

Factors Affecting the Generation of Solid Waste in Human Settlements in India: A Review

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Abstract

Solid waste management is considered a serious issue all over in India and particularly so in the cities and the vernacular informal settlements. In order to effectively manage them, it is essential to ensure productive methods for estimating the types of solid waste, quantities, nature of presence and ways of collecting and processing. This paper examines different factors that affect solid waste generation in India. It explores the relationships between income, education, occupation, lifestyle, urbanization, population density, infrastructure, and climate, and their impact among other factors on waste generation.

It begins this exploration by employing a document survey and analysis of relevant past research studies, reports, and data which have examined the factors influencing waste generation. In so doing, it intends to contribute to a preliminary understanding of generation of waste in the human settlements and ways to dispose them so that, India can have a cleaner and healthier environments across cities, and informal settlements.

The conclusions offer ways of developing effective waste management strategies that can reduce the environmental impact of solid waste generation.

Keywords: Solid waste, Management, Sustainability, Socio-Economic aspects, Spatial qualities, Quantification of Waste.

Introduction:

Waste is considered a major environmental and public health-related issue especially in developing countries (Ziraba, Haregu & Mberu, 2016). The problems are highly related to generation of solid waste because they need to be managed through proper systems and disposed. Most waste is generated by households in cities, although villages and informal settlements also produce waste. Various studies on the issue of the generation of solid waste have found that they are related to the demographics, use of land, social status and wealth levels, locations of the settlements, nature of the communities and the social changes. Many have also described the inter-relationship between household solid waste generation and socio-economic factors (Beigl, 2004).

In terms of economics, it has been found that agglomeration of household waste depends mainly upon the income levels, sizes of households and attitudes of people. They also result often from the refusal of fees for the services, refusal to follow packing and collection and varying patterns in different cultures. While there are ample spaces in vernacular settlements to dispose waste that may perish in natural surroundings, the situation in the urban

spaces are critical. On the one hand, there is no space. On the other, there is a huge quantity generated daily. Vernacular settlements and informal settlements are specially vulnerable because often, there are no municipal systems to collect waste, and even if there is, people find it hard to afford them.

In this context, this paper examines the factors affecting the generation of household waste in settlement spaces in India. The aim is to explore the relationship between different factors and their impact on solid waste generation. Its objectives are:

- To identify the socio-economic and spatial factors that affect solid waste generation.
- To identify specific social and spatial factors.
- To evaluate the processes suggested by experts.

Theoretical Framework

Waste refers to any material, substance, or by product that no longer wanted, or deemed unusable and therefore is discarded. There are different types of waste, such as general solid waste, green waste and recyclables. Solid waste is of different types such as municipal waste, commercial, agricultural, medical, construction and demolition waste etc. Solid waste management involves establishing the interconnected elements that influence waste production in order to process and dispose them. Three factors are generally recognised as being instrumental in the generation of waste: Social, Spatial and Systems. According to the current understanding from literature following aspects signify the interconnectedness and mutual influence of these factors.

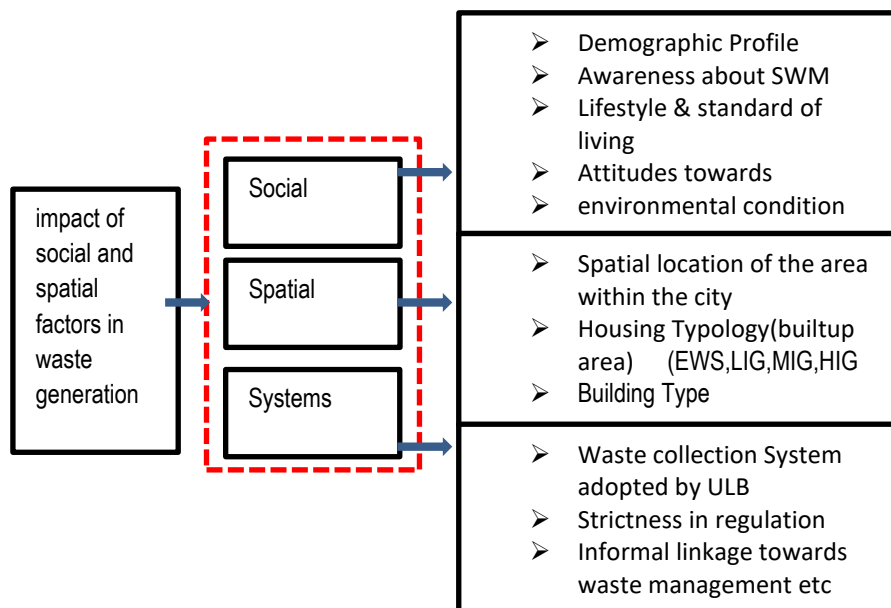


Fig.1: The main categories of factors influencing solid waste management
Source: Author

It is predicted that, if current practices continue, the total global waste produced will reach 46 billion tons by 2050. In contrast, municipal solid waste (MSW) makes up a smaller fraction, fluctuating between 2.3 and 3.1 billion tons (with an average of 2.7 billion tons) in 2019. Municipal waste is the highest in quantities in most cities of the world. Managing them is a very challenging task for the urban planners and decision makers (UNEP, 2015). Therefore, the United Nations (1992) setting out the agenda 21 concerning the environment and development stresses that sound solid waste management is essential to make safe disposal of them. It also stresses on reducing waste by maximizing recycling and reusing methods (Gde, dos & Rocha, 2014).

