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Community Perception on Solid Waste Management in the Trans -Himalayan Region of Ladakh: A Research

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ABSTRACT: Solid waste management is an emerging concern around the world. However, solid waste management is one of the most inefficient services and its neglect leads to environmental pollution and health risks. The solid waste management approach is extremely inefficient in Ladakh. Land filling is one of the most widely used municipal solid waste disposal methods worldwide, since all waste treatment processes have residues that cannot be further reused or recovered and are eventually land filled.

The aim of this study is to characterize the waste production of tourist destinations in the union territory of Ladakh, which is facing serious pollution due to solid waste. However, the tourist accommodation sector is a major contributor to the city's solid waste production and a major challenge to the region's sustainable development. To date, very few scientific studies have been conducted to analyze the level of waste production. Therefore, the present study is a scientific attempt to estimate the scale, composition, quantity and temporal trends of solid waste generation at household level and tourism influencing waste generation.

The study assessed the involvement of local communities in waste management in Ladakh, data was collected using primary and secondary data methods, primary data was collected through an online questionnaire, and direct observation through a series of questions with local communities. Sample size of 100 household among the community was selected randomly on the basis of different income group. The secondary data was collected through journals, articles, Municipal Corporation of Ladakh and research papers.

Results indicate that the amount of municipal solid waste collected varies widely by number of visitors visiting Ladakh. Results also indicate that lack of collection of waste at household and community level is a major problem, another major issue is that tourism in Leh is at the peak currently so the pollution of land, air and water, there is apathy and lack of awareness among different stakeholders. As people lead to more modern and affluent lives and are moving away from traditional foods and customs, further efforts are needed to educate and raise awareness among community members about their role in solid waste management and also require strong environmental committees to increase community participation at the municipality level.

KEYWORDS: Solid waste management, land filled, pollution, community, stakeholder, municipality.

I. INTRODUCTION

The increase in industrialization and urbanization has led to problems such as increased energy demand, generation of bulky waste and environmental impact. As a result, the implementation of an effective solid waste management strategy is gaining momentum. The urgency becomes clearer because of the 17 sustainable development goals, most of them and their objectives are directly linked to solid waste management. Public awareness is essential for good waste management as well as social and demographic issues.



In contemporary society, many everyday objects are designed to be used and discarded. Disposable packaging and disposable items define many of our consumption habits. The increasing availability of disposal facilities has further raised the question of how to get rid of all this waste. Solid Waste Management is unwanted or unnecessary solid matter generated from a combination of residential, industrial and commercial activities in a given area. It can be classified according to its origin (domestic, industrial, commercial, construction or institutional); according to its content (organic substances, glass, metal, plastic paper, etc.); or by degree of hazard (toxic, non-toxic, flammable, radioactive, infectious, etc.). Solid waste management reduces or eliminates negative impacts on the environment and human health, supports economic development and improves quality of life. There are several processes involved in effective waste management for a municipality. These include monitoring, collection, transport, processing, recycling and disposal.

Global Solid Waste Scenario:

The world generates 2.10 billion tons of municipal waste a year, of which at least 33% is not managed in an environmentally friendly way. The global amount of waste generated per person per day averages 0.74 kilograms, but varies widely between 0.11 and 4.54 kilograms. Although they represent only 16% of the world's population, high-income countries produce about 34% or 683 million tons, of the world's waste. Global waste is expected to reach 3.40 billion tons by 2050, more than double the population growth over the same period. Overall, there is a positive correlation between waste generation and income levels. Daily waste per capita in high-income countries is expected to increase by 19% by 2050, compared with low and middle-income countries, where an increase of about 40% or more is expected. The total amount of waste generated in low-income countries is expected to more than triple by 2050. The East Asia and Pacific region generates the most waste in the world, at 23%, and the Middle East and North Africa region produces the least in absolute terms, at 6%. However, the fastest growing regions are Sub-Saharan Africa, South Asia, the Middle East and North Africa, where by 2050 the total amount of waste generated is expected to more than triple, double and double. In these regions, more than half of waste is currently landfilled, and the waste growth trajectory will have broad impact on the environment, health and well-being, thus requiring actions to be taken (Worldbank, 2020).

Currently, the top three producing countries of municipal solid waste are the United States accounting for 258 million tons, China accounting for 220 million tons, and India accounting for 168 million tons. Five developing countries, namely China, India, Brazil, Indonesia and Mexico, are among the top ten producers of municipal solid waste due to rapidly growing large urban populations and adoption (Worldbank, 2020). The mode of high waste consumption is similar to that in developed countries. Developed countries tend to generate much higher amounts of municipal solid waste per capita than developing and third world countries, as the rate is contingent on a nation's economic and social prosperity (Fig1).

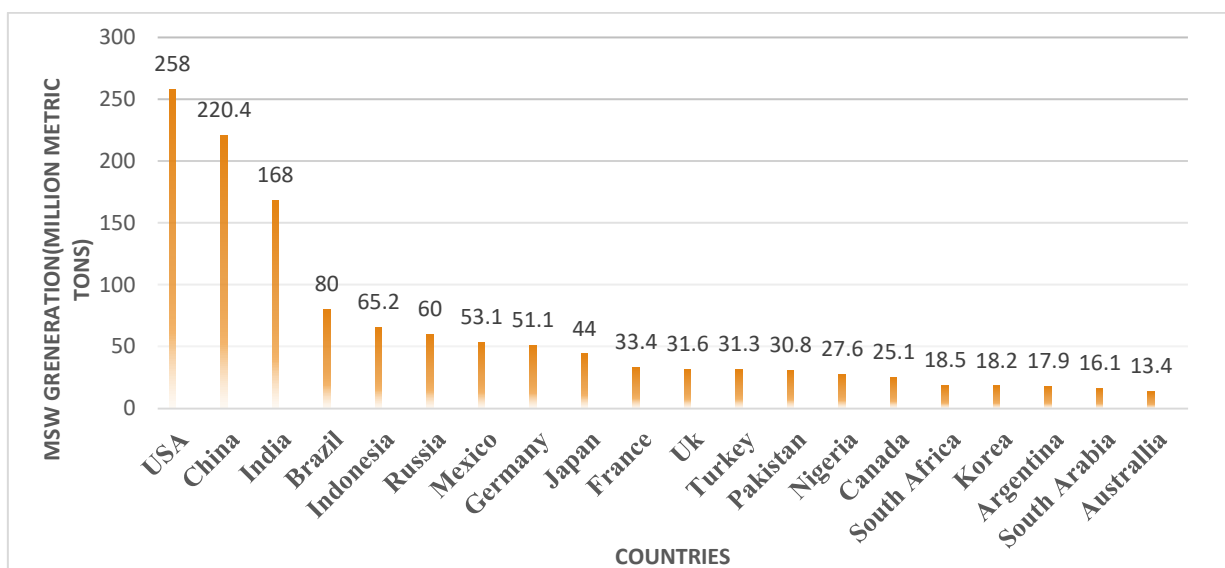


Figure1: Worldwide generation of municipal solid waste (Worldbank, 2020).



Indian Solid Waste Scenario:

Waste management in India is the responsibility of the Union Ministry of Environment, Forests and Climate Change (MoEF&CC). In 2016, ministry published the Solid Waste Management rules, which replaced the municipal solid waste rules of 2000. This national policy plays an important role in the initial recognition and participation of the informal sector (recyclers) in the waste management process. India generates 62 million tons of waste every year. Approximately 43 million tons (70%) are collected, of which approximately 12 million tons are treated and 31 million tons are deposited in landfills (GoI, 2016).

Among the cities, Delhi produces highest waste followed by Mumbai and Kolkata (Table 1).

In the case of India, sustainable Solid Waste Management would provide 9.6 million tons of compost that could have resulted in a better agricultural yield, energy equivalent to 58 million barrels of oil from non-recyclable waste 6.7 million tons of secondary raw materials to industries in the form of recyclable materials, and livelihood to the urban poor (Paulraj et al., 2019).

