Solid Waste Management in Municipal Corporation Shimla: A study

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Abstract-In recent years, the management of municipal solid waste has been a major environmental issue in all urban areas of our country. Improper and inadequate management of municipal waste cause adverse effects on environment such as air, water and land pollution along with global warming. Estimation on the quantity and the characteristics of municipal solid waste and its forecasting over the planning period is the key to a successful solid waste management plan. Due to increase in urbanization and growth in population has revealed the need for sustainable development and developing innovative solutions to these existing problems and effective management of municipal solid waste is one of them. In this paper, a case study of Municipal Corporation Shimla in Himachal Pradesh has been carried out to know about its existing solid waste management system.

Keywords: Municipal solid waste, Open dumping, Bio-degradable, Segregation, waste management plant, Bioconversion technologies.

INTRODUCTION

A solid waste management system includes the generation of waste, storage, collection, transportation, processing and final disposal. In developing countries like India, the effective disposal of solid waste management poses a serious problem. Solid waste management is a basic public necessity and is provided by respective urban local bodies in India. The growing population in the city increases the production of solid wastes proportionally. Solid waste management in India traditionally has been neglected area of urban development and often accounted for severe urban health problems in the past (Rana R. Ganguly Rajiv, 2019). Solid waste management starts with the collection of solid wastes and ends with their disposal or beneficial use. The government at central, state and city levels have become more aware and pay attention to continuously annoying problem of garbage, initiating various waste management projects and special cleaning drives as well as drafting new policies. Indian cities are still struggling to achieve the collection of all municipal solid waste generated. Quality of solid waste generated by the nation is highly variable and is function of its geographic location, season and economic status. The aim of the work is to analyse the present status and future challenges of solid waste management in Shimla.

Several cities across the world have tried and tested various policies, technologies and conducts for sustainable Municipal Solid Waste Management. Effective Municipal Solid Waste Management procedure consists of six functional elements, which initiates at the time of waste generation and concludes by the time of waste disposal. The six functional elements are; waste generation, at source handling, collection, transport, processing and transformation and disposal (Marshall, R., & Farahbakhsh, k. 2018).

Solid Waste

Any discarded or abandoned materials are solid wastes. Solid waste can be solid, liquid, semi-solid or containerised gaseous material. Examples of solid waste are waste tyres, septage, scrap metal, latex paints, furniture and toys, garbage, appliances and vehicles, oil and anti-freeze, empty aerosol cans, paint cans and compressed cylinders, construction and demolition debris and asbestos.

Types of solid waste

Solid waste is classified into different groups, depending on the source (origin) and property. Based on the origin, solid waste includes household waste, institutional waste, agricultural waste, biomedical waste, municipal waste, and industrial waste. However, according to their property, solid waste could be organic waste, inorganic waste, biodegradable waste, non-biodegradable waste,

hazardous waste, and non-hazardous waste. Other forms of solid waste include plastic waste, radioactive waste, sewage waste, mining waste, and garbageashes waste. The major different types of solid waste are illustrated in Fig. 1 and described in detail below (Bioresource Technology Reports 2023).

