Himalayan J. Soc. Sci. & Humanities ISSN: 0975-9891 https://doi.org/10.51220/hjssh.v20i1.1
Vol. 20, (2025) 1-8

Municipal Solid Waste Management of Leh Town, India

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Received: 22.09.2025; Revised: 24.12.2025; Accepted:25.12.2025

Abstract: Waste generation is a result of urbanisation, economic development and population increase. Over the years excess growth in waste generation and improper waste management has affected public health, life of flora and fauna, climate change, and has a significant influence on inhabitants' quality of life. The quantity and complexity of waste produced determine the waste management system in each location, which is also influenced by cultural, climatic, economic and institutional factors. The present paper aims to study the Leh Solid Waste Management System. For primary data simple random sampling has been used and sample includes total number of 100 households from 13 Municipal Wards. Data were collected using schedule and direct field observation. Findings indicate that a: The increase in waste generation is a result of rapid population growth, especially during the summer owning to tourists and migrant labourer. b: Local's changing lifestyle and behaviour, which call for more packaged and processed goods, have increased dry waste consumption while decreasing time for recycling and reuse. Hence to decrease waste generation and boost treatment, the Municipality of Leh still needs to accelerate the implementation of an efficient waste management system.

Key words: Solid Waste Management; Leh Town; Material Recovery Facility (MRF)

Introduction

Municipal Solid Waste Management (MSWM) has emerged as one of the most pressing and unavoidable environmental challenges across the globe. Municipal solid waste refers to the unused and discarded by-products of human activities arising from households, commercial establishments, institutions, and public spaces. The generation of municipal solid waste is closely linked to population growth, as an increase in population inevitably leads to a corresponding rise in waste generation. However, the quantity and composition of waste are not uniform across regions; rather, they are strongly influenced by the income levels and consumption patterns of countries.

Globally, approximately 2.1 billion tonnes of municipal solid waste are generated each year, and this figure is projected to rise to 2.59 billion tonnes by 2030 and further to 3.40 billion tonnes by 2050. High-income countries (HICs), despite accounting for only about 16 percent of the world's population, generate nearly 34 percent of global waste, whereas low-income countries (LICs), with around 9 percent of the global population, contribute only about 5 percent. By 2050, daily per capita waste generation in HICs is expected to increase by about 19 percent, while low- and middle-income countries are projected to experience a much sharper rise of approximately 40 percent or more.

Income level also significantly influences waste composition. High-income countries tend to generate a larger proportion of dry and recyclable waste, reflecting higher consumption of packaged goods. In contrast, low- and lower-middle-income countries such as India, Pakistan, Afghanistan, Nepal, Bangladesh, and Myanmar generate predominantly organic or food waste, accounting for nearly 56 percent of total waste, compared to around 36 percent in HICs. Waste collection efficiency also varies considerably. In North America, which falls under the HIC category, waste collection rates are close to 100 percent. In contrast, collection rates in lower-middle-income countries average around 51 percent, and drop further to about 39 percent in LICs. Rural areas in LICs are particularly underserved, with waste collection falling from 48 percent in urban areas to just 26 percent in rural regions.

Disposal and treatment practices show equally stark disparities. Globally, about 40 percent of waste is disposed of in landfills, 11 percent is incinerated, 33 percent is openly dumped, and 19 percent undergoes material recovery. In LICs, nearly 93 percent of waste is openly dumped and only 3 percent reaches landfills, whereas in HICs, about 39 percent is landfilled, 22 percent is incinerated, and only 2 percent is openly dumped (World Bank, 2016).

The management of solid waste has evolved significantly over time. Early human settlements disposed of waste by dumping it in nearby fields or water bodies. With the Industrial Revolution in the 19th century, cities began developing formal waste management systems, including landfills and incinerators. By the mid-20th century, Integrated Solid Waste Management (ISWM) emerged, emphasizing waste reduction, recycling, composting, and advanced treatment technologies. In recent years, the focus has shifted toward sustainability and the circular economy, aiming to minimize waste generation while maximizing resource recovery and environmental protection.

