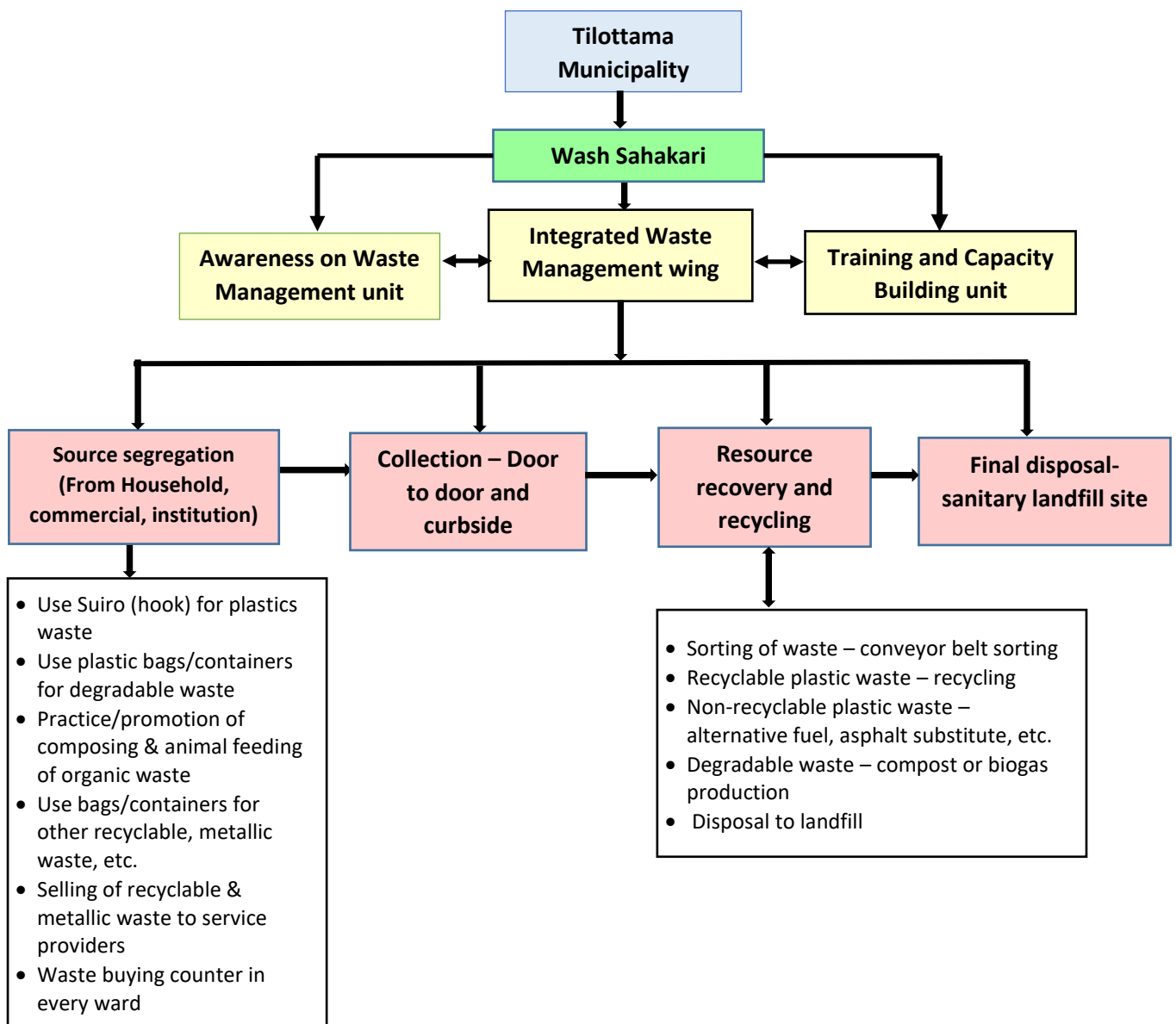
The SWOT analysis of the waste management system in Tilottama municipality and observations from the current waste management service providers (WASH Cooperative, Sunder Nepal and Ward No2), WASH Cooperative is comparatively in a better position among the 3 service providers, in terms of infrastructure facilities, technical tools, trained manpower, recovery and recycling programs, public relations, etc. Furthermore, it has a strong financial base and good international support as well.

Therefore, in the context of Nepal management of MSW could be handled in a very effective way if a Cooperative model like that of the WASH Cooperative could be developed and initiated. For such a model the Wash Cooperative system should be studied and further improved in terms of infrastructure, manpower, multi stakeholder cooperation and participation.