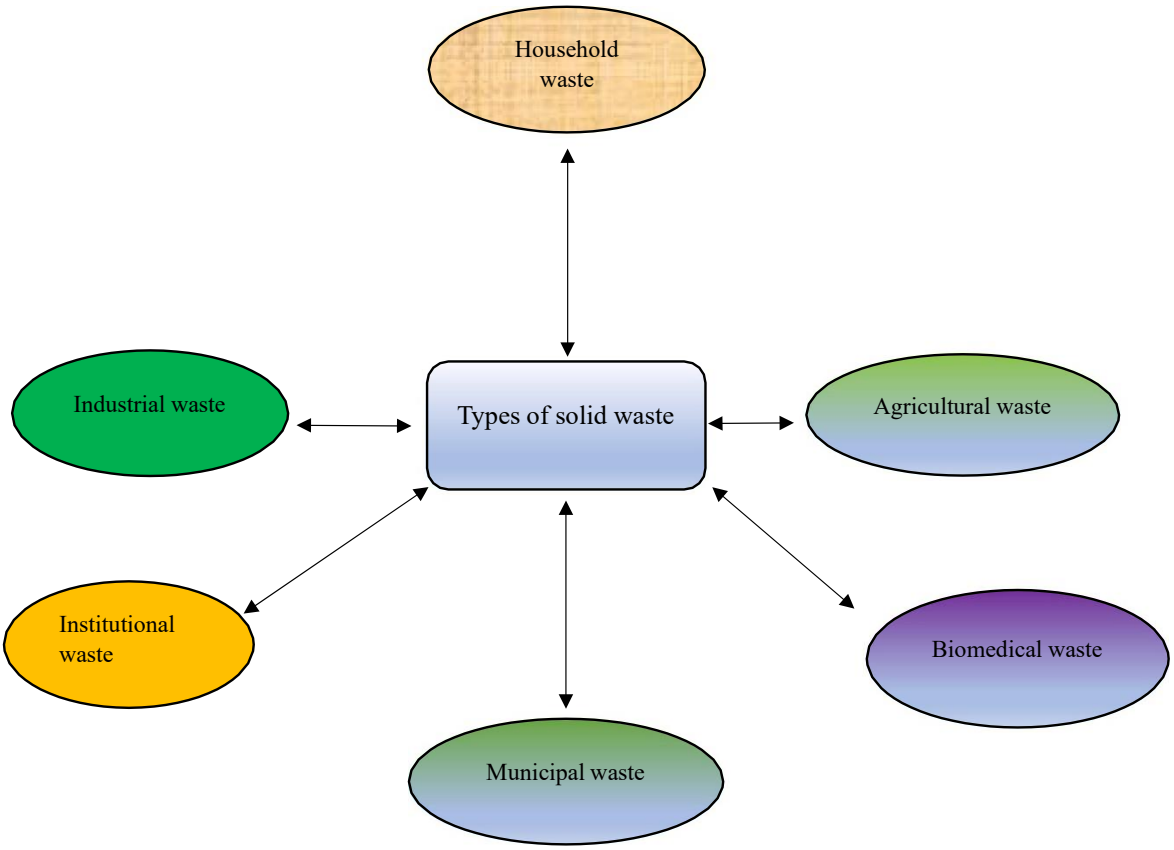

Fig. 1. Schematic diagrams illustrating various types of solid waste.

Municipal Solid Waste Management in Himachal Pradesh

It is the collecting, treating, and disposing of solid material that is discarded because it has served its purpose or is no longer useful. Improper disposal of municipal solid waste can create unsanitary conditions, and these conditions in turn can lead to pollution of the environment and to outbreaks of vector-borne disease that is, diseases spread by rodent and insects. The tasks of solid-waste management present complex technical challenges. They also pose a wide variety of administrative, economic, and social problems that must be managed and solved.

Government of India has launched various initiatives through Ministry of Urban Development for ensuring effective solid waste management at Urban Local Body level. The 74th Constitutional Amendment Act (1992) based National Urban Sanitation Policy (NUSP, 2006) provides draft framework for the states to develop its own state sanitation strategy and City Sanitation Plan based on respective peculiar conditions. Urban Infrastructure Governance component of Jawaharlal Nehru NationalUrban Renewal Mission (JNNURM) gave impetus to achieve overall urban hygiene within a city. The JNNURM programme and the Urban Infrastructure Development Scheme for Small and Medium Towns provide the much needed financial support to the budget deficit ULBs for infrastructure development whereas capacity building initiatives for ULBs are also exercised through thr MoUD support (Municipal corporation online city guide/Shimla).

Background of the sector

The reported generation of Municipal Solid Waste (MSW) in the State of Himachal Pradesh was estimated to be 304.3 TPD in 2011 (CPCB, 2012). The per capita waste generation rate in Himachal

