R4D PROJECT:

CHALLENGES OF MUNICIPAL WASTE MANAGEMENT: LEARNING FROM POST-CRISIS INITIATIVES IN SOUTH ASIA

PROJECT WORKING PAPER #6

WASTE CHAINS AND LOOPS IN THE KATHMANDU VALLEY, NEPAL

AUTHORS: BISHNU RAJ UPRETI, YAMUNA GHALE, RENÉ VÉRON, DRISHTI UPRETI, PIA HOLLENBACH, YASH MAN KAMACHARYA, SUDARSHAN RAJBHANDARI

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AUTHORS: B. Raj Upreti, Y. Ghale, R. Véron, D. Upreti, P. Hollenbach, Y. Man Kamacharya, S. Rajbhandari

CO-EDITOR: P. Hollenbach

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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
BS	Bikram Sambat
BW2V	Blue Waste to Value
CBOs	Community Based Organizations
CEO	Chief Executive Officer
CIUD	Centre for Integrated Urban Development
CRC	Community Recycling Centre
GoN	Government of Nepal
Ha	Hectare
IWWs	Informal Waste Workers
JICA	Japan International Cooperation Agency
KII	Key Informant Interview
KMC	Kathmandu Metropolitan City
KWMS	Kirtipur Waste Management Service
LDCs	Least Developed Countries
LEAD	Leadership for Environment and Development
MoFAGA	Ministry of Federal Affairs and General Administration
MoU	Memorandum of Understanding
MSWM	Municipal Solid Waste Management
MT	Metric Tons
NGOs	Non-Governmental Organizations
PET	Polyethylene Terephthalate
PRISM	Poverty Reduction of Informal Workers in Solid Waste Management Sector
PVC	Poly Vinyl Chloride
RRR	Reduce Reuse and Recycle
SWM	Solid Waste Management

SWMTSC	Solid Waste Management Technical Support Centre
TLOs	Tole Lane Organizations
WEPCO	Women Environment Preservation Committee

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1. Introduction

Nepal's municipalities, which are responsible for the management of household waste, face increased capacity constraints and pressure to manage the country's annual 700,000 tons of waste (GPRBA 2015). In the Kathmandu Valley[1], in particular, rapid population growth[2], urbanization and urban sprawl[3], economic development and changing consumption patterns contribute to an increasing generation of garbage and to the accumulation of new types of waste (Dangi et al 2011).

Attempts to implement 'scientific' and centralized waste management in the Kathmandu Valley were made with the support of the Japan International Cooperation Agency (JICA) in 2005. This initiative was structured around the construction of a waste processing/composting facility, an additional transfer station and a long-term sanitary landfill site as "turning points", but it also included the improvement of the collection and transportation system (including private sector participation), waste reduction, behavioral change strategies and the institutional coordination between the five major municipalities (KMC 2015). However, the comprehensive ten-year action plan was implemented only very partially; for example, the "temporary" landfill site at Sisdol was not replaced by a long-term structure, no waste processing facility was built, and collection systems differ between municipalities sometimes involving multiple private companies, NGOs, and informal waste workers.

The current waste economy in the Kathmandu Valley largely follows a linear method of waste collection and disposal (Amatya 2019) whereby large amounts of mixed waste end up in the Valley's only landfill site in Sisdol 25 km away from Kathmandu. However, multiple small-scale efforts from various governmental, non-governmental and private organizations have been undertaken, in part motivated by the waste crisis triggered by the 2015 earthquake and subsequent Indian blockade of supplies to Nepal (see chapter 7), to

[1] The Kathmandu Valley consists of the Kathmandu Metropolitan City, the nation's capital and largest city, the Lalitpur Metropolitan City, Nepal's third largest city, 16 municipalities (including Bhaktapur, Kirtipur, Madhyapur Thimi, Bhaktapur) and three rural municipalities. The Valley covers an area of 570 km^2 divided into three districts (Kathmandu, Lalitpur and Bhaktapur). It has a total population of about 2.5 million.

[2] In the Kathmandu Metropolitan city (pop. 1,472,000 in 2021), for example, the population currently increases 3-4% every year (UN, 2021).

[3] The built-up area of the Kathmandu Valley increased from 2,153 ha to 11,019 ha from 1989 to 2016 (Ishtiaque, Shrestha, & Chhetri, 2017).

strengthen a circular waste economy through waste segregation at source, composting, recycling, and reusing wastes.

The objective of this paper is to describe the current diverse and complex waste chains and loops in the Kathmandu Valley with a focus on three sites: (1) the generation, collection, and recycling of waste in the municipality of Kirtipur, where the private sector is also actively engaged; (2) the sorting and recycling at the transfer station in Teku (Ward no. 12 of Kathmandu Metropolitan City (KMC)); and (3) the final disposal and scavenging at the landfill site in Sisdol (it is exhausted its capacity so a new landfill site is in the final stages of construction in Bancharedanda[4] for disposal of the wastes from the Kathmandu Valley). These descriptions will refer to the involved materials, processes, and actors with the aim to identify the main challenges and opportunities in the waste chain. The paper also examines the influence of the waste crisis triggered by the earthquake and Indian blockade in 2015.

This paper draws upon both primary and secondary data collection. Methods of primary data collection were key informant interviews, focus group discussions and in-situ observations. All total 10 key informant interviews were conducted, representing private waste collectors, engineers engaged at the landfill site in Sisdol, local social leaders, and elected representatives. Similarly, five focus group discussions, each of them having six participants, were conducted with garbage collectors, local people of the landfill site, and representatives of non-governmental organizations working on environmental and waste issues. Further, the team of researchers visited the three sites several times to observe and interact with local government officials and other key stakeholders. The interviews were conducted in Nepali. Notes were taken during the interviews; parts of the transcriptions of the notes were translated into English (as required for this paper). Furthermore, quantitative data are complemented by data from a household questionnaire survey conducted in Kirtipur from 29 March to 17 April 2021. In total, 402 respondents were surveyed in Kirtipur (57% female and 43% male from different age groups).

This study does not represent the solid waste management practices of the whole of Nepal because of its focus at Kathmandu valley. Given the population size and urbanization of

[4] Bancharedanda is the new official landfill site under construction as per the long-term plan of the Government of Nepal in order to replace Kathmandu Valley's sole landfill site at Sisdol in order to safely manage the solid waste of the Valley in future.

the Kathmandu Valley, however, the solid waste management issue is most pressing in this region; other urbanizing regions of Nepal may soon face similar challenges. Furthermore, this paper is not able to examine the waste value chain of institutional waste producers, such as schools, hotels, restaurants, or shopping malls.

The method of data analysis for this paper is largely qualitative. The interview transcripts and observation notes were analyzed using categories and themes from which new meanings emerged. In addition to the textual data, descriptive statistics were used to present the data from the questionnaire survey.

After this introduction, chapter 2 briefly describes the traditional, localized SWM practices that are gradually disappearing in the Kathmandu Valley. Chapters 3-6 then follow the waste chains and loops from household waste generation, segregation, treatment and recycling to the final disposal. Unlike in the classic depiction of a linear model of scientific waste management, the stages of waste management overlap and concur in certain spaces. Chapter 7 examines the waste management practices during the 2015 crisis and their longer-term impact on the waste chain in the Kathmandu Valley. Chapter 8 looks specifically at the gender dimensions at each stage and space of the waste chain. The conclusions in chapter 9 summarize the findings and point to the main challenges and opportunities of solid waste management in the Kathmandu Valley.

2. Traditional solid waste management practices

Until early 1940s, most of the residents of the Kathmandu Valley were farmers and most of their wastes generated was organic and came from agriculture, kitchens, religious ceremonies and festivals (Tuladhar and Bania 1997, cited in Duwal, 2015).

The traditional inhabitants of the Kathmandu Valley, the Newars[5], used *saaga,* a compost pit built indoors, often under a staircase, to produce fertilizer from biodegradable kitchen waste, which was later used for agriculture. The *saaga* was drained out 3-4 times a year onto the household's adjacent agricultural plot (Baker 1997).

[5] The Newar are a mix of Indo-Aryan and Tibeto-Burman ethnicities. Newar caste groups are engaged in architecture, sculpting, painting, woodcarving, pottery making, farming, etc. They are predominantly Hindu and Buddhist.