Table 1- Top six municipal solid waste generating cities

S.NO	Cities in India	Population (million)	Waste Generation (Tonnes per day)
1	Delhi	19.1	9260
2	Mumbai	20	8600
3	Kolkata	14.7	6000
4	Chennai	10.1	5000
5	Bangaluru	10.4	4200
6	Hyderabad	9.1	4000

Source:(GoI,2016)

Waste management in India, administration and regulation is governed by the Ministry of Environment and Forests and Climate Change (MoEF&CC), the Ministry of Urban Development (MoUD), the National Environmental Engineering Research Institute (NEERI), Central Pollution Control Board (CPCBs), State Pollution Control Boards and ground-level implementation responsibility lies with Urban Local Bodies.

The major steps taken by government of India for solid-waste management in India during the last two and half decades includes- National waste management committee: The main objective of the committee constituted in 1990 was to identify the recyclable contents in solid waste picked up by rag-pickers. Strategy Paper: A manual on solid waste management has been developed by the Ministry of Urban Development (MoUD) in collaboration with the, the National Environmental Engineering Research Institute (NEERI) in August 1995. Policy Paper: the Ministry of Urban Development (MoUD) and the Central Public Health and Environmental Engineering Institute prepared a strategy paper for the treatment of wastewater, appropriate hygiene, solid waste management (SWM), and efficacy in a drainage system. The master plan of Municipal Solid Waste: A stratagem was formulated by the combined efforts of the Ministry of Environment and Forests and Climate Change (MoEF), Central Pollution Control Boards (CPCB), and Urban local body (ULBs) to develop a master plan for solid waste management with an emphasis on biomedical waste. In 1995, a High Powered Committee was constituted under the Chairmanship of Dr. Bajaj, to encompass a long-term strategy for the Solid Waste Management using appropriate technology (GoI,2015).The policy initiatives were summarized in (Table 2 and 3).



Table-2 Waste Management Initiative in India

SL.NO	Policy and Regulation	Legislative and Policy
1	Institutional Framework	Central Level. State Level. Other Organizations/Associations.
2	Legal Framework	74th Constitutional Amendment Act, 1992. Management and Handling Rules. Environment (Protection) Act, 1986. Water (Prevention & Control of Pollution) Act, 1974. Water (Prevention & Control of Pollution) Cess Act, 1977.
3	Policy Initiatives	National Urban Sanitation Policy, 2008. National Environment Policy, 2006. National Conservation Strategy and Policy Statement on Environment and Development, 1992.
Key Government Programmes		
4	JNNURM	Program meant to improve the quality of life and infrastructure in the cities.
5	MNRE's Waste-to-Energy Programmes	Integrated Low Cost Sanitation Scheme. National Biogas and Manure Management Programmes.

(GoI, 2015)

Table 3. Solid Waste Management Rules in India

Sl. No	Waste Management Rules	Implementation year	Purpose
1	Hazardous Waste Rule	1989	It is to control, manage, and handling of hazardous waste.
2	Biomedical Waste Handling Rule	1998	It is related to control, manage, and handling of waste generated from the hospital, super-specialty centers, and nursing homes.
3	Municipal Waste Management & Handling Rule	2000	These rules are applicable for Municipal Solid Waste and implemented by Urban Local Bodies for scientific management.
4	Batteries(Management and Handling) Rules (2001)	2001	It applies to stakeholders associated with the manufacturing, handling, and utilization, and reuse of batteries or components thereof.
5	National urban sanitation policy	2008	Focus on management of human excreta and associated public health and environmental impacts.
6	Plastic Waste Rule	2009	It deals with the scientific disposal of plastic waste and an extended producer responsibility clause has also been incorporate in it.
7	E- Waste handling Rule	2010	It applies to stakeholders associated with the manufacturing, handling, utilizing, processing, and recycling of electrical and electronic-related waste items.
8	Solid Waste Management Rule	2016	Included Municipal areas and have included urban agglomerations, census towns, notified industrial townships, areas under the control of Indian Railways, airports, special economic zones, places of pilgrimage, religious and historical importance, and State and Central Government organizations in their ambit.

(GOI, 2016)



Solid Waste Scenario in Ladakh:

Ladakh, one of the most pristine and thus far unspoiled landscapes in the world, has been exploited by tourism industry, which result in accumulation of waste in the recent decades. Due to the rugged terrain and climatic conditions, it is not possible to transport large amounts of waste for proper disposal. Since before the boom of the tourism industry there was minimal waste, there is not much infrastructure for the waste storage and disposal. Even the locals have started to produce much more waste in recent decades due to convenience, changes in eating habits, improved access, and lifestyle changes due to exposure to the world market.

In 2018, Ladakh three lakh eager and adventurous visitors visit Ladakh, bringing with them approximately sixteen tons of trash production every day, rising levels of tourism and modernization come various issues. When the Ladakh first opened to tourism In 1974, there were total of 527 tourists visited in Leh, and by 2018, it increased to 3 lakhs which leads to tons to waste generation up to 40 tonnes per day, During peak tourist season, Leh city collects 16 to 18 tonnes of waste per day, and annual waste production stands at an alarming 374 tonnes (Dutta, 2018).

Many plastic products, such as food packaging, plastic bags, disposable silverware, and plastic bottles, are only used for a few minutes or hours, but can last in the environment for hundreds of years. Although Ladakh has managed to avoid the use of plastic bags in supermarkets and other retailers, packaging waste in the form of plastic, glass, cardboard, aluminium, wood, steel and paper is invading our homes, workplaces and the environment. The move to online shopping only compounded the problem. Marine and terrestrial animals suffocate and die from solid waste pollution. To achieve the goal of a "climate neutral Ladakh", the Union Territory administration has completely banned single-use plastics in all public and private institutions. Amount of waste generation over the year was given in (Figure 2 and 3).

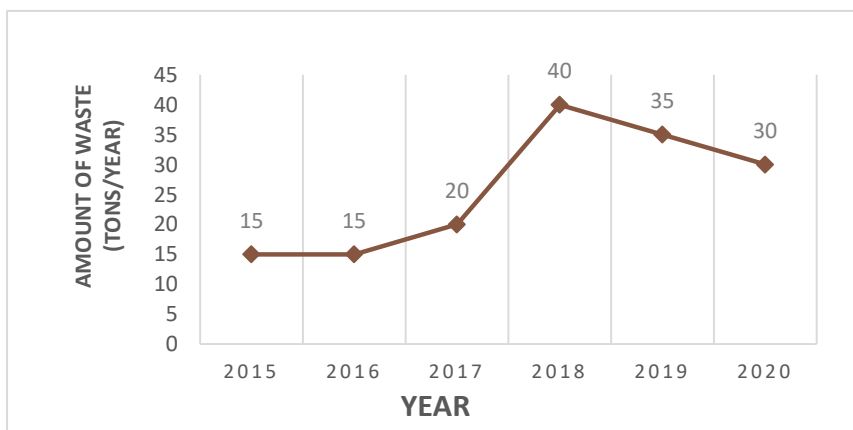


Figure 2. Waste generation in Ladakh tons/day

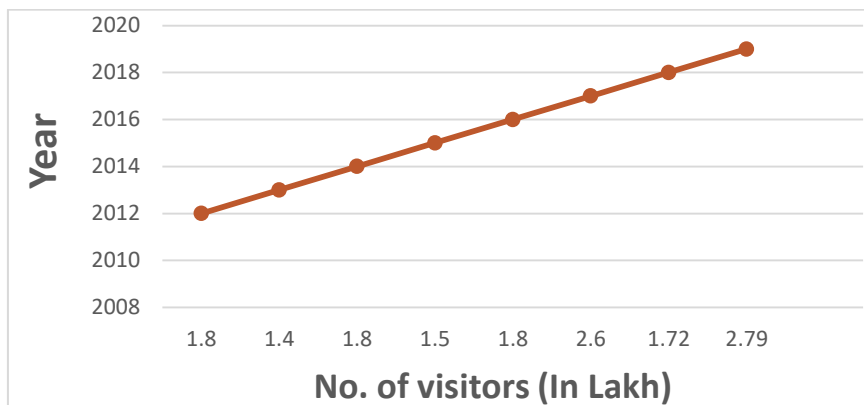


Figure 3. Waste generation in Ladakh with respect to no of visitors



II. LITERATURE SURVEY

The following review article highlighted solid waste management scenario at global, national and regional solid waste initiative, practices, and related core challenges.