Pradesh is around 0.413 kg/day. It is also estimated that 60% of the waste generated ends up in landfills. Dumping of waste in unscientific manner creates anaerobic condition at thedisposal site which leads to uncontrolled emission of methane which is a greenhouse gas (GHG)like methane. The total GHG emissions from waste sector in Himachal Pradesh is estimated at 6.129 tonnes of equivalent CO2 (Department of Science and Technology, GoHP, 2012). The sewage treatment capacity in Class I cities of Himachal Pradesh is 35.63 MLD and the actual sewage generation rate is of 28.94 MLD (CPCB, 2009). The state generates 42147 MTA of hazardous waste out of which 84.27% is landfillable, 5.33% is incinerable and 10.39% is recyclable (CPCB, 2009). The population of Himachal Pradesh is expected to rise in the years to come and so is the generation of MSW. The urban population in 2011 and the waste generation rate in that year were used to derive the per capita waste generation in H.P. Based on current annual MSW increase rate of 1-1.33% annually (Pappu et al., 2007) and estimates for the urban population projections in the year 2011, 2021, 2031 and 2041 for the State, total amount of MSW generated ispresented in Table 1 below (Jai Kishan Malik, Shri Prakash, 2015).

Table 1: Estimated waste generation in Himachal Pradesh

Himachal Pradesh			
Year	Per capita waste generated (kg/day	Urban Population(x1000)	Waste generated(T/day)
2011	0.413	736.3369	304.3
2021	0.472	883.3212	416.6
2031	0.538	1023.429	550.9
2041	0.614	1155.249	709.6

Source: www.teriin.org

The daily waste generated in the state of Himachal Pradesh is expected to rise by almost 133% by 2041. Even today the state is struggling with waste management and in the coming years the quantum of waste generated is only expected to increase, which will assume a crisis for the urban local bodies in the State.

Historically, the urban local bodies (ULBs) in Himachal Pradesh have worked in isolation without much coordination resulting in little or no treatment of the collected MSW and unscientific disposal of waste at dumpsites. This led to resistance from public and the state government came up with a waste management plan.

Building initiatives for ULBs are also exercised through Mod support. Himachal Pradesh is the least urbanized state of India with 59 urban agglomerations reported by Census Operations (2011). Waste quantities arising in the steadily expanding urban areas of Himachal Pradesh are at much lower rates than the other metropolitan Indian cities. The quantities of municipal solid waste generated in Himachal Pradesh is 300-350 tonnes per day; an insignificant contribution to 100,000- 120,000 tonnes per day produced by the country. Mismanagement of even small wastequantity in fragile ecosystem of Himalayan state may lead to serious environmental and health problems. Various studies have also reported more than 5% annual increase in total quantities of solid waste.

Impacts of Mismanagement of Solid Waste Management

- As mentioned earlier, Municipal Solid Waste Management is a concern across the globe as any failure in its process could lead to serious repercussions. Often improper Municipal Solid Waste Management leads to accumulation of putrefying waste on ground, particularly in landfill sites.
- This situation could lead to several negative impacts. Some of the major concerns possessed by mismanagement of Municipal Solid Waste are briefed below Mismanagement of Municipal Solid Waste could lead to putrefying piles of solid waste in road sides and leachate flow from the heaps could lead to water contamination and associated health risks.
- As Municipal Solid Waste could contain medical wastes generated from houses, its mismanagement could prove hazardous. The primary sufferers would be the workers in the site itself. The presence of untreated medical waste raises the concern of contamination from

infectious components.

- In locations where open dumping or open burning of Municipal Solid Waste takes place, the emission of toxic gases will be more and it could stimulate climate change.
- Open dumping of Municipal Solid Waste possesses increased health risk to the nearby communities.
- Failure in adhering to sanitary safety norms could negatively impact the people, flora and fauna, and the environment as such.

Introduction to the Study Area

Shimla Municipal Corporation is one of the oldest municipalities of India and dates back to 1851. This was the first municipality in pre-Independence Punjab. Today, the Shimla Municipal Corporation has three authorities - the House, the House Committees and the Municipal Commissioner. The House is the legislative wing and consists of Councillors who are directly elected by the people. The House also has a few nominated persons with knowledge or experience of municipal administration. The House is headed by a Mayor and assisted by a Deputy Mayor. The House Committees are created to facilitate the working of the House. The Municipal Commissioner is the administrative head of the Corporation. All executive and administrative powers for the purpose of carrying out day to day functions are vested in the Commissioner. The Commissioner is appointed by the State Government for a designated period of time and is assisted by a Joint or Assistant Commissioner who is also appointed by the State Government to head the administrative staff of the municipal corporation, implement the decisions of the corporation, and prepare its annual budget. The Municipal Corporation carries out its functions through its well-organised divisions or departments, which are headed by the concerned HoDs.

