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Assessment of municipal solid waste management and socio-economic challenges in integrated solid waste management (A study of Rampur municipality, Palpa)

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Abstract

Solid waste is the useless, unwanted, and discarded material performed from the day- to-day conditioning in the community. The solid waste operation could also be outlined by the discipline related to the operation of generation, storehouse, collection, transfer, processing, and disposal of solid waste. The present paper is based on the study carried out in 75 houses having small family sizes a member of five to seven for identification and categorization of solid waste in Rampur municipality. For the research field, visits and desk studies for data collection were made through a questionnaire survey, key informant survey, and visits to various households and dumping sites were made. From the analysis, composition of the waste is found as follows, organic waste-65%, Plastic-14%, Paper-5%, Glass-6%, rubbers-4%, Hazardous-2%, and Other-4%. The study has found that the average per capita per day waste of the study area is 0.022 Kg/Person/Day. The average waste generation per person per day in a municipality is 0.078 kg, and total waste generation in the study area and municipality per day are 435kg and 3325kg respectively. It has been observed that more than 65% of the waste is generated by households and the remaining, mixed waste is then collected and dispatched to the Bittar landfill site by trucks, which is located at 5Km far from the Rampur Municipality office. From the study, it was concluded that for the sustainable solid waste management in Rampur Municipality landfilling option was suggested and required size, cost estimation for construction and operation was also carried out.

1. Introduction

Municipal solid waste (MSW) could be a growing debit within the civic areas around the world that is growing quicker than the speed of urbanization. In 2002, 2.9 billion civic residents generated 0.64 kilograms of waste per capita per day multiplied by3.45% in Population and a thumping 87.5% in waste generation in 2012 (3 billion civic residents generated 1.2 metric weight unit of waste per capita per day). By 2025, it's projected that 4.3 a billion civic residents can induce 1.42 metric-weight units of waste per capita per day [1]. The matter of solid waste operation is anticipated to accentuate within the developing and developed countries that warrant the foremost in terms of technological advancement and socio-political settings favorable to beat similar conditions. Regarding (20- 50) % of the external budget in developing countries being spent on managing MSW. Still, (30-60) % of the waste is uncollected and lower than 50% of its population is served [2]. A study conducted by the Asian Development Bank[3] in 2013 calculated that the composition of Municipal Solid Waste is given; Organic waste 56%, plastics 16%, paper, and paper products 16%, glass 3%, Metals 2%, textiles 2%, rubber, and leather 1% and others 4%.

Nepal lacks correct visioning and planning in the overall solid waste operation system. A study conducted in 2016 showed that the composition of municipal solid wastes contained substantially Organic matter 68% and 51% in homes and business waste severally, whereas, the dominant bit was paper and paper products 41% in institutional waste. The findings of this study showed that the municipal waste of all municipalities is well

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feasible for producing compost. The families within the main rural areas of municipalities do family composting traditionally, but in the civic homes, where lower land is on request, the unit generally does family composting [4]. Municipalities units are unfit to achieve their thing of solid waste operation as a result of the inadequacy of specialized and human resources, data, statistical records, proper planning, meager budget, lower public and private participation, and surplus political issues.

Khadka et al. 2004, before 1980 solid waste had been regionally managed in urban areas of Asian nations with no issue. The majority of the waste was used as organic manure. By the 1980's it's been discovered that the fast increase and increasing affluence has considerably modified the degree and kinds of waste generated. As a result, municipal solid waste has emerged as distinct urban setting waste material with important implications for public health and also the native environmental quality. Relating to solid waste management, the SWMRC act (1987), municipal act, and native self-governance act (1999) create municipalities to manage solid waste to stop adverse effects on natural and cultural settings and to safeguard the general public health.

SWMRMC 2008, Proper assortment, transfer, and disposal of solid waste Square measure major issues faced by the 58 municipalities of Asian nations. Regarding 62% of the waste being organic and regarding pure gold of the waste being reusable/recyclable, the remaining waste ought to be finally disposed of e.g. by healthful landfilling. Medical wastes square measure incinerated by hospitals themselves in a majority of municipalities. But in some cases, it's burnt or simply inexpertly drops. The foremost common method of managing industrial waste is stream dumping. The number of human resources operating within the waste management varied from 1324 in Katmandu to no solid waste workers in Khandabari municipality which shows the acute variation. Municipalities square measure unable to attain its goal of SWM due to a lack of technical human resources, data, applied mathematics records, correct coming up, insufficient budget, less personal participation, and excess political problems.

