



Research Article

Supply Chain Analysis of Municipal Solid Waste Released in Hetauda Sub-Metropolitan City of Nepal

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Keywords: Municipal solid waste; supply chain; recycling; Nepal

Abstract

In Nepal, solid waste management is one of the major environmental issues, especially in the urban areas. While solid waste management (SWM) has become a major concern for municipalities and the country as a whole, the status of SWM is not fully understood due to the lack of SWM baseline data, which are also essential for effective planning. Such a back drop, this research attempts to assess the plastic waste released, management and recycling in supply chain in Hetauda Sub-Metropolitan City. This study revealed that about 83.8% households segregate their waste. None of the surveyed households have had public waste collection bin nearby their home whereas all households have had knowledge on solid waste management. About 63% HHs heard of importance of plastic waste recycling and all express their readiness to segregate the plastic solid waste if recycling program is set up in municipal area. Per capita waste generation per day is 141 gm out of which about 15% is plastic waste. On an average daily waste released at household level are 0.8 kg/HH which is 28.1 kg per institution. Total wastes release per day from Hetauda city is 27.4 MT and 10006.8 MT per year. About 931 MT plastic per year are gone in dumping sites in the Hetauda Sub-Metropolitan City. This study suggests that municipal office needs to develop an appropriate policy and strategy framework together with technical guidelines on key issues such as organic composting, recycling and landfill operation from dumping sites.

Introduction

In Nepal solid waste management is one of the major environmental issues, especially in the urban areas (Rijal, 2014). Rapid and uncontrolled urbanization, lack of public awareness, and poor management by municipalities have intensified environmental problems in towns in Nepal, including unsanitary waste management and disposal. While solid waste management (SWM) has become a major concern for municipalities and the country as a whole, the status of SWM is not fully understood due to the lack of

SWM baseline data, which are also essential for effective planning. On the other hand, plastics-based waste management and recycling activities in the major cities of Nepal has not adopted in the sustainable manner.

Municipal solid waste (MSW) normally termed as “garbage” or “trash” is an inevitable byproduct of human activity. Population growth and economic development lead to enormous amounts of solid waste generation by the dwellers of the urban areas (Karishnamurti & Naidu, 2003). Human activities generate waste materials that are often

discarded because they are considered useless. These wastes are normally solid, and the word waste suggests that the material is useless and unwanted. So, Waste generation encompasses activities in which materials are identified as no longer being of value and are either thrown away or gather together for disposal.

In developing countries like Nepal, open dump sites are common, due to the low budget for waste disposal and non-availability of trained manpower. Open dumping of MSW is a common practice in Nepal. Today major problem is unsystematic waste management on urban area. Dumping of waste in open area induced animal hazard on that area. Road accident, zoonotic disease and pollution are increasing due to the vertebrate present on the dumping site (Acharya, 2017).

Previous studies have been conducted to collect SWM baseline information, but most of these were limited to municipalities in the Kathmandu Valley (Dangi *et al.*, 2011; Dangi *et al.*, 2009; JICA, 2005). A nationwide SWM baseline study of all 58 municipalities in Nepal was carried out by the SWM and Resource Mobilization Center (SWMRMC, which has been renamed the SWMTSC) in 2003 (SWMRMC, 2004). This was the first attempt to collect SWM baseline information at the national level. The SWMRMC and others made efforts to update these data, but due to the lack of consistent scientific methods and the different assumptions made to quantify the waste generated from different sources, the findings of these waste quantity and quality studies were inconsistent (Manandhar, 2009).

The per capita generation of solid waste in developing countries in Asia ranges from 0.3 kg/day to 1kg/day and the data shows that the higher the economic development and rate of urbanization, the greater the amount of solid waste produced (ADB, 2013). The urban population of Nepal is approximately 14% of the total population. According to ADB (2013), the findings of the MSW generation in Nepal was 170 grams/capital/day and comparable with findings from other studies done in Nepal. The generation of MSW is comparatively low however the rapid, haphazard and unplanned urbanization has created problems on facility management and has become an enormous burden for the government in urban areas. Various health, sanitation and environment problems have been increasing from last decades. With the major objective to maintain a clean and healthy environment by minimizing adverse effects of solid waste on health and environment Solid Waste Management Act, 2011 was enacted¹.