Study Area

The study area for this research is Leh Town. Leh is situated in Ladakh. In 2019, Ladakh was declared as Union Territory diving it into two districts; Leh and Kargil. The total area of Ladakh is 59,146 sq.km as per census 2011. District Leh comprises of 45,100 sq.km of total area from which Leh town covers around 9.15 sq.km area. The Municipal committee Leh has extended its serivice to 13 wards called the municipal boundary. These wards include houses, commercial building, institutions, shops, industries, hospitals, agriculture fiels. Waste management in these wards falls under the municipality service. The total poputalion from these wards is 34,798 with 7263 households. Ladakh has two waste dumping sites, the old dumping site is called Bombgarh which is now declared as legacy waste and the new duping site is a Material Recovery Facility (MRF). Currently the old site is under cleaning and all the waste dumping and treatment is carried out at new site (MRF). MRF is situated at an isolated place away from settlements bounded by mountains. However, it is only 1 km away from the immediate settlements and 3 km from main town.

Objective

The main objective of the research is to study the Leh Municipal Solid Waste Management System, identify various gaps and suggest suitable measures to improve the management.

Methodology

Using simple random sampling, 100 Household samples have been taken from 13 wards. Participant observation, narratives, oral histories, focused group interviews and structured interviews are some of the techniques used to acquire primary data. Further, for Secondary data reports, articles, journals and local newspapers are used.

Results and Discussion

The type of waste generated in Leh town is mostly dry waste (Dry waste comprises both hazardous and non-hazardous waste in leh) mainly during summer months. The quantity of waste in year 2022 increases as high as 272 tonnes per month during summer and eventually falls as winter approaches. The population of leh varies drastically during summer and winter seasons which reflects the waste generation. During summer, the waste generated by locals per day (kg) is around 15,659 which declines to 8973 kg per day. The tourists and migrant labourers generated 5484 and 17500 kg per day during summer months which also declines to 120 and 100 kg per day during winter months (Odsal, 2021). This is mainly because of the high tourists and migrant population during summer. Thus, population growth and waste generation has positive correlation.

Ward 1 and 2: Gonpa/ Gangles and Sankar/ Yourtung

Ward 1 has the lowest population with 175 households and most of the land is used for agriculture purposes. It is infact one of the cleanest wards with plenty of lush flora and flowing river streams. Recently, this ward has drawn locals' attention for picnics, especially during summer resulting in open dumping along waterways, defiling and polluting the area. In ward 2, there is fewer open dumping and is also agriculturally active area but has few concentrations of hotels and guest houses. This ward doesn't have much issues with open dumping. This ward also has migrant labour population but in very less number.

Ward 3, 4 and 5: Changspa/Karzoo, Tukcha and Shenam

These wards have large number of hotels and guest houses therefore, making it a tourist concentration area. These wards also face open dumping mainly in the river streams during the night by the tourists and taxi's while cleaning their vehicles. However, active community clean up drive takes place once or twice a year, which encourages the locals to be more conscious in open waste dumping.

Ward 6 and 7: Skara and Skalzangling

These two wards, other than household population also have maximum number of industrial unit's. Thus, most of the hazardous and industrial waste is collected by municipality from these wards. There is an active involvement of informal waste collectors in these two wards for collection of industrial waste.

Ward 8, 9 and 10: Murtsey, Housing Colony A and Housing Colony B

Wards 8, 9, and 10 have a concentrated population that is entirely residential. However, many people in ward 8 don't live there all year round since they frequently travel back to their hometown in the winter and summer. This contributes to a lack of community responsibility for organising clean-up campaigns and keeping the community or the neighbourhood clean.

Ward 11,12 and 13; Maneytselding, Skampari and Zangsti Skyanos

Ward 11 and 13 consists of market area as well as residential area. The former has high concentration of hill settlements and later has concentration of hotels and guest houses. Ward 12 is also a residential area but this ward has seasonal migrant labour population. Most of the open dumping is seen in this ward as labour's show complete carelessness in disposing waste in suitable bins. The community involvement is also severely lacking. At household level maximum waste generated from different wards per week is between 5-10 kgs, quantity of waste also depends upon the number of family members in the household, especially infants. During the survey it was noticed that, quantity of waste increases between 10-20 kgs per week in families with new born baby due to usage of diapers.