In India, municipal waste management is subject to municipal regulations for solid waste disposal. However, most urban local authorities (ULB) do not have adequate action plans for the implementation and adoption of the municipal waste rule (GoI, 2013). Unfortunately, no city in India can claim 100% waste segregation in residential units and on average only 70% waste collection is observed, while the remaining 30% is mixed and lost in the urban environment. Of the collected waste, only 12.45% of the waste is scientifically processed and the rest is disposed of in open landfills (GoI, 2013). Respect for the environment, profitability and acceptance by the local community are important attributes for achieving an efficient waste management system. The following is a critical examination of the important parameters of, Municipal Solid Waste Management practice in relation to the Indian scenario (GoI, 2013).

Segregation- There is no organized and scientifically planned separation of Municipal Solid Waste, either at the household or in the community level. Garbage segregation is mainly done by disorganized departments and is rarely done by waste manufacturers. Separation and sorting takes place under unsafe conditions and the efficiency of segregation is reasonably low due to the unorganized sector that separates only valuable components to be discarded from the waste stream, this can ensure relatively higher economic returns in the recycling market (Kaushal *et al.*, 2012). In some cases, due to improper handling, separated components are remixed during transport and disposal (GoI, 2013). Lack of segregation deprives waste of proper scientific disposal (Singhal, *et al.*, 2001).

Collection - Waste generated by households is usually sent to conventional trash cans made of metal, concrete, or a combination of the two. Street sweeping also ends with community trash cans. These community trash cans are also used by other essential commercial industries near the bins that dispose of household waste, except when certain business complexes or industrial units require the city government. Transfer their waste to a disposal site and pay a certain amount (Chatterjee and Kumar 2009).

Transportation- The means of transportation for Municipal Solid Waste Management practiced in India are bullock carts, manual rickshaws, single drum rollers, trucks, tractors, trailers and tippers. In smaller cities, trucks with a load capacity of 5 to 9 tons are used without a corresponding cover system. Stationary compressors, mobile compressors / closed speeds and vehicles with canvas are used to transport urban waste, with which approximately 65, 15 or 20% of the waste is transported. Maintenance of vehicles used to transport waste is usually performed in a workshop operated by ULB, but most of these workshops can only perform minor repairs. Not surprising, because if these vehicles break down, the efficiency of collection, transport and disposal is drastically reduced. In some metropolises there are only a few transfer stations, for example Mumbai (Joseph, 2002).

Reuse/Recycling- This involves activities such as the collection of these materials from waste, which can be recovered cost-effectively and used to create new products. Since unsorted waste is dumped in community bins, optimal recycling is not possible. However, scavengers sort, pick up and sell recyclable materials like plastic, glass, etc. In Pondicherry, almost all recyclable materials are sorted by scavengers and absorbed into the material stream through recycling (Pattnaik *et al.*, 2010).

Disposal- In India, almost every city and town adopts an unscientific way of eliminating Municipal Solid Waste. Existing practices and technologies for Municipal Solid Waste Management in 59 cities (Kumar *et al.*, 2009). Of these cities, 40 showed an increase in waste generation, seven a decrease, and more or less the same for six. Although there has been population growth within a decade in these cities, there is no good reason given by the author for the reduction or equivalent amount of waste generated for the cities. This. However, the cause that can be reduced can be because the generated waste cannot reach the designated landfill and is lost in the suburbs of towns, roadside, low-lying areas, culverts, green spaces, etc. The data suggest that uncontrolled surface landfill is a common feature of most cities (Kumar *et al.*, 2009). The following processing methods are used in the hierarchy.

Open dumping- In India, generated Municipal Solid waste is often disposed of directly in lowlands out of habit, in violation of landfill procedures. Almost no Urban Local Body has adequate sanitary landfills and municipal solid waste is dumped on the outskirts of the city along the roads. Unscientific landfills are prone to flooding and are a major source of surface water pollution during monsoons and groundwater contamination by leachate seepage (Moret *et al.*, 2006). Landfill will continue to be widely accepted in India, although urban centers such as Delhi, Mumbai, Kolkata and Chennai have little land for waste treatment and designated landfills operate beyond their capacity (Sharholiyet *et al.*, 2008).



Development of new sanitary landfills/expansion of existing ones reported in states such as Andhra Pradesh (Vijianagaram), Delhi (Bhalswa, Okhla and Ghazipur), Goa, Gujarat (8 locations) , Haryana (Sirsa and Ambala), Karnataka (12 locations.), Madhya Pradesh (Gwalior and Indore), Maharashtra (Nashik, Sonpeth, Ambad, Pune, Navapur and Navi Mumbai), Pendjab (Adampur), Rajasthan (Jodhpur)) and West Bengal (17 sites) (GoI, 2013). According to CPCB's 2013 report, to date, India has 59 landfills operational and 376 are in the planning and implementation stages.

A study was conducted that focused on understanding public perceptions and attitudes towards local waste management practices in Ogun State, Nigeria. Five local government areas were selected based on population, land mass, geographic location, and distribution. The results of the survey, which examined socio-demographic aspects, household characteristics and standard waste disposal practices at the household and community level, showed that important factors such as age, income and level of education influence perceptions, practices and attitudes of people towards solid waste disposal. One third of the population practices open landfill, and most residents still believe that sanitation is too expensive and should be the prerogative of state and local governments. These results suggest that the government and relevant stakeholders should make more efforts to properly enforce environmental laws and raise awareness about the proper disposal of solid waste in schools and public places (Olukanni *et al.*, 2020).

The Delhi NCT examined community attitudes, perceptions and willingness to dispose of solid waste. Household data collection was based on the field survey through personal interviews, which were carried out with the help of survey instruments such as structured questionnaires and field observations. The majority of respondents in the field survey found a willingness to participate in waste management both physically and financially. While they expect their waste to be collected on a daily basis, they also show responsible responses by being willing to segregate sources and use recyclable products. It was found that people are aware of reduce, recycle, refuse and reuse (4R) (Kumar and Anand, 2017).

A survey was conducted in Bangalore to examine community attitudes, perceptions and willingness to dispose of solid waste. Household data were collected randomly based on their socioeconomic status through focus group discussions and structured interviews. People have been found to be environmentally conscious and most of them are willing to commit to better management along with separating and using recyclables that they use to transport vegetables, grains, etc. of entire stores / markets used because they were aware of reduction, recycling and reuse (R3). The need for a greater social commitment to reduce waste at source was recognized through scientific campaigns (Kumar and Nandini, 2013).

Community participation has a direct impact on efficient waste management. However, local authorities have failed to mobilize the community or educate citizens on the basics of waste management and proper container storage at the household, commercial and operational levels (Asnani and Zurbrugg, 2017). Municipal solid waste management remains one of the most underserved urban development areas in India. In many cities, more than half of the solid waste generated is not collected. This large amount of uncollected waste becomes a source of environmental pollution and contamination of groundwater resources at the same time.

An assessment of the attitudes, perceptions and level of awareness regarding Solid Waste Management practices of the people of Lahore, Pakistan was carried out. Respondents with three different income levels (high, medium and low) from the city of Lahore were analyzed through a questionnaire conducted through door-to-door and face-to-face interviews of 300 households. The survey found that current Solid Waste Management practices have improved but remain unsatisfactory. Source segregation and recycling were rarely practiced, and people generally swept their places while dumping waste components on the street or nearby properties. An increase in the amount of waste was also observed with increasing income levels. Although three-quarters of the population were willing to pay for recycling, high-income areas generated more waste and were happier than others, but the trend in recycling old equipment and waste collection varied across income levels high to low more (Heidari *et al.*, 2015).

A survey designed with Questionnaire administered on 215 respondents in Ibadan metropolis selected randomly. The objectives of the study were to examine the influence of some socio-economic factors on solid waste generation and disposal in Ibadan Metropolis. The information was analyzed using frequency and correlation matrix. The finding showed that the composition of waste generated and the choice of method of disposal in Ibadan Metropolis were a reflection of variation of socio-economic factors of the people such as income, age, education, occupation and building types. The paper recommended that effective solid waste management can be achieved through the adoption of urban renewal strategy on the chaotic areas, provision of sizable fund by the government and proper education to the people among others (Alakinde, 2012).