Elected Body

The elected body of Shimla Municipal Corporation has 39 councillors of which 34 are elected, while 5 are nominated by the Government of Himachal Pradesh. The tenure of the elected corporation is five years. Councillors elect the Mayor and Deputy Mayor from amongst themselves for a tenure of two and half years. The House, comprising of elected and nominated Members, takes all policy decisions and meets at least once every month. The Corporation has several statutory and non-statutory functional committees which are represented by Councillors. These set out the obligatory and discretionary functions bestowed upon the Corporation by the 74th CAA. Each committee consists of not less than three and not more than five Councillors including the Mayor or Deputy Mayor (shimlamc.hp.gov.in).

Shimla City/Town Future Population 2021-2031

Shimla City	Population
2011	169,578
2021	220,000
2022	226,000
2023	232,000
2024	238,000
2025	245,000
2026	252,000
2027	259,000
2028	266,000
2029	273,000
2030	281,000
2031	289,000

Source:https://www.census2011.co.in/data/town/800137-shimla-himachal-pradesh.html

Shimla is a Municipal Corporation city situated in Shimla tehsil of Shimla district. The Shimla city is divided into 34 wards. As per the Population Census 2011, there are a total 46,306 families residing in the Shimla city. The total population of Shimla is 169,578 out of which 93,152 are males and 76,426 are females thus the Average Sex Ratio of Shimla is 820. The population of Children aged 0-6 years in Shimla city is 13571 which is 8% of the total population. There are 7179 male children and 6392 female children between the age 0-6 years. Thus as per the Census 2011 the Child Sex Ratio of Shimla is 890 which is greater than Average Sex Ratio (820). As per the Census 2011, the literacy rate of Shimla is 93.6%. Thus Shimla has a higher literacy rate compared to 83.6% of Shimla district. The male literacy rate is 94.79% and the female literacy rate is 92.19% in Shimla. Shimla Municipal Corporation has total administration over 46,306 houses to which it supplies basic amenities such as water and sewerage. It is also authorized to build roads within Municipal

Corporation limits and impose taxes on properties coming under its jurisdiction.

Current estimated population of Shimla Municipal Corporation in 2024 will be approximately 238,000. The schedule census of 2021 for Shimla city has been postponed due to covid. We believe new population census for Shimla city will be conducted in 2024 and same will be updated once it is done. The current data for Shimla town are estimated only but all 2011 figures are accurate.

Objectives of the Study

1. To evaluate the government initiatives regarding solid waste management.
2. To evaluate the administrative efforts for solid waste management.
3. To analyse the community awareness regarding solid waste management.
4. To suggest some measure for the effective solid waste management.

Sampling

For the present study total 100 respondents were selected with the random cum purposive sampling technique. Out of total 34 wards of Municipal Corporation Shimla, 4 wards namely Dhalli, Dhingudhar, Engine Ghar and Benmore were selected randomly. 25 sample respondents were selected from each ward.

Data Collection

For this study data has been collected from primary and secondary resources. The primary data was collected from the tested questionnaire/schedules. The data was also collected through personal interviews and discussion conducted with people.

Data Analysis

With the help of pre-tested questionnaire, the required information was collected from the selected respondents to know their opinion regarding the present problem. The data collected through different modes was analysed with the help of average and percentage.

Table 2-Education wise Distribution of the Respondents

Variables	Frequency	Percentage
Illiterate	0	0.00
Primary	4	4.00
Matric	13	13.00
Senior Secondary	51	51.00
Graduation	26	26.00
Post-graduation & Above	6	6.00
Total	100	100.00

Source: Field Survey

The table 4.4 depicts the educational qualification of the sample respondents. From the total it is clear that 51 per cent respondents were senior educational qualification with senior secondary followed by 26 per cent were graduate, 13 per centwere matric, 6 per cent were Post graduate and above and 4 per cent were primary.

Table 3-Family Size of the Respondents

Variables	Frequency	Percentage
Two	1	1.00
Three	5	5.00
Four	46	46.00
Five	37	37.00
More than five	11	11.00
Total	100	100.00

Source: Field Survey

The classification of the respondents based on size of the family of the respondents shows that 46 per cent respondents were having four family members in their family, followed by 37 per cent were having five family members, 11 per cent were having more than five family members, 5 per cent were having three family members and the remaining 1 per cent respondents were having two family members in their family.