¹⁰ Exploring the Environment Effects of Using Refused Derived Fuels (RDF) and its Cost Analysis against the Traditional Fuels used in Factories, UNDP report, September 2021

Based on this background it is highly recommended to introduce an integrated system (Cooperative model) of waste management under the close coordination, cooperation, support and guidance of Municipality and WASH Cooperative. WASH Cooperative can involve other stakeholders in the management of MSW under its leadership and guidance from the municipality. The proposed organizational structure of the management systems is reflected below. With introduction of such a working system, the waste management, resource recovery, proper recycling as well as disposal of MSW could be well organized rather than poor management with uncontrolled disposal, dumping and burning of waste.

Integrated Solid Waste Management (ISWM) MODEL



Integrated waste management wing

The following major functions will be fulfilled by this wing in close cooperation with the municipality and concerned stakeholders in process of proper waste management.

- Initiate Suiro (Hook) program and for recovery of plastics waste through distribution of metallic hooks to households, commercial and institutions¹¹.



Plastics waste on hook

- Open buying counter in every ward ¹² (resource recovery)
 - Plastic wastes (all kinds recyclable and non-recyclable)
 - Paper and paper products
 - Metallic wastes (Iron, Aluminium, etc.)
 - Glass bottles (all kinds of bottles)
- Distribution/installation of waste collections bags/bins with color codes for degradable and non-degradable waste. WASH Cooperative has already plans to distribute such plastic bags or used PP sacks/flex bags.



Plastic bags



Plastic containers

¹¹ Suiro Abhiyan at Hetauda Municipality Best, Practices on SOLID WASTE MANAGEMENT OF NEPALESE CITIES, Practical Action 2008

¹² Such waste buying counters were very popular in the late 80ies and early 90ies in many wards of Kathmandu city, but faded away after the political change of 2046-47.



Used plastic sacks



Metallic containers

- Collection and transportation of waste - MSW collection system: fleet of vehicles, manpower, tools, proper dress code for health and hygiene, etc.
 - Door to door collections of waste (segregated and non-segregated waste)
 - Roadside and curbside collections of waste from containers, bins, bags, etc.
 - Transportation of waste to processing center
 - Waste sorting in processing center
- Resource recovery and recycling – sorting of waste with different tools and trained manpower
 - Recovery from biodegradable (organic) waste
 - Composting and biogas generations
 - Compost bins and compost making training
 - Use of compost and vegetable cultivation
 - Domestic scale biogas plants
 - Training and use of biogas plants
 - Large scale biogas plants
 - Recyclable plastics waste – recycle to granules, yarn, fibre, etc.
 - Non-recyclable plastic waste – wrappers, food packaging, cups, plates, etc.
 - RDF briquettes from non-recyclable plastic wastes as alternative fuels
 - Plastic waste for substitute of asphalt in road construction
 - Plastic waste as fuel in cement and other industries
 - Plastics lumber for furniture and bricks
 - Addition of plastics in concrete bricks
 - Paper card board and paper products – recycle to get paper
 - Glass waste (all kinds of glass, bottles, etc.) – recycled glass as raw material
 - Metallic waste – different metals, cans, etc. – recovery of metals
- Final disposal to landfill

- Digging and preparation of earthen pits
- Dumping of remaining waste (inert and remaining waste, etc.)
- Covering with soil and preparation of surface cover

Awareness on waste management unit

- Organization of talk programs, interactions, visits and exposures
- Information brochures and pamphlets about MSW
- Awareness programs through mass media and social media
- Information on source segregation and resource recovery

Training and capacity building unit

- Capacity building on MSW
 - Development of qualified manpower through education and trainings
 - Development of Technical capacity- new technologies and adaptation
 - Development of infrastructure, machinery/equipment and facilities for MSW management
 - Information on different technical and technological means of waste management
 - Research and Development unit
 - Technical information data base
- Training programs on waste management
 - Training on segregations of waste at source
 - Training on MSW and information on different types of waste
 - Training on handling and sorting of waste
 - Training on resource recovery and recycling

4.2 Technological options for Waste recovery and recycling

1) Organic recycling – Compost and Biogas production

- Domestic (small quantities of) biodegradable waste – making compost in traditional way, vermi composting using compost bins, and other means. Using compost for vegetable cultivation.
- Small scale and large scale (large amounts of organic waste)
 - Small and medium scale biogas plants to produce biogas as alternative to LPG. Alternative Energy Promotion Center (AEPC) can assist in installation and operation.