A study was conducted in the city of Kampala, Uganda, examining the impact of public education on waste management. Due to the heterogeneous nature of the study population, a cross-sectional research design was used. The study was carried out with the help of organizations involved in public education. Public meetings, use of the media, community rallies, and instructions for individual home owners were the main strategies used to educate city communities on waste management. Public education has been found to improve waste management in the city. However, there has been less education about the sorting and disposal of organic waste, which accounts for more than 50% of the city's waste. Waste separation would improve the quality and quantity of plastic waste delivered to the recycling industry, and training on organic waste management would reduce the quantity and cost of waste disposed of in landfills (Fredrick *et al.*, 2018).

The study was conducted to understand the characteristics of solid waste generation in Ladakh for the formulation of a suitable coping strategy in the tourist accommodation sector. The tourists generate annually 1093.69 tons of waste out of which 60% can be diverted for composting and 30% for recycling which depicts the huge potential of resource recovery. The data set generated through this pilot study could (be indispensable for envisaging) contribute to an integrated solid waste management plan for the town (Wani *et al.*, 2020).

Another study was carried out to identify the optimal location for landfill sites. The evaluation was done concerning socio-economic variables employing buffering, erase, and weighted overlay analysis techniques in the Geographic Information System (GIS) environment. Seven potential sites with good road connectivity were identified, out of which three being located on alluvial tracts are moderately suitable and only two can be considered in terms of slope and geology. The methodology used can also help to locate other critical facilities in Leh town or any other towns to ensure sustainable environmental management (Daret *et al.*, 2021).

Scope of the study:

The agenda of 2030 United Nation Sustainable Development Goals include dedicated goals on Good health and wellbeing (SDG3), Clean Water and Sanitation (SDG6), Affordable and Clean Energy (SDG 7), Sustainable Cities and Communities (SDG 11), and Climate Action (SDG 13). The sustainability practices in solid waste management will contribute to all these scopes of SDGs by 2030.

The Ladakh region is one of the most popular tourist destinations in South Asia, and also one of the most sensitive ecological regions of the Trans Himalayan region. The Ladakh region provides a steady water supply to the Indus Riversystem, which is the main source of water supply. Drinking water, irrigation, hydropower production and tourism development. The tourism business has brought a new wave of growth to Leh, Ladakh, creating tremendous job opportunities while generating massive amounts of waste.

In this context, Community survey will be carried out to reveal the existing integrated solid waste management system and also to understand the importance of community participation in waste management. The study would act as an input to government and other implementing agencies for a quick decision making and prioritizing action related to Solid Waste Management (SWM) in Ladakh region.

Objective of the study:

- To assess the status of ongoing programs on waste management in Ladakh.
- To assess Community status of perception, and willingness towards Solid Waste Management in Ladakh region.

III. METHODOLOGY OF PROPOSED SURVEY

Study area:

The study area is located in the mountainous north of the state of Ladakh in India. Leh is located between 32 ° to 36 ° north latitude and 75 ° to 80 ° east longitude, Ladakh is at a fairly high altitude, the geographical location of Ladakh varies from 2,750 m altitude near Kargil to 7,672 m high near Saser Kangri, in the Karakoram Mountain Range. Due to its high altitude, Ladakh experiences a very cold climate in which even summer temperatures rarely exceed 27 ° Celsius (figure 4).

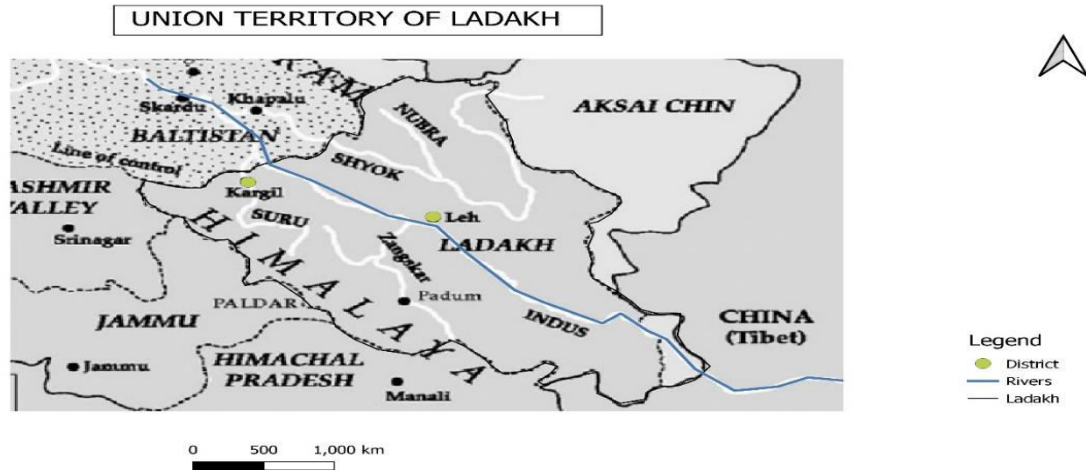


Figure4. Union territory of Ladakh, India

Ladakh has a population density of 274,300 (GoI,2011).With extreme topography and a highly variable cold desert climate, subsistence agriculture has historically been an important part of both society and the economy. Herders trade in dairy products, wool, and pashmina goat fiber. Arable barley and wheat cultivation is strictly limited to the summer months between May and September. Since the partition of India, there have been ongoing border disputes from both Pakistan (since the 1940s) and China (since the 1960s). Ladakh itself is divided into the predominantly Buddhist district of Leh and the Islamic district of Kargil. The economy is increasing integration in India and the demand for military bases leads to rapid investments in infrastructure, the opening of tourism in 1974 results in thousands of jobs, Road access consists of two highways, Leh-Srinagar and Leh-Manali, both closed annually for 7 months with heavy winter snowfall.

The study covers the trans-Himalayan region of Ladakh. Amidst the covid-19, survey through online and secondary data were the only means of data collection. So a questionnaire survey is done with the scope of the study limited to 100 respondents.

Approach and Methods:

A participative and consultative approach has been adopted to collect information on the status of implementation of schemes and programs in the Ladakh region. Further discussions were held with various stakeholders on program implementation.

Data was collected using an online Questionnaire survey and direct observation using a set of questions with the local communities at a household level, The survey was conducted from different locations on multiple random bases, In assessing the general perception and willingness of respondents on the household solid waste management system, the sample size of 100 households among the community was selected randomly based on different income groups like the low-income group, lower middle income, upper middle income, and high-income group (World bank,2020).

IV. PROPOSED METHODOLOGY AND DISCUSSION

Socio-economic profile of household

Socio-economic characteristics including gender, age, education, number of person in the family, employment status, and income of the respondent perception, and willingness to participate in solid waste management-activities are tabulated as follows (Table 4).



Table4.Socio-economic profile of Household

Sl.no	VARIABLES	RESPONDENTS (n=100)	PERCENTAGE (%)
GENDER			
1	MALE	29	29
2	FEMALE	71	71
AGE			
1	15 -21	10	10
2	22-45	82	82
3	45-60	7	7
4	Older then 60	1	1
EMPLOYMENT STATUS			
1	Government employ	14	14
2	Private employ	3	3
3	Self-employed	4	4
4	Student	69	69
5	Unemployed	11	11
6	Other	0	0
EDUCATION QUALIFICATION			
1	Illiterate	0	0
2	Primary schooling (5 th to 7 th)	2	2
3	Secondary schooling(8 th to 12)	12	12
4	College or higher education	86	86
INCOME (World bank classification, 2020)			
1	Low income level(Rs70,069 or less)	20	20
2	Lower middle Income (Rs70,137 to 273,167)	35	35
3	Upper Middle(Rs2,73,167 to 8,46023)	55	55
4	High(Rs8,46,023)	0	0
HOUSEHOLD SIZE			
1	1-2 People	4	4
2	3 to 4 people	47	46
3	5 to 7 people	49	50
4	More than 7 people	0	0



The results presented in Table 4 show that 71% of the respondents participating in this study were women (Figure 15). About 82% of the participants were 22-45 years old, 10% were 15 to 21 years old, 7% of the participants were 45-60 years old, and only 1% were over 60 years old. Among these 69% are students, 14% government, 11% are unemployed, 4% are self-employed and 3% are private sector employees, of which 86% of the total participants have a degree university or higher, 12% graduated from high school and 2% attended primary school, more than half of respondents live in a household with 5-7 family members, and the remaining 46% have 3 up to 4 members and 4% of respondents built family. With 1 to 2 members, the Municipal Solid waste collection is an important aspect of maintaining public health in cities around the world. The municipality Collection rates range from as low as 20% in low-income families to 35% in the low-middle income group to as high as 55% in high-income level.