Table 4-How Long Respondents are Living in the Shimla City

Variables	Frequency	Percentage
Less Than 1 Year	0	0.00
1-5 Years	17	17.00
6-10 Years	48	48.00
11-15 Years	23	23.00
More Than 15 Years	12	12.00
Total	100	100.00

Source: Field Survey

From the table 4.6 it is clear that 17 per cent respondents were living in Shimla city for less than one year. 17 per cent respondents were loving in Shimla city for 1-5 years, 48 per cent respondents were living in Shimla for 6-10 years, 23 per cent respondents were living in Shimla city for 11-15 years

and 12 per cent respondents were living in Shimla city for more than 15 years.

Table 5-Have you ever heard about Solid Waste Management

Variable	Frequency	Percentage
Yes	92	92.00
No	8	8.00
Total	100	100.00

Source: Field Survey

It is pertinent from the table 4.12 that 92 per cent respondents were having knowledge about solid waste management and only 8 per cent were not having knowledge of solid waste management.

Table 6-What type of solid waste comes out from your house

Variable	Frequency	Percentage
Paper and Carton	6	6.00
Plastic	2	2.00
Food Waste	24	24.00
Tins/Cans	3	3.00
Fiber Bags	8	8.00
All the above	57	57.00
Total	100	100.00

Source: Field Survey

The data in the table 4.13 reveals that 6 per cent respondents responded that paper and carton are the main source of waste at their houses. 2 per cent respondents responded that plastic is the main source of waste at their houses. 24 per cent respondents responded that food waste is the main source of waste at their houses. 3 per cent respondents responded that tins/cans are the main source of waste at their houses. 8 per cent respondents responded that fibre bags carton are the main source of waste at their houses and 57 per cent respondents responded that all the above mentioned sources are the main source of waste at their houses.

Table 7-In what type of container do you collect waste?

Variable	Frequency	Percentage
Carton	12	12.00
Waste Basket	16	16.00
Old Bucket	48	48.00
Plastic Bag	17	17.00
Tins Bag	7	7.00
Total	100	100.00

Source: Field Survey

It is concluded from the above table that 12 per cent respondents collect their waste in carton, 16 per cent collect in waste basket, 48 per cent collect in old bucket, 17 per cent collect in plastic bags and 7 per cent collect in tins bag.

Table 8-How often the Garbage Collector visit to your house to emptied the wastecontainer

Variable	Frequency	Percentage
Daily	36	36.00
Once in Two Days	32	32.00
Once in Three Days	29	29.00
Once in a Week	3	3.00
Total	100	100.00

Source: Field Survey

It is clear from the above data that 36 per cent respondents opined that the garbage collector visit their house daily. 32 per cent opined that the garbage collector their houses once in two days. 29 per cent opined that the garbage collector visit their houses once in three days and 3 per cent of the respondents opined that the garbage collector visit their houses once in a week.

Table 9-How can you describe the state of the pubic bin near your house

Variable	Frequency	Percentage
Rusting	11	11.00
In a Good State	16	16.00
Adequate Size	23	23.00
Inadequate	2	2.00
Not in a good Condition	48	48.00
Total	100	100.00

Source: Field Survey

A question was asked from the respondents regarding condition of the bin placed nearby their house. 11 per cent opined that the bin was rusty. 16 per cent opined that the bin was in good condition, 23 per cent opined that the bin was of adequate size. 2 per cent respondents opined that the bin was inadequate and 48 per cent respondents opined that the bin was not in good condition.

Table 10-Are you aware about the environmental impact of the solid waste

Variable	Frequency	Percentage
Yes	93	93.00

No	7	7.00
Total	100	100.00

Source: Field Survey

The data in the table 4.19 reveals that 93 per cent of the respondents were aware about the environmental impact of solid waste and 7 per cent respondents were not aware about the environmental impact of the solid waste.