Plastic has become indispensable parts of day-to-day life with most of the products utilized are either made up of plastic materials. Plastic waste is not an environmental

problem, it is an opportunity to maintain circular economy. The world generates large amount of plastic waste, most of which comes from the household and industries such as electronics, construction, packaging, automobile and agriculture among others.

Recycling of plastic is prime need of society because it not only ensures energy recovery but also reduces carbon footprint. For every ton of plastic that's recycled, seven yards of land can be saved from landfills and 80% of energy can be conserved for the production of new plastic material. Plastic is relatively cheap and versatile, recycled plastic is used to manufacture variety of products such as bottles, cloths, films, garbage bags, containers, and carpet among others. The Plastic Waste Management market will benefit from recycled plastic use for industrial application which is expected to increase significantly over the forecast period.

There is a very few research to attempt plastic based solid waste management and recycling in supply chain in the municipalities of South Asia including Nepal. On the other hand, this study tries to understand the life cycle of different types of plastic in order to find what is not recycled/reused and goes to the landfill and what are the reasons that. Supply chain analysis defines full range of activities from inputs used, production, distribution, consumption and final disposal and re-use of the waste. Plastic is the major solid waste and these wastes hamper the cities environment and major source of pollution due to non-disposal characteristics. Reduce, reuse, recycle and refuse (4R) is the major approach to manage plastic waste in the city's areas of Nepal

Such a back drop, research on plastic waste management and recycling potentiality in supply chain in Hetauda city was realized. To achieve this, a Supply Chain Analysis (SCA) of the Plastic based Solid Waste Management sector was carried out to identify recycling potential of plastic waste, job rag pickers in their profession healthier and better for earning their livelihood and in the process contribute to improving services in these communities as well as economic benefit of plastic based waste management in three major cities of Nepal. The SCA of plastic solid waste streams is expected to indicate the potential better livelihoods opportunities, reducing plastic used, recycling in the supply chain system and economic gain while dealing with major environmental effects of poor plastic waste management practices in these cities.

In this context, the overall objective of this research is to analyse the plastic waste management and recycling potentiality in the supply chain including actors involved in waste release, collection activities, dumping, segregation of plastic waste and recycling practices and potentialities in

¹ Solid Waste Management Act (2011). Government of Nepal. www.lawcommission.gov.np

supply chain, enabling business environment and inputs/service provision in and Hetauda Sub-Metropolitan city of Nepal.

Methodology

Both quantitative and qualitative data were collected and analysed for plastic based solid waste management and recycling in supply chain Hetauda sub-metropolitan city from January to August, 2018. Information was collected through questionnaires, interview and discussion with concerned stakeholders. Personal interview schedule (PIS) with plastic waste producers at household level and from different sectors, key informant interview (KII) with concerned line agencies like metropolitan environment officers, hospital managers, hotel managers, District chamber of commerce and industry (DCCI), Associations etc. and in-depth interview with plastic industries in Butwal and Birjung city were conducted. As well, purposive interview schedule was made with rag pickers, solid waste collectors, cooperatives, groups and other inputs/service providers related to plastic materials in Hetauda sub-metropolitan city. Similarly, field observation and data collection of transfer center, collectors and landfill sites were done.

Following research instruments were used in this study:

Desk Review and Policy Assessment: Desk Review and Policy Assessment were done from Government report and policies documents such as Solid Waste Management Act, 2011; waste minimization measures such as Cleaner

Production (CP), 3R principles and Green Productivity (GP)

Personal Interview schedule: Personal interview schedule was conducted with 50 households at three wards of Hetauda. Seven days measured of household waste from 50 households.