Local community participation in solid waste management in Leh Ladakh:

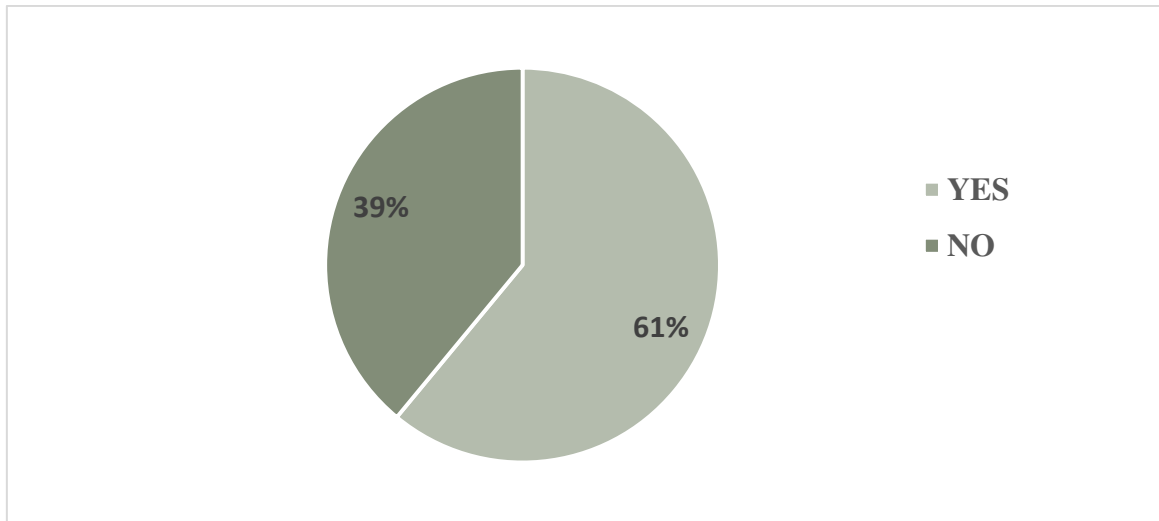


Figure 5. Number of people aware of the operating system for waste management

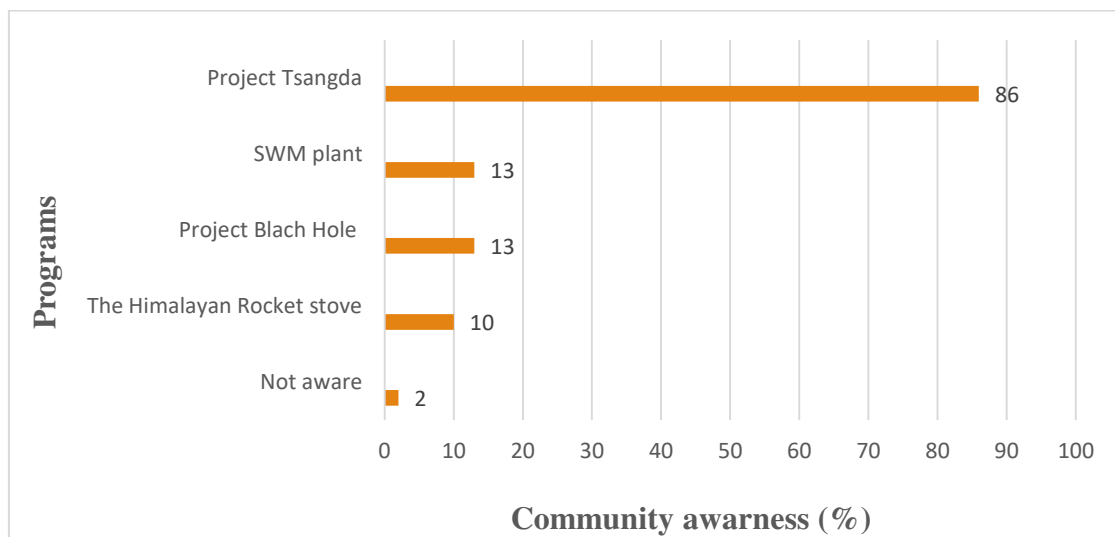


Figure 6. Community awareness on different programs on Solid Waste Management

The respondent was asked if they knew of an operating system in Ladakh. The results show that (61%) of the people are familiar with the current waste disposal system in Ladakh and (39%) of the people are unaware of the various operating



systems listed, (86%) of the people are familiar with Tsangda (13%) of the people are aware of the SWM (solar base) plant and the Tesla Blackhole project, and (10%) are aware of the Himalayan rocket furnace and (2%) of the participants are unaware of this project (Figure 5, 6).

The major reason for waste generation in Ladakh

Ladakh being the touristic place, majority of the participant (46%) believe that the root cause of waste generation is mainly because of tourism, apart from that poor management & and lack of awareness among people are the major reason for the heavy influx of waste generation.

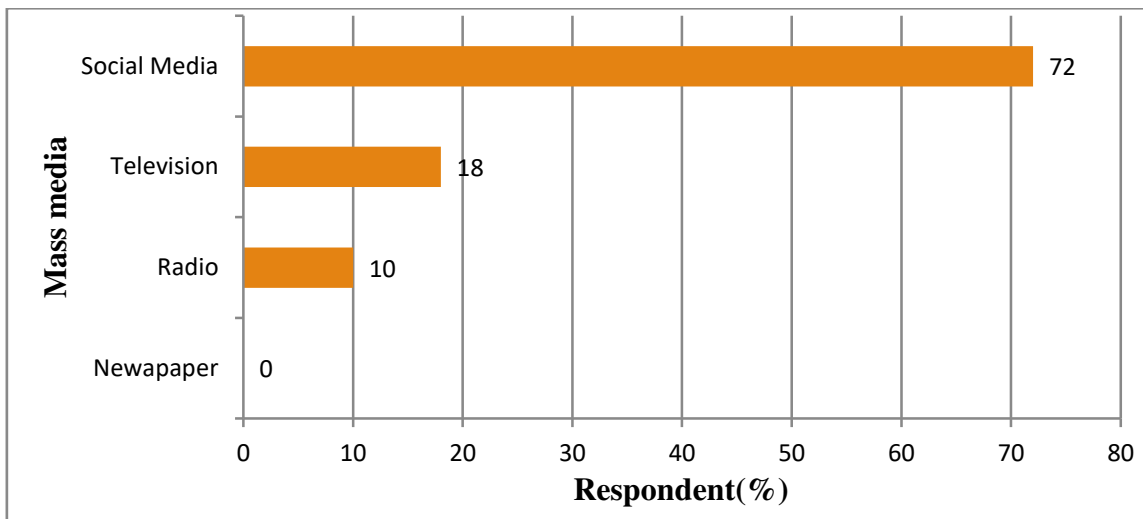


Figure 7. Type of mass media component that are more effective in generating awareness

Respondent were asked which mass media component is more effective in generating awareness majority (72%) of respondents believe that social media is one of the most effective tools in generating awareness, 18% of people think that it's the television and (10 %) of people think that radio is more effective since people of Ladakh tune to air Leh for confirmation of news even today (Figure 7).