Table 11-Do you know about the waste management centre of Municipal Corporation Shimla

Variable	Frequency	Percentage
Yes	22	22.00
No	78	78.00
Total	100	100.00

Source: Field Survey

The data shows that only 22 per cent respondents were aware about the waste management centre of Municipal Corporation Shimla while 78 per cent respondents were not aware about the waste management centre of Municipal Corporation Shimla.

Table 12-How do you rate the waste management process of Municipal CorporationShimla

Variable	Frequency	Percentage
Excellent	19	19.00
Good	11	11.00
Fair	23	23.00
Poor	47	47.00
Total	100	100.00

Source: Field Survey

The data in the table shows that 19 per cent respondents rate the waste management process of Municipal Corporation Shimla as excellent, 11 per cent respondents rate the waste management process of Municipal Corporation Shimla as good, 23 per cent respondents rate the waste management process of MunicipalCorporation Shimla as fair and 47 per cent respondents rate the waste management process of Municipal Corporation Shimla as poor.

FINDINGS OF THE STUDY

- Out of the total 100 sample respondents, majority i.e., 79 per cent respondents were from 46-60 years of age group. 15 per cent were from 36-45 years of age group, and 6 per cent were above 60 years of age group. 34 per cent male respondents and 66 per cent were female respondents.
- 51 per cent respondents were senior educational qualification with senior secondary followed by 26 per cent were graduate, 13 per cent were matric, 6 per cent were Post graduate and above and 4 per cent were primary.
- 46 per cent respondents were having four family members in their family, followed by 37 per cent were having five family members, 11 per cent were having more than five family members, 5 per cent were having three family members and the remaining 1 per cent respondents were having two family members in their family.
- 17 per cent respondents were living in Shimla city for less than one year. 17 percent respondents were loving in Shimla city for 1-5 years, 48 per cent respondents were living in Shimla for 6-10 years, 23 per cent respondents were living in Shimla city for 11-15 years and 12 per cent respondents were living inShimla city for more than 15 years.
- 92 per cent respondents were having knowledge about solid waste managementand only 8 per cent were not having knowledge of solid waste management.
- 6 per cent respondents responded that paper and carton are the main source of waste at their houses. 2 per cent respondents responded that plastic is the main source of waste at their houses. 24 per cent respondents responded that food waste is the main source of waste at their houses. 3 per cent respondents responded that tins/cans are the main source of waste at their houses. 8 per cent respondents responded that fibre bags carton are the main source of waste at their houses and 57 per cent respondents responded that all the above mentioned sources are the main source of waste at their houses.
- 12 per cent respondents collect their waste in carton, 16 per cent collect in waste basket, 48 per cent collect in old bucket, 17 per cent collect in plastic bags and 7 per cent collect in tins bag.
- Garbage collectors visit to their houses to empty the waste containers.
- 36 per cent respondents opined that the garbage collector visits their house daily. 32 per cent opined that the garbage collector their houses once in two days. 29 per cent opined that the garbage collector visits their houses once in

three days and 3 per cent of the respondents opined that the garbage collector visits their houses once in a week.

- 72 per cent respondents said that there is public bin nearby their house and 28 per cent said that there is no public bin nearby their house. 11 per cent opined that the bin was rusty. 16 per cent opined that the bin was in good condition, 23 per cent opined that the bin was of adequate size. 2 per cent respondents opined that the bin was inadequate and 48 per cent respondents opined that the bin was not in good condition.
- 93 per cent of the respondents were aware about the environmental impact of solid waste and 7 per cent respondents were not aware about the environmentalimpact of the solid waste.
- 22 per cent respondents were aware about the waste management centre of Municipal Corporation Shimla while 78 per cent respondents were not aware about the waste management centre of Municipal Corporation Shimla.
- 19 per cent respondents rate the waste management process of Municipal Corporation Shimla as excellent, 11 per cent respondents rate the waste management process of Municipal Corporation Shimla as good, 23 per cent respondents rate the waste management process of Municipal Corporation Shimla as fair and 47 per cent respondents rate the waste management process of Municipal Corporation Shimla as poor.