Collectors’ survey: Survey was conducted with fifteen rag pickers/scavengers in the three cities (@ 5 rag pickers/city) to assess their importance role on collection of non-degradable solid waste and play major role in supply chain.

Case studies: Case studies were made purposively in institutional sector of schools, offices and hospitals as well as at commercial sector of grocery shops/wholesalers’/retailers, hotels and restaurant in three core cities areas to assess amount of total waste and plastic waste released and their management.

In-depth interview: In-depth interview was conducted with plastic industries proponents and to assess potential of plastic waste reuse and recycle in industrial area.

Key informant interview: Key informant interview (KII) was conducted with concerned stakeholders from metropolitan, sub-metropolitan, Chamber of Commerce and Industry (CCI), private waste collection partner companies under city Public Private Partnership (PPP) model.

Supply chain map of plastic waste recycling: Supply chain map of plastic waste recycling of each surveyed city was prepared based on supply chain function, actors and enabling business environment enablers/supporters.

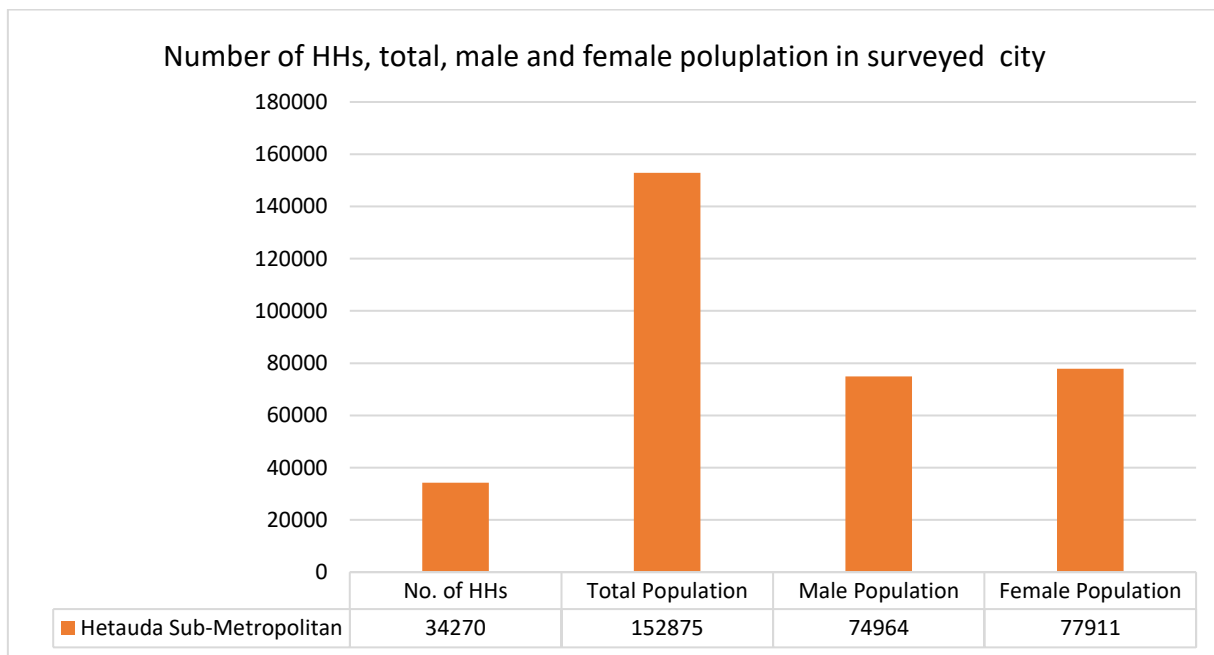


Fig. 1: Household numbers, total population, and male and female population of Hetauda Sub-Metropolitan city.

