

## **Establishment of Integrated Solid Waste Management System in Mongar Town, Bhutan**

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**Abstract.** Bhutan is a small landlocked nation located in eastern Himalayas. With a total land area of about 38,394 km<sup>2</sup>, the country has a population of about 0.76 million. The socio-economic achievement is accompanied by negative pressures on natural resources and the environment. The unprecedented escalation of municipal solid waste (MSW) generation especially in urban areas has emerged as one of the most serious challenges to the Royal Government of Bhutan (RGoB).

The RGoB, over the past years has been searching for options and opportunities to tackle the challenge. To date, public participation in the waste management system has not been strong. The waste quantity generated may not be alarming compared to the waste quantities in other countries, but for the population size and urbanization system in a steep mountain terrain, it has become a serious concern.

This action research aims to study the current situation of MSW management system in Mongar, an urban town in eastern Bhutan, in order to identify appropriate integrated solid waste management system for various waste streams that will ultimately lead to a zero waste city. Field visits and stakeholder consultations were carried out to ensure participation of various sectors from the beginning. Currently, a total of 1.76 tons of MSW is being generated daily with the per capita generation of approximately 0.28 kg/day in Household (HH) and approximately 1.44kg/day in Commercial establishment. The major component of waste includes organic (48.92%), paper (9.79%), glass (7.3%), plastics (6.49%), metals (1.74%), medical waste (17.72%), and others (8.04%). Management gaps in the current system were identified as: no waste segregation at source due to both low awareness and poor waste collection system, all wastes including autoclaved medical waste being dumped into the same landfill, and local authority having limited resources (human, fund, infrastructure, and technology) to handle the increasing quantity of waste.

In order to improve the situation, various solid waste management intervention options were proposed. Intervention options were categorized into 3 major groups; waste streams based (organic and recyclables), management system based (segregation and collection system), and waste generator based (school, household and commercial sectors). Involvement of stakeholders has proved to be a key success factor. Waste segregation and separate collection for dry and organic waste can improve the situation. Market for recyclables exists across the border in India.

**Keywords:** Integrated solid waste management; municipal solid waste management; zero waste initiatives; waste management interventions

### **1. Introduction**

Bhutan is a small landlocked nation located in eastern Himalayas, bordered by India in the east, south and west and by China in the north. With a total land area of about 38,394 km<sup>2</sup>, the country has a population

of about 0.76 million. Ever since Bhutan emerged out of a self-imposed isolation and initiated the five-year plans for its developmental activities, the national GDP growth rate increased from approximately 5% in 1998 to more than 8% in 2004. The revenue generation from hydropower electricity export and agriculture subsistence farming contributes significantly to the national GDP. In 2013, Bhutan's gross domestic product per capita was US\$ 2440[1]. Unfortunately, this unprecedented socio-economic achievement is accompanied by adverse impacts on natural resources and the environment. With population concentration in the urban areas and changes in consumption pattern driven by economic gains, various social and management challenges emerge[2]. The unprecedented escalation of municipal solid waste (MSW) generation especially in urban areas has emerged as one of the most serious challenges, lately, to the Royal Government of Bhutan (RGoB) [3].

The RGoB, over the past years has been searching for options and opportunities to tackle the challenge. To date, public participation in the waste management system has not been strong. The waste quantity generated may not be alarming compared to the waste quantities in other countries, but for the population size and urbanization system in a steep mountain terrain, it has become a serious concern.

This action research aims to identify the current status of solid waste management as well as to establish the integrated solid waste management approach in Bhutan. Mongar is one of the 20 Districts in Bhutan that is used as a pilot project for the establishment of integrated solid waste management system. Various solid waste management interventions are proposed based on the existing situation. Mongar District, which covers both the Mongar and Gyelposhing towns amongst others, is located in the eastern Bhutan at 27°25' N latitude and 91° 2'E longitude [4]. The total area covered by this district is 1,940.26 sq.km, with altitudes ranging from 400m to 4000m above mean sea level. Therefore, the lower and southern parts are sub-tropical while northern and higher regions have temperate climatic conditions. Mongar town lies in between the sub-tropical and temperate climatic zones while Gyelposhing town is located in the sub-tropical part of the district.

## **2. Methodology**

### **2.1. Baseline data collection**

Collection of baseline data was done between October 2014 and June 2015. Both primary and secondary data are being collected from relevant sources. Data includes characteristics of waste, generation rate, options for waste management, disposal technology including any reuse/recycling adopted [5]. In addition to the situation in the study site, efforts are made to identify if there are any good practices in other parts of the selected countries. If such system exists, this will help in better adoption of the good waste management practice by learning from the local examples.