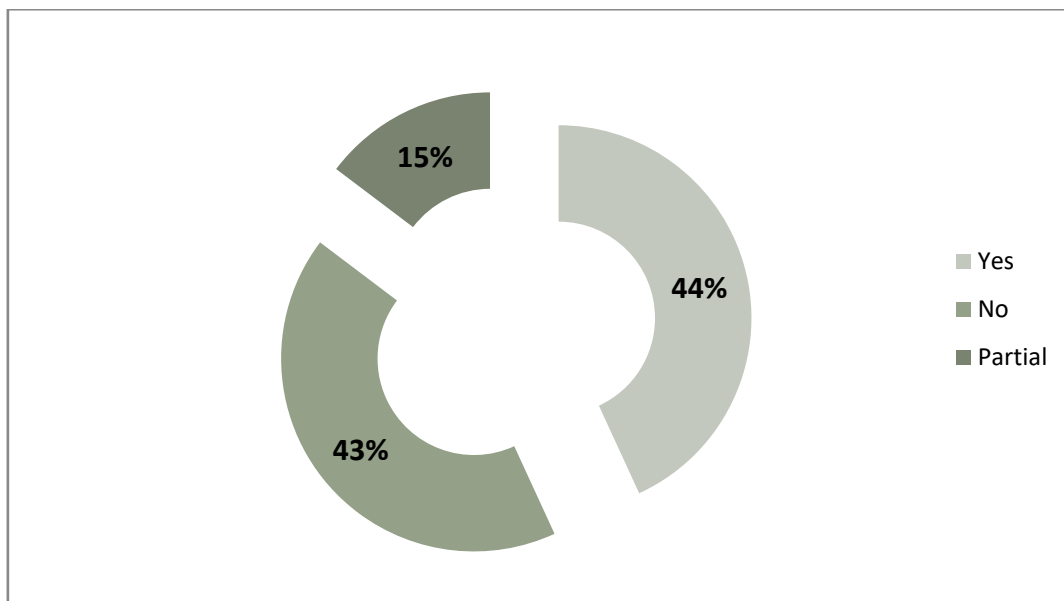


Figure 8. Waste segregation and measurement of different types of waste is done at home



Waste separation is important as it facilitates the recycling process and waste separation minimizes the negative impact on the environment. Of the data collected (44%) of the people separate their garbage at home, (15%) of the participants partially separate their garbage and (43%) of the participant’s dispose of their garbage without separation (Figure 8).

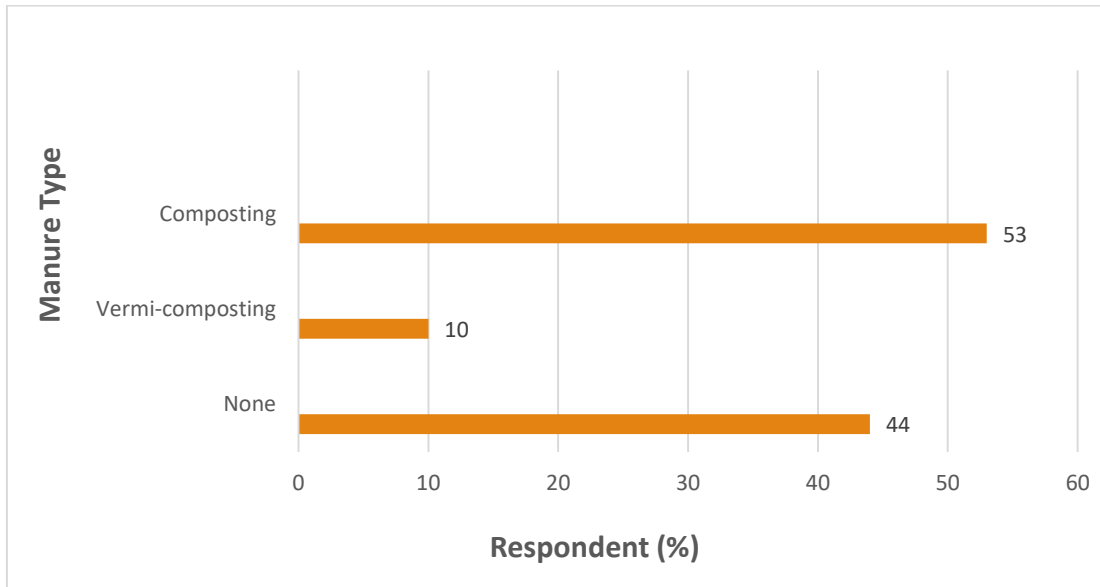


Figure9. People practicing composting and vermicomposting

Compost is organic material that can be added to the soil to help plants grow, according to the collected data, (53%) of the participants practiced home composting, (10%) of the participants practiced vermicomposting at home and (44%) of people don't practice both (Figure9).

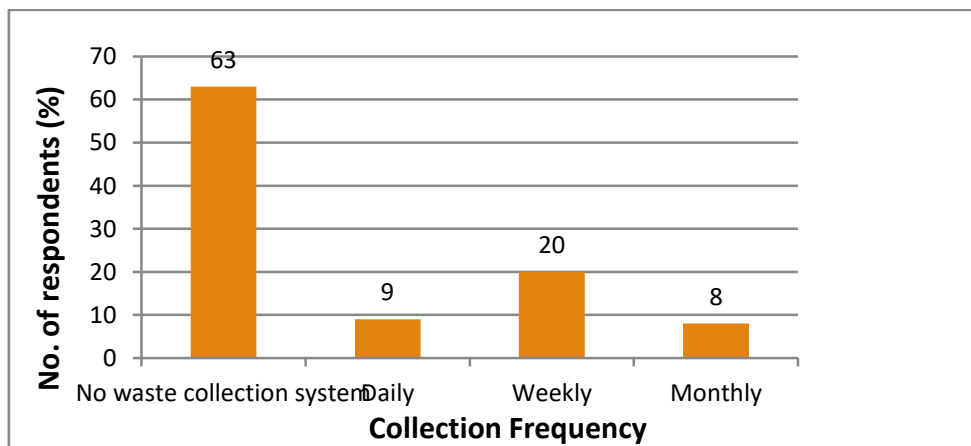


Figure 10. Frequency of the garbage collection system in a community

The frequency of collection is an important aspect of Waste management. From a health perspective, no more than a weekly collection is needed. Good waste collection programming requires an ongoing iterative approach between collection crews and generators. Therefore, waste generators should be aware of the true costs of collection and ideally be charged for these directly

In Ladakh, the waste collection system is limited to only city areas and there is no waste collection facility available for village areas, according to the data collected (63%) of the participant has not any waste collection facility at their



household level, (9%) of the participant have the daily waste collection system, (20%) disposed their waste weekly and remaining(8%) disposed their waste on monthly basis respectively(Figure10).

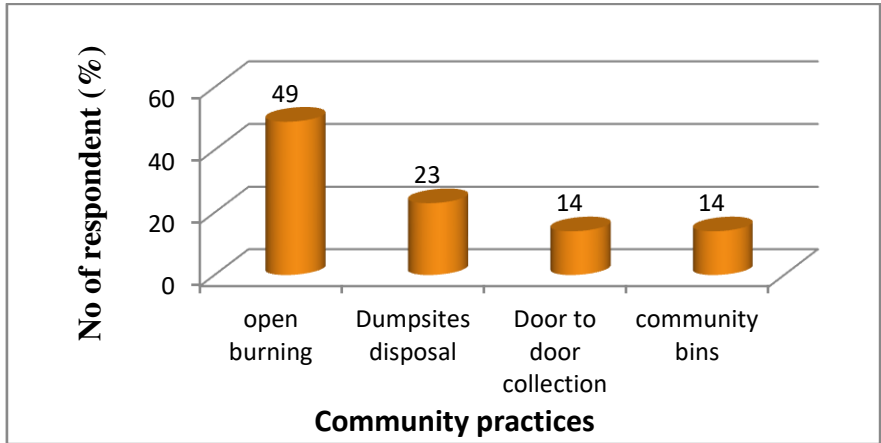


Figure11.Waste handling method community practice

We observe piles of garbage in the streets as we drive down a highway. Open landfill is the most common waste disposal method in India. Landfills are normally exposed to the environment and the elements. They rarely have sparse cover, which can often attract pests or vermin. These landfills are sometimes subjected to open incineration which can emit toxic fumes and vapors. There have also been cases where enough heat was generated to cause spontaneous combustion. Sometimes waste is illegally dumped into rivers and canals or used to fill sinks without proper advice. These practices cause many long-term problems. These can range from soil degradation to the leaching of toxic chemicals into groundwater sources. Therefore, proper waste disposal methods must be used to avoid such scenarios. Respondents were asked how they normally disposed of their waste from their household after collection, and according to the data collected about (49%) of the household perform open burning, in addition, (23%) of the household disposed to nearby available dump side, (14%) of the participant has a door to door collection facility while (14%) of the household disposed of their waste in nearby community bins respectively (Figure 11).