PPPUE, Final Report 2009, Disposal and treatment of business and municipal wastes can prove emissions of most of the very important greenhouse gases (GHG). The foremost very important gas made of solid waste treatment and disposal is that the alkane series (CH_4). Landfilling gas consists of roughly fifty percent greenhouse gas and fifty percent CH_4 by volume. However, the share of gas in landfill gas is additionally smaller because of the decomposition of substrates with a high hydrogen/oxygen quantitative relation (e.g., fats, hemicelluloses), and since variety of the gas dissolves in water at intervals the situation. Waste disposal practices of concern for CH_4 emissions vary at intervals the degree of management of the position of waste and management of the situation. The composition of waste is one amongst the factors influencing the amount and conjointly the extent of CH_4 production at intervals of waste disposal sites. MSW sometimes contains necessary quantities of degradable organic matter and is that the potential to provide relatively high CH_4. Different factors like temperature, moisture, pH scale, and nutrients accessible. Approximately three to four percent of annual world evolution CH_4 is countable to be created and free into the atmosphere from solid waste treatment and disposal. It does because of this solid waste disposal and treatment that's a vital provide of GHG emissions globally.

Solid waste management consists management of production, collection, transportation, processing, and disposal in an exceedingly very manner that is below the foremost effective principles of public health, economics, engineering, and totally different environmental concerns [5]. Inappropriate waste handling, storage, collection, and disposal practices cause environmental and public health risks in urban and peri-urban areas.

Composting is self-made as results of its low cost and less-infrastructure set-up and additionally creates compost that will be a marketable byproduct, additionally to make a contribution to agriculture; the sale of organic waste reduces waste assortment and disposal [6]. As per the MNRE in India, "Composting could also be a method throughout that micro-organism, principally fungi, and microorganisms, convert degradable organic waste into humus-like substances. This finished product appears to be like soil is high in carbon and atomic number seven and may be an excellent medium for growing plants[7]. Composting might minimize the necessity for costly waste disposal methods like landfilling and combustion. Composting reduces the number of waste going to landfills; biological decomposition of most of the solid waste generated in urban centers is probably the foremost partaking and property totally different to waste exercise. The method of solid waste might perform joined of all the foremost effective chemical alternatives if well processed and managed since inorganic fertilizers area unit in most cases unaffordable to resource-poor farmers [8]. No-hit composting desires among various things, acceptable materials and conjointly the development of applicable bio-digestion facilities.

Waste-to-Energy combustion (WTE) is outlined as a way of controlled combustion, pattern of an inside device to thermally break down inflammable solid waste to an ash residue that contains little or no fuel that produces, electricity, biogas, or totally different energy as a result [9]. The energy desires of a community are

usually happy to some extent by energy recovery from wastes as a way higher distinction to landfilling. Energy recovery could also be a strategy of unwell the energy in Municipal Solid Waste. Energy hold on in wastes could also be a fraction of the input energy spent in making those materials. Owing to the excellence in resources (materials/energy) which is able to be recovered, energy recovery falls below material recovery on the hierarchy of waste management[6].

Recycling Solid waste; Plastic waste additionally has nice potential for resource conservation and GHG emission reduction, like producing fuel from plastic waste [10]. Recycling has additionally been viewed as a veritable tool in minimizing the quantity of home solid waste that enters the dumpsites. It also provides the desired raw materials for industries. These management aspects of exercise, reuse, disposal, and others, want those members of the many communities up-to-date in mind correct management techniques and conjointly the potential impacts of improper management. Residents of municipalities too got to bear in mind this management technique if the overall public and environmental problems associated with plastic waste area unit to be avoided. Usually in developing cities, their area unit found "buyers" of waste materials like cardboard and glass [11, 12]. These patrons might facilitate entertaining many materials out of the waste stream. Since exercise materials could also be a financially viable enterprise, little enterprises have and may still arise whenever there is a probability. The thieving of source-separated recyclable materials has been documented in many pilot schemes in every developed and developing nation [11]. Municipalities mustn't exclusively acknowledge the exchange of recyclables, but they got to additional embrace it, by allowing little interposes to handle the matter. Perhaps through micro-loans or small–scale facilitate, native governments might support and legitimatize these entrepreneurs.