Figure 1: *Saaga,* a traditional practice of waste treatment

(Source: Ajib Maharjan)

In addition, some of the Newars had also an ash pit *(naugaa)* in addition to *saaga* on the ground floor, often below the stairs and often dividing the space below the staircase for both. In these ash pits, urine, and ash (from fuel wood) were collected and stored for about 3-4 months after which they were emptied, either in a dedicated pit nearby house or directly on agriculture fields (ENPHO 2007). The composted material from the *saaga* and the *naugaa* was used as manure in agriculture (Gantenbein & Khadka 2009).

The traditional practices of *saaga* and *naugaa* started to disappear in the early 1950s, when the government assigned the responsibility for waste management to the municipalities (Joshi 2015). Municipal authorities deemed the traditional treatment of solid waste at the household level inappropriate and unhygienic (Joshi 2015). In addition, the use of chemical fertilizers replaced the practice of using local manure in the family farms of the Kathmandu Valley (Baker 1997). Other reasons for the disappearance of these traditional composting methods include rising standards of living, changes in food habits, and increased use of non-biodegradable materials, such as plastics, tins, metals, and paper, as well as urban sprawl and an increase in population density leading to a decrease in the land available for agriculture and waste management.

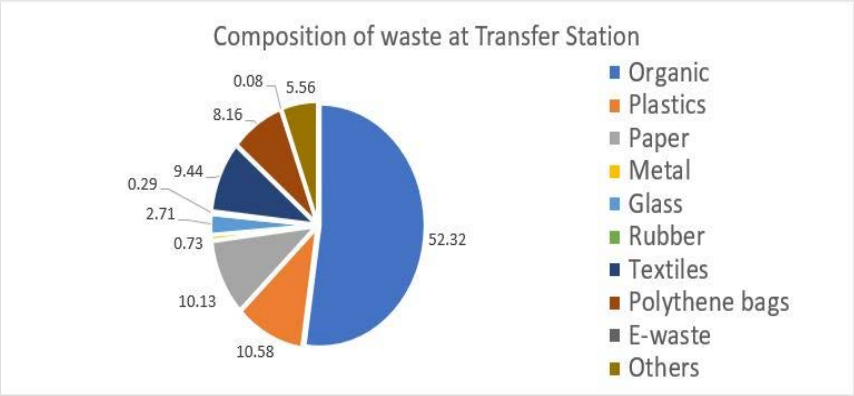
Due to these political, economic, social and morphological changes, the localized, cyclical waste management system was gradually transformed into more linear waste chains,

where the generation, collection, transport, treatment and disposal are often spatially separated and involve multiple actors. (Such a separation in different phases and places has become typical across the globe. In the following, this paper follows the current waste streams and loops in the Kathmandu Valley from waste generation to its collection, transport, and transfer, and finally to its disposal (the step of energy recovery in form of the production of electricity from bio-methanization or incineration being largely missing in Nepal).

3. Household waste generation, segregation and treatment

Municipal solid waste (MSW) includes waste generated at the household, institutional and commercial level (ADB 2013). As mentioned earlier, this study focuses on household wastes. Previous studies on Kathmandu show that households generate a large fraction of MSW (Dangi et al 2011). According to the most recent official figures, MSW generation amounts to 513 tons per day (KMC 2021) of which 277 tons per day come from households (MoFAGA 2018). Furthermore, household waste generation is on the rise; it seems to have grown by 44 tons per day between 2013 and 2018 (own estimate based on figures from MoFAGA 2018 and (UNEP-IETC-GRID-Arendal 2019). However, per capita waste generation remains low if compared to other countries. A representative of Kathmandu Metropolitan City Environment Division, for example, reported that the current household waste generation rate stands at 180 grams/capita/day[6]. KMC also provides data on the composition of waste (see figure 2).

Figure 2: Waste composition of municipal solid waste



(Source: KMC, January 2021)

[6] Information given at the r4d project annual meeting (online) in January 2021.

Figure 2 shows that more than half of the unsegregated, mixed MSW collected is organic. Plastics, paper and textiles are the most important recyclable wastes (in terms of volume and weight). For recycling, glass and metals are also important (see below). E-wastes represent a small but growing component of household waste in Kathmandu.

However, the KMC data must be read with caution. Their estimates are based on measurements of waste collected by the municipality at the transfer station in Teku and do not account for waste that is managed directly at the household level or collected by informal waste workers. For example, our qualitative studies in Kirtipur show that households with access to agricultural land or a kitchen garden usually produce compost from their own biodegradable wastes. Some households feed leftover food and kitchen waste to livestock and to other animals.

> *"I usually make compost out of skins of fruits and vegetables. If there are leftover foods, I usually give the remaining edible ones to my pet dogs. If the food is not suitable to feed the dogs, I usually give it to the birds. I even feed the fresh skins of kitchen waste to domestic cows nearby" (Focus group, Tyanglaphant, Kirtipur, 17th April 2019)*

> *"If we have access to a kitchen garden, we dig a pit to either dump the wastes or burn them." (Focus group, Panga, Kirtipur, 16th April 2019)*

As indicated in the quote above, some households in Kirtipur also manage non-biodegradable garbage themselves, through the (environmentally problematic) practice of burning. Our 2019 field survey showed that although people are aware about the harmful effects of burning non-biodegradable wastes, such as plastics, milk packets and cooking oil pouches, households in rural parts of Kirtipur with access to kitchen gardens continue this practice. In these cases, people use plastics to light a fire[7]. Some of these households have not yet taken membership for waste collection.

> *"If there are paper wastes at home, I burn them to make compost out of it as well"- (Focus group discussion at Tyanglaphant, Kirtipur, 17th April 2019)*

[7] In-depth Interview at *Ittagol,* Kirtipur, 8th April 2019

"We usually burn the plastics to manage the plastic wastes. (Focus group discussion at Panga, Kirtipur, 16th April 2019)

"It is only after the waste collectors started household waste collection that we started depending on them. Otherwise, we used to keep the surroundings clean on our own." (Focus group discussion at Ittagol, Kirtipur, Female, 64 years, 16th April 2019)

Other households, mostly in more urbanized areas of Kirtipur, segregate their waste by putting leftover food and kitchen waste in the bin for biodegradable waste, non-biodegradable waste kept in another bin. Recyclable wastes, such as plastics, paper, glass bottles, etc., are stored, as far as possible, and sold off to informal recyclers.

We exchange (with cycle hawkers) bottles of shampoos, metal pieces, batteries, old mobile phones, glass pieces and broken machines for potatoes. During our childhood, there weren't any cycle hawkers"- (Focus group, Panga, Kirtipur, 16th April 2019)

The wastes which cannot be stored are sent to the waste collectors."- (Focus group discussion at Tyanglaphant, Kirtipur, 17th April 2019)

These quotes from Kirtipur indicate that not the whole amount of the generated household waste ends up in the municipal waste chain. The official figures on waste generation are therefore likely to be underestimated. In any case, the waste collected by the municipality (or by contracted private companies) is unsegregated. Households send away all their mixed wastes with the waste collectors due to lack of space or lack of use for particular wastes.

"I usually send all kinds of wastes with the waste collectors because there is no space for making compost manure"- (Interview, Female respondent from Tyanglaphant, Kirtipur, 18th April 2019)

"We store all kinds of waste in the same polythene bag and the waste collectors come and pick it up"- (Interview, Female respondent from Ittagol, Kirtipur, 18th April 2019)

"The waste collectors usually ask to keep only the glass pieces separately. Therefore, I only separate the glass pieces. Since they usually take other wastes together, I don't separate other wastes"- (Focus group discussion at Tyanglaphant, Kirtipur, 17th April 2019)

Nepal's Solid Waste Management Act, 2011 prescribes the segregation-at-source of biodegradable and non-biodegradable wastes and gives key responsibilities to municipalities[8]. This is reinforced by the guidelines of KMC, 2011 (2068 B.S.) that states: "every house, business, school, office premises, etc. must compulsorily implement the arrangement of separating domestic wastes from biodegradable with non-biodegradable and store them in a separate container prior to disposal." However, this practice is not very widespread in the Kathmandu Valley yet, as the above citations indicate. Alam et al (2008) confirm in a 2003 study on the city of Kathmandu, that only 16% of the households practice waste segregation. Our field survey shows that now more than half of the respondents segregate their household waste (see table 1), indicating a remarkable increase from 16% in 2003.

