



Urbanization and Solid Waste Management in Varanasi City:Challenges and Sustainable Solutions

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ABSTRACT

Urbanization is becoming a global phenomenon, but developing nations are more affected than developed ones. Municipal solid waste (MSW) generating amounts are impacted by population growth, urbanization, and changing lifestyles, placing pressure on the management system and the cities' capacity to control waste. Waste generation is directly impacted by urbanization, and improper disposal of waste results in environmental damage and health risks. Municipal Solid Waste (MSW) management has become a difficulty in the majority of the world's nations during the past few years. The current study is based on a secondary source of data. The 2011 District Census Handbook is used to compile the population statistics. The findings demonstrate that Varanasi, like other Indian cities, is also having issues with incorrect and insufficient solid waste disposal. The issue of collecting, transporting, and disposing of solid waste is proving to be a tough task for the local civic bodies or the municipal corporation of the city due to the growing population, changing dietary habits, level of living, commodity consumption patterns, and lack of knowledge. This paper presents the current status of solid waste management practices and challenges in Varanasi city. It also provides measures for managing this waste in a healthy and environmentally responsible manner, converting it from waste to a resource.

Keywords: *Municipal solid waste, solid waste management, urban population, disposal of solid waste*

INTRODUCTION

Urbanization is a process in which a growing proportion of the rural population comes to live in urban areas. It's a global phenomenon. It has been driven by some obvious factors like good quality of life, technological changes, economic development, and population growth. Urbanization in India has been a growing trend in the last few decades. The population in cities and towns has been growing faster than the rural population. India has the second largest population in the world, behind China. 68% of its population lives in rural areas, while 32% lives in urban areas (World Bank, 2014). The urban population has been increasing steadily over the last few decades. According to the World Bank, in 1951, only 17.35% of people lived in urban



areas, which increased to 36% in 2022. which means 1 out of every 3 people lives in an urban area (Census of India, 2011). Despite being a low-urbanized country, the urban population of India in 2011, which accounted for 377.1 million, is still more than the entire population of the USA in 2022, which is 333.28 million (US Census Bureau, 2022). A significant number of people are moving to the city area for better opportunities. The rate of per capita waste generation increases due to uncontrolled urbanization and improved living standards. The problem of municipal solid waste (MSW) is becoming more acute day by day and more challenging in India (Vij, D., 2012). Since 2000, the World Bank has spent \$4.7 billion on solid waste management programs worldwide (World Bank, 2020).

The volume and per capita waste generation have been increasing rapidly globally, with religious cities and towns experiencing a worsening situation. Religious tourists generate vast quantities of municipal solid waste. According to UP tourism records, Varanasi city has a population of 1,198,491, and 59,47,355 tourists visited it in 2017. On average, 650 tons of solid waste per day are generated in the city, but only 87% of it is collected for ultimate disposal, and the rest is left uncollected. Managing municipal waste and religious waste at the same time is a big task on the day of festival events (Varshney Shubham 2018).

Most of the solid waste generated in Varanasi city is disposed of as land fill in low-lying areas. Inadequate collection, lack of transportation in some areas, lack of advancements in treatment technologies, and financial shortages in municipalities are other factors for poor solid waste management practices. In this study, comprehensive review of municipal solid waste in Varanasi city has been provided to elaborate current status and to identify problems of municipal solid waste management.

Municipal waste and certain industrial waste have relatively significant environmental impacts. A significant portion of this waste is highly hazardous to organisms, including humans (Misra et al. 2004). Improper disposal and management of municipal waste leads to all kinds of pollution, including air, soil and water. In urban areas, municipal solid waste clogs drains, creates stagnant water for insect farming, and causes flooding during the rainy season.