[Source: City profile based on CBS (2011)]

Results and Discussion

Waste Management Policy at Local and National Level

The Acts and Policies pertaining to solid waste Management are the Solid Waste Management Act 2011, Solid Waste Management Regulation, 2013, Local Self Governance Act, 1998, Environment Protection Act 1996, Solid Waste Management National Policy, 1996, Nepal Environmental Policy and Action Plan, 1993, National Urban Policy, 2007 etc. Among the Solid Waste Management Acts and Policies, Solid Waste Management Act, 2011 and the National Policy on Solid Waste Management, 1996 are more relevant. The National Policy on Solid Waste Management formulated in 1966 to address emerging problems caused due to urbanization and aims to make effective and simple measures to treat solid waste, improve public participation and create awareness to reduce the impact on health and environment.

The Government of Nepal enacted the Solid Waste Management Act of 2011 effective from 15 June 2011. The objectives of the act include maintaining a clean and healthy environment by minimizing the adverse effects of solid waste on public health and the environment. It also mentions the participation of the private sector in waste management and the provision for waste management fees. The local bodies, such as municipalities, have been made responsible for the construction, operation, and management of infrastructure for collection, treatment, and final disposal of Municipal Solid Waste (MSW). The act mandates local bodies to take the necessary steps to promote reduce, reuse, and recycle (3R), including segregation of MSW at source. It also provides for the involvement of the private sector, community-based organizations (CBOs), and non-government organizations (NGOs) in SWM through competitive bidding. Procedures for bidding, selection of the successful bidder, and authority of the bidder in collecting tipping fees (tariffs) against SWM services are provided. In addition, the act authorizes the imposition and collection of service fees against SWM services, and prescribes the basis for fixing such fees and procedures for their collection and usage. It also authorizes the local bodies to formulate rules, by-laws, and guidelines, with the approval of the municipal board. As provisioned in the act, the SWM Technical Support Center (SWMTSC) under the Ministry of Urban Development shall provide technical support to all local bodies for effective and sustainable SWM and advance research and development in this sector.

As the federalism is endorsed all over the country, more power and responsibilities is transform to the local level. Solid waste management is also included as the performance indicator of Municipality. It is a challenge and a good opportunity for newly formed Municipality. They should manage separate mechanism and structure for solid waste management. It is an opportunity to manage the waste

is proper manner. They can endorse their rules and regulations to reduce the volume of the waste at source level. Proper management separation transportation mechanism, recycle and recovery mechanism as well as final disposal methodologies can be properly used.

However, facilitating the proper implementation of the act for management of waste is a low priority as there is a higher demand for other public services in many municipalities in Nepal (ADB, 2013). People are still unaware of the problems associated with solid waste management though people's and households' perception about waste is very important (Marshall & Farahbaksh, 2013). Furthermore, due to financial constraints, Nepal and its cities lack proper infrastructure, experts and implementation of appropriate laws for effective waste management. In addition, due to managerial inefficiencies, the available resources are often not utilized effectively. Therefore, waste management is one of the biggest challenges for the whole nation, which requires urgent attention (Singh *et al.*, 2014).

Municipal bodies would chance to formulate new local level SWM policy and strategy that may specify key policy objectives, guiding principles, and an implementation strategy with a timeline and a clear monitoring and evaluation mechanism. Technical guidelines will also need to be developed for issues such as organic composting, resource recovery technologies, and landfill development and operation. Awareness campaign, implementation of 3R mechanism, public private partnership (PPP), cost effective methodology and integrated management system could be effective approaches for municipal solid waste management in Nepal.