Table 1: Practice of Segregation of Household Waste in Kirtipur

Waste Segregation Practice	Number	Percentage
General Household Waste	222	55,2 %
Kitchen Waste	217	54,0%
Recyclable Waste	199	49,5%

Source: NCCR Field Survey 2021

The table above shows that 55.2% of the households practice waste segregation at source of some sort. Almost all of them (54% of the total sample) segregate kitchen waste and a large majority of them (49.5% of the sample) segregate recyclable wastes.

One of the reasons of such increase in segregation is awareness raising, as the following excerpt from a focus group discussion in Kirtipur indicates:

> "*We keep separate bins for biodegradable and non-biodegradable wastes in our homes. Therefore, we discard the leftover foods and kitchen waste in the bins separated for biodegradable waste individually. We discard unused paper in the dustbin meant for non-biodegradable wastes. We are self-aware about the segregation of wastes and were also provided with a training called "kareso kuhiyaune"*

[8] Chapter 2, section six of the Act states "the responsibility to separate the solid waste into at least decomposable and non-decomposable lies in the hand of the local body" (GoN, 2018).

(decomposing biodegradable waste) by Kirtipur Municipality."- (Focus group discussion at Ittagol, Kirtipur, 16th April 2019)

According to the official rules, furthermore, wastes must be either composted by the household itself, applying a method of their own choice, or brought to the nearest Community Recycling Centre (CRC) (GoN 2018). However, only a very few neighborhood communities have systems in place to compost biodegradable wastes (Sherpa 2017 cited in Das et al 2018).

KMC has been undertaking public education campaigns for the past three years through its community mobilization section. On request, this section organizes segregation-at-source awareness raising for women, senior citizens, and youth in communities and at schools[9]. Further, environmental and waste concern groups are heavily engaged in 'waste awareness' on segregation of waste at source help improving the solid waste system. KMC also supports rooftop farming programs to turn biodegradable wastes into compost manure. Roof garden farming initiatives contributed to the advance understanding and practices of waste generating households. Similarly, KMC promotes the use of compost bins for turning biodegradable wastes into manure. This method of turning biodegradable wastes into compost manure is a form of recycling[10]. However, the formal system often does not collect the wastes separately; municipal waste collectors mix all the waste together to dump in the landfill. The use of waste segregation at source is therefore limited to cases where composting can be done at the local level or where environmentally oriented NGOs, or private enterprises engage in waste collection (see below).

4. Waste Collection

In most of the municipalities in the Kathmandu Valley, household waste is collected with multiple methods by multiple collectors (mainly private sector enterprises and municipalities themselves). Such methods include door-to-door collection, roadside collection from neighborhood containers and from piles of waste on the ground (Silwal 2019).

[9] Key Informant Interview with official of the KMC Environment Management Department Office, 29th May 2019
[10] Key Informant Interview with Mr. Sharkardeep Shrestha of KMC Environment Management Department Office and site in-charge for Sisdol landfill site, 29th May 2019

The door-to-door collection practices are largely carried out by environmentally sensitive waste collecting NGOs and private sector and they collect separately from the containers of biodegradable and non-biodegradable wastes separated by the environmentally sensitive households by keeping separate bins to store decomposable and non-decomposable wastes and the waste collectors collect them on different days (as the collectors have fixed the date of collection of decomposable and non-decomposable waste transport only one type of wastes (e.g., decomposable) at one day and another type (non-decomposable) at another day. Municipalities and NGOs are providing segregation bins for those interested to segregate the waste (this is still small portion compared to those waste generators who do not segregate). We have noticed in Kirtipur Municipality that the private sector collectors collect waste on alternate days and they have also specified the days to collect degradable and non-degradable wastes. During the crisis period (especially in the time of earthquake, segregations waste at household was dramatically increased and since then this practice is continued by waste collection companies.

Recently, some local institutions have become active in SWM. For example, women waste workers are organized in a cooperative i.e., the Sanyukta Sarsafai Jaagaran Savings and Cooperative Pvt. Ltd. All members are informal waste workers. Similarly, several private companies and social enterprises have also become active in SWM in the Kathmandu Valley. Some of the noticeable ones are: a) Nepal Pollution Control and Environment Management Center, b) Kirtipur Waste Management Service (KWMS), c) Clean Nepal, d) Sirjansil Batabaran Samrakshan Kendra (Innovative Environment Conservation Center), e) Nepal Swachha Batabaran Sirjana Kendra (Nepal Clean Environment Innovation Center) and f) Organic Life. All of them are actively engaged in SWM in Kathmandu Valley. Likewise, some social enterprises such as Blue Waste to Value, Khaalisisi, Doko Recyclers, Hatti Hatti, Tyre Treasures, Dhasoo are creatively engaged in SWM in Kathmandu Valley. The use of compost in agriculture and rooftop gardening are other common projects now a days.

Nepal's SWM Act, 2011 provides the legal basis permitting private companies to be involved in MSWM, in particular, to collect, transport and dispose solid waste, to reuse and recycle it, and to enhance public awareness for waste reduction (GoN, 2018). For this, they require a license awarded by the relevant local body (municipality) through an open and competitive tendering process. The involvement of the private sector is usually regulated

by a MoU signed by the municipality and the respective private company or NGO. MoUs can be very diverse and include various tasks related to waste management, from the collection to the segregation and recycling of wastes. Currently, about 60 private companies are involved in waste management in the Kathmandu Valley and about 110 vehicles are used for transportation (NEPSEMYAK, January 2021[11]).

In Kathmandu, for example, the Environment Management Department of KMC is responsible for waste collection and disposal (Rana 2013). At present, KMC collects about 513 tons[12] of waste per day from the 32 wards of KMC. The garbage is transferred to Teku transfer station[13]. The wastes in certain core areas of Ward Numbers 12, 13, 14, 15, 16, 18, 19, 20, 21, 22 and 23 come to Teku[14]. In these areas private waste companies do not have their programme and waste is managed by the municipality itself[15]. In these wards, KMC oversees door-to-door collection of household wastes, collection of roadside deposits such as public spaces and footpaths, offices, and factories using rickshaw, mini-tractors, mini-trucks, and dedicatedly designed waste collection trucks depending on the volume of garbage. Once they are transported to the collection centers, the KMC staff upload the collected waste to the larger waste truck to be sent to the landfill site.

In other wards of KMC, private companies are involved in waste collection. Many of the companies are small in size and non-registered; they tend to be involved in semi-formal collaborations with KMC (Silwal 2019).

In Kirtipur, four private companies are actively working in solid waste management in collaboration with the municipality. They include a) Kirtipur Fohar Byabasthapan Sewa Pvt. Ltd. (Kirtipur Waste Management Service (KWMS), b) Swochchha Batabaran Samrakshyan Samiti (Clean Environmental Conservation Committee), c) Nepal Swochchha Batabaran Shrijana Kendra (Centre for Clean Environment) and d) Clean Energy Nepal. In addition, a private company called Blue Waste to Value working across the country is technically supporting KWMS. KWMS was established in 2013 for collecting

[11] Based on the presentation by the representative of a private waste company, Nepsemyak Sewa Pvt. Ltd., for R4D's Online Regional Meeting, January 2021. Nepsemyak is a private waste company working in the field of community based solid waste management, pollution control, environment improvement and public awareness in the Kathmandu Valley.

12 Some sources suggest that the waste generated per day in KMC is 566 tons (www.nepaljol.info : 3 June 2018)

13 Based on the presentation by the representative of Kathmandu Metropolitan City Environment Division for R4D's Online Regional Conference on January 2021

[14] Key Informant Interview (KII) with the representative of KMC's Environment Management Department, Teku, on 2019 May 29

[15] Key Informant Interview with Mr. Sharkardeep Shrestha of KMC Environment Management Department Office and site in-charge for Sisdol landfill site, 29th May 2019

wastes and the company manages 25% of wastes of Kirtipur Municipality. The remaining 75% waste is managed by other private companies and the municipality itself. KWMS has specialized in biodegradable wastes, but its waste recovery center also collects electronic wastes (e-wastes) separately such as old television sets, printers, refrigerators, and small radios. which they send away with social enterprises working in recycling such as Blue Waste to Value (BW2V) and *kawaadis*. Some electronic devices are repaired and sold to those who cannot afford or do not like to afford the new electronic equipment. In context to printer wastes, they dismantle the parts and separate them accordingly. They extract the harmful black powder from cartridges in different containers and disposed it into the landfill waste. The remaining non-recyclable parts of the e-waste is secretly dumped to isolated open spaces or at local waste assembly points.