- Slurry can be used as organic fertilizer for cultivation
- Large scale biogas plants to produce biogas and bottling to get CNG as alternative of LPG and save foreign currency. Many such plants are in operation in Pokhara, Biratnagar, Nawalparasi, etc. This gas can also be used for power generation. A plant of this type was in operation in Teku, Kathmandu with KMC
- Reduce use and import of LPG (fossil fuel) and reduce GHGs
- Can earn money through CDM mechanism
- Sanitary Landfill gas technology for power generation. (Tilottama municipality can participation in “Integrated solid waste management project (ISWMP)” in Sainamaina Municipality)¹⁴.

2) Mechanical/Physical recycling – establishment of recycling industries

These industries are energy intensive industries that need to be established in the country for the recycling of metals, glass, plastics, paper, etc. In near future the energy generation within the country is predicted to be in surplus and energy intensive industries are required to consume this surplus energy. So far waste metals and glass all goes to India at low price. Plastics granules as raw materials has to be imported. Setting up recycling industries can produce granules for the existing plastic industries.

- Smelting of Metals – ferrous, aluminum, etc. – recovery of metals
- Glass – glass smelting (energy intensive) glass as raw materials
- Paper – new paper, card board, paper pulp industry, etc.
- Plastics – recyclable plastics - granules of thermo-plastics materials as raw materials for industry (PE, PP, PET, PVC, etc.)

3) Thermal recycling or energy recovery from non-recyclable plastics

- Energy generations from incineration of hazardous waste and mixed plastics. This is proven technology used in many developed countries for base load electrical energy generation and use. It can also be used to use the heat of incineration for hot water and space heating.
- Production of RDF as alternative fuels to displace traditional fuels – fuelwood, coals, etc. This technology is also popular in many developing countries and neighboring India to

¹⁴ Pre-feasibility Study of ‘INTEGRATED SOLID WASTE MANAGEMENT PROJECT’ (Butwal Sub-Metropolitan City, Devdaha Municipality, Tilottama Municipality, Siddharthanagar Municipality & Sainamaina Municipality), Investment Board, Government of Nepal, March 2019 New Baneshwor, Kathmandu, Nepal

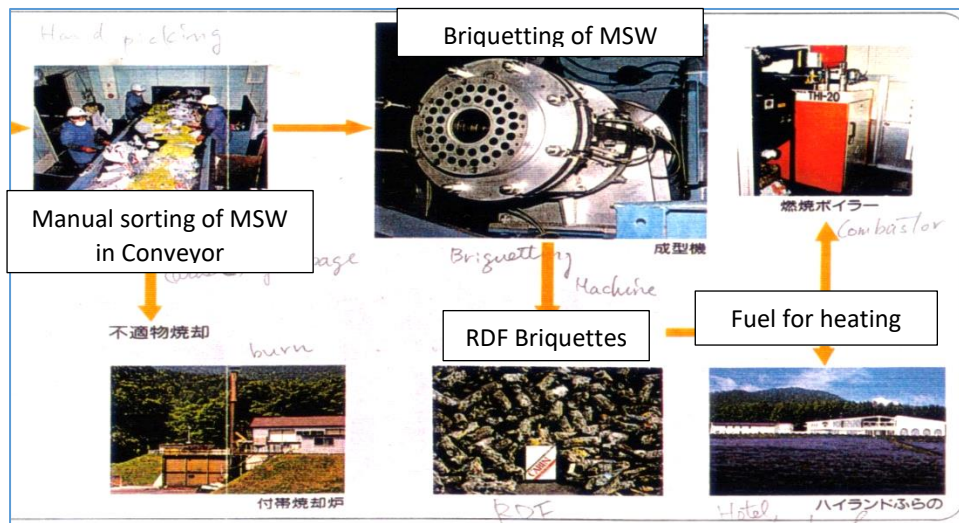
produce RDF briquettes and use as an industrial fuel. CEEN also has developed this technology as is planning to promote this technology for broader use of RDF.

- Waste plastic wrappers as fuel in cement and other industries. This technology is already in use by Agni Ventures to substitute at least 5% of coal with plastic waste.
- Substitute for asphalt in road construction. Green Road Waste management Pvt. Ltd. has used plastic waste up to 10% as substitute of asphalt in road construction.