Most of the MSW in developing countries is dropped ashore in an exceedingly, very loads of or less uncontrolled manner. These dumps produce uneconomical use of the out there house, alter free access to waste pickers, animals, and flies, and often end up unpleasant and dangerous smoke from slow-burning fires[13]. The selling of solid waste in landfills is probably the oldest and conjointly the foremost typical sort of final disposal. Many "landfills" area unit nothing quite opens, usually controlled, dumps. The excellence between landfills and dumps is that the amount of engineering, planning, and administration concerned. Open dumps area unit characterized by the dearth of engineering measures, no leachate management, no thought of landfill gas management, and few if any operational measures like registration of users, management of the number of "tipping fronts" or compaction of waste.

With the speedy increase globally likewise as in our country, the number of varied types of waste generated has collectively inflated unprecedently. The assorted wastes generated have collectively inflated unprecedently. The assorted wastes generated from types of sources unit found to be prejudicial to human health, environmental welfare, and thus the complete system. With the shortage of correct coming up with and scientific technologies, solid waste management has shown a significant threat to the surroundings and health sectors. And might continue in the longer term for additional serious if any imperative and eventful steps unit were taken instantly. Municipal solid waste management is the authoritative bodies attributable to the ever-increasing population, and lack of correct rules and cash resources.

The main objective of this research work is to assess the effectiveness of Municipal Solid Waste Management System in Rampur Municipality and its socio-economic challenges in moving towards Integrated Solid Waste Management System.

2. Methodological framework

2.1. Study area

The study was administrated in Rampur municipality of Palpa district, which is at the province no. 5. The municipality was established on 18th May 2014 by merging the existing Gadakot, Gejha, Khaliban and Darchha village development committee. The municipality is located at an elevation of 1100m from the sea level and covers the total area of 123.5 km square. The valley is bounded by Syangja district in the north, Tanahun district in the northeast and Nawalparasi district in the east, as shown in figure 1. The rainfall isn't uniform throughout the district, thus the average rainfall is about 477.26 mm[14].

Demographic details

Total Population - 42,451
Population of male - 21,785
Population of female - 20,666
Total household - 8,456
Growth Rate - 5.02%
Total Municipality Area - 123.34 sq. km
Population Density - 344.179 persons per sq. km
Household size - 5.02

2.2. Data collection tools/ technique

Primary sources

For characterizing the MSW generated in the city, a simple commingled waste sampling method was used. In the method, 10 kgs of representative commingled (mixture of recyclable and non-recyclable) wastes are

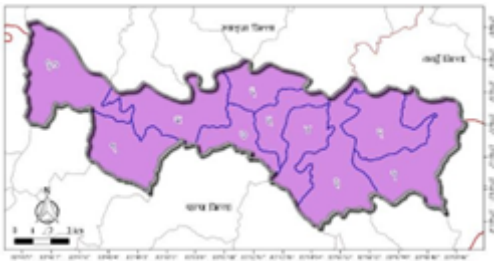


Figure 1: Map of Rampur Municipality
Source: Rampur municipality profile, 2076

taken out from the final waste disposal site, the components of the wastes was segregated and the weight by the mass of each categorical waste are measured then its resultant compositions was determined in percentage.

Most of the remaining data were generated from a questionnaire-based household survey (Random Sampling Method) and key informant interviews. Most of the questions are closed-ended for Household surveys regarding their perception, satisfaction, and willingness to pay for the overall improvement of the Solid Waste Management System in the municipality.

For KII, most of the questions were asked in the open-ended format regarding the current management practices, their effectiveness, and financial and other factors causing hurdles in the Integrated Solid Waste Management System.