Solid Waste Management Council has been constituted for the purpose to formulate policies for the management of solid waste which is submitted for approval of the Government of Nepal. The Council is also responsible to make policy arrangements among the concerned agencies for coordination. Solid Waste Management Technical Support Centre (SWMTSC) was established under Ministry of Local Development, according to Solid Waste Management Act, 2011. It was established with an objective to support the local body for solid waste management in many ways such as:

- To support the local body for development of appropriate technology for management of solid waste and capacity enhancement,
- To monitor and evaluate the technical aspects of solid waste management and providing technical assistance or advice,
- To prepare annual budgets and programs and submit to Board of Directors for approval,
- To collect statistics, conduct or cause to conduct research and make the public known of the facts

related to situation of solid waste management and how to improve,

- To suggest local body regarding fixation and collection of service fee,
- To identify and develop techniques based on the nature of solid waste and to encourage their adoption,

Emphasize on the Role of An Individual on Solid Waste Management

Household waste is a major part of the Municipality Solid Waste (MSW). The Solid Waste Management Act 2011, stresses out the community role and emphasizes on reduction in generation of solid waste. Under this act any individual, organization or body shall, as far as possible, reduce the production of solid waste while carrying out some transaction or activity (Solid Waste Management Act, 2011). Every household member could contribute by making arrangement for disposal on their own land or reuse of solid waste. This would be easier when segregation of solid wastes are made. The Act has clearly mentioned the local body should prescribe to separate the solid waste into at least organic and inorganic including different kinds at its source. Total 21 municipalities have conducted some activities to promote waste segregation at source in recent years, effective and large-scale segregation programs are yet to be implemented by most municipalities (ADB, 2013). Discharging of solid waste in places and time other than prescribed by the local body and throwing or depositing of solid waste from the house, on the compound premises, on the road or any public places is considered as an offence and subjected for punishment.

Waste Management at Local Level

According to Solid Waste Management Act 2011, the local body shall be responsible for the management of solid waste by construction and operation of infrastructure like transfer station, landfill site, processing plant, compost plant, biogas plant and also collection of waste, final disposal and processing. The duty for transportation of solid waste from the collection center up to the transfer center or solid waste management site lies on the local body. The vehicles and equipment available for transport varies in the local body but generally used vehicles are rickshaws and carts for primary collection, tractors and dump trucks for secondary collection and transport to disposal sites. The Act mandates the local bodies to take the necessary steps to promote reduce, reuse and recycle (3R). The time, place and manner for the discharge of solid waste shall be as determined by the local body. Similarly, the landfill site, is prescribed by the local body for the management and permanent disposal of the solid waste collected within its area. The collection and fixation of service charge from the concerned person, body or organization that needs to be made for the management of solid waste is also done by the local body. The fixing of service charge shall be made on the basis of

quantity, weight and nature of solid waste and other matters as prescribed by the local body.

Households Level Solid Waste Release and Management

Socio-demographic characteristics of city households:

Table 1 presents the general socio-economic characteristics information of city households’ respondents. The average age of the respondent is 39.67 years. The average age of the household head is 53.78 years. Average family size is to be found 5.43 members. Average number of children under age 15 years is 1.11 whereas economic active household members are 4.34 and elder members in household above 59 years old are 0.70 in the surveyed city. The average monthly income per household is NRs. 46,142. On an average household has been lived in surveyed pace for 17.64 years.

Table 1: General information of major city respondents

Variable	Hetauda SMC (n=50)
Age of the respondent (years)	39.67
Age of the HH Head (years)	53.78
Family size	5.43
Children in HH (up to 14 years age)	1.11
Economic active HH members (age group 15 to 59 years)	4.34
Elder in HH (age group =>60 years)	0.70
Monthly HH income (NRs.)	46142
Living in place (since, years)	17.64

Waste segregation at household level:

Out of total 50 households surveyed; 83.8% households are segregating waste. About 91.7% households sold the aluminum cans and pets bottles from home None of the households have had public waste collection bin nearby home in the surveyed city.