Shimla Municipal Corporation is in charge of solid waste management. The Shimla Environment Heritage and Beautification Society (SEHB) was established by the corporation in 2009 to handle municipal solid waste at the ward level. According to the 2011 census, Shimla's total population was 48,940. The city generates 93 metric tonnes of waste per day from various sectors and from its wards. The total amount of waste generated in the city is approximately 18 tonnes per day and 6225 tonnes annually, or roughly 29% of all waste generated in the city. The municipal bins, door-to-door collection, dumping, and partial burning are the methods used to dispose of the solid waste, in the wards the garbage is primarily collected door-to-door. The handling of solid waste presents a range of environmental and health risks. Improper handling can result in severe ecological issues. Therefore, appropriate waste management practices must be used to lessen or eliminate the issues.

Consciously or unknowingly, human civilisation is about to produce an enormous amount of solid waste, which will have a major negative impact on health. The well-known proverb "prevention is better than cure" applies here as well; preventing these behaviours negative effects on environment and living systems is preferable to curing them. However, a competent waste management system and most importantly, public awareness are required for this to be possible. Waste management is a comprehensive system that includes reducing waste generation, collecting, sorting and appropriately transporting it to the recycling centre. The harmful effects of solid waste are not as effectively reduced by typical disposal methods.

SUGGESTIONS FOR THE EFFECTIVE SOLID WASTE MANAGEMENT

Composting, landfill incineration, smart trash bins, recycling, optical routing, plasma gasification, pneumatic waste collection, pyrolysis, waste-to-energy, waste compaction, waste disposal, biogas production, and so on are some of the methods used to handle solid waste. In addition to these solid waste management strategies, there are other useful approaches that communities can use in their daily lives to aid with garbage management without having to pay for them. These are the following:

1. One of the most crucial methods for reducing waste is to refuse. Although it may require some effort to learn how to refuse waste, the best strategy to reduce waste is to incorporate this method into daily life. We can avoid buying wasteful or non-recyclable things. Companies can employ this strategy as well. Businesses can ask for reusable or returnable containers and refuse needless product packaging when negotiating with vendors. Organisations can more easily "refuse" waste by making better purchase selections and establishing guidelines and expectations early on in the process.
2. Use fewer hazardous, unnecessary, and non-recyclable products. Decreased reliance on inefficient products means fewer waste materials wind up in landfills and the detrimental effects they have on the environment. Always use the bare minimum needed to prevent wasting money. To reduce waste production by half, print a document on both sides, for instance. Businesses

should also concentrate on cutting back on single-use plastics, plastic packaging, organic waste, and Styrofoam cups, among other frequently used products.

3. One-time use Plastics have normalised the use of materials once and then discarding them, which has led to the creation of a "throw-away" society. The rate at which we use plastics has reached unbelievable proportions, and the plastic crisis has grown to be one of the biggest environmental issues facing the planet. In a effort to reduce waste, reuse goods across the office instead of buying new ones. Start by concentrating on one aspect of your company at a time, such as the break room. Swap out all of the single-use cutlery, paper plates, water bottles, and Styrofoam cups for reusable or biodegradable ones. Once you have mastered one area, give reusing packaging peanuts, printer cartridges, cardboard boxes, food containers, and rechargeable batteries top priority when it comes to other goods in your organisation.
4. Try finding a new use for every object that cannot be rejected, lowered, or reused. The term "up-cycling" is often used in the green community to describe this technique. Though there are countless options, sometimes ingenuity is needed. Try repurposing printer waste paper as scrap paper, cardboard boxes as supply organisers, binder clips to secure power cords and chargers, and even tin cans, coffee mugs, and mason jars to store pencils and pens.
5. The most environmentally responsible way to dispose of rubbish is through recycling. A significant amount of garbage was eliminated by several business establishments who implemented this strategy and set up an efficient recycling program.

Global garbage management is undergoing a transformation, thanks to a few cutting-edge, contemporary technology. These waste management strategies are:

Smart Trash containers: People frequently neglect to sort their waste into the appropriate trash or recycling containers when left on their own. The Polish business Bin-e created a smart waste bin that automatically sorts recyclables into several compartments using artificial intelligence-based object identification in an effort to eliminate improper recycling sorting. The machine compresses the waste after sorting and keeps track of how full each bin is. Recycling facilities may handle materials more quickly and easily by eliminating human error from the first sorting phase with the use of smart waste bins. This can significantly increase worker productivity and cut waste management expenses by up to 80%.