A series of visual inspections were made from the place of waste collection to the place of final disposal sites for understanding the actuality of the situation.

Secondary sources

Records on the total waste generation rate, collection, disposal, and the involved cost for waste management practices were reviewed to collect data. Published Municipal profiles, unpublished municipal records, reports, and computer-recorded data are used as major secondary sources.

2.3. The sampling framework

There are 4,017 households in ward no 3, 4, 5 & 6 of Rampur Municipality. In the case of household survey, following formula was used. The sample size of the households for questionnaire survey was determined at 95% confidence level by using the formula adopted by Arkin and Colton (1963).

$$n = \frac{NZ^2P(1-P)}{Nd^2+Z^2P(1-P)}$$

Where, N = 4,017 (total number of households)
Z = 1.96 (at confidence level of 95%)
P = 0.05 (estimated population proportion)
d = 0.05 (error limit of 5%)

While using this formula, the minimum sample size of the research is 71.69 ≈ 72 samples. Thus, for low error in the research a total of 75 households were surveyed through questionnaire survey in ward no 3, 4, 5 & 6 of Rampur Municipality. The sampling framework for each social infrastructure sectors is shown in table 1.

2.4. Data analysis

Records on the total waste generation rate, collection, disposal, and the involved cost for waste management practices are reviewed to collect data. Published Municipal profiles, unpublished municipal records, reports, and computer-recorded data were used as major secondary sources.

3. Results and discussion

3.1. Current Waste management stream in Rampur municipality

The waste from the household is collected through a door-to-door collection method and the containers; other wastes especially from the market and roadside are collected through sweeping. All the collected waste is being dumped near the Kaligandaki River. Scattered settlements can be seen surrounding the dumping site. No prior segregation of waste is practiced.

3.2. Composition of solid waste from results of households survey

Figure 2 shows, The organic waste dominated the overall composition of waste which was found to be 65% whereas plastic, paper, glass, rubbers, Hazardous, and others were 14%, 5%, 6%, 4%, 2%, and 4% respectively.

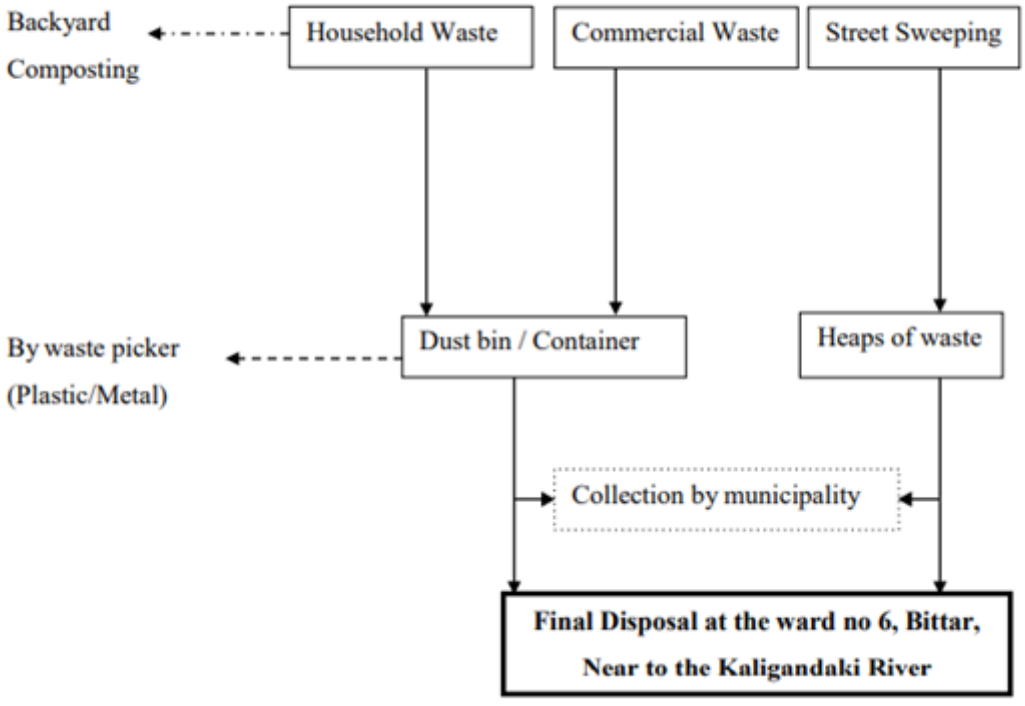
3.3. Comparative analysis of amount of waste generation with some other municipalities