As far as composition of waste is concerned, all wards generate both wet and dry waste. The wet waste consists of mainly recyclable food/green waste and dry waste consists of both recyclable and non-recyclable. However, Ward 1,2,3,4 and 6 recycle mostly food waste at source by compositing or cattle fed and ward 7, 8, 9, 10, 11, 12, 13 do not recycle which also implies that maximum waste is generated from these wards as both wet and dry waste is given for collection.

Waste Collection and Transportation

The Municipality Leh has extended its service of waste collection into 13 wards. Waste collection frequency and timing varies seasonally and ward to ward depending on the population of the ward and quantity of waste generated. There are 17 vehicles for waste collection out of which 7 are advanced refuse compactor, 4 open tipper and rest are small vehicles. Separate vehicles are dedicated for wet and dry waste collection, but they may change their shifts according to the need of the situation. The process of collection and transportation is sometimes affected by the transportation routes as Leh has narrow steep roads, which impacts the quantity of waste collection. Although the waste collection has improved from past years but there is still a need for more advanced vehicles and effective planning. The municipality as of now (March,2023) has 104 sanitation workers out of which there are 50 females and 54 males allotted in 13 wards, these workers consist of sanitary supervisor, sanitation workers (safai-wala) and drivers.

There are huge improvements brought up by Municipal Corporation (MC) in waste collection service, especially removing the secondary storage bins from wards, markets and from collection points. Thereby making the collection service primary and Door-to-Door (DTD). This has shown visible results especially in market areas and roads by maintaining cleanliness and it had also helped prevent stray dogs and other animals from consuming hazardous wastes. But Municipality still need to pick up its pace in street cleaning service for picking up open dumping wastes. Although every ward has few open dumping spots but due to active contribution from people in community cleaning, ward 1,2,3,4,5 and partly 6 and 13 are in much better conditions than ward 7,8,9,10,11 and 12. Open dumping portraits a very poor picture of the area and also questions the management system, not to forget its negative impact on health and environment. Thus, to reduce this practice, MC needs to pay more attention on increasing its manpower and service frequency. Since, ward 1,2,3,4 and 6 mostly generate dry waste such as paper/cardboard and plastics as these wards are actively involved in agriculture and wet/ food waste are recycled as compost or cattle fed, therefore they give mostly dry waste for collection. And ward 7, 8, 9, 10, 11, 12, 13 as per waste generation, give both wet and dry waste. When it comes to suitability of time for waste collection, 38 percent of people finds waste collection time not suitable and 62 percent of people finds it suitable. As per the people from ward 7, 8, 10,11 and 12 the collection timing is not fixed and it is not suitable for the employees, also the DTD service is not 100 percent.

Waste Disposal and Treatment Site (Material Recovery Facility, Leh)

Leh until 2019, the disposal and treatment were carried out at a place called Bombgarh, for many years it was the main disposal area and in 2019 it was declared as Legacy Waste leading to the formation of new plant, MRF. Since then, MRF is under functioning and all the MC waste are disposed here. This site is bounded by mountains and almost a km away from immediate settlements. As of now there are one Picking belt, two Trommel machine and conveyor belt to deeply segregate, for less than 50mm waste, three Multi-Layered Plastic (MLP) shredder machine and four Glass shredding machine and two compressors for cardboard and Low-Density Polyethylene (LDPE) waste and one Sanitary landfill.

Process of Waste Dumping and Treatment

The current Facility receives both wet and dry waste and treatment is carried out for both. The disposal process of wet and dry waste is same. The waste is collected from source, transported to the Material Recovery Facility. At MRF it first goes through the weight check at weighing bridge and then the respective unloading stations.

Process of Wet and Dry waste Disposal

For the treatment of the waste, different process takes place for Wet and Dry waste

Wet Waste Treatment Process

The current wet waste plant capacity is 30 TPD and 2 Trommel machine are available for the process to take place. The waste is first manually segregated by the workers, separating any dry waste mixed with wet waste. The waste after being sorted manually is sent to a trommel machine by the conveyor belt for screening treatment. The rotating screen machine divides the MSW into two parts, materials larger than 50mm on the sieve and materials smaller than 50mm under the sieve. The materials larger than 50mm go through the magnetic separator to remove iron materials. The waste material that are smaller than 50mm are mainly organic matter that go through the hanging magnetic separator to separate iron materials. The remaining waste is organic waste that is piles up and kept for four to five days before being sent for composting. The in-vessel compost plant installed in the facility has a capacity of 10TPD with a shredder and heating vessel.