### **2.2. Stakeholder Analysis**

Stakeholders involve in solid waste management were identified [6]. Meetings with the identified stakeholders were carried out in order to incorporate their concerns. Stakeholder analysis matrix was developed to be used by the municipal office in the future planning.

### **2.3. Solid waste Management Option Identification**

Management options were identified based on the baseline data collected and comments from stakeholders. High potential, high impact initiatives were selected to be implemented as a pilot project.

## **3. Results and Discussions**

### **3.1. Waste Generation & Composition**

Mongar town generates a total of 0.95 tonnes of MSW per day with a waste generation rate of 0.23 kg/person/day while Gyelposhing generates a total of 0.60 tonnes of MSW per day with a generation capacity of 0.22 kg/person/day. From a study of ten urban centres in Bhutan, it was found that the per capita waste generation of Mongar town was around 0.28 kg/person/day in 2008 (Phuntsho et al., 2010). The present waste generation rate is therefore slightly lower than the one found in 2008. The results of waste composition undertaken in May for the two towns are shown in Figure 1. It can be seen from the results that

organic waste contributes at least 50% of the total waste generated in the two towns. Except for the percentage of medical waste generated in Mongar town, the contribution of other components of waste such as paper, plastic, metals and glass are almost similar. The remaining waste, categorized, as ‘others’ comprises of rubber, wood and textiles make up made up 7.54% and 8.62% in Mongar and Gyelposhing town respectively.

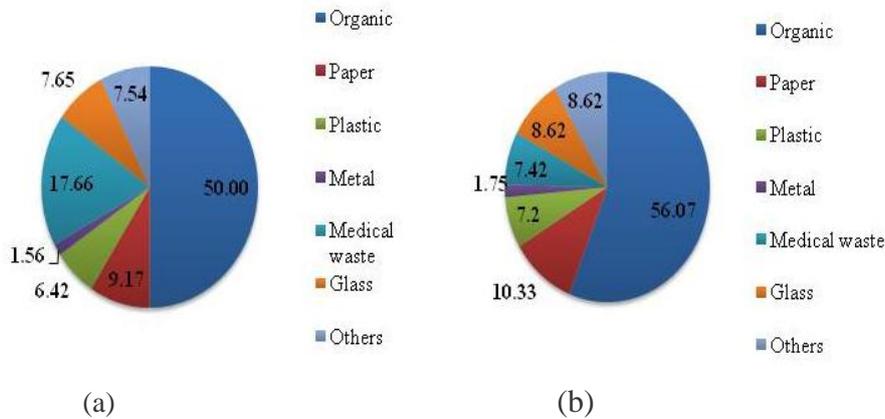


Fig. 1: Waste composition in (a) Mongar town and (b) Gyelposhing

### 3.2. Existing Waste Management System

The waste collection system in Mongar town consists of 2 refuse collector trucks, which moves around the town collecting MSW from different areas. The efficiency and effectiveness of the collection of MSW in Mongar town is therefore to a large extent dependent on the reliability of these two waste collector trucks.

At present, the Mongar municipality employs two types of waste collection methods:

- Door to door collection: Households dump their waste in the municipal truck, which moves from door to door of the residents,
- Community waste collection: Community waste bins are located in certain parts of the town, where local residents can dispose their waste. The municipality later empties these community bins.

Most of the MSW collected from Mongar town is currently in the mixed form as very minimal segregation takes place at the source of waste generation. The waste collected is then transported to a landfill site located in Gyelposhing, 30 km away from Mongar town. The previous landfill site in Mongar town was closed as it attracted a lot of public complaints and criticisms of foul odour in its vicinity. A new landfill is currently at the design stage, and will be located at about 7km from Mongar town. This is expected to decrease the cost of transporting the MSW from Mongar town. At the Gyelposhing landfill, a private firm “We-Care” waste management employs 2 workers to segregate the recyclable wastes, from the mixed waste being deposited by the Mongar municipality.

In Gyelposhing, waste management is outsourced to “We Care” waste management, a non-governmental organisation. “We Care” owns a single truck which is used to ferry the waste from the town to the landfill site. This truck has two compartments, one for recyclables and the other for organic waste. When the waste that is mixed at source is collected, workers segregate into recyclables and organic waste before loading the waste onto the truck. Segregation of waste is therefore done at the point of collection in Gyelposhing. Collection of waste in Gyelposhing is done once in a week for residential areas, industrial areas, schools and BHU while it is done twice a week for the commercial establishments. Figure 2 shows the current waste stream in both Mongar town and Gyelposhing.