Table 2: Waste segregation at HH level by surveyed city of Hetauda

Variables	Frequency	Percent
Does HH segregate waste?		
Yes	31	83.8
No	6	16.2
Does anyone in house purchase aluminum cans and pets’ bottles?		
Yes	33	91.7
No	3	8.3
Public waste collection bin nearby home		
Yes	0	0.0
No	36	100

Knowledge and information related solid waste management at households' level:

Knowledge and information about solid waste management at households' level in surveyed cities is presented in Table 3. All of the respondents have had a knowledge about SWM which in Hetauda (100%). Majority of respondents acquired SWM knowledge information from TV (41.7%) and Radio (27.8%). About 50% respondents state that solid waste management in city is good whereas 22.9% respondents state the bad and 27.1% are neutral response which are found significant different at 1% level. Average 16.2% respondents have ever been educated about waste management by municipality. About 6.1% city respondents acquire knowledge of the plan made by municipality toward solid waste management. Regarding satisfaction with the work of municipality toward solid waste management, 26.5% are satisfied. Majority of respondents (63.3%) ever

heard of importance of recycling. About 89.9% respondents are ready to segregate the "Plastic Solid Waste" if recycling program is set up in the city nearby home (Table 3).

Concern about waste management at households' level:

All the respondents are concerned about health risks related to burning garbage whereas 100% are concerned about illegal dumps polluting rivers, streams and wells in the study area. Also, 100% respondents are concerning about diseases that are related to improper storage and disposal methods of solid waste like malaria. About 95.9% respondents are concerned about flooding due to garbage blocking drains and gullies whereas only 75.5% are concerned about the service provided by the garbage truck. About 95.5% respondents are concerned about illegal dumping in their area. The concerned about waste management in survey cities is presented in Table 4.

Table 3: Knowledge and Information about solid waste management at households' level

Variables	Hetauda SMC (n=50)
Knowledge about solid waste management	
Yes	36 (100.0)
No	0 (0.0)
From where heard solid waste management information (in %)	
TV	41.7
Radio	27.8
Newspaper	0.0
Internet	8.3
Mobile	0.0
TV + Newspaper	22.2
State of waste management in locality (in %)	
Good	50.0
Bad	22.9
Can't say	27.1
Educate about solid waste management by municipality members	
Yes	6 (16.2)
No	31 (83.8)
Knowledge about the plan of SWM by municipality	
Yes	3 (6.1)
Satisfaction with the works of municipality towards SWM	
Yes	13 (26.5)
Heard of importance of recycling	
Yes	31 (63.3)
Are you ready to segregate the "Plastic Solid Waste" if recycling program is set up?	
Yes	44 (89.8)

Note: Figures in parentheses indicate percent.

Table 4: Concerned about waste management by Hetauda

Concerned	Hetauda SMC (n=50)
Health risks related to burning garbage	100.0%
Illegal dumps polluting rivers, streams and wells	100.0%
Diseases that are related to improper storage and disposal method (like malaria)	100.0%
Flooding due to garbage blocking drains and gullies	95.9%
Service provided by the garbage truck in locality	75.5%
Illegal dumping in the locality	95.9%

Willingness to participate for plastic solid waste management:

Table 5 presents the willingness to participate for plastic solid waste management by surveyed city. Almost respondents (100%) heard about composting. If a recycling program is set up, 100% respondents would be ready to separate different types of solid waste into separate bags for collection purposes. About 75.5% households would be willing to pay for pickup of recycling materials from their home. Majority of households (89.8%) express willingness to participate in a program to compost food and yard waste whereas 100% households express willingness to participate in a program to return the plastic waste if pay for every plastic bottles that return to the grocery store.

Waste generation in households' level:

Total waste generation of each household in a week is 5.57 kg. Out of total waste generation per household per week, 3.93 kg is organic waste (degradable) and 1.64 kg is plastic

waste (plastic bottles and bags). Waste generation rates could vary depending on the season, month and day of the week (Tchobanoglous *et al.*, 1993). The per capita household waste generation rate per week is 0.99 kg which and per capita waste generation per day is 141 grams (Table 6).

Institutional and Commercial Waste Generation

On average rates of waste generation from institutional sources is 28.1 kg per day. Out of total 28.1 kg per day institutional waste, the plastic materials are generated rates of 6.7 kg per day.