Dry Waste Treatment Process

The current waste treatment process for dry waste is the manual segregation of types of waste into and then to the compressors. The MLP, LDPE, Tins and Cardboards are the waste that goes into compressors to form bundles of each segregated waste. These bundles are sent to other cities to private companies to change into final products. As of now, the plant has treatment for only MLP, LDPE, Tins and Cardboards, Glasses, Clothes and Industrial wastes are segregated and kept aside untreated. There are more than 80 bundles of segregated products weighing more than 150 kgs each and glasses segregate weights around 60-70 tones. As of now, there is no treatment for wastes such as Sanitary Pads, Diapers and polyethene's**.**

The waste quantity varies drastically from summer to winter. This is mainly due to the population changed during seasons. The summer season has tourist and migrant labour population and eventually falls down during winter. The winter season also receives less waste because of the decrease in the local population. Due to extreme cold harsh climate during winter, most of the local people travel to nearby states. Owning to this reason, the quantity of waste varies. The DRY waste reaches as high as 272.4 Tonnes in the month of May and drastically decreases in the winter to 54.4 Tonnes during January. Similarly WET waste increases from 19.6 Tonnes in January to 95.8 percent during July which is the summer months. Overall, the quantity of dry waste is higher than wet waste.

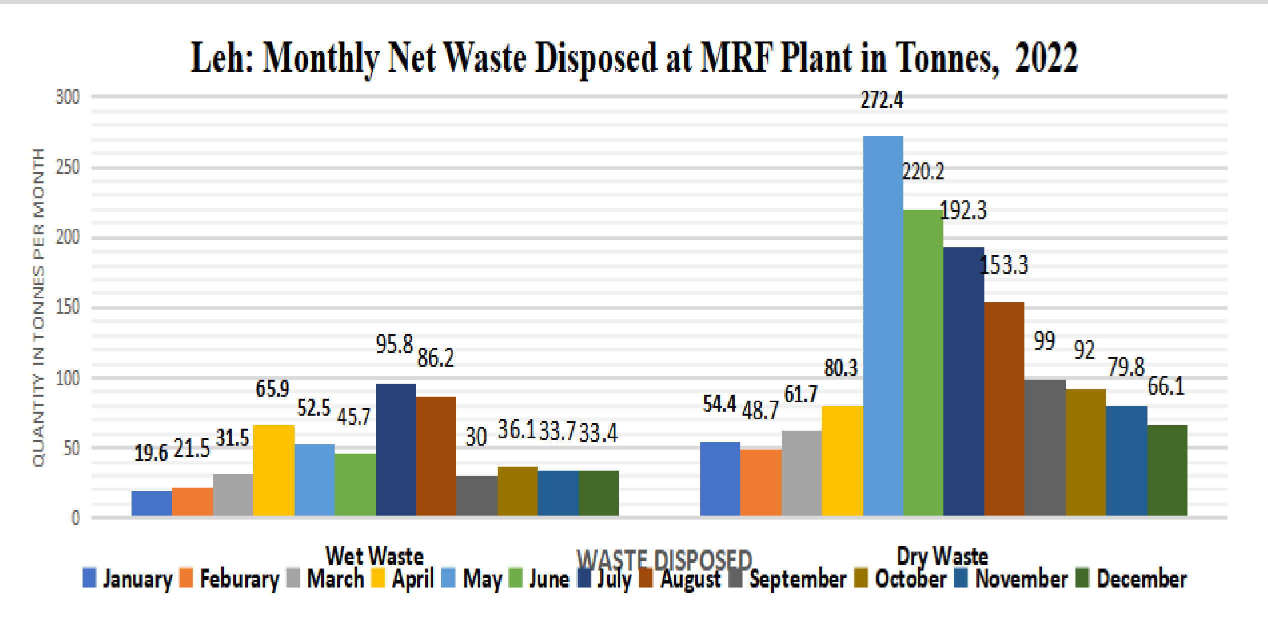

Fig 1; Monthly Net waste disposal at MRF plant in Tonnes (2022): Source: Field Work,2024