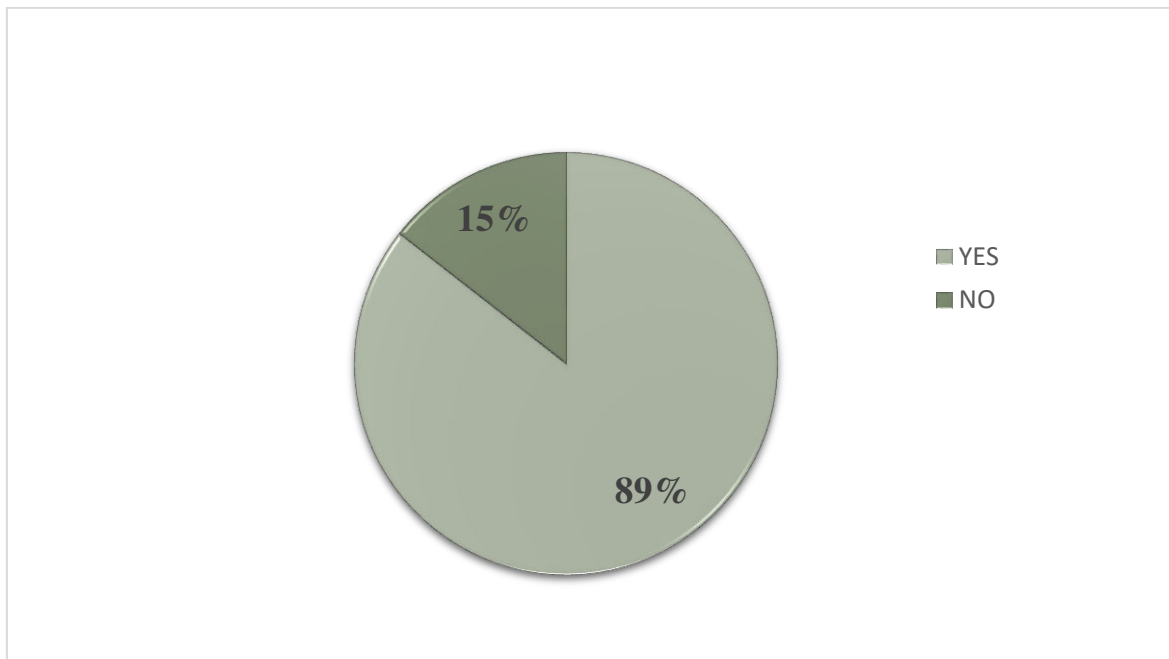


Figure 12.Waste as a resource



Based on empirical study (85%) of the household knew that a considerable part of the garbage could be converted into resources. Through sustainable recycling, we can improve our environmental footprint, create jobs, and produce high-value products (Figure 12).



Figure13. Effective Ways to regulate the waste in the tourism sector

There is not even a single place in India that has not been vandalized or polluted by the people, tourism in Leh is at the peak currently so the pollution of land, air and water, there is apathy and lack of awareness from both tourist and locals, leading to bad waste management, another issue in Leh is that most of the product is bought from the outside of Ladakh, As people live more modern and affluent lives, they are moving away from the traditional food and practices, and according to data collected people believe that encouraging local items, single-use plastic ban, facilities for proper waste disposal, hotel lodges to compost their waste and (1%) of the participants believe that educating domestic tourists by a tour operator and by taking strict action against violators can be effective in the regulation of waste in the tourism sector (Figure 13).

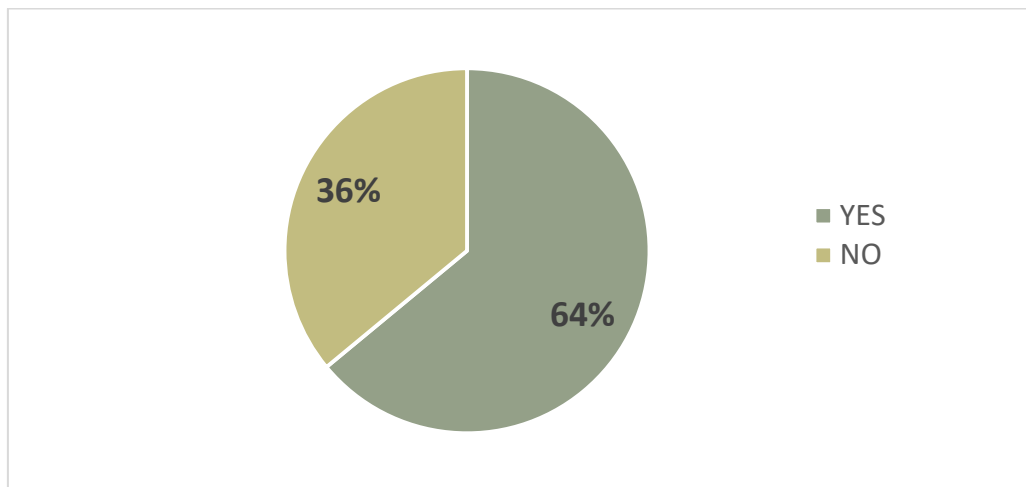


Figure14. People awareness of the Waste Management Rule



The Municipal Solid Waste (Management and Handling) Rules, 2000 were notified in the year 2000 and came into force on September 25, 2000. However, post the suggestions of the public, the set of rules were updated in the areas of plastic, e-waste, biomedical, hazardous, and construction, and demolition waste, Later the Government notified Solid Waste Management Rules in the year 2016.

The new set of rules are now not only applicable in Municipal Areas but have also included urban agglomerations, census towns, notified industrial townships, and also areas that fall under the control and direction of Indian Railways, Airports, Special economic zones, Places of Pilgrimage, Religious and Historical importance, and Organisations under the conduct of State and Central Government. According to the data collected (64%) of the people are aware of the waste management rule and out of which (36%) of the people are unaware of the waste management rule (Figure14).

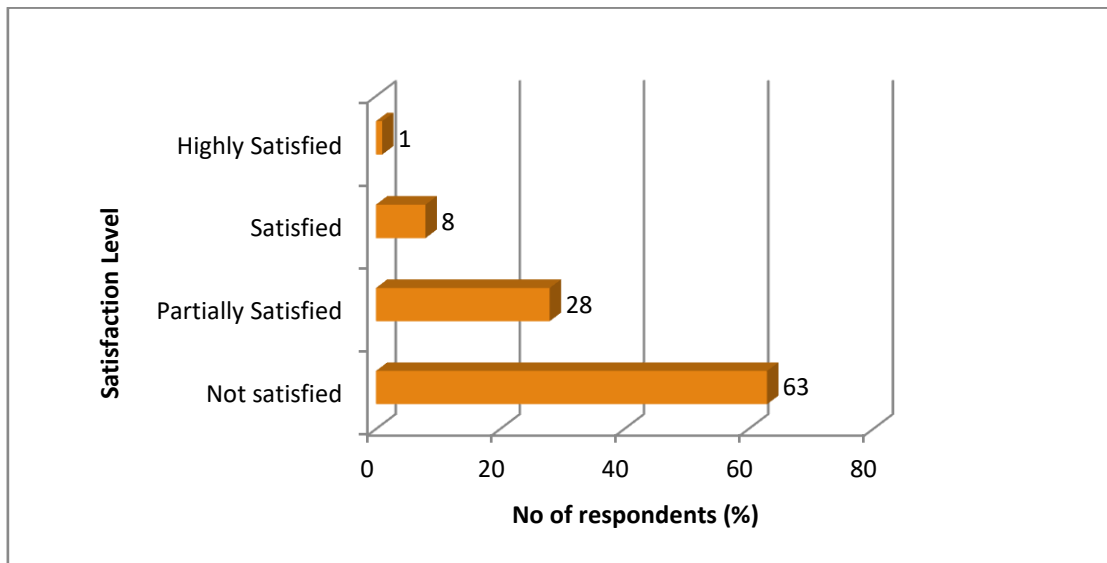


Figure15.Satisfaction Level of people on the existing waste management in Ladakh

Undeniably, the tourist boom has brought in increased revenue and created employment. But it has also strained the region’s scarce natural resources. Consumption patterns have changed and this is most apparent in the indulge of packaged food, which leads to the immense no of waste generation and management of the waste is becoming a major challenge, so out of the data collected (63%) of the people are not satisfied with the existing waste management in Ladakh, (28%) of the people are partially satisfied and(8 %)of people are satisfied with the current system (Figure15).