In total, about 12-14 vehicles operate daily in Kirtipur to collect and dispatch solid waste. The municipality has allocated specific collection areas to the four above-mentioned private companies. In their allocated areas, companies request households to pay for a membership. They only collect waste from these member households. Each household must pay a certain fee agreed between the household and the company. These fees range from NRs. 150-1000 depending upon the number of stories of a house, number of families staying in a house and the nature of the settlement - urban or rural areas. Usually, a household with a small family of four pays NRs. 150-250 whereas a household with more than 3 families especially, residing outside the core area pays NRs. 300-450. Apartments, household with restaurants, guesthouses and those serving lodging facilities are charged a minimum of NRs. 350 which is increased as per the volume of wastes. For additional wastes, extra waste fee ranging from NRs. 500-1000 is charged. In case of resident renting the flat/rooms, the owner/landlord charges them based on the occupancy of the rooms and number of families residing in the rented house. For instance, a renter occupying only 1 room is charged NRs. 100. On the other hand, renter with 3-4 families in a house maybe charged up to NRs. 500 with a minimum charge of NRs. 100-150. If the whole house is occupied by more than 5-6 families of renter, then they may charge up to NRs. 1000. This is mostly prevalent in the ward 2 and 10 of Tyanglaphant area of Kirtipur. The mode of operation of waste collection is similar in the different parts of the Kirtipur municipality; standard rules are applied by the private companies involved in collection of solid waste in

accordance with the MoU signed with Kirtipur municipality and the four operating private waste companies.

In our qualitative study in Kirtipur, we found that the employees of the private waste companies (collectors) blow a whistle to signal the households to bring out their wastes. The companies use mini-trucks (see figure 3) for door-to-door waste collection, as the roads leading to the houses are often very narrow. After loading all the waste on the mini-trucks, tippers and tractors, they are brought and transferred to a bigger waste truck[16]. The mixed waste is then taken to the designated waste sorting stations (few stations were designated/developed as sorting centers specially after the 2015 earthquake), by some private waste company[17]. After crisis, all sorting stations are located on the same waste yard and the space for the sorting centers were provided by municipalities.

Figure 3: A waste truck from a private company engaged in household waste collection in Kirtipur

Source: Hollenbach 2019

In addition to the formal, municipal or privately contracted waste collection system, informal, self-employed waste workers (who are neither organized, nor employed or contracted by

[16] Key Informant Interview with Mr. Padam Thapa of a private waste company called Clean Nepal working in Kirtipur, 17th April 2019

[17] The total waste produced in the Kathmandu Valley is not sorted into bio-degradable and non-degradable, in some specific areas it has been started by as environmentally friendly practices by some innovate private waste companies. Further, the generable sorting in some sorting stations/centers is related to valuable (or waste with better price) wastes, not bio-degradable and non-degradable.

anybody,) collect recyclable wastes from households and from open dumpsites in the city. For example, cycle hawkers (locally known as *kawadiwala*[18]) collect recyclables, such as shampoo bottles, metal pieces, batteries, old mobile phones, glass pieces and broken machines from door to door. Sometimes they give a small amount of money or goods (like potatoes or soap) to get the *kawadi saman* (unusable material) but often they get these materials free of costs. They also segregate the usable goods and use or sell and unusable they give to scrap dealers. These informal activities are coordinated by scrap dealers, who are independent entrepreneurs without any association. The scrap dealers also buy recyclables directly from rag pickers[19]. Recyclables, such as paper, carton, shampoo bottles, alcohol bottles, shoes, and leather bags, are usually transferred to Birgunj, located in the Terai about 135 km to the south of Kathmandu, and to traders in India. The recycling industries from those places call for auctions of the waste collected at *kawadi* centers in Kathmandu, where the recyclables are sorted, cleaned and exported for recycling (Beukering and Badrinath 1995 cited in Luitel & Khanal 2010) mostly to India and some amount to Bangladesh. Currently, plastics seem to be the most important product for the scrap dealers, as the quote below suggests:

> *"Mostly, it is the plastic wastes that are collected. The other wastes include glass bottles and few quantities of electric wastes, aluminum and wires. We collect about two tons of waste every day." (In-depth interview with scrap dealer at Teku)*

Furthermore, private recycling companies, which are distinct from the waste collection companies, have recently emerged to collect reusable items, such as paper, plastics, glass bottles, metals, and electronic wastes, through door-to-door collection with the help of mobile apps, free of cost, and even allowing the public to sell their recyclable wastes. Some of these private companies include Khalisisi.com, Doko Recyclers and BW2V, who have been involved in the waste-to-energy projects[20]. These companies get recyclables from traditional recyclers, including cycle hawkers. With their new forms of collection, more efficient management and performance, the new recycling companies present a challenge

[18] Literally, those people who collect small volume of waste (Kawadi) by visiting house to house.

[19] There are different terms used to informal waste workers like waste pickers, rag pickers, cycle hawkers, reclaimers, salvagers, scavengers, etc. However, people working in the waste management issues have started to criticize the term 'scavengers' as it is demining because it compares with animals.

[20] One company in Lazimpat developed a local incineration plant as part of a "waste to energy" campaign, but it did not succeed because of lack of clear policy to deal about incineration such as planning permit, subsidies, etc. Some companies are working on bio-methanization (producing methane gas from organic waste), but they are not able to operate at commercial scale due to policy gap to promote such initiatives.

to informal recyclers/hawkers and their livelihoods. In some cases, they have replaced informal recyclers.

Table 2: Primary method of waste disposal in Kirtipur

Types of Waste	Collected by third party		Brought to collection point in neighborhood		Brought to collection point in building (compound)		Littered		Burnt		Others (waste managed by households either by disposing in pit, compost bin, or feeding for animals)	
	N	%	N	%	N	%	N	%	N	%	N	%
Mixed Waste	373	92.8	1	0.2	-	-	-	-	9	2.2	19	4.7
Kitchen Waste	178	44.3	1	0.2	-	-	-	-	1	0.2	222	54.9
Plastic	361	89.8	1	0.2	-	-	-	-	-	-	10	2.3
Polythene	347	86.3	1	0.2	-	-	-	-	23	5.7	9	2.2
Paper	322	80.1	-	-	-	-	-	-	51	12.7	7	1.7
Cardboard	266	66.2	-	-	-	-	-	-	40	10	3	0.7
Glass	296	73.6	1	0.2	-	-	-	-	-	-	16	3.9
Metal	287	71.4	-	-	-	-	-	-	1	0.2	-	-
Electric (Wires, Battery)	253	62.9	-	-	-	-	-	-	-	-	2	0.4
Electronic	228	56.7	-	-	-	-	-	-	-	-	1	0.2
Medical Waste	266	66.2	1	0.2	-	-	-	-	1	0.2	5	1.2

Source: Field Survey 2021

The table 2 shows that the primary method of disposing waste, such as mixed, kitchen and other wastes like plastics, polythene, paper, cardboard, glass, metals, electric, electronic and medical as reported by the respondents in Kirtipur is done through the collection by a third party. The third party collects 92.8% of the unsegregated waste. The third party collects only 44.3% of the kitchen waste whereas the mixed waste here may include only a few amounts of paper and plastic wastes which are dirty and not in the condition for reuse or recycle. On the other hand, reusable clean plastic wastes and newspaper bundles in bulk amount fall under the categories of paper and plastic wastes.

5. Waste sorting, recycling and processing

As indicated in the previous chapter, cycle hawkers collect recyclables from door to door and rag pickers collect them from the streets. Furthermore, the mixed waste collected by the formal system is also sorted at the transfer stations by informal waste pickers or by employees of private companies (as in the case of the waste yard in Kirtipur). At Teku, for

example, informal waste workers segregate recyclables wastes, such as PET bottles and other reusable plastics from milk packets, etc., metals such as aluminum, electric wastes such as wires, televisions, etc. (Teku Field, May 2019). A waste worker reported to us that they must go through mixed waste where even hospital wastes are sometimes found.