Analogy of MSW of Tilottama and Furano city of Hokkaido, Japan

Parameters	Furano city	Tilottama
Country	Japan	Nepal
Area (km ²)	600.97	126.2
Population	22, 715	149,657
MSW management awareness & commitment	High awareness town for MSW management and example of successful demo of MSW management	High awareness for MSW management and award winning city for
MSW management	Recycling, Composting and RDF	Recycling, Composting & RDF (machine ready)

Furano town: Conveyor belt for manual sorting and processing of MSW; RDF production and use for space heating and hot water in schools and public organizations.



Furano city- Conveyor and manual sorting of MSW



Conveyor and manual sorting



Proposed briquetting machine for RDF



Use in industrial kilns

Tilottama city- Conveyor and manual sorting of MSW, proposed briquetting machine for RDF and use in industrial kilns

4.2 Business value

Earlier waste was considered as a nuisance and dumped mainly in dumping sites and later in landfill areas. Now it became a valuable resource. Waste materials are no longer end of supply chain but rather beginning of another chain. Products can be recycled again and again to get new products and also can be reused. If earlier degradable portion of MSW was used for composting alone, now besides composting biogas generation in small as well as large digesters to produce biogas and CNG are well developed. Now recycling within Nepal is coming up very fast. Non-recyclable combustible waste has high energy value, so energy recovery from such materials in the form of RDF can not only be an inexhaustible form of Renewable energy but also be a safe, economic waste disposal of residual waste, resulting in Greenhouse gas reduction.

Now a days the municipality can sell the recyclable wastes like glass, paper, metals, and plastics to the scrap dealers or recycling centers and generate the revenue. The MSW waste is now looked upon as a valuable resource. As the saying goes: “Fohar is now Mohar (waste is now money)” and recycling has turned out to be a big business. Thousands of scrap or rag pickers earn their living by collecting and selling recyclable materials such as bottles, waste plastics, paper, metallic scarp etc. There are many scarp dealers, kabaddi shops, etc. that buy the scarp originating from MSW. The business has grown big and there are many recycling industries of different scales and sizes, different associations such as Recycled Plastic Manufactures Association (2000), Nepal Recycle Producer Association (NEREPA) who buy scrap materials for recycling.

The average waste composition of Tilottama Municipality (figure 4.) shows that 47% (13.16 tons) of the waste is organic or biodegradable waste. This can be used to generate biogas using different size anaerobic digesters. The biogas can be used to replace LPG (Rs 1500 per 15 kg cylinder), which is very expensive and requires foreign currency for import. The biogas produced can be compressed into CNG cylinders, which are now available in the Nepalese market. It is very environment friendly and does not add GHGs as LPG. Also biogas production offers the owner to earn money through Clean Development Mechanism (CDM). In addition during Biogas generation substantial amounts of organic fertilizer (slurry) is produced as a byproduct, which also has high nutrient as well as monetary values. Earnings from the sales of this fertilizer is also going to be substantial.

The plastics waste is just over 21 % (6tons/day), which consists of PET bottles, polypropylene (PP) sacks, multilayers food packing, wrapping materials, PE shopping bags, etc. PET bottles

used for water, oil, soft drinks (coke, Fanta, Sprite, Pepsi, fruit juices, etc.) has a value of up to Rs 30-40 per kg in the scrap market. The bulk of the plastics waste consists of PP sacks, whose market value is about Rs 14/kg. For example if 3 tons (or 50%) of the plastic waste was PP sacks, about Rs 42,000 can be earned from selling it. Similarly, from the sales of the metallic components, glass bottles, etc. can also get good returns as the price of these materials in the market is also attractive depending on the types of metal or bottles. The paper and card board waste is about 6% (or 1,68tons). Selling it at the current price of Rs 14/kg it can give Rs 23,500. A wide range of materials like bottles, carton boxes, metal items, plastics items, etc. are being recovered by WASH in its processing center. The amount earned from the sales of the recovered materials after processing for March 2022 was about NRs 126947.