About 4.7 kg daily wastes are generated from commercial sector (mainly shop and hotels/restaurants). The average daily plastic waste generated from commercial sector is 1.3 kg. Overall waste generation at institutional and commercial sectors in surveyed cities is presented in Table 7.

Table 5: Willingness to participate for plastic solid waste management by surveyed city

Willing to participate (Yes)	Hetauda SMC (n=50)
Ever heard about composting	100.0%
Ever heard about recycling	63.1%
If a recycling program is set up, willing to separate solid waste	100.0%
Willing to pay for pickup of recycling materials	75.5%
Willing to participate in a program to compost food and yard waste	89.8%
Participate in a program to return the plastic bottles to the grocery store, if pay	100.0%
Willing to purchase fewer throwaway products	98.0%
Like more information about how and what types of garbage you can compost, reuse, and recycle in order to reduce the amount of garbage that you need to get rid of	100.0%
If a reuse site was located in your community, would you be willing to carry your garbage to it	73.5%
Willing to participate in building the waste reuse for your community	73.5%
Willing to participate in the maintenance of this reuse and recycle system	73.5%

Table 6: Households level waste generation within a week by surveyed city

HH level waste volume generated in a week	Hetauda SMC (n=50)
Total solid waste (kg/HH)	5.57
Household size (number)	5.6
Per capita waste generation (kg/person/week)	0.99
Per capita waste generation per day (gm/person/day)	141
Degradable waste (kg/HH)	3.93
Non-degradable waste (kg/HH)	1.64
Plastic bags (kg/HH)	0.58
Plastic bottles (kg/HH)	0.61
Metal and other waste (kg/HH)	0.45

Table 7: Overall waste generation from institutional and commercial sectors in surveyed city

Waste	Hetauda SMC
Average Institutional² daily waste generation	
Total waste (kg/day)	28.1
Organic (kg/day)	8.4
Plastic (kg/day)	6.7
Other (kg/day)	13.0
Average Commercial³ daily waste generation	
Total waste (kg/day)	4.7
Organic (kg/day)	2.0
Plastic (kg/day)	1.3
Other (kg/day)	1.5