In the neighborhood of Teku and at the transfer station, a women's cooperative is also very active in in collection and segregation of waste and handover to the private companies who collect and transfer to dumping sites. They are well-organized and negotiate with the KMC for better support of their SWM initiative. A leader explained their activities to us:

> *"We usually, bring the recyclable wastes at the waste collection center, Teku (Ekikrit) and manage them accordingly by categorizing them based on the type of the wastes. We send the recyclable items to India and also to some parts of Nepal such as Birgunj"- (key informant interview, Sanyukta Sarsafai Jagaran Pvt. Ltd. (SaSaJa cooperative), Teku, 28th May 2019)*

It is estimated that 20-25% of collected waste is diverted for recycling at the Teku transfer station (Key informant interview, Nepsemyak Sewa Pvt. Ltd, Jan, 2021[21]) and that approximately one ton per day of recyclable waste is sorted here by informal waste workers (KMC, Jan, 2021[22]). All the waste workers with their combined effort segregate around 50KGs of recyclable wastes in a day (Teku Field, 12th May 2019).

At the waste yard in Kirtipur, the employees of the small waste companies are assigned to sort through the mixed waste and separate paper, textiles, plastics, PET bottles, etc. (Key informant interview, *Nepal Swachha Batabaran Sirjana Kendra* at Kirtipur, 17th April, 2019[23]). The waste collection center also receives e-wastes, such as old television sets and small radios (Kirtipur field visit, April 2019).

NGOs, community-based organizations and small private entrepreneurs have recently started recycling initiatives in the Kathmandu Valley (Silwal, 2019), thus contributing to

[21] Based on the presentation by the representative of a private waste company, Nepsemyak Sewa Pvt. Ltd., for R4D's Online Regional Meeting, January 2021. Nepsemyak is a private waste company working in the field of community based solid waste management, pollution control, environment improvement and public awareness in the Kathmandu Valley.

[22] Based on the presentation by the representative of Kathmandu Metropolitan City Environment Management Department for R4D's Online Regional Conference on January 2021

[23] Key Informant Interview with Mr. Damodar Bhatta of a private waste company called *Nepal Swachha Batabaran Sirjana Kendra* working in Kirtipur, 2019

rendering waste chains more circular and localized. Figures 4 and 5 depict some of the recycling activities taking place at the waste recycling yard in Kirtipur.

Figure 4: Management of recyclable wastes as carried out by a private waste company at Kirtipur

Source: Sarab Kumar Maharjan, 2020

Figure 5: Management of organic waste and production of compost through use of technology as carried out by KWMS at Kirtipur

Source: Sarab Kumar Maharjan, 2020

However, waste recycling centers remain far and between in the Kathmandu Valley.

> *"The circular process of recycling has been practiced but is in very few numbers because had it not been in practice, we would have been getting the wastes in large amount. However, we have not been able to reuse or recycle wastes by installing huge recycling plant"- (Key Informant Interview, landfill site in-charge, Sisdol landfill site, Sisdol, May 2019)*

An important and technically simple way to reduce wastes going to the landfill is the treatment of organic waste, for example through composting. Even though KMC has promoted the use of compost bins for turning biodegradable wastes into compost manure, it has failed to install composting or bio-methanization plants. It has not able develop and promote resource-recovery products, such as compost for agriculture. Several other initiatives linked to organic waste treatment have been started by NGOs and neighborhood organizations in Kathmandu Valley.

Furthermore, plastic has been identified as one of the main factors in Nepal's environmental pollution (Amatya, 2019). Instead of exporting recyclables plastics to India, for instance, the youth employees of the Green Road Waste Management Company used plastic wastes from packaging materials for noodles, biscuits, milk, tobacco, etc. for the black-topping of a 100-meter road section in Pokhara, Nepal, in 2018. They introduced plastic from waste into the traditional bitumen mixture, reducing the amount of expensive asphalt concentrate (Lamichhane, 2018). In collaboration with the municipality, the same company replicated this initiative in Kirtipur, where a 100-metre road section was black-topped using plastic wastes in 2019 (Kshatri, 2021) as a test case. If successful, the use of plastic waste in black-topping roads will be scaled up and applied in a more professional way.

6. Waste disposal

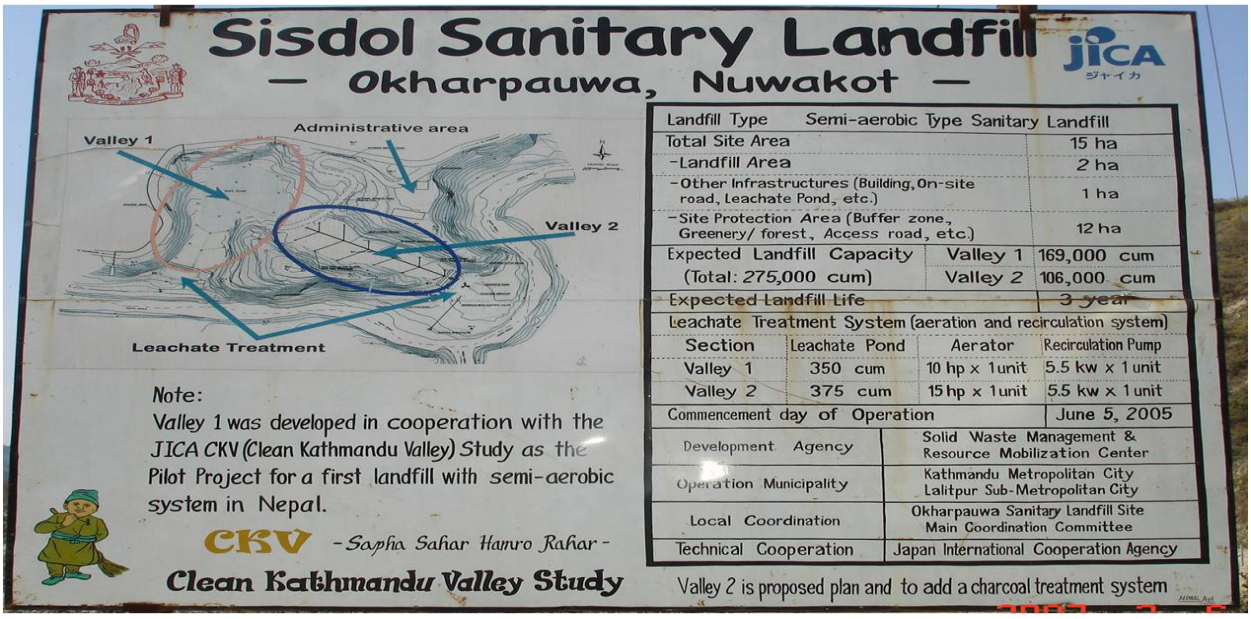
Disposing of wastes is the least preferred option in the MSWM hierarchy. According to a study conducted by ADB, only about 10% of MSW of KMC would have to go to the landfill if waste recycling and resource recovery methods were maximized (ADB 2013). At present, the mixed and only partly recycled wastes from the urban transfer stations and other areas of the 18 municipalities in the Kathmandu Valley are loaded onto big waste trucks and brought to the Sisdol landfill, which is the only legal and official site available since 2005 (Tamang 2010). Out of 513 tons of waste generated daily, an estimated 419 tons of waste per day are disposed at Sisdol landfill site and remaining 94 tons per day is recycled or composted (KMC, January 2021).

The landfill site is located on an area of 15 hectares of which 2 hectares are used for waste disposal in a narrow sense. The rest of the area is used for buildings, on-site roads, a leachate pond, and a large site protection area (see figure 7)[24].