The packaging industry is the largest consumers of plastics consuming about 40% of the total plastic production in the world market. Food packaging could consume half of it. Most of the food packing material are multi-layered packaging or wrappers. Most of the packing materials used are non-recyclable and goes to the landfill. Noodles packing and many other snack foods packaging materials or wrappers are made of plastics (mainly mixture of PE or PP with PET). These materials also have a thin lining of aluminium inside. Like all plastic materials they have high energy content or have high calorific value and can undergo thermal recycling i.e. get back the energy it contains as it has high fuel value. They can be used as an alternative fuel rather than dumping them in the landfill. CEEN with the support from UNDP had conducted research and tested RDF briquettes made from 50% wai wai noodle wrappers and 50% waste paper. As fuel used in kilns in Thimi, the RDF was superior to traditional fuelwood in performance. Nearly 50% fuel saving was found with lower stack emissions than fuelwood. In terms of price the RDF briquettes cost around Rs 10-12/kg depending upon the availability of waste free of transportation and raw materials cost fuelwood, whereas fuelwood costs around Rs 15-35/kg, depending on the type and quality. Presuming that 50% of the plastics waste (3tons) is non-recyclable and it is converted into RDF briquettes, then about Rs 30,000 (3000kg*Rs10) can be earned from sales of fuel briquettes.

An alternative use of this type of valuable plastic waste is its use in the kilns of cement industries as a partial substitute of coal. Cost of coal in Nepal ranges from Rs 14146- 18135/MT, depending upon the quality of it. Coal is an expensive fossil fuel, combustion of which generate carbon dioxide. Substitution of at least 5-10% of the coal used in cement industries could give immense financial savings as well as reduction in CO₂ generation. There over 21 operating cement factories

operating in Nepal, which consume thousands of tons of coal annually. Even partial substitution of this fuels will give huge financial savings.

This concept of “Energy from Waste” or EfW, has multidimensional benefits. EfW allows for clean renewable power; safe, low cost and long-term waste disposal local waste, reduction in transportation cost, employment opportunities for people.

Non-recyclable plastics wrappers can also be used as a substitute of asphalt in road construction. Green Road Waste Management Pvt. Ltd has successfully tested using up to 10% plastic waste as substitute of asphalt in the road construction in Pokhara and Kirtipur. Asphalt is also an expensive commodity which has to be imported. Large amounts of asphalt is consumed in road construction and partial subsection will lead to substantial savings in the import.

Another use of waste plastic wrappers could be in the construction business to produce bricks. With UNDP support Green Road Waste Management Pvt. Ltd had produced and tested concrete bricks introducing small amounts of shredded plastic wastes during production. Test results showed that introducing small amounts up to 10% shredded plastic waste does not change the properties of bricks. Rather the insulation properties were better with lower weight in comparison with bricks made of pure concrete alone. The price of such bricks will be lower than original ones¹⁵.

5. Conclusion

The present existing condition solid waste management system in Tilottama Municipality was studied in this rapid assessment. The waste generated here is looked after and managed by three different service holders as mentioned in table 2 above. Due to rapid urbanization, huge volume of waste is constantly generated and accumulated.

Analysis of solid waste composition shows that the amount of organic waste was higher as compared to other inorganic waste in household and commercial business whereas in institutions the amount of inorganic waste mostly paper and textile was higher. In the operating areas of WASH and Sundar Nepal, the MSW was supposed to be segregated to some extent, but the

¹⁵ “Turning Plastic Waste into Bricks | UNDP in Nepal,” UNDP, accessed February 11, 2022, <https://www.np.undp.org/content/nepal/en/home/presscenter/articles/2021/Turning-plastic-waste-intobricks.html>.

composition results show that 45 (6.3 tons) and 48 % (4.8 tons) is till organic waste. This probably means that the waste is partially segregated.

Observations from the current waste management service providers (WASH Cooperative, Sunder Nepal and Ward No2) in Tilottama and their activities, WASH Cooperative among three is in a better position comparatively with adequate trained manpower, infrastructure and some technical facilities.

WASH Cooperative has its waste processing center (near bank of Sukhaura River) with adequate infrastructure (building and sheds), technical facilities such as conveyor belt for segregation of MSW, baling machine to bale selective plastic waste, program of compost preparation for degradable wastes, etc. It has been earning money through resource recovery and selling of waste plastics and metals after segregation using conveyor belt. Resource recovery from the conveyor belt is conducted by trained manpower with proper knowledge of health and hygiene with proper protective gears. For door-to-door collections and road pick up system of waste it uses up to 4 vehicles (2 round).