STUDY AREA

Varanasi is one of the most important and historic city located almost in the middle Ganga valley in the northern plain of India. The city is situated between two mighty rivers viz. "Varuna" and "Assi" and therefore known as Varanasi (Kumar et al., 2012). The city is also called Banaras or Kashi (Singh, 1997). The river Ganga only here flows south to north having the world-famous Ghats (Hamner et al., 2006) on the left bank of the river. Varanasi town lies between the 25° 13'N to 25° 24'N latitudes and 82° 54'E to 83° 04'E longitude. The city is believed to be more

than 3000 years old and considered as one of the oldest living cities of the world. Varanasi located at 76.21m above sea level, spreads over an area of 79.79 sq km. The city is also situated at one of the most important road systems of India since long back. For the convenience of civic administration, the city is presently divided into 90 Wards and 14 sanitary wards. The city is also known for its silk spinning and weaving industries as well as for metal manufacturing industry. As per 2011 Census, Varanasi city has a total population 1,198,491. Population density of the city is 150 persons/ha. About 70.30 percent of the population of city is literate. The sex ratio of the city is found to 887 females/1000 males (Mishra, Rai 2014).

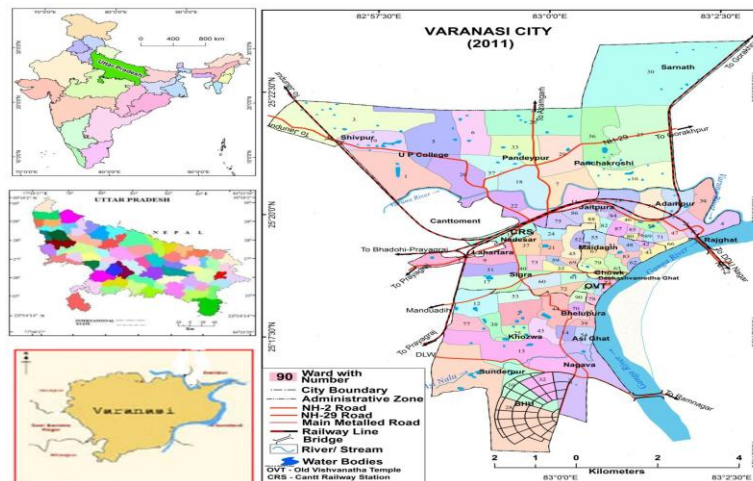


Fig. 1. Location Map of Study Area

OBJECTIVE OF THE STUDY

The main two objectives of this article are to provide a comprehensive analysis of urbanization and waste management in the city. The first is the nature of the urbanization of Varanasi and the resulting production of municipal solid waste; the second is the identification of challenges in solid waste management and the strategies for resolving these issues.

DATA COLLECTION AND METHODOLOGY

The present work is based on the secondary data. A small amount of primary data that was obtained through interviews with Varanasi Municipal Corporation employees and computed for the entire city is also included in the study. The 2011 District Census Handbook is used to compile the population statistics. For the creation of maps for municipal solid waste management, Arc GIS 10.1 software was utilized.

URBANIZATION IN VARANASI

Varanasi is the fifth-largest urban centre in Uttar Pradesh, India. Table No. 1 reveals that Varanasi's population growth rate was negative from 1901 to 1911 (-4.20), and from 1911 to 1921 (-2.89). The drought and famine that occurred at that time were the major causes of this negative growth rate. The rate of population growth in Varanasi city began to rise after 1921 and

was consistent from 1931 to 1961 (+4.46% to +36.82%). The enormous influx of immigrants, particularly refugees from Pakistan and job seekers from nearby rural regions, was the primary cause of the decade 1941–1951's quick growth (32.57%). With the beginning of growth along a planned route after 1951, urbanization's speed picked up. Therefore, the period 1951–1961 saw the biggest increase, or 36.82 percent. Varanasi city's population growth rate during the decade of 1961 was higher than the state's overall growth rate (+16.70%) and Varanasi district's (+19.43%), which stayed at +36.82%. Following this, Varanasi's population growth was seen to slow between the years 1961 and 1991 (+36.82% to +16.6%, respectively. Between 1991 and 2011, there was a slowdown in the growth trend. The 2011 census showed a decrease in population growth rate, which was recorded at +17.15%). It might be caused by a variety of factors, including overpopulation, high living expenses, pollution, declining employment prospects, and high cost of living, on the one hand, and the growth of amenities and new sources of income in rural regions, on the other.