Figure 6: Transportation of wastes from City to Sisdol landfill site

Source: Yash Man Karmacharya, November 2019

Figure 7: Figure showing operational activities at Sisdol sanitary landfill site



Source: Sharkardeep Shrestha, site in-charge, Sisdol landfill site, January 2020

[24] Based on the presentation by Mr. Sharkardeep Shrestha, KMC Environment Management Department Office and site in-charge for Sisdol landfill site, Regional Workshop, Nepal, Jan 2020

Figure 8: Sisdol landfill site before operation

Source: Sharkardeep Shrestha, site in-charge, Sisdol landfill site, January 2020

Figure 9: Sisdol landfill site in February 2007

Source: Sharkardeep Shrestha, site in-charge, Sisdol landfill site, January 2020

Figure 10: Sisdol landfill site in June 2019

Source: Yash Man Karmacharya, November 2019

Figure 11: Sisdol landfill site in operation (2005)

Source: Sharkardeep Shrestha, site in-charge, Sisdol landfill site, January 2020

KMC is responsible for managing all wastes transported from the Kathmandu Valley to the Sisdol landfill. Initially, a semi-aerobic system was used for the disposal and the final storage of the mixed waste. Since the planned capacity of the landfill was exceeded in 2008, controlled dumping has been applied. The Figure 7 shows that Sisdol was just a pilot project having an expected lifespan of 3 years. However, it is continued until now. The waste is simply dumped in the landfill site and leveled with the help of bulldozers. At the end of each day, the latest layer of waste is capped with soil (Key informant interview, KMC Environment Management Department at Teku, 12th May 2019). In order to minimize the

infiltration and percolation of rainwater into the waste deposit area and thus to reduce leachate (Wong, 2012). The collection points for leachate are only partially functional.

The Sisdol landfill receives mixed wastes composed of plastics, plastic, paper, metals, biodegradable wastes, including as kitchen wastes and wastes from green plants.25 According to the site engineer, however, only few plastic bottles and metal pieces come to the landfill thanks to increased recycling earlier on in the waste chain. For instance, about 23% of waste collected by private companies is recovered through recycling and does not reach the landfill site (KMC, Jan 2021). However, we did not find the daily data about waste collected by individual municipalities within Kathmandu Valley. Consequently, the organic content of the waste disposed at Sisdol is very high (about 62%) ((Shrestha, Maharjan, Khatiwada, & Thapa, 2020). Still, with the initiation of programs, such rooftop farming by KMC that promote the production of compost from organic wastes, the amount of organic waste ending up on the landfill is reduced.

Despite recycling on the waste yards of private companies and at the Teku transfer station, mixed waste arriving at the Sisdol landfill still contains recyclable materials, because many areas of Kathmandu lack such facilities and informal recyclers. Therefore, about 200-300 waste pickers gain their livelihoods on the Sisdol landfill daily. Most of them are from surrounding areas of the landfill site[26]. They do not allow new waste pickers from the outside to come and collect waste. The local waste pickers sort out wastes, such as milk packets, plastics and PET bottles, and they usually sell them to scrap dealers located at the Teku transfer station at about rupees 300 per sack. Normally, these workers collect two bags of sack of plastic items per day. The sack weigh around 30-35 kg.

Compared to the waste at the Teku transfer station, the value of the waste at Sisdol is lower. Therefore, sorting through waste to collect recyclable materials requires more work here. However, from our interviews with informal waste workers at the Sisdol landfill, we learned that individual collectors earn up to 200K per year. This presents a good earning in the local context, even though they are located at the bottom of the waste value chain and are forced to work hard in unhygienic conditions.

[25] According to waste workers at the Sisdol landfill, the site even received hazardous hospital wastes, such as syringes, severed human hands and legs and aborted fetuses, in the past. After registering a complaint to the concerned ministry, hospital wastes were no longer disposed of in Sisdol (Sisdol Field, June 2019).

[26] Solid Waste Management of Kathmandu Metropolitan City Environment Audit Report, 2015 states 300 whereas the respondents at Sisdol site explained us about 200 waste pickers.

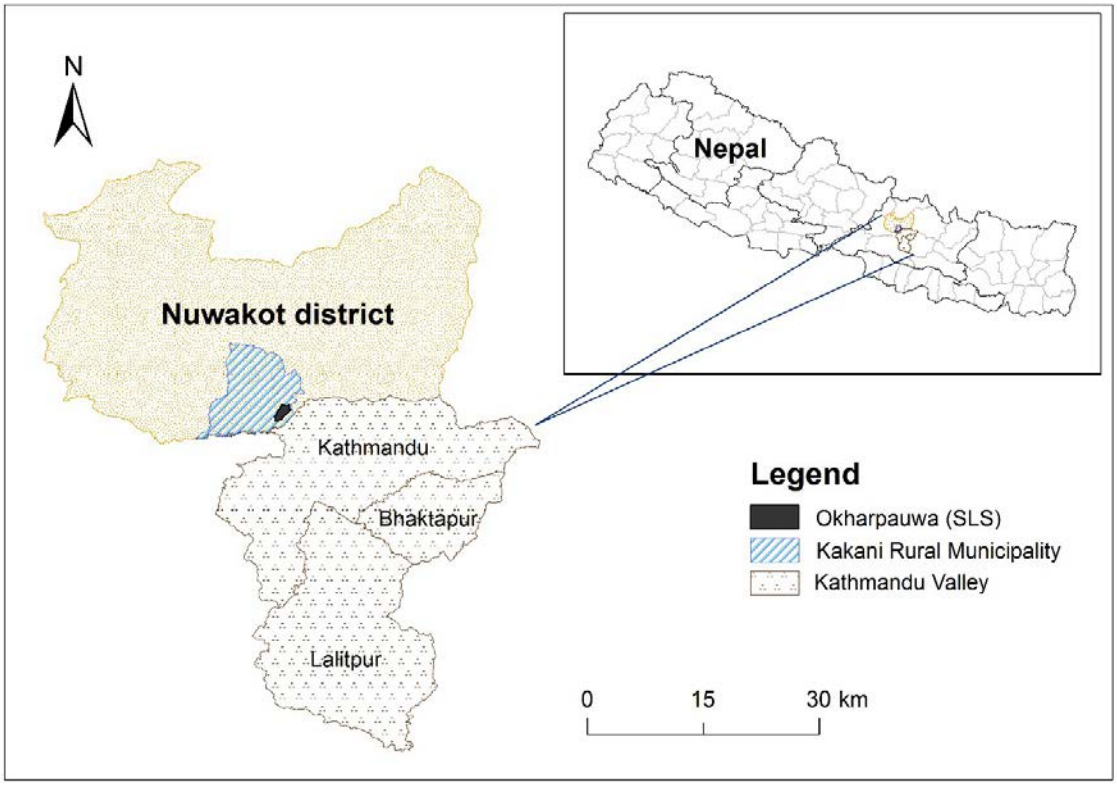
One of the main challenging aspects for waste collectors and waste segregators working in the waste in the landfill site is that they often fall ill and contract diseases.

> *"Most of the cases are related to skin infections due to direct exposure to the wastes at the landfill site. The second most common case which the waste workers come seeking for is APD or also known as Acid Pepsin Disorder. The third most common case is of gastritis."- (Key Informant Interview, health assistant, Sisdol landfill site, Sisdol, June 2019)*

Chronic and non-communicable diseases such as diabetes, cancer are also on the rise recently. As informed by the health assistant at Sisdol health post, gastrointestinal disease (dysentery) is the number one disease that the waste workers usually suffer from. The second most common disease is typhoid whereas skin infection is the third most common type of disease faced by the waste workers working in the landfill site.

The Sisdol landfill operating beyond its lifespan, the government of Nepal has planned a new landfill and bought land at Bancharedanda in the rural municipality of Kakani, Nuwakot District, for this purpose.

Figure 12: Map showing operational Sisdol landfill site in Nuwakot



Source: Shrestha et al 2020

The Bancharedanda landfill is to replace the Sisdol landfill. This sanitary landfill is currently under construction and will cover an area of 13.21 ha with a dam length of 256 m and a dam height of 30 m (upstream) and of 45 m (downstream). The landfill area comprises a buffer zone of 53 ha and has the capacity of storing waste of 2,500,000m^3 (SWMTSC, n.d.). The new landfill site is estimated to operate for the next 30 years[27]. This site was constructed by KMC with the support of Government of Nepal. However, some disputes between the local communities and the local government, on the one hand, and KMC/central government, on the other side, have been observed even before its operation have started. The local actors lament the indirect costs of the landfill site for their communities and the problems linked to the access roads.