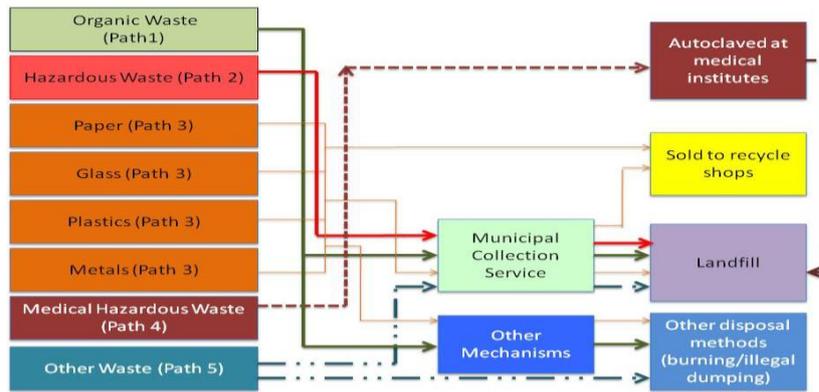


Figure 2 Current waste streams in Mongar Town and Gyelposhing

### 3.3. Stakeholders Concerns

Stakeholders in this study can be grouped into three categories; community, private sector and public sector. When asked what their concerns are regarding the municipal solid waste management at present and what are expected in the future, each stakeholder stated the lack of cooperation and integrated planning in MSW management. Details of their concerns are detailed in Figure 3. A bottom up approach may be used in the planning in order to satisfy the needs of all stakeholders.

Environment			Stakeholders		Recipients (Community)	Providers (Public and private)
Community (Residents, communities)	Private (Private companies, NGOs)	Public (Government)	Now	Future	More participation and involvement	Collaboration with other parties to avoid overlapped work
<ul style="list-style-type: none"> <li>- Providing natural resources to produce and provide goods, services, and land spaces</li> <li>- Receiving pollutions caused by high amount of waste generated and ineffective MSWM service</li> <li>- Being enhanced its value by collaboration of service providers and recipients through establishing voice for nature in PPCP through MSWM practices</li> <li>- Combining innovative co-created values from collaborative PPCP actions of service providers and recipients to benefit the environment and society through social entrepreneurship</li> </ul>	<ul style="list-style-type: none"> <li>- No collaboration</li> <li>- Traditional mechanism (manage by government)</li> </ul>	<ul style="list-style-type: none"> <li>- Old system and policy</li> <li>- No collaboration</li> <li>- Lack of budget</li> </ul>	<ul style="list-style-type: none"> <li>- No overlapped policies and practices</li> <li>- Sustainable work</li> </ul>	<ul style="list-style-type: none"> <li>- More participation and involvement</li> <li>- No overlapped policies and practices</li> <li>- Sustainable work</li> </ul>	<ul style="list-style-type: none"> <li>- Collaboration in MSWM program</li> <li>- Being part of MSWM system to minimize waste</li> <li>- Preventing inefficient service</li> <li>- Minimizing MSW according to knowledge and guideline provided</li> </ul>	<ul style="list-style-type: none"> <li>- Practical policy with other departments</li> <li>- More involvement and work together</li> <li>- MSWM knowledge</li> </ul>
<ul style="list-style-type: none"> <li>- Ineffective management and service</li> <li>- Lack of involvement</li> <li>- Break the laws</li> <li>- Being educated in MSWM</li> <li>- More participation and involvement</li> <li>- Building awareness on MSW impacts and the environment</li> </ul>	<ul style="list-style-type: none"> <li>- More involvement and work together</li> <li>- Practical method and policy</li> </ul>	<ul style="list-style-type: none"> <li>- Practical policy with other departments</li> <li>- More involvement and work together</li> <li>- MSWM knowledge</li> </ul>	<ul style="list-style-type: none"> <li>- Collaboration in MSWM program</li> <li>- Being part of MSWM system to minimize waste</li> <li>- Preventing inefficient service</li> <li>- Minimizing MSW according to knowledge and guideline provided</li> </ul>	<ul style="list-style-type: none"> <li>- Sustainable work</li> <li>- Sustainable policy with other departments and practices</li> <li>- Sustainable policies</li> </ul>	<ul style="list-style-type: none"> <li>- Collaboration with other parties to avoid overlapped work</li> <li>- Practical policy with other departments</li> <li>- Sustainable policies</li> </ul>	
<ul style="list-style-type: none"> <li>- No formal MSWM business activities but act as recyclable waste buyers, lack of social concern</li> <li>- Promoting MSWM method</li> <li>- Increasing CSR activities</li> <li>- Launching program to increase participation</li> <li>- No formal collaboration</li> <li>- Lack of good attitude on public benefits</li> <li>- Lack of awareness on MSW impacts</li> <li>- Work together to minimize waste</li> <li>- Concern more on MSW's situation and MSWM in community</li> </ul>	<ul style="list-style-type: none"> <li>- No collaboration</li> <li>- Profit oriented</li> <li>- Association for MSWM companies</li> </ul>	<ul style="list-style-type: none"> <li>- No collaboration</li> <li>- Profit oriented</li> <li>- Association for MSWM companies</li> </ul>	<ul style="list-style-type: none"> <li>- Sustainable work</li> <li>- Sustainable policy with other departments and practices</li> <li>- Sustainable policies</li> </ul>	<ul style="list-style-type: none"> <li>- Sustainable work</li> <li>- Sustainable policy with other departments and practices</li> <li>- Sustainable policies</li> </ul>	<ul style="list-style-type: none"> <li>- Collaboration with other parties to avoid overlapped work</li> <li>- Practical policy with other departments</li> <li>- Sustainable policies</li> </ul>	
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Fig. 3: Stakeholders concerns on the situation of municipal solid waste management in Mongar Town.