Table 1: Population Growth of Varanasi City (1901 to 2011)

Year	Population	Decadal growth rate %
1901	226105	N.A.
1911	217012	-4.20
1921	210745	-2.89
1931	220143	4.46
1941	278955	26.72
1951	369799	32.57
1961	505952	36.82
1971	635175	25.54
1981	797162	25.50
1991	929,270	16.6
2001	1,091,918	17.5
2011	1,198,491	17.15

Source: Census of India (2011)

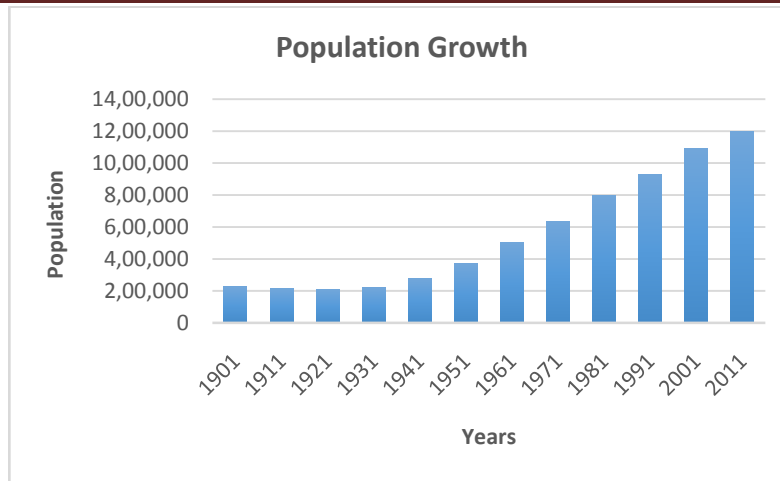


Fig. 2. Year wise Population Growth of Varanasi City (1901-2011)

Municipal Solid Waste – An Outcome of Urbanization

With the ever-increasing population of the city, from 929,270 in 1991 and 1,198,491 in 2011 the amount of solid waste has also been increasing. According to the data provided by the population division of the Vikas Bhavan around 70,000 persons visit the city every day for one reason or the other. Thus, due to the increasing burden on the civic infrastructure, on account of the increasing population, of the city it becomes very difficult for the civic authorities to collect and dispose off all the waste with their meager resources. With increasing population, the amount of generated solid waste has also been increased from 425 tons/day (2001) to 650 tons/day (Varanasi Municipal Corporation, 2011). Here about 70 percent of total generated solid waste is domestic and rest generated from other sources. It is notable that in the city share of industrial waste to the total generated waste is lowest.

Table 2: Estimated Generation of Solid Waste by Different Activities

Categories	Generation amount (tons/day)
Commercial waste/Household	90
Industrial Waste	20
Road Sweeping waste	475
Clinical Waste	25
Nala Cleaning Waste	15
Construction and others	25
Total	650

Source: The study on water quality management plan for Ganga River in republic of India: JICA, NRCD, MOEF, July, 2005.