Figure 13: Construction site of new sanitary landfill site at Bancharedanda

Source: Yash Man Karmacharya, November 2019

7. Solid waste management during the 2015 crisis

Depending upon their nature and severity, disasters (such as earthquakes, tsunamis, floods or typhoons) can cause physical damages, including the destruction of buildings and infrastructure, and create enormous amounts of construction waste (Karunasena, Amaratunga, Haigh, & Lill 2009). The earthquake in Nepal in April 2015 generated construction waste and rubble consisting of bricks, stones, concrete blocks, tiles, cement, concrete, steel bars, wood, steel pipes and tanks, polyvinylchloride (PVC) pipes and tanks, electrical wires and cables, and broken glass pieces (Gautam & Chhetri 2016). The wastes resulting from disasters can be managed using four steps of pre- and post-disaster waste

[27] Key informant interview, KMC Environment Management Department, 12th May 2019

management strategies. These four steps are prevention and preparedness as pre-disaster waste management strategies, as well as removal and recovery as post-disaster waste management strategies (Memon 2016).

The earthquake and the subsequent Indian Blockade from September 2015 to March 2016 (whereby India hindered the entering of trucks, particularly fuel trucks, into Nepal) caused a sense of fear among the citizens of the Kathmandu Valley. The earthquake drastically affected parts of Kirtipur, where almost all of the old houses were damaged. According to the Centre for Integrated Urban Development (CIUD), one of our selected field sites, Ittagol, a neighborhood in Kirtipur, was among the hardest hit areas. 106 out of the 196 households in Ittagol were directly affected by the earthquake displacing many local residents (CIUD 2015). Our interviews with households in Kirtipur confirm that those who have access to agricultural land were partly able to manage household waste. However, all households faced problems with the building waste (ruins) of the earthquake. No waste was collected during the crisis of Indian blockade.

> *"More than focusing on managing wastes, people were concerned about their lives at that time."- (IDI, Housewife, 32 years, Tyanglaphant, Kirtipur, April 2019)*
>
> *"At that time (during crisis), people used to throw the wastes in a nearby jungle. Even we were compelled to throw the wastes outside at that time."- (IDI, tailor, 40 years, Tyanglaphant, Kirtipur, April 2019)*
>
> *"During the earthquake, I realized that if people lack humanity, then no matter how much we educate them, they will never change – because I observed that people threw wastes wherever they stayed during the earthquake."- (IDI, Housewife, 32 years, Teku, May 2019)*

All private waste companies saw the necessity to collect wastes during the crisis. Since many people resided in temporary settlements after the earthquake, private companies working in SWM, such as Clean Nepal, came forward to collect waste free of cost. In Kirtipur, furthermore, KWMS asked the municipality for a bulldozer to clear the rubbles and ruins from the earthquake. KWMS was also able to collect household waste during Indian Blockade of 2015 as they have a fuel storage at their recovery center where 200 liters of fuel were kept as a backup.

"At that time, people were staying in temporary settlements. Some of them managed the wastes on their own. We collected the wastes from the temporary settlements free of cost... For 3-4 months, we provided free services. We collected the wastes from the households in Panga, Kirtipur. I believe there were about 200-300 households. We pressurized the households to manage the biodegradable wastes on their own... During the Indian Blockade in Nepal, the National Trading Corporation (a dedicated body created by government to make goods at a relatively cheap price, especially at the time of festivals and crisis) had given the priority in providing fuel for the press (media) and waste vehicles."- (Key Informant Interview, KWMS, Kirtipur field, 16th April 2019)

"During the earthquake of 2015, all the wastes were mismanaged. We were the only ones who, without any support from the municipal waste workers, who, went around the community in order to make people aware of the infestation of communicable diseases...We didn't want anyone to get infected with any kind of diseases. Thus, we collected the wastes at least once a week. I think 3-4 days after the earthquake, we were able to collect the wastes."- (Key Informant Interview, Clean Nepal, Tyanglaphant, Kirtipur, April 2019)

The crisis period also proved to be very challenging for the scrap dealers since they could not find suppliers to transfer the recyclables and had to sell them to local collectors at a very low price. The waste chain was different during the crisis in terms of waste generation (households produced less waste because packed foods were not available because of the blockade), segregation at households was practiced less as they were mostly relying on their own goods so no need of segregation, collection was hampered (because there was less waste produced), transfer was less frequent, and recycling was more.

"We had a stock of more than 100 tons of recyclables. The rate was cut to half of 100 tons. We had to sell the recyclables at loss. At that time, a lot of recyclable wastes were generated ranging from metals, tins, etc."- (IDI, Scrap dealer, 46 years, Teku, 12th May 2019)

Since the earthquake of 2015, several new organizations emerged and started working in SWM whereas few were started slightly before the crisis. Some of the noticeable ones are: a) Nepal Pollution Control and Environment Management Center, b) Kirtipur Waste

Management Service (KWMS), c) Clean Nepal, d) Sirjansil Batabaran Samrakshan Kendra (Innovative Environment Conservation Center), e) Nepal Swachha Batabaran Sirjana Kendra (Nepal Clean Environment Innovation Center) and f) Organic Life. All of them are actively engaged in SWM in Kathmandu Valley. Likewise, some social enterprises such as Blue Waste to Value, Khaalisisi, Doko Recyclers, Hatti Hatti, Tyre Treasures, Dhasoo are creatively engaged in SWM in Kathmandu valley.

8. Gender and waste management

In Nepal, women hold the main responsibility for waste management at the household level. A study conducted in the city of Bharatpur in the Kathmandu Valley, for example, showed that over 80% of the wastes from the household are managed (segregated and disposed of) by women. On average, a woman spends about 30 minutes a day on waste management activities such as separation and disposal after every meal (Rai, Nepal, Khadayat, & Bhardwaj, 2019). Our qualitative interviews largely confirm the predominant role of women in waste management at the household level, but they also point to some nuances in the gendered division of tasks and decision-making, as the following quotes indicate.

> *"Managing wastes are a part of household work which is usually carried out by women. It feels very odd to ask my husband to throw the waste... there are men who brings out the waste because some of them live with their brothers and sisters and some of them live with their friends and some might be husband and wife. Therefore, whoever is free and has time takes out the garbage"- (IDI, Female, Tyanglaphant, Kirtipur, April 2019)*

> *"Usually, it is the women who segregate waste at home. Though there is no fixed role of women to segregate the wastes, all our family members engage in the management of wastes"- (IDI, Male, Chaarghare, Kirtipur, April 2019)*

> *"I think usually, it is the women who are more active in practicing waste management. However, the main idea behind the management of waste lies in men... Women usually do not have the knowledge about managing the wastes...women are engaged in the day-to-day activities especially in the kitchen work. Therefore, women are usually responsible for carrying out all the works whereas men guide them about how to manage the wastes coming out from the house"- (Key Informant Interview, Female, Tyanglaphant, Kirtipur, April 2019)*

"Both men and women are responsible for taking out the garbage. Sometimes my wife takes out the garbage, sometimes my daughter-in-law takes out the garbage and sometimes I myself take out the garbage"- (IDI, Male, Thambahal tole, Kirtipur, April 2019)

"I believe the engagement of men is greater in separating the waste... My mother separates the biodegradable waste (kitchen waste) from non-biodegradable waste and my father takes it to make compost"- (FGD, Male, Tyanglaphant, Kirtipur, April 2019)

Waste management at the household level is often the women's responsibility because of its ties to other traditionally female, domestic responsibilities such as cooking that generates biodegradable wastes ((UNEP-IETC-GRID-Arendal, 2019).

"We are still following the age-old traditional practice where women are responsible of cleaning. Though it is the responsibility of every person, I think women are often dominated due to which they are compelled to do all the chores like washing clothes and cleaning"- (IDI, Female, Tyanglaphant, Kirtipur, April 2019)

…women are engaged in the day-to-day activities especially in the kitchen work. Therefore, women are usually responsible for carrying out all the works …"- (Key Informant Interview, Female, Tyanglaphant, Kirtipur, April 2019)

The women's responsibilities are also prominent in community-based waste management initiatives. For example, a group of 16 housewives from Lalitpur (another city in the Kathmandu Valley) promoted in 1992 environmental awareness and waste segregation at source. This initiative led to the establishment of the Women Environment Preservation Committee (WEPCO) in the same year. WEPCO operates locally in close collaboration with local communities in the area of rooftop gardening. By 2004, WEPCO offered waste collection and segregation services to 1000 households and managed 4-5 tonnes of waste daily (WEPCO, 2015) from Kathmandu and Lalitpur. WEPCO is still active in these areas.

