ISSN 2976-1190 (Online)
Journal of Engineering and Sciences
Vol. 1 Issue 1

Municipal Solid Waste Generation in Birgunj Metropolitan City, Nepal: Quantitative and Qualitative Analysis

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(Manuscript Received 16/08/2022; Review: 15/09/2022; Revised 30/09/2022; Accepted 05/10/2022)

Abstract

United Nation's SDG no. 11 (Sustainable cities and communities) considers special attention to municipal waste management in order to reduce adverse per capita environmental impact of cities. This study was conducted for analysis of MSW of Birgunj Metropolitan City (BMC). Birgunj is a one and only metropolitan city of Madhesh province, Nepal. Rapid population growth, unmanaged urbanization and lack of public awareness have intensified environmental problems of Birgunj. For quantitative analysis, waste generation from household, commercial and institutional establishment and medical facility was considered. The waste was measured at sample location. For qualitative analysis, the waste was physically classified into eight categories i.e., Organic, Paper and paper product, Plastic, Metals, Rubber, Glass, Textile and Inert. Stratified random sampling survey was carried out into three regions: core, outer and rural part of the city and quarter and coning method was used for qualitative analysis as well as key personal of BMC was interviewed to know the current status of waste management practices of city. The study showed that the per capita waste generation rate of BMC to be 0.467 Kg/capita/day with total solid waste generation of city as 125.364 MT/day. The organic content by weight of household and commercial waste was observed to be the highest with 61.84% and 43.41% respectively. The paper content of institutional waste was obtained the highest with share of 41.89%. Out of total medical solid waste of city, 37% was observed to be hazardous. The collection efficiency of solid waste by BMC was 41.93% and the major portion of solid waste was still openly dumped near water course and open field indicating further analysis and planning for implementation of efficient solid waste management in Birgunj.

Keywords: Birgunj; Household waste; Landfill; Municipal solid waste; Waste characterization

1. Introduction

Municipal waste is defined as wastes produced by residential, commercial and public services sectors that are collected by local authorities for treatment and/or disposal in a central location. Currently, developing countries are facing unmanaged trend in urbanization and industrialization which has become the main cause of increased generations of solid wastes [1]. Besides this, population growth patterns and living standards of people also contribute in the solid waste generation. Integrated management of municipal solid wastes comprises of eight required elements, including waste minimization, storage, collection, transportation, processing and recycling, final disposal and surveillance after disposal of solid wastes [2].

1.1 Scope of study

In 2015, the municipal solid waste generation rate was 0.35 Kg/capita/day for Birgunj Sub-Metropolitan city, Nepal [3]. This was based on total of 19 wards of Birgunj Sub-Metropolitan City. After the declaration of Metropolitan city, the newly added 13 wards did not have any information regarding quantity and quality of municipal solid waste. Therefore, city lacks integrated solid waste management plan for sustainable development.

The project intended to provide qualitative and qualitative assessment of solid waste generation in Birgunj Metropolitan City (BMC). Waste generated per capita, total municipal solid waste generated, total municipal solid waste collected and collection efficiency of waste were explored. The study covered 32 wards (divisions) for survey on the basis of urban and rural localities to represent the whole city. Out of total households, 83 sample households, 20 institutions (schools and offices), and 20 commercial establishments (shop, hotels and restaurants) were considered. The medical solid waste from the health facilities was also considered. The medical waste was divided into hazardous and non-hazardous category.

2. Methodology

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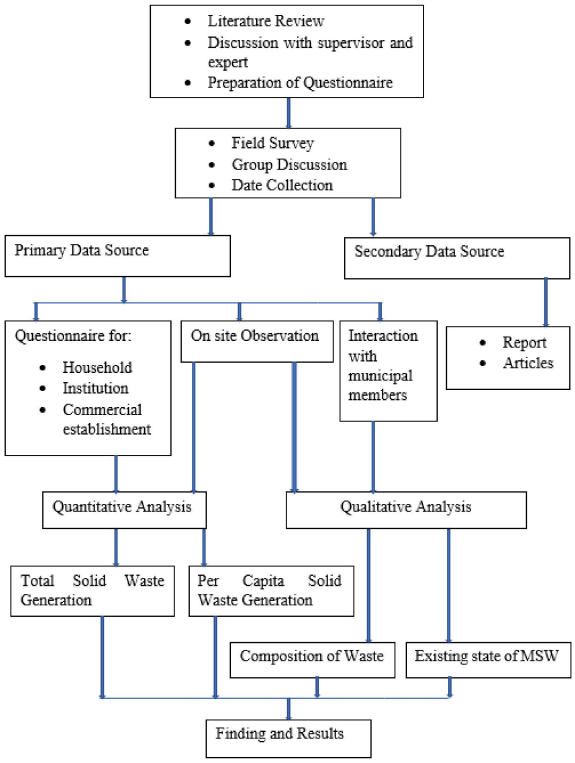
The study was carried from January to April, 2022 in BMC by dividing the total wards into three regions: core, outer and rural. The methodological framework of the study is shown in figure 1.
The sample waste was segregated and weighed at source. Similarly, quartering and conning method was used to determine the waste composition [4]. The composition of municipal solid waste was divided into eight categories: Organic, Paper, Plastic, Metal, Glass, Rubber and leather, Textile, Inert [5]. The overall methodological framework of the study is shown in Figure 1.