Among the six major municipalities of Nepal namely Kathmandu, Pokhara, Butwal, Tansen, Rampur and Waling, Kathmandu is the highest waste generator i.e. 466.14 ton/day whereas others have 117.11, 27.12, 11.84, 3.3 and 5.51 ton/day respectively. Which is shown in figure 3.

Similarly, Figure 4 shows Kathmandu has the highest per capita waste generation i.e. 0.46kg/person/day. Whereas, Pokhara, Butwal, Tansen, Rampur and Waling have 0.44, 0.22, 0.38, 0.078 and 0.23kg/person/day respectively.

Table 1: Sampling Framework

S.N	Participants	Methods	No. of Participants
1	Committee of Municipal Solid Waste Management, Municipal Authoritative Bodies	Key Informant Interview, Discussion	5
2	Households (Ward No 3, 4, 5 & 6)	Questionnaire (Random Sampling Method)	75
3	Educational Centers (Ward No 3, 4, 5 & 6)	Questionnaire (Random Sampling Method)	19
4	Health Centers (Ward No 3, 4, 5 & 6)	Questionnaire (Random Sampling Method)	3
5	Recreational Centers (Ward No 3, 4, 5 & 6)	Questionnaire (Random Sampling Method)	43
6	Commercial Center (Ward No 3, 4, 5 & 6)	Questionnaire (Random Sampling Method)	67
7	Industries (Ward No 3, 4, 5 & 6)	Questionnaire (Random Sampling Method)	70
8	Bank/Financial Institutes (Ward No 3, 4, 5 & 6)	Questionnaire (Random Sampling Method)	25



3.4. Waste generation per day in each ward of Rampur municipality

Based on the survey, waste generation in each ward number i.e. 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 of Rampur Municipality from each sector in Table 2 and Compositions of waste generation by Mass (Kg) and Percentage (%) in Table 3, is tabulated as below:

3.5. GHG emission from the mix MSW landfilling/open dumping

Total in-organic/mix waste generation in Rampur municipality was around 1500kg per day i.e. maximum;

Table 2: Participants (Each Sectors Waste Generation by Mass (Kg))

Rampur Municipality Ward Numbers	Population	House hold	Educational Centers	Health Centers	Recreational Centers	Commercial Centers	Industries	Bank/Financial	Waste Generation (Kg)
1	3721	60	35	10	45	50	55	15	270
2	2098	50	25	15	55	60	65	10	280
3	4654	130	45	30	60	65	70	10	410
4	4331	120	50	20	70	75	80	15	430
5	6539	115	55	35	65	70	75	15	430
6	3829	100	60	40	80	85	90	15	470
7	3586	60	30	15	45	50	55	10	265
8	4351	65	35	10	55	60	65	10	300
9	3177	45	30	15	35	40	45	10	220
10	6165	55	35	10	40	45	50	15	250
Total	42451	800	400	200	550	600	650	125	3325

Table 3: Compositions of Waste Generation by Mass (Kg) and Percentage (%)

Rampur Municipality Ward Numbers	Organic Waste (Kg)	Avg. Organic Waste (%)	In-organic Waste (Kg)	Avg. In-organic Waste (%)	Hazardous and Others (Kg)	Avg. Hazardous and Others (%)	Avg. Waste Per Capita (Kg/person/day)
1	210.6	78%	54	20%	5.4	2%	0.07
2	229.6	82%	42	15%	8.4	3%	0.13
3	200.9	49%	184.5	45%	24.6	6%	0.09
4	206.4	48%	193.5	45%	30.1	7%	0.10
5	219.3	51%	172	40%	38.7	9%	0.07
6	272.6	58%	164.5	35%	32.9	7%	0.12
7	182.85	69%	66.25	25%	15.9	6%	0.07
8	216	72%	60	20%	24	8%	0.07
9	151.8	69%	55	25%	13.2	6%	0.07
10	185	74%	50	20%	15	6%	0.04
Total	2075.05	65%	1041.75	29%	208.2	6%	0.08