Mostly, women are engaged in the informal waste sector; only a few women are employed in the formal waste sector by municipalities or private companies (see table 3). In the informal waste sector, a significant wage gap is prevalent between men and women. Female waste segregators at Teku transfer station, for example, pointed out that they are paid less than their male counterparts. Female waste segregators earn rupees 350-400 per day and male earn 700-800 rupees. This difference in earning is related to the

accomplishment of work requiring physical strength (e.g., carrying, loading and unloading heavy piled garbage). Men are usually responsible for bringing waste from different sources to the waste collection and segregation centers (or transfer stations) whereas female are responsible for the segregation of wastes. It was frequently reported by the respondents that men are generally responsible for waste collection – whether by the municipalities, by officially contracted private companies, or by informal waste hawkers.

Generally, one person segregates around 50 kg of recyclable wastes in a day by working 8 hours. Regarding the number of male and female staff working in the waste collection center, around 8-10 female work as waste collectors/segregators against 20-25 men. The waste segregators at Teku waste collection center were given trainings through the European Union (EU) funded Poverty Reduction of Informal Workers in Solid Waste Management Sector (PRISM) project (Teku field visit, 12 May 2019).

Table 3: Waste collection workers by gender (N=402)

Types of Waste	**Female**		**Male**		**Not Specified**	
	N	%	N	%	N	%
Mixed Waste	4	1	380	94.5	18	4.5
Kitchen Waste	25	6.2	194	48.3	183	45.5
Plastic	4	1	366	91	32	8
Polythene	4	1	349	86.8	49	12.2
Paper	7	1.7	326	81.1	68	16.9
Cardboard	6	1.5	275	68.4	120	29.9
Glass	2	0.5	299	74.4	101	25.1
Metal	1	0.2	287	71.4	114	28.4
Electric (Wires, Battery)	1	0.2	251	62.4	150	37.3
Electronic	1	0.2	229	57	172	42.8
Medical Waste	1	0.2	267	66.4	134	33.3

Source: Field Survey 2021

About 80-90% of the waste collectors for collecting all types of waste such as mixed, kitchen, plastics, polythene, paper, cardboard, glass, metals, electric, electronic and medical waste are male.

9. Conclusions

The Kathmandu Valley, which is currently following a linear method of waste collection and disposal, lacks sustainable waste management practice. The traditional method of composting biodegradable waste such as *Saaga* and *Naugaa,* which once were prevalent, are slowly disappearing with the increase in population, urban sprawl, rising standards of living, changes in food habits that imply increased use of plastics, tins, metals and paper. Even though plastic wastes have become the cause of concern in the solid waste management sector, the biodegradable waste still comprises the largest percentage in the waste composition within the Kathmandu Valley. The country also lacks a sanitary landfill site.

Kathmandu Valley faces continuous challenges in managing solid waste due to a growing population leading to the generation of more wastes, changing lifestyles contributing to the use of plastics and other non-biodegradable materials, as well as increasing density and urban sprawl that reduce open spaces that can be used for decentralized waste management. On the one hand, there is a lack of a holistic SWM strategy of the government. Furthermore, only a few municipalities in the Kathmandu Valley provide enough appropriate space for waste segregation. If there is no segregation provision, no possibility for reuse, recycle and reduce (RRR). The government fails to establish recycling centers and to provide required support to the private sector for establishing recycle centers. The single focus on building a new landfill site without promoting reuse, recycle and reduce (RRR) measures will not adequately address the growing challenges of SWM in the Kathmandu Valley.

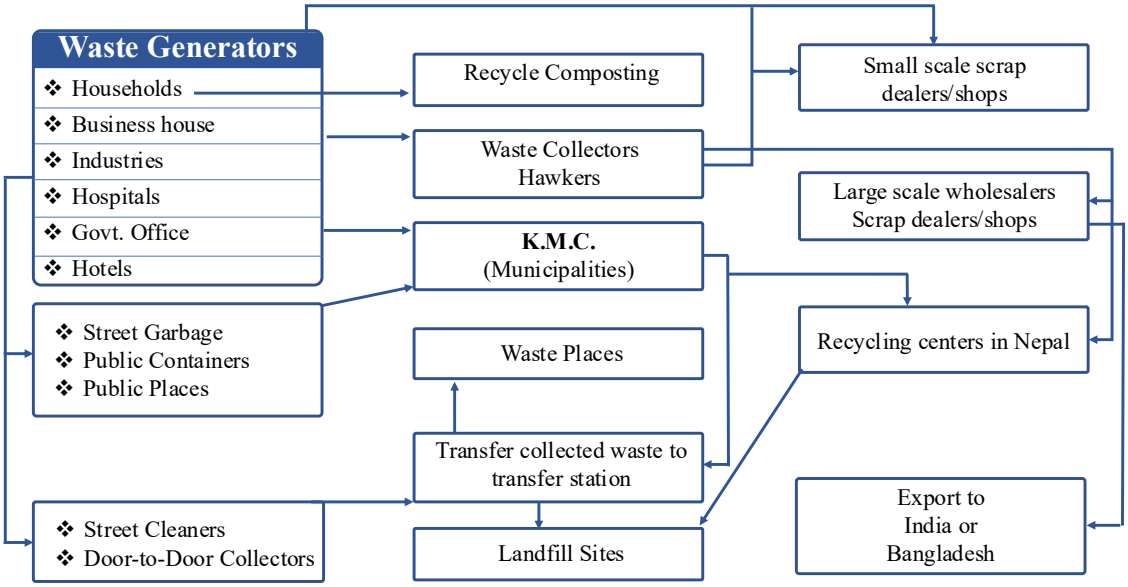
Recently, some local institutions have emerged and become active in SWM. For example, women waste workers are organized in a cooperative operating since 2014 the Sanyukta Sarsafai Jaagaran Savings and Cooperative Pvt. Ltd. All the members of this cooperative are formally employed. Similarly, several private companies and social enterprises have recently become active in SWM in the Kathmandu Valley. If there is conducive strategy to support women in awareness rising and mobilization, SWM would be far better. However, the respondents explain that these new initiatives are not getting full support from the government. If they were better supported (through legal provisions, space for segregation and recycling, etc.), they could realize their potential and substantially contribute to urban waste management in the Kathmandu Valley.

The conclusion of Maskey (2018) is that the first and fundamental step to solve municipal household solid waste problem is the segregation of waste at source and collecting it separately (Maskey, 2018). Waste segregation should be considered as a crucial first step in the overall waste management process as it leads to better diversion of recyclable waste when categorized into biodegradable and non-biodegradable wastes (Maskey & Singh, 2017). Waste segregation is also termed as the first phase out of 3 phases in waste recycling where the waste generators separate wastes having market value such as papers, bottles, plastic, tin, glass, metal, old clothes, shoes, etc. to sell it to the street hawkers (Gautam P. 2011).

One of the major concerns at present is the lack of cooperation and coordination between the federal, provincial, and local government in SWM. In Nepal, SWM relates to all three tiers of government: (the Federal government is responsible for law and policy, the provincial government for infrastructure and the local government for daily operations. However, the three tiers of government are not fully working together to address the growing urban SWM challenges.

Further, there is lack of coordination and cooperation even within the local governments of the 18 municipalities in the Kathmandu Valley. Hence, the waste governance system is victim of noncooperation between the local government and lack of coordination between the three tiers of government (federal, provincial and local). In addition, intervention of high-level government body, Investment Board of Nepal which is responsible for coordinating between the investors and the municipality for the management of wastes at Sisdol landfill site has also blocked the initiatives led by these municipalities and caused discrepancy between actors at different levels. This hinders the formalization of waste workers and the integration of their work capacities in the formal governance structure. It also constrains the provision of the required space for segregation and for recycling centers. Finally, laws and regulations that would create appropriate incentive structures for more effective waste management are missing.

Figure 14: Recyclable wastes flow in Kathmandu Valley



Source: Own fieldwork, Luitel and Khanal 2010, Ito 2019

Figure 14 shows the formal recyclable waste management. The formal waste chain (managed by KMC, and other municipalities etc.) starts with collection of waste from primary waste generators like households, business houses, industries, hotels and restaurants, industries, hospitals, government offices, streets and public places and then it goes to Recycling centers. From the recycling centers either it goes to land field sites or to India. Similarly, the informal waste chain starts with the hawkers and cycle pickers collects wastes from primary waste generators and provide to small scale scrap dealers and shops or big recycling centers or large-scale wholesalers and from there wither it goes to India and Bangladesh or to the land field sites.

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