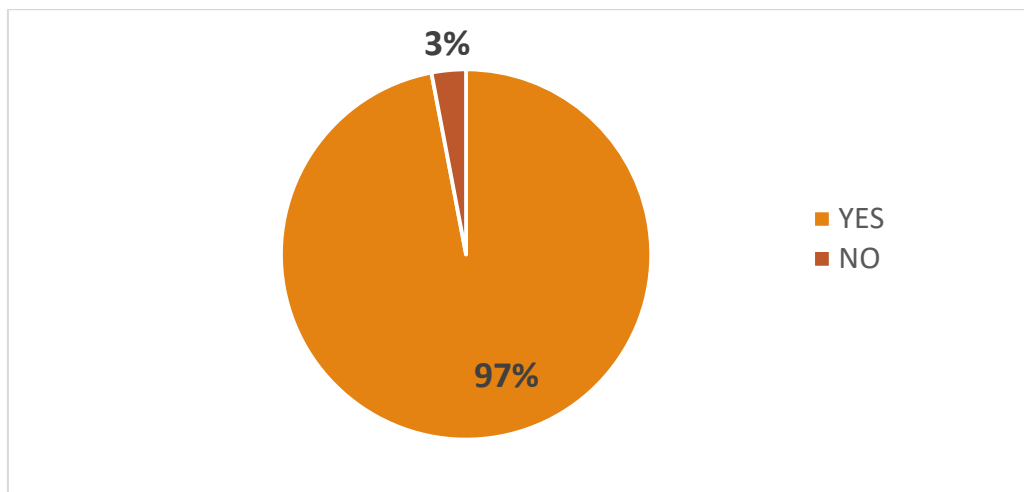


Figure16. The willingness of people in better management



A high number of respondents (97%) were willing to participate in proposed solid waste management initiatives. Solid Waste Management (SWM) is one such activity, where public participation is key to success. Public awareness, effective community participation, transparent and clean administration, the introduction of citizen charters, and accountability at all levels can only bridge this gap (Figure 16).

V. CONCLUSIONS AND FUTURE WORK

This study assessed the local community participation in solid waste management in Ladakh, the result revealed that there is a lack of collection, sorting, and storage facilities at a household level, whereas at the community level transport, treatment, and disposal areas are of major concern. Results also suggest that since the traditional Solid Waste Management (SWM) practices are not sustainable as about 49 % of the house hole involve in this study use open burning, 23% use dumpsite disposal as a mechanism for solid waste management products in the household, it is there for crucial to look for other modern Solid Waste Management approaches such as recycling and reuse. There is a need to educate people on the importance of community participation and involvement in matters concerning the environment.

Recommendation

Following are various recommendations that evolved from this study to improve the existing Municipal solid waste management practices in Ladakh, India:

- There is an urgent need for municipalities to learn from the few successful innovative practices and replicate them.
- Municipalities need to increase the efficiency of their waste collection systems.
- Introducing an on-time or door-to-door collection system.
- A municipality should find ways to optimize the system and charge a service fee to citizens to ensure that the overall waste management system is financially viable.
- The private sector and community groups can participate in waste management to reduce costs and increase efficiency.
- People should be educated to understand the importance of source segregation at the point of generation as a biodegradable, inert and recyclable material for proper waste management.
- Viable decentralized composting plants should be installed to reduce the burden on the ULB from collecting and transporting municipal waste.
- Protection of groundwater contamination from leachate percolation from open dump/landfill sites should be made compulsory. The appropriate technological solution should be adopted to achieve this goal.
- Environmental committees and community-based groups should be formed for purpose of boosting participation at a lower level among local residence of Ladakh.
- Local government agencies must focus on raising awareness and influence of the community members the importance of participating in SWM activities.
- Tourism and ecotourism should be regulated in mountain and eco-sensitive regions.
- Illegal waste dumping should be monitored and such people should be punished with penalty.
- Waste disposal sites should not be aligned in hilly terrain areas, which are subjected to landslides and erosion.
- Central government should be provide funding's to establish waste management facility in the region.

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Appendix

Questionnaire

Socio-economic of house holds

HOUSE HOLD DETAIL

*Required

1. NAME

2. VILLAGE NAME *

3. Gender *

Mark only one oval.

- Male
 Female

4. Age *

Mark only one oval.

- 15-21
 22-45
 45 -60
 Older then 60



5. Employment status *

Mark only one oval.

- Government employ
- Private employ
- Self employed
- Student
- Unemployed

6. EDUCATION QUALIFICATION *

Mark only one oval.

- illetrate
- Primary schooling
- Secondary schooling
- College or higher education

7. OCCUPATION SPECIFY

8. Income/year

Mark only one oval.

- Low income level (Rs 70,069 or less)
- Lower middle income (Rs 70,137 to 273,167)
- UPPER Middle (Rs2,73,167 to 8,46,023)
- HIGH(Rs 8,46,023)
- Other: _____



9. House hold size *

Mark only one oval.

- 1-2 people
- 3 to 4 people
- 5 to 7 people
- more then 7 people

Community attitude towards solid waste management in Ladakh

Household Waste Generation and Disposal

10. 1.Are you aware of any operational system for waste management in Leh *

Mark only one oval.

- Yes
- No

11. 1a. If the answer for 1 is yes then kindly mention which of the operational system you are aware about? (can select multiple option)

Tick all that apply.

- Project Tsangda (waste to resource)
- SWM plant (100kwp SOLAR BASE)
- PROJECT TESLA BLACKHOLE (waste to valuable energy)
- The Himalayan ROCKET STOVE

Other: _____



12. 2a. In your opinion which of these is a major reason for heavy influx of waste generation in Ladakh (Rank your priority from (1-5) a-TOURISM *

Mark only one oval.

1	2	3	4	5
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

13. 2b. In your opinion which of these is a major reason for heavy influx in waste generation in Ladakh (Rank your priority from (1-5) b-POOR MANAGEMENT *

Mark only one oval.

1	2	3	4	5
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

14. 2c. In your opinion which of these is a major reason for heavy influx in waste generation in Ladakh (Rank your priority from (1-5) c- LACK OF AWARENESS *

Mark only one oval.

1	2	3	4	5
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



15. 3. What type of mass media component is more effective in generating awareness ? *

Mark only one oval.

- Television
 Radio
 News paper
 Social media

16. 4. Is the segregation & measurement of different type of waste is done at your home? *

Mark only one oval.

- Yes.
 Partial
 No

17. 4a. If the answer for 4 is yes , Kindly provide the average quantity of waste generated per day for the following categories a.DRY WASTE (eg. paper, plastic) KGS

Mark only one oval.

- 1-2kg
 2-3 kg
 3 - 4 kg
 more then 4 kg
 Other: _____



18. 4b. If the answer for 4 is yes , Kindly provide the average quantity of waste generated per day for the following categories b. Wet WASTE (eg. kitchen waste, vegetables peels) KGS

Mark only one oval.

- 1-2kg
- 2-3 kg
- more then 4 kg
- Other: _____

19. 4b. If the answer for 4 is yes , Kindly provide the average quantity of waste generated per day for the following categories c. Reject waste (eg sanitary pad ,napkins, broken glasses, hazardous waste,) KGS

Mark only one oval.

- 1-2kg
- 2-3 kg
- 3 - 4 kg
- more then 4 kg
- Other: _____

20. 5. Do you practice following at home? (can select multiple option) *

Tick all that apply.

- Composting
- Vermicomposting
- None

Other: _____



21. 6. Do you have regular garbage collection in your area? if yes then how frequently waste get collected? *

Mark only one oval.

- No waste collection system
- Daily waste collection
- Weekly
- Monthly
- Other: _____

22. 7. What are the waste handling method you performe? *

Mark only one oval.

- open burning
- Dumpsites disposal
- Door to door collection
- community bins
- Other: _____

23. 8. Do you consider Waste as a resource? *

Mark only one oval.

- No
- Yes



24. 9. How to regulate the waste in tourism sector (can select multiple option) *

Tick all that apply.

- Encouraging local item
- Single use plastic ban
- Facilities for proper waste disposal
- Hotel lodges to compost their own waste

Other: _____

25. 10.Are you aware about the waste management rule in India ? *

Mark only one oval.

- No
- Yes

26. 11. Are you satisfied with the existing waste management in your area? *

Mark only one oval.

- Notsatisfied
- Partially satisfied
- Satisfied
- Highly satisfied

27. 12.Are you willing to participate for better management? *

Mark only one oval.

- No
- Yes
- Other: _____



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