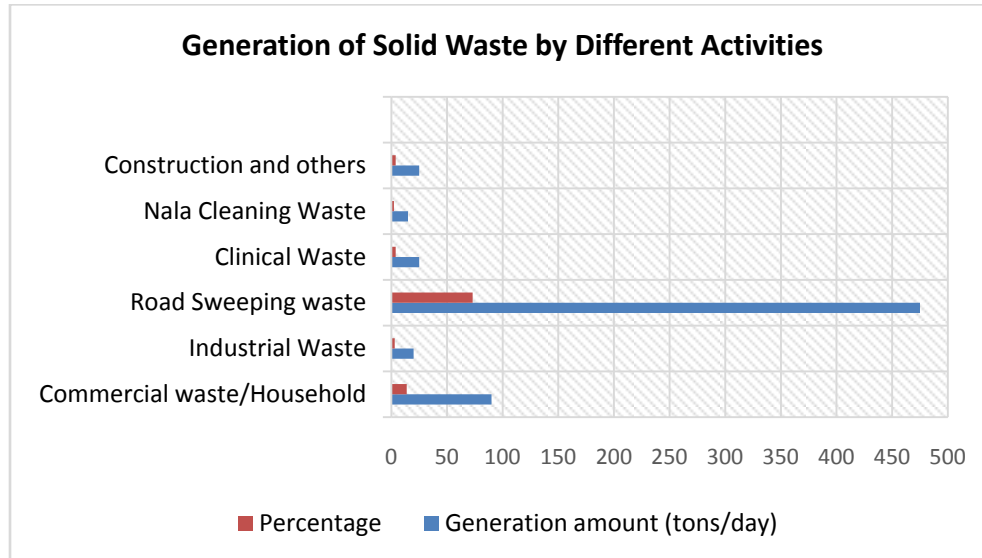


Fig. 3. Estimated Generation of Solid Waste by Different Activities

The ward wise generation of municipal solid waste is minimum in Birdopur ward while it is maximum in Shivpurwa ward. Sanitary ward wise generation of municipal solid waste has been shown through Jaitpura sanitary ward generates 74.58 tons per day which is maximum in quantity and Nadesar sanitary ward generates 24.12 tons of solid waste per day which is minimum in quantity. Though Dasashwamedh sanitary ward is comparatively smaller in area than others; generating higher quantity of solid waste (49.95 tons).

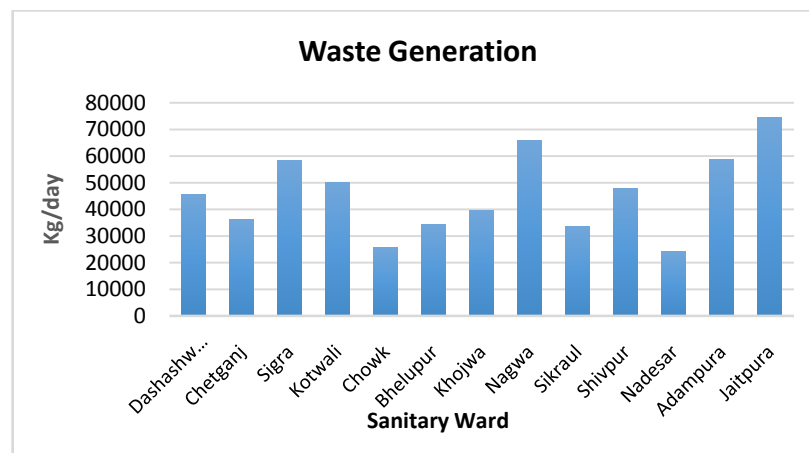


Fig. 4. Ward wise Generation of Solid waste in Varanasi City

Table 3. Overall Waste Generation Composition in the City

Waste Type	Percentage (%)
Biodegradable	51.25
Recyclable	15.30
Other Waste	33.45

Composition of Recyclable Waste

Waste Type	Percentage (%)
Paper	32.8
Polythene	25.6
Plastics	7.3
Glass	5.7
Metals	5.8
Miscellaneous	22.8

Source: Municipal Corporation Varanasi

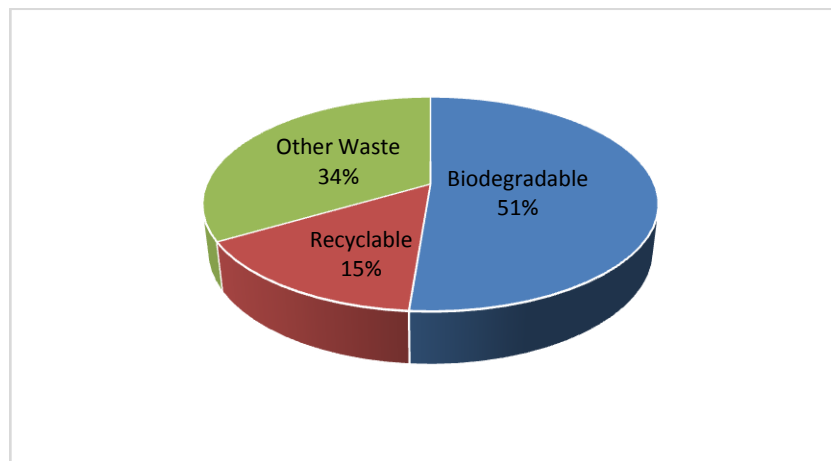


Fig. 5. Physical composition of waste

Challenges in Waste Management:

Several significant concerns of solid waste management in Varanasi include:

- Waste is not being separated at the source. There isn't a suitable mechanism in place right now for the collection and transportation of waste. Every day, 75% of the waste is transported by primarily unregistered trucks.