Waste Level Sensors: To get rid of their rubbish, homes and businesses all around the nation depend on regular waste collection services. Although weekly services have been in existence for many years, they aren't always the best choice. Companies and municipalities can put garbage level sensors in bins or dumpsters of any size to help reduce needless journeys to and from landfills. By gathering and storing data on fill levels, these devices help collection agencies forecast how frequently bins will need to be emptied. This also lessens the chance of nearby areas becoming contaminated by overflowing public containers.

Artificial Intelligence Recycling Robots: Recycling facilities are essential in lowering the quantity of waste that is annually dumped into landfills and waterways. However, many centres are finding it difficult to meet demand because of a diminished workforce brought on by the COVID-19 pandemic. Thankfully, artificial intelligence (AI)-powered recycling robots can assist in making up some of the lost time. By precisely identifying and sorting recyclable items, these robots increase productivity and lessen the need for human labour. Recycling facilities will eventually save money from this, and it also helps divert waste that might otherwise wind up in landfills.

Garbage Truck Weighing Mechanisms: Weighing mechanisms mounted in garbage trucks can assist in anticipating fill levels and minimising collection trips, much like waste level sensors. They accomplish this by weighing waste bins, storing the data, and utilising it to forecast fill levels over time. With the use of this technology, cities may lower their annual collection expenses and more precisely forecast how frequently they need to dispatch their trucks.

Pneumatic Waste Pipes: The requirement for waste management technologies that can handle growing rubbish volumes grows along with urban population growth. By constructing pneumatic garbage disposal

bins that connect to a network of subterranean pipes, several cities are tackling this difficulty. The pipelines carry trash to a garbage collection facility where it is either sorted or removed. By doing away with the requirement for conventional garbage collection, this system lowers energy expenses while boosting overall effectiveness.

Solar-Powered garbage Compactors: Manufacturer Ecube Labs developed a solar-powered garbage compactor that can store up to five times more rubbish than conventional trash bins in an effort to improve collection efficiency and minimise trips to and from the dump. In addition to gathering and transmitting data on fill and collection times to help expedite the collection process, these machines compress trash as it accumulates to maximise bin capacity.

E-trash Kiosks: Improper disposal of electronic trash can have negative effects on the environment and human health. Thankfully, a large number of businesses and organisations have launched e-waste disposal initiatives that will take in and even pay for used electronics. This concept was furthered by ecoATM, a clever recycling firm, which developed a line of e-waste recycling kiosks that let you instantly trade in your devices for cash. Even while they don't usually give money for broken or destroyed electronics, they do accept phones, tablets, and MP3 players in any condition and make sure the materials are recycled correctly.

Recycling App: One of the main problems facing recycling facilities is sifting through polluted waste. Organisations have launched apps like Recycle Nation and iRecycle that make recycling easier for individuals in an effort to decrease the amount of non-recyclable waste that reach these centres. These apps give users access to recycling rates and centre locations, and their extensive material listings assist users in identifying recyclable products.

Global trash production is predicted to exceed 4 billion tonnes by 2050. The recent decades have seen a growth in consumer culture and an increase in urban population, both of which are contributing factors to the rapid ascent that shows no signs of abating. Across the world, communities are utilising intelligent waste management technology and solutions to lessen the burden this is placing on the environment and rubbish collection systems.

CONCLUSION

Solid waste generation is the one of the problem arises from the increase in the population. Huge tons of solid waste is generate daily and stored in the city and resultsin the change in existing land pattern of the town. Large scale urban expansion and population increase is witness in the Shimla city. The municipal limits have expanded tremendously putting extra load on the existing infrastructure. The population of SMC is 16975 8 (census 2011) and the decadal growth rate is 17%. Population growth is no stopped, it will reach to 2, 56,883 in 2021. The predicted population of Shimla city is 4,18,296 in 2041. This increase in population puts extra load on the available resources of the area. The Municipal Corporation of Shimla's unique geographic and demographic setting presents a wide range of complicated challenges for solid waste management. Shimla can, however, improve its waste management procedures with focused advancements in technology, public involvement, infrastructure, and legislation. This study emphasises the necessity of a multimodal strategy to deal with the problems found and guarantee the long-term solid waste management in this lovely hill station.

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