Factors Affecting the Waste Management Process in Leh Town

High Raised Boundary: Lack of high-rise boundary is one of the main factors affecting the process and treatment of the waste especially with dry waste. This leads to the feral dogs entering the plant crossing the boundaries and creating chaos of the segregated wastes as well the waste compiled for segregation. Another issue rises from low boundary is when the wind blows, it allows light weight waste to blow away and settles down at the mountains which further blows and chokes the river banks. **Rapid Tourism Growth:** Having a quality tourist is very important in order to minimise generation, efficient segregation at source and reducing open dumping of waste mainly in river streams. In 1974, Ladakh was opened for tourism and initially, in the early 80s and 90s, almost 90 percent of the tourists were foreigners. The late 2000s started attracting more tourists which led to influx from 50 percent to 80 percent domestic tourists with the total tourist arrivals increasing from 14,282 in 1982 to 2,79,937 in 2019. In 2019, 38,652 foreigners and 24128 domestic tourists visited Ladakh, exceeding its own population. Since 2011, the domestic tourists have been on the rise with 55,685 travellers visiting in 2010 to 241,285 in 2019 showing the compounded annual growth rate of 17.69 percent while foreign tourist arrivals show a growth rate of just 6.40 percent (Tourism Vision Ladakh). **Change in Lifestyles and Behaviour**: As much as tourism contributes to waste production, local waste production and composition also require attention. With the passage of time, people's eating habits shifted from eating organic foods to packaged and processed ones, which increased the dry waste production. For instance, in the past, cloth diapers were used for new born babies, which was safer, appropriate, and more sustainable, but today, the usage has completely shifted to using diapers. Traditionally locals used to actively participate in recycling, reusing, and consuming sustainable and little trash since that was the attitude they lived with. However, as lifestyles evolved and demanded more dry waste goods and less time for reuse and recycling.

Lack of Awareness and Ignorance: One of the factors leading to excess waste generation in Leh is because of lack of awareness and ignorance of people towards waste. Most of the people does not know what harm it could bring to the people and to the environment in long term if waste is not managed properly. While some are aware of the consequences but choose to ignore. Because Leh has slow onset process of waste turning into hazard most of the people either are not aware of the consequences or choose not to consider the consequences.

Wind & Weather Conditions: Leh has extreme weather conditions reaching to maximum 30° C during summer to minimum -25 ° C during winter. This leads complication to workers in segregating waste under such conditions. The availability of technology can affect the efficiency and effectiveness of waste treatment and disposal. For example, newer technologies may be more effective at reducing the environmental impact of waste disposal.

Conclusion

Ladakh has a very slow onset process of developing any phenomena into a hazard and to a disaster. One of the ongoing hazards the world is witnessing is the climate change and Ladakh is a part of it and current scenario of waste in Leh is also adding to the climate change. Considering the fragile ecology of Ladakh, the excess waste generation and improper treatment is a severe issue. The location of MRF of Leh Town is considered a flood prone area and it is also constructed in proximity to a river stream. Although the stream is inactive but in case of any severe change in weather conditions which Ladakh is facing already, this plant might be at high risk of flood. In present, continues burning of wastes for days leading to release of toxic smoke in the air contributing to environmental hazard. The protection Kit provided to workers is not suitable to them. Thus, they use self-bought gears such as scarfs and shoes which does not provide safety during working hours. The workers also lack awareness about health hazards they are exposed to and no medical kit is available neither medical insurance. In addition, MRF plant has more than 400 feral dogs consuming different types of wastes. From consuming sanitary pads and diapers to medical waste, dead animals, these dogs have become dangerous and life threatening.

Therefore, proper planning is essential for effective and efficient waste management which can include emergency plans, annual surveys on quantity of waste generated and maintaining transparency between local government and its people regarding the material recovery rates to allow public to go more sustainable towards waste generation and to develop future strategies and to identify gaps. Further, the Leh municipality can improve its management by providing Closed-circuit television (CCTV) at open dumping points, issuing more dustbins at household level, strengthening manpower and advanced vehicles can be opt to avoid spillage of wastes.

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