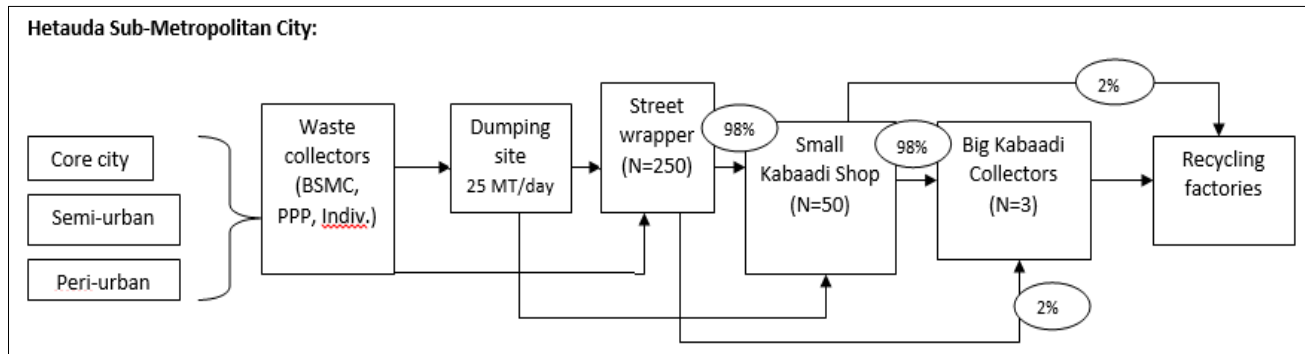


Fig. 2: Supply chain management of solid waste in Hetauda Sub-metropolitan city

Supply Chain Map of Solid Waste in Hetauda Sub-Metropolitan City

On an average daily household level waste release from Hetauda is 0.80 kg/HH (I.e. 5.56 kg/HH in a week) whereas total daily HH level waste released from 34270 HHs are 27.4 MT and 10006.8 MT per year. Out of total waste 21.7% is found the plastic materials, which accounts 2701.8 MT annual plastic waste released from core, semi-urban and peri-urban households. Average institutional daily waste (from school, office and hospital) released is found 28.1 kg per institution whereas daily waste released from commercial sector (shop, hotel and restaurant) is 4.7 kg per commercial point. Plastic waste composition from institutional sector is found 23.9% and 27% from commercial waste in Hetauda. On an average about more than 50 MT wastes are released in Hetauda city from different sector. Only 25 MT wastes are collected and filled up in dumping site daily from Municipal office, private company under PPP model (Green and Clean City Service Pvt. Ltd.) and community own effort. About 250 street waste wrappers, they collect city waste and sell to the small *Kabaadi* shops (98%), and 2% to the big *Kabaadi* shops whereas 98% *Kabaadi* shops sell their non-degradable waste to the big *Kabaadi* shop and remaining 2% to the industries. In Hetauda, 50 small and 3 big *Kabaadi* shops. Major enablers in plastic solid waste supply chain are Butwal Sub-Metropolitan city, its private company in PPP

model, Butwal Chamber of Commerce and Industry (CCI), CBOs, I/NGO at city level where as Ministry of Urban Development (MoUD), Ministry of Federal Affairs and General Administration (MoFAGA), Ministry of Agriculture and Livestock Development (MoALD), Ministry of Industry, Commerce and Supply (MoICS), Solid Waste Management Act (2011) at regional and national level (Fig. 2).

About 930.7 MT plastic per year are gone in dumping sites/landfilling sites in Hetauda Sub-metropolitan city.

Table 8: Estimation of city plastic release and recycling in supply chain in Hetauda Sub-metropolitan city

Per day waste collected (MT)	25
Plastic waste composition (%)	24.2
Per day city plastic released (MT/day)	6.1
Plastic Waste composition in city dumping sites (%)	14
Plastic waste in city Dumping Sites (MT/day)	3.5
Plastic waste recycling, burn/ burry (%)	10.2
Plastic waste for recycling, burn/ burry (MT/day)	2.6
Plastic waste for recycling, burn/ burry (MT/Year)	930.7

Conclusion and Policy Recommendation

In Nepal solid waste management is one of the major environmental issues, especially in the urban areas. Rapid and uncontrolled urbanization, lack of public awareness, lack of proper policy and strategy and poor management by

² Waste generated from schools, offices and hospitals are categorized as “Institutional waste”.

³ Waste generated from shops, hotels and restaurants are categorized as “Commercial waste”.

municipal authorities have intensified environmental and health problems in major cities in Nepal, including unsanitary waste management and open disposal nearby core city. While solid waste management (SWM) has become a major concern for municipalities and the country as a whole, the status of SWM is not fully understood due to the lack of SWM baseline data, which are also essential for effective planning. On the other hand, plastics-based waste management and recycling activities in the major cities of Nepal has not adopted in the sustainable manner. Such a back drop, this research attempts to assess the plastic waste released, management and recycling in supply chain in Hetauda Sub-Metropolitan city.

Based on the key research findings, it is suggested that municipal office needs to develop an appropriate policy and strategy framework based of SWM act 2011 together with technical guidelines on key issues such as organic composting, recycling and landfill operation from dumping sites. Furthermore, public awareness and private sectors involvement mechanism should be promoted for reduce, reuse, reduce and recycle (4R) of plastic waste as well as participatory market system development of solid waste in supply chain management though involvement of all concerned stakeholders. Similarly, recyclable material such as metals and plastics should be separated at point source. Integrated solid waste management should be emphasized. Public-private partnership and encouragement of local participation is equally important. Metropolitan and sub-metropolitan cities can formulate own solid waste management policy sand strategy based on Solid Waste Management Act (2011) with balanced linkage of policy and innovative technologies for sustainable waste management.

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