Sundar Nepal has its dumping site (Shankharnagar community forest) but without any infrastructure (building, sheds, etc.). It uses 4 tractors for door to door collections and road pick up system of waste and transportation to Shankharnagar community forest site. But more often it is dumped and burnt on the banks of Tinau River causing severe pollution. It virtually does not have trained manpower for segregation, resource recovery and recycling. Ward No 2 was said to fall under the jurisdiction of Sundar Nepal, but sought separate identity. In terms of facilities (one tractor) and manpower it is not sufficient for door to door collection but for road pick up system. Gaps in recyclable waste management in Tilottama Municipality were identified. The foremost reason behind lack of enhancement of recyclable waste collection business is market imbalance and market imperfection. Entire recyclable waste collection community lack authorized organization or institution accountable to rights, freedom and welfare of people involved in such business. Lack of proper information management system is creating gap for effective recyclable waste collection and management system. Knowledge and information regarding kind of recyclable waste materials and their scope of dimensions is key factors in management of recyclable waste material. Recyclable waste collection business is expected to be at risk due to various possible market factors i.e. demand supply chain.

The current assessment work is a rapid assessment, so the results and data acquired are just preliminary. In the assessment work only three days were devoted to study the waste management run by three different service providers. The waste generation of these particular days were studied as an example. However, this data has been used to make some estimates of the waste generated and the composition of the waste. Based on assessment study results and existing situation and experience of Tilottama municipality, an integrated waste management system has been proposed at the leadership of WASH Cooperative. It should work in close cooperation with the Municipality involving all the stakeholders for the proper and efficient management of waste. Many activities and technological options have been proposed for recovery and recycling of MSW, looking at it as a valuable resource. Examples of energy recovery and recycling of the MSW, which have given positive results in the current context of Nepal has been put forth to use MSW as starting raw material.

However, the true picture of the status of MSW in Tilottama will be available only after conducting a baseline study of the waste generation and management. With higher possibility of waste recovery i.e. 90% from current waste scenario, there is higher opportunities to plan MSWM with a business model in Tilottama.

Annexes

Questionnaire

List of KII

Table: KII during Rapid Assessment

S.N.	Name (key persons)	Designation and Organization
1	Khem Prasad Gautam (Chairman)	WASH (Jana sahabhagita wash swasthya sahakari sastha ltd.
2	Tan Prasad Pandeya (Vice Chairman)	WASH (Jana sahabhagita wash swasthya sahakari sastha ltd.
3	Krishna Maya Karki (Chairman)	Sundar Nepal private limited
4	Yadunath Giri (Supervisor)	Sundar Nepal private limited
5	Lekhnath Bhattarai (Supervisor)	Ward 2, Tilittama Municipality
6	Dr. Murali Parajuli (Consultant)	WASH (Jana sahabhagita wash swasthya sahakari sastha ltd.
7	Rama Kanta Bhusal (committee member)	WASH (Jana sahabhagita wash swasthya sahakari sastha ltd.
8	Gorakh Nath Khanal	Environment Department (Tilottama Municipality)
9.	Yubraj Panthee	St. Engineer (Tilottama Municipality)

List of Focus Group Discussion (18th March) at Tilottama Municipality

S.N	Name	
1	Jageswor Devi Chaudhary (Deputy Mayor)	
2	Khem Prasad Gautam (Chairman)	Wash Sahakari
3	Tan Prasad Pandeya (Vice Chairman)	
4	Dr. Murali Parajuli (Consultant, WASH)	
5	Aarju Karki	
6	Youbraj Panthe (St. Engineer)	
7	Purnima Bajracharya	UNDP
8	Gorakh Nath Khanal	
9	Ramesh Man Singh	CEEN
10	Deepesh Raj Sharma	CEEN
11	Prabina Raut	Researcher Student
12	Binisha Kalika	Researcher Student
13	Srijana Karki	Researcher Student
14	Lekhnath Bhattarai	

QUESTIONNAIRE

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KII (QUESTIONNAIRE)

"Rapid Assessment on Potential Waste and its Business Value for Tilottama Municipality"

GPS coordinate:

1. Date:
2. Name of respondent:
3. Position:
4. Department:
5. Address:
6. Municipality/ Ward Population:
 - a. Male: Female:
7. Total household (number):

8. Area:
9. Who are the major stakeholders responsible for solid waste management? (Municipality, Private Organizations, Others). Name them if any with details and contact number.
10. What are the major components of the waste management system being practiced?
(Collection, Segregation, Recycling, Transfer station, Transportation, Dumping site, Landfill, Composting, Awareness, Trainings etc.)
11. How many collection points are there in the ward?
12. Are local people engaged in solid waste management? If yes, are they doing it by themselves or is it launched by ward office? Name major programs.
13. What are the major wastes being generated and collected by municipal waste channel?
14. Do you collect hazardous waste too?
15. Do the municipality charge or intend to charge waste collection fee for collecting the waste from community like Household, Hospital, Business/ Industries, Shops, Restaurants, Institutions etc.?
16. How do you find the willingness of local people to pay for waste management?
17. Are there any waste treatment plants/ practice being adopted by Ward /Municipality before being disposed to dumping/landfill site? If no, are there any potential sites where waste processing / transfer station/dumping/landfill site can be constructed? Please provide Location details, area, land details and guide to visit the land?
18. Where is the final waste disposal site? And its lifespan? How much waste is disposed everyday? What kind of waste are taken there?