### 4. Management Options Identified

The study proposes to focus on the two major aspects of the SWM as solutions for waste minimization in Mongar District:

**Reduce** – raise awareness through education: This study proposes educational campaigns, seminars, researches and academic involvement as a method for raising awareness and knowledge in SWM for the people of Mongar District. It includes students from various schools and institutes and the nearby community. In order to carry out the awareness campaigns, the project proposes to seek voluntary help and support from teachers and students. These volunteers will help the team conduct campaigns and prepare education materials to raise the awareness. MSW awareness campaign may include performing dances, short plays or any other entertainment activities to attract a large number of people.

**Up cycle management** – turn organic waste to fertilizers through composting: One of the main methods to ensure the “reuse” of the waste materials is to convert the unwanted materials into a useful product and energy. The MSW stream in Mongar and Gyelposhing towns contains at least 50% organic waste. Organic waste in this context refers solely to the food and vegetable waste and do not constitute any agricultural wastes. Thus, the conversion of organic waste to fertilizers through composting appears to be feasible. To establish this system, this project seeks to develop a composting plant to convert the organic waste into fertilizers and thereby minimize the amount of waste deposited in the landfill. The new waste streams are proposed in Figure 4.

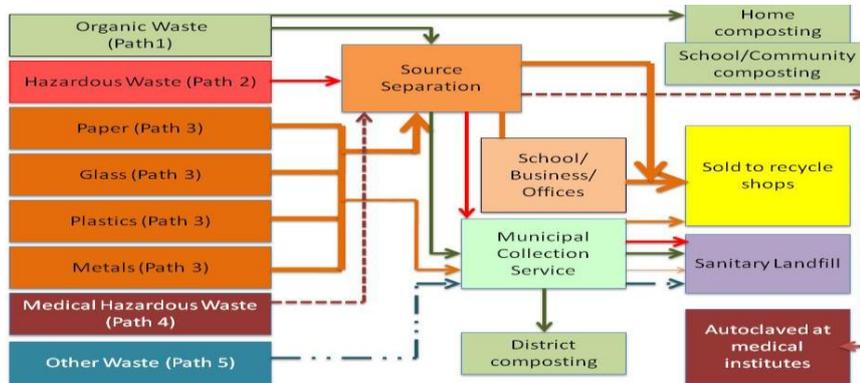


Fig. 4: Proposed waste management options and the waste streams after implementation

## 5. Conclusions

Based on the baseline data collected as well as meeting with stakeholders, it can be concluded that integrated solid waste management system that incorporate needs and constrains of stakeholders into consideration is vital. The successful implementation from now on will depend on the uninterrupted involvement of stakeholders. Local government should ensure this involvement by developing the action plan with proper monitoring system on the implementation of the plan.

## 6. Acknowledgements

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