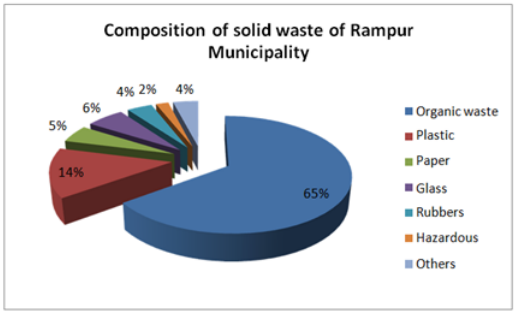


Figure 2: Composition of Solid waste

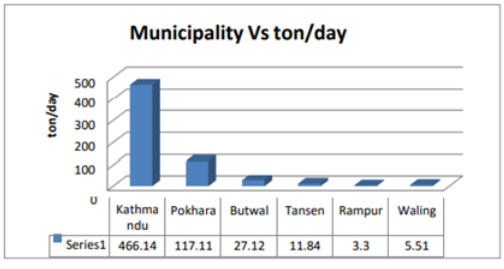


Figure 3: Comparison of solid waste generation of Rampur Municipality with other Major Municipalities Source: Asian Development Bank Report, 2012

this collected MSW was shifted near to the Kaligandaki riverside at Bittar-06, 5Km far from the Rampur municipality office. During the survey, it was found that 65% of organic waste, Plastic 14%, Paper 5%, Rubber 4%,

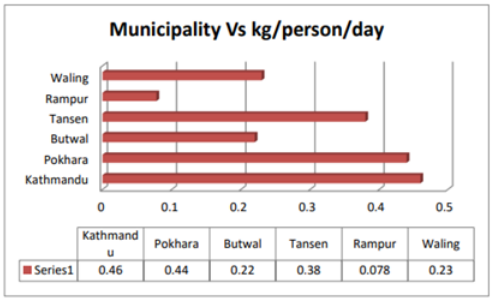


Figure 4: Comparison of per capita solid waste generation of Rampur with other Major Municipalities Source: Asian Development Bank Report, 2012

Glass 6%, Hazardous waste 2%, and Others around 4% of waste generated in the municipality, which is shown in Table 4.

Calculation of GHG emission

Total mix waste landfilling= 45 tons/month

Amount of diesel fuel use for operation of machineries =1100L/month

Type of landfill = Unmanaged-shallow (<5m waste) Composition of landfilling waste

Emission of Methane (CH_4) from landfilling= 15.67 kg of CH_4/tons

Direct GHG emission from Landfilling= 394.97 kg of CO_2-eq/tons of mixed waste

Total GHG emission from landfilling per month= 17773.52 kg of CO_2- eq/month

Table 4: Composition of MSW

Components	Percentage (%)
Organic waste	65
Plastics	14
Paper	5
Rubber	4
Glass	6
Hazardous waste	2
Others	4
Total	**100**

3.6. Conceptual design of engineered landfill

Keeping in mind the availability of land and capital cost, the construction scientific landfill is proposed for keeping the waste for the next 10 years. The total volume of inert/ non- bio degradable rejects from the processing Plant (assuming 15% maximum of feed) for disposal to landfill, assuming density as 0.85 tons per cubic meter for the duration 2022–2031 is 1376.47 cubic-meters. Considering, 30% volume of soil cover, linear and bund, and 5-meter height of the landfill. Therefore, in the first year, design for the Engineered landfill is done for the first 10 years for the square meter of 275.3, Hence the size of the Engineered landfill is 14-meter x 22-meter. The design parameters can be found in Table 5.