Figure 1: Methodological framework of the study.

The sample size of household survey was determined on ward basis using Slovin's formula as given in Eq. (1).

$$SS = \frac{N}{1+N.e^2} \quad (1)$$



where *SS* denotes the sample size, *N* is the number of households in each word, *e* is the margin of error.

2.1 Study Area

Birgunj metropolitan city is situated in the district of Parsa in Madhesh Province of Nepal. It was declared as metropolitan city on 22nd of May 2017. Birgunj city is one of major industrial, economic and business zone of Nepal, covering an area of 75.24 square kilometer. It shares its border by Bara District in east and north, by Bihar, India in the south and mainly Parsagadhi and Bahudarmai Municipality of Parsa District in the west. It is divided into 32 wards.

2.2 Primary Data Source

Primary data for this study was collected from three different ways: Questionnaire, Onsite observation and interview. A set of ten questions was prepared for the household solid waste data. The questionnaire survey was done using online platform – google forms and in person interview.
The number of households was calculated using Eq. (1) for each ward of BMC respectively. Total 20 commercial and 20 institutional establishments were considered for this study. The solid waste was weighed at site and the waste was segregated into predefined categories. The weight for each category was measured on site. The landfill site of Birgunj was observed on February, 2022 to overview the overall treatment process of collected unsegregated solid waste. Interview was conducted in person with the key personal of solid waste management section of BMC. Similar interview was conducted with key personal of M/S NK International Construction Pvt. Ltd, which is private partner under PPP model of BMC for integrated solid waste management.

2.3 Secondary Data Source

The population of BMC can be project for 2022 by taking base year data of 2011 and annual growth rate of the city. However, the recent census was carried out in 2022. Therefore, the population of BMC was taken from the census 2022 preliminary report. The daily solid waste collection data at landfill site was provided by BMC. Similarly, the details of existing solid waste management of city and overall treatment of collected waste at landfill site was provide by BMC. The details of total medical facilities inside the city were also provided by BMC officials.

3. Results and Discussion

On the basis of analysis and findings in the filed survey, the per capita solid waste generation rate of BMC was obtained as 0.467 Kg/day. The total municipal solid waste (household, commercial, institutional and medical) generation of BMC was quantified to be 125.364 MT/day which included 81.96% of household waste, 12.79% of commercial waste, 1.47% of institutional waste and 3.78% of medical waste. The composition

of solid waste from household is shown in Figure 2.

It was observed that the organic content in the household solid waste of BMC was high with 61.84%. This was because of various organic matter like food leftover, vegetable wastes, rotten organic items. The next portion with high portion in solid waste was inert materials. This included baby dippers, sanitary pads, dust from cleaning, Styrofoam, sand etc. The plastic waste from the household was 9.32% of total solid waste generated. This included the packing materials, shopping bags, disposable plates and cups and so on.

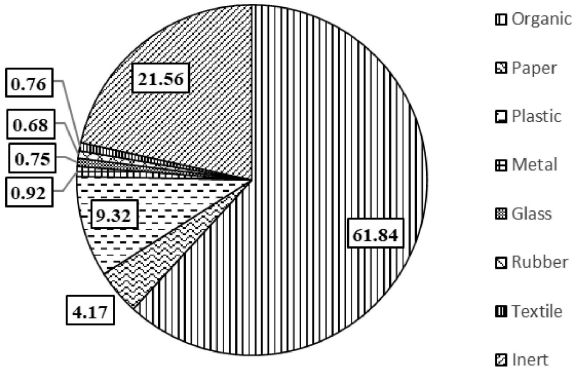


Figure 2: Composition of Household waste of BMC.