19. Is the Material recovery and 3R principal concept being practiced ? If yes, kindly mention (Be waste specific/ Waste types/company name and address)
20. If the material recovery and 3R principal is practiced, how much average income is generated by Municipality by selling recyclable waste?
21. How much of the collected waste from ward/municipality is being transported to disposal site?
22. Do ward/ Municipality collaborate with any NGOs, GOs and civil organizations for any means of programs that are purely dealing with Municipal solid waste management?
23. What safety equipment is provided to waste handlers?
24. What is the ward office roles and responsibility for ensuring the implementation of proper waste management system ?
25. How many staff is involved in waste management at ward level/ Municipality?
 - a. Male: Female:
 - b. Waste Collectors:
 - c. Waste Transportation
 - d. Waste treatment:
 - e. Waste disposal:
26. What is the average budget allocated for Sweepers, Collectors, Driver, others that are directly or indirectly engages in Solid waste management?
27. What is the attitude of local people towards solid waste management?
28. What is the main problem created by the solid waste?

29. Do you think people are happy/satisfied with current waste management practice? If no, why?

30. Do you think current work carried out for management of municipal solid waste enough? If no, what more do you think should be done?

31. What is your future plan regarding solid waste management?

32. What can be done to eliminate the problem of solid waste in your society? Do you think any of these are better options for you? If no, please recommend options.

33. Awareness

34. Forming user group

35. Providing physical facilities

36. Penalty

37. Privatizing

38. Giving emphasis on reuse , reuse and recycle

39.

Questionnaire for Pvt Company

KII (QUESTIONNAIRE)

"Rapid Assessment on Potential Waste and its Business Value for Tilottama Municipality"

GPS coordinate:

Date:

1. Name of Company:
2. Address:
3. Name of respondent:
4. Position:
5. Major work:
6. Staff number:
7. Equipment and assets:
8. Members/clients (total):
9. Members/clients (Tilottama Municipality with ward details):
10. Waste Collected/Resource intake (types and kg per month):
11. Waste collection frequency/ Resource intake frequency (Number per month):
12. Any changes in the trend of waste collection till date?
13. Waste Recovered/ Products (kg per month):
14. Where is the transfer site/ segregation facility/ production area?
15. Where is the waste dumped or landfilled?.....
16. Waste landfilled (kg per month):
17. Major revenue generation: product sales or monthly service fee or
18. Range of service fee (monthly)
19. Major expenses: equipment or vehicles or human resources or
20. Organogram of the entire waste management mechanism
21. How is ward/ Municipality responding or assisting towards proper waste management at ward level?
22. How do you find the willingness of local people to pay for waste management?
23. Is the Material recovery and 3R principal concept being practiced in waste management system?
If yes, kindly mention (Be waste specific/ Waste types and approx. weight per month)
24. What safety equipment are provided to waste handlers?

25. How do you assure the occupational health safety of waste handlers/ staff? (Collectors, Transporters and at disposal site)?
26. What is the provision of monitoring and evaluating the proper waste management practice in your working area?
27. What is the average salary for them (Sweepers, Collectors, Driver, others)?
28. What is the attitude of local people towards solid waste management?
29. What is the main problem created by the solid waste?
30. Do you think people are happy/satisfied with current waste management practice? If not, Why?
31. What do you think needs to be done to make better sense of waste management at Namobuddha?
32. What is your future plan regarding solid waste management?
33. What can be done to eliminate the problem of solid waste in your society? Do you think any of these are better options for you? If no, please recommend options.
34. Awareness
35. Forming user group
36. Providing physical facilities
37. Penalty
38. Privatizing
39. Giving emphasis on reuse , reuse and recycle
40.
41. What are the challenges faced regarding solid waste management?
42. What kind of support or assistance do you require for better waste management activities?
43. How much Capacity do you have for capital investment for a proper setup of waste management model?
44. What resources do you have? Land/ Financial/Expertise/ Human resources/ Equipment/Others?