Table 5: Design parameters of landfill

Waste Volume for 10 years	1058.8	Cubic meters
Volume of Soil Cover (30% assumed)	317.65	Cubic meters
Total Landfill Volume	1376.5	Cubic meters
Height of the Landfill	5	Meters
Area of Landfill	275.3	Square meters
Required Landfill Dimensions	14 x 22	Meters x Meters

Leachate evaluation

Considering 477.26 millimeters per year average total precipitation in the City and 80% rainfall in four months, the leachate quantity is 2.39 cubic meters per day. A rainy season for continuous 3 days with no evaporation due to sunlight is assumed. Therefore, the area required for a leachate tank that can hold the quantity of leachate for 3 days is 7.17 cubic meters. A 2.0-meter depth of leachate tank and 30-centimeter freeboard is provided. Hence the size of the leachate tank is 2 x 2 x 2.3 cubic meters.

Detailed cost estimation

The estimated cost of the proposed Engineered Landfill of 14-meter x 22-meters and the cost of the proposed Leachate collection tank of 2-meter x 2-meter x 2.3-meter is around NRs. 1-1.5 crore Rupees including taxes. The detailed cost estimation for landfilling option is shown in Table 6.

3.7. Effectiveness of municipality in waste collection

The municipality has been collecting and managing the waste from the roads and households to keep the municipality neat and clean through the municipality office branch named Public Health, Sanitation and Environment branch. The municipality workers collect waste from roads, sewers, and other public places on the daily basis from 5 am to 8 am and from 1 pm to 5 pm and transport it for final disposal. For this purpose, the municipality has mobilized 7 general workers and 2 drivers.The total amount of production of waste is about

Table 6: Detailed Cost Estimation for Landfilling Option

Parameters	Amount (NRs)
Location Selection and Characterization Expense	3,97,000
Detailed Engineering Design Expense	2,00,000
Construction Expense	26,50,000
Yearly Construction Expenses	31,73,500
Yearly Operation Expenses	22,50,000
Yearly Closure Expenses	1,71,50,000
Yearly Post Closure Care Expenses	4,90,000
Total Cost (NRs.)	**1,08,75,500**

3-3.5 tons per day, of which the municipality collects about 1-1.5 tons/per day. The principal generators of waste are households, shops, and institutions respectively. The produced wastes are either stored in a basket in the home before the delivery or emptied into a public container. The street wastes are gathered at a point and collected.The municipality is self-involved in the collection and disposal of solid waste in the municipality. This collects waste based on the door-to-door collection system by taking some service charges [14] i.e. for households and general stores NRs. 150 per month, for hotels and restaurants NRs. 250 per month and for commercial organizations NRs. 350 per month.

Suggested sustainable SWM Plan for Rampur municipality

This suggested SWM plan gives in details of MSW management from sources to the end of disposal for a sustainable SWM plan in Rampur Municipality as shown in figure 5:

Note: Social Infrastructure waste consists of Educational waste, Health waste, Recreational waste, Commercial waste, Industries waste and Bank/Financial Institutions waste.

4. Conclusion and recommendations

4.1. Conclusions

The overall waste management system of Rampur Municipality was not found as environment friendly, no segregation was done before disposal. All the waste was dumped in one place regardless of its nature, near the bank of Kaligandaki River. As there was controlled dumping the management of hazardous waste and composting plants as well as landfilling facilities is still absent.

The municipality has not taken any specific action to reduce the amount of waste and has no specific plan for the future, yet. Organic waste dominates the overall composition of waste, which was found to be 65%, whereas plastic, paper, glass, rubbers, Hazardous and other was found as 14%, 5%, 6%, 4%, 2%, and 4% respectively. The study has shown the average capita per day waste of the study area was 0.022 Kg/Person/Day. The average waste generation per person per day in the municipality is 0.078 kg, and total waste generation in the study area and municipality are 435kg and 3325kg respectively.

From the survey data and various factors considered in solid waste management in Rampur Municipality. It was concluded that for MSW management in Rampur Municipality, the sustainable solid waste management system i.e., the landfilling option was suggested and the detailed cost estimation for the construction and operation for 10 years was estimated, which is around NRs 1-1.5 Crores per year with running and construction cost of the project, having dimensions 14-meter x 22-meter x 5-meter for Engineered Landfill and 2-meter x 2-meter x 2.3-meter for Leachate collection tank.