- The door-to-door collection facility has been withdrawn due to contract termination, with waste being collected from secondary points by Varanasi Municipal Corporation and transported to dumping grounds. Workers' health is at risk since loading and unloading are entirely manual tasks.
- Cleaning the city of Varanasi is challenging due to a shortage of workers for cleaning the roadways.
- There is currently no winning condition when it comes to solid waste management in the city. In order to facilitate the regular primary collection operation, VMC has not supplied a suitable number of dustbins for the storing of both wet and dry waste.
- The current study shows that a municipal corporation's lack of modern equipment and well-trained people make it impossible for it to satisfy the demands of an expanding population.
- An adequate institutional organization and technical knowledge are lacking. At Ramna dumping ground, waste is being disposed of without any competence, beneath the open sky. Neither the equipment nor the management of the current landfills is adequate. There is currently no scientific garbage disposal facility or waste treatment available in the Municipal Corporation.
- There is insufficient community involvement in waste management and maintaining hygienic conditions.
- Lack of awareness has led to citizens' indifference towards waste management.

Policy recommendations to enhance urban solid waste management:

The following policy recommendations for improved solid waste management in Varanasi city can be made based on the study's findings.

- The optimal approach to waste management is to separate it at the source. It would be easy to handle and manage waste if it were separated into different bins according to its generation point for biodegradable, non-biodegradable, and hazardous materials
 - The transportation of waste to landfill sites should be handled by appropriate vehicles that are specifically built for this purpose. This will prevent any waste from becoming scattered before it reaches the landfill sites.
 - Additionally, it is recommended that regular, pre-planned scheduling and collection of solid waste be used to organize house-to-house collection.
 - In order to prevent waste from being accumulated or thrown around by residents or waste collectors, door-to-door collection systems should be promoted as often as possible.
 - Local government agencies must inform the public about the importance of maintaining clean public spaces, neighbourhoods, and surrounds. To increase the effectiveness of MSWM, efforts should be made to involve the public and private sectors through NGOs.
 - VMC should implement door-to-door campaigns and engage ULB (Urban Local Bodies) employees in order to raise awareness about hazardous waste.
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- An additional component of MSWM is data management. Real time data will improve the tracking of how well options for final disposal, transportation, processing, and collection are working. In this regard, the geographic information system (GIS) and the global positioning system (GPS) are crucial tools. These technologies are useful for acquiring, storing, analysing, and visualizing spatial and attribute data.
- Reuse and recycling should be the foundation of waste management strategies, beginning with the production and distribution phases of economic activities.
- The recommended course of action for improper management of organic waste is to encourage home composting techniques and build connections with centralized composting facilities and bio-methanation plants.
- Establish monitoring mechanisms, enforce twin bin systems at markets, and maintain regular cleaning.
- An open dump or an uncontrolled waste disposal area should be rehabilitated. A gradual transition from open dumping to sanitary landfilling is advised. Only non-biodegradable, inert waste and other waste that is unsuitable for biological processing or recycling should be disposed of in landfills.
- Lastly, it is proposed that the primary obstacles to urban solid waste management are a lack of resources, including funding, infrastructure, appropriate planning and data, and leadership, and that these issues need to be successfully resolved.

Conclusion

The rapid population growth and inadequate management of Varanasi's municipal solid waste pose significant challenges. This poses a risk to public health and the spread of infectious diseases. To address these issues, the city must find sustainable solutions and address the negative effects of waste on development. A sustainable waste management system should consider environmental, financial, social, institutional, political, and legal aspects. Integrating modern waste management practices with community involvement, public awareness campaigns, and efficient infrastructure development can lead to a cleaner, greener, and more sustainable future.

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