The composition of solid waste from commercial establishments is given in Figure 3. The maximum portion of this waste was organic with 43.41%. This included the kitchen waste from different hotels and restaurants. After organic, plastic waste was found to be high with 19.96% followed by paper waste. Commercial waste was found to be unsegregated and was collected by BMC on daily basis.
The composition of institutional solid waste is given in Figure 4. In this waste, the share of paper waste by weight was found to be highest with 41.89%, followed by paper with 21.68% and organic waste with 19.16%.

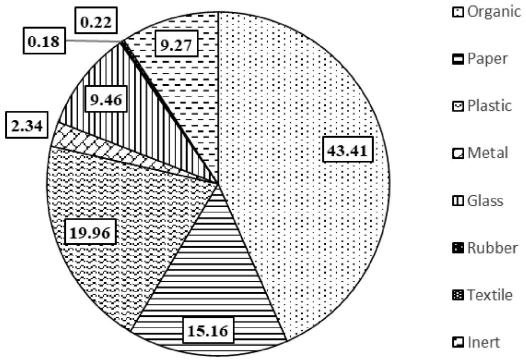


Figure 3: Composition of commercial solid waste.

This type of waste contained paper products like cardboard, newspaper, envelope, office paper and other. Such waste was found to be sold from the owner to the unauthorized ragpickers. Hence, other waste except plastic and paper was found to be collected by BMC. At landfill site, BMC had appointed 20 ragpickers to pick the dry recyclable waste from the collected waste before disposal to landfill cell. It was observed that on average of only 0.81% of waste was segregated in the month of November, 2021. Therefore, proper management of waste segregation with sufficient manpower is require to recover the recyclable waste which in turn increases the revenue.

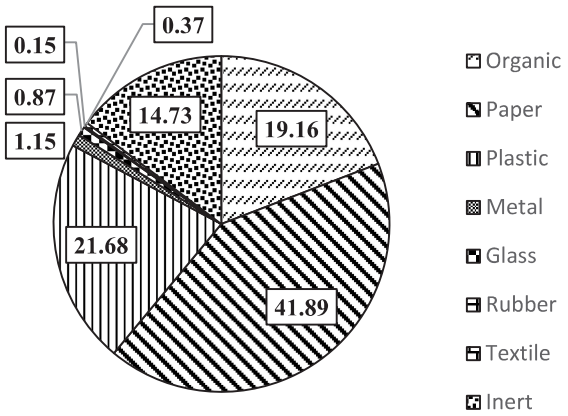


Figure 4: Composition of institutional solid waste

The medical solid waste was categorized into hazardous and non-hazardous. Out of total waste, 63% was found to be non-hazardous and remaining 37% was hazardous waste. The weight of individual category of

waste per healthcare facility is mentioned in Figure 5.

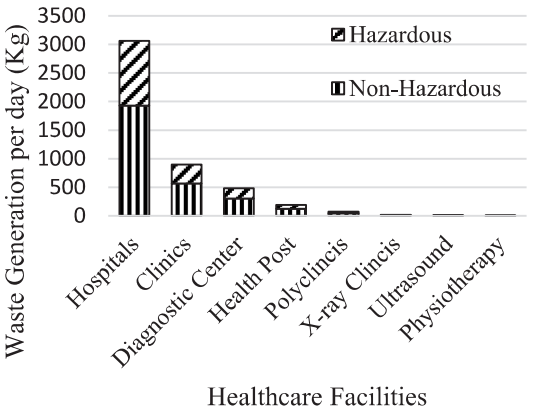


Figure 5: Waste composition per healthcare facility in BMC

It was observed that hospitals were the main source of medical solid waste. Many hospitals of BMC lacked the facility to treat the hazardous waste. However, it was observed that, separate vehicle was used by BMC with proper safety to collect such hazardous medical waste.

4. Conclusions

Total solid waste generation of Birgunj municipality was determined by collecting solid waste generation data from various sources like household, commercial, institutional and medical establishments. Based on the analysis and findings in the field survey, it was observed that the per capita generation of municipal solid waste was 0.467 Kg/capita/day and the daily solid waste generation was 125.364 MT. The per capita per day solid waste generation was observed to have an increasing trend from 0.35 Kg in 2011 to 0.467 Kg in 2022. The projected per capita solid waste generation in 2022 was 0.39 Kg [3]. The actual generation rate in 2022 was observed to be 0.467 Kg. This showed that the per capita waste generation was increased by 33.4%. The average collection volume of solid waste by BMC was 52.57 Tons/day. Therefore, it was observed that only 41.93% of total daily waste was collected. Hance, a large portion of solid was still found to be openly dumped at water sources like river, pond. Also, the organic waste from household was observed to be high. This may be used as organic fertilizer. Therefore, there is a need of detailed analysis and planning for implementation of effective solid waste management in Birgunj.

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