Despite resident's eagerness to participate in the management system, the municipality is unable to train or educate them, so the need for provision for training or technology transfer was noticed. The joint effort from the public and private sectors can help in the waste management process, as it was in practice in many other municipalities of Nepal, under the Public-Private Partnership Program. The introduction of the 3Rs policy could significantly reduce the volume of waste. Composting has the potential to reduce waste volume by about 65%. Adoption of clean mechanisms not only helps to reduce waste but also generates sources of income and employment. At present, the volume of waste is low and can be managed efficiently with simple measures. But the increasing population and urbanization within and in neighboring places could result in a larger amount of waste in the future then CDM could be one of the better options in coping with it.

4.2. Recommendations

Sustainable management of solid waste is an emerging task for all urban areas like Rampur in Nepal. People consider waste a burden but it can be a resource if some technologies are applied. Composting from organic waste can be the first option. Similarly, recycling, reusing, etc. help to reduce the waste for final disposal to large extent. Managing authorities are also found to be unaware of this fact. Simply by practicing segregation, waste management could become much easier. The following points are recommended based on the results and discussion for the solid waste management of Rampur municipality:

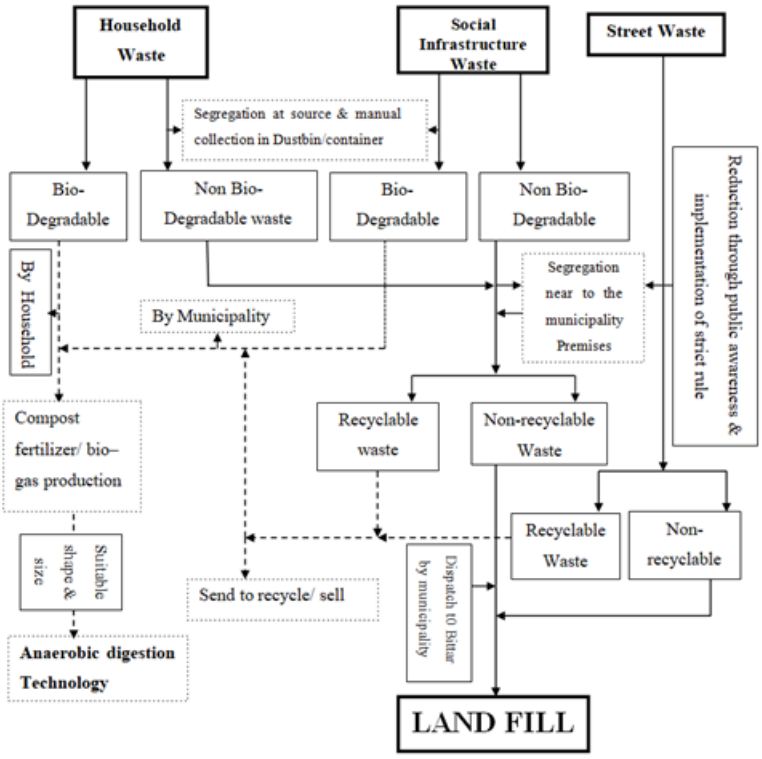


Figure 5: Suggested sustainable SWM Plan for Rampur municipality

4.2.1 Policy level recommendations

- The policy of the municipality should shift from post-production management of waste to the reduction and alternative management measures at the source.
- Plastic bags should be banned.
- There should be the provision of fines for the person who throws waste in open places, for this continuous monitoring is required

4.2.2 Management and technical aspect recommendations

- The municipality should stop dumping waste near the bank of Kaligandaki River immediately as it is polluting the river, for this municipality should locate another place for dumping waste.
- The proposed landfill site should be constructed and bring it into operation as soon as possible.
- The municipality can also implement a Private Public Partnership program for Waste management.
- Other alternative methods such as composting, incorporation of 3R principles, recycling, etc. should be adopted gradually in the future.
- Types of equipment used for waste management should be repaired frequently.

4.2.3 General recommendations

- The municipality should increase the number of containers and the frequency of waste collection from households.
- The municipality should encourage local communities and clubs to manage their waste at the community level.
- Awareness programs and training about the management of waste at the household level such as composting should be organized regularly.

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