“Rapid Assessment on Potential Waste and its Business Value for Tilottama Municipality”

Field Visit Plan

Date	Programme	Remarks
9 th March, 2022 Wednesday	Kathmandu to Tilottama Municipality	
10 th March, 2022 Thursday	<ul style="list-style-type: none"> • Survey on three sites • Weight on Dharmakanta • Unloading wastes and calculation of waste composition Quadrant method	
11 th March, 2022 Friday	Questionnaire to key persons n other stakeholders. Questionnaire to: kabadi, recycler, sellers. Etc.	
12 th March, 2022 Saturday	<ul style="list-style-type: none"> • Survey on three sites • Weight on Dharmakanta • Unloading wastes and calculation of waste composition Quadrant method. Cross questionnairing to HH and others.	Reconfirmation
13 th March, 2022 Sunday	<ul style="list-style-type: none"> • FGD at Municipality with different sectors • Presentation on RDF (DR. RMS) • Presentation on draft data analysis and findings • Remarks form stalk holders 	
14 th March, 2022 Monday	Back to KTM.	

PHOTOGRAPHS



Weighing at Dharmakata



Waste segregation (dumping site-Wash Sahakari)





Weighing the separated waste



Waste workers- Wash Sahakari



KII with Chairman- Wash Sahakari



Open burning of waste at Tinau River bank



Group meeting at Tilottama Municipality



Presentation Session



KII with focal Persons of Municipality



KII with Chairman-Sundar Nepal pvt



Cleaning campaign in Tilottama – last Saturday of the month



Interview with owner of Mat factory



Waste to the lanfilling site of Sunder Nepal



Weighing of the collected waste by WASH

PASCHIMANCHAL YATAYAT BEWASAI SAMITI
DHARMA KATA RAMNAGAR -10 BUTWAL

RST NO : 1093 VEHICLE NO : 9173LU1TA

TARE Wt: 3360 kg Date:12/03/2022 Time:06:50

Charges(1): Rs. 0

OPERATOR'S SIGNATURE:

PASCHIMANCHAL YATAYAT BEWASAI SAMITI
DHARMA KATA RAMNAGAR -10 BUTWAL

RST NO : 1097 VEHICLE NO : 9173LU1TA

GROSS Wt: 4540 kg Date:12/03/2022 Time:10:17

Charges(1): Rs. 50

OPERATOR'S SIGNATURE:

WELCOME

Receipt from Dharmakata before and after waste collection

Panchakanya Steel Pvt. Ltd.
Kotuhawa, Bhairahawa, Distt. Rupendhi, Lumbini Zone, (Nepal)
071-514161, 071-514168

Weighment Slip

Slip No. : 23,716 Date : 26/11/2078


Material Name : Vehicle No. : LU3TA2572

Consignee Name : TRACTOR Customer Name :

Gate Pass No : Address :

Remarks : Material Group : PK.PLASTIC

GROSS WEIGHT :	5380 Kg.	26/11/2078	2:01:00PM
TARE WEIGHT :	3460 Kg.	26/11/2078	8:46:00AM
NET WEIGHT :	1920 Kg.		

Signature: 

यात्रा गर्दा निस्कने फोहर सडकमा फालेमा कानून बमोजिम दण्डनीय हुनेछ । सार्वजनिक यातायातका साधनहरूमा डस्टबिनको प्रयोग गरौ । यात्रुहरूलाई सडकमा फोहर फाल्न निरुत्साहित गरौ ।

म फोहर गर्दिन, अरुलाई पनि फोहर गर्न दिन्न । सरसफाई हाम्रो संस्कृति हो त्यसैले मेरो नगर सफा राख्न म प्रतिबद्ध छु । घर तथा व्यवसायबाट उत्पादित फोहर आफ्नै डस्टबिनमा राखी फोहर व्यवस्थापन गर्नेछु ।

घरधनी/व्यवसायको नाम _____

घरधनी/सञ्चालकको दस्ताखत _____



तिलोतमा नगरपालिका

रूपन्देही, लुम्बिनी प्रदेश, नेपाल



नगरस्तरीय टोल विकास संस्था सञ्जाल
तिलोतमा, रूपन्देही, लुम्बिनी प्रदेश

सडक तथा फुटपाथमा
व्यापार व्यवसाय गर्न,
निर्माण सामग्री राख्न
सक्नु मनाही छ ।



तिलोतमा नगरपालिका
रूपन्देही, लुम्बिनी प्रदेश, नेपाल



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