To achieve this, it is necessary to know how Municipal waste is generated, where and by whom: cities, informal settlements, villages and vernacular settings. Undeniably, it will help provide a direction on the quantity and type of solid waste and their creation enabling capacity building by identifying the social and cultural practices that affect the generation of waste.

Municipal Solid Waste Management in India

Compared to the developed countries, the composition and quantity of solid waste in developing countries show variations. For example, a major portion of waste in India is biodegradables and food waste. Nevertheless, there is no effective waste quantification or management system implemented by the municipalities In India. Limited facilities and exact quantity of waste for waste processing and recycling is a major problem in most of the cities. As Chatterjee (2016) points out, many waste disposal sites are also overloaded. Needless to say, proper waste segregation at the source is a critical aspect of MSW management. It is difficult to carry out efficient management without having an accurate method that provides a correct estimation of the type, quantity and distribution of solid waste effectively (Narayana, 2009).

Factors Affecting Waste Generation

According to current understanding, following aspects affect the generation of waste in human settlements: socio economic factors, spatial factors and management systems.

Socio economic factors

1. Impact of Income on Waste Generation

The income levels of people and households have been found to have a significant impact on the amount of solid waste generated. People with higher income levels are generally associated with increased consumption and therefore, higher waste generation. In this connection, Beigl (2004) shows a positive correlation between income and waste generation, with affluent households producing more waste than the low-income households.

2. Impact of Education on Waste Generation

Education levels have also been found to influence solid waste generation. This comes from the fact that people with higher levels of education tend to be more aware of environmental issues and are more likely to engage in sustainable behaviors, such as reducing waste generation. In this regard, Khan (2016), shows that education is negatively correlated with waste generation, with individuals with higher education levels generating less waste than those with lower education levels.

3. Impact of Occupation on Waste Generation

Occupation is another socio-economic factor that has been found to affect solid waste generation. People in certain occupations, such as healthcare, hospitality, and food service, generate more waste than those in other occupations. However, the relationship between occupation and waste generation is complex and varies depending on the specific industry and job type.

4. Impact of Lifestyle on Waste Generation

In fact, lifestyle factors such as diet, shopping habits, and leisure activities also impact solid waste generation. For example, people who consume a lot of packaged and processed foods generate more waste than those who consume fresh and locally sourced food. Similarly, as Fan Klemeš & Chew (2021) point out, people who engage in activities such as shopping for non-essential goods or frequent travel generate more waste than those who prioritize sustainability in their leisure activities .

Spatial factors

1. Land use

The use of land and its parameters to create solid waste is attempted for the residential use of land which is not considered only factor but also includes other factors like household size, income that also depend on the typology of housing, area of the floor of Residence and lifestyle only. The area of the plot be an indicator of the number of occupants in a residence. Larger residences may accommodate larger families or multiple households, which can lead to increased waste generation due to higher consumption levels.

2. Impact of Built Density on Waste Generation

Population density is another spatial factor that affects solid waste generation. Higher population densities generally lead to increased waste generation due to the higher concentration of economic activity and consumption. However, the impact of population density on waste generation varies depending on the specific context, such as the level of infrastructure development and waste management practices (Chithra, 2016).

3. Building typology

Quantity and composition of solid waste can be identified through the types of buildings. The previous research considering empirical and geospatial analysis based on building type such as detached & semidetached house, multi storied housing type gave a effective quantification method.

Waste Management Systems

1. Lack of sufficient infrastructure

It is reported that municipal waste management system in India is highly burdened and could not undertake more responsibilities. Ferronato & Torretta, (2019) point out that there has been an increase in the demand for solid waste management activities in urban as well as rural regions but due to lack of sufficient manpower, the services provided by municipal bodies could not be extended to many regions. In fact, there is a lack of sufficient infrastructure like garbage trucks, landfills, and resources to fulfil the increasing demand for solid waste management. Narayana (2009) says that in such conditions, people are forced to throw garbage in open places that make the neighbourhoods unhygienic and filthy. It degrades the living conditions of people and the settlements become prone to diseases and pollution.

2. Rules and strictness adopted by Urban Local Bodies (ULB)

Approaches and overseeing of waste management systems by the urban local bodies play an important role in managing solid waste. Abdulredha, et al. (2020) point out that “user fees” and “spot fines” rules have been newly introduced for littering and segregation by the ULB for mandatory segregation of waste at household levels and for cleanliness of the surroundings. However, factors such as the norms and habits play important roles in adopting recycling behaviour by a person.

3. Informal sector

Inclusion of informal sector plays an important role in waste management due to their contribution in collection processes (Gonçalves et al. 2018). However, most of the authorities do not formalize their role in Solid waste management (SWM). While the informal sector plays a crucial role in waste management, there are challenges associated with it. Informal waste workers often face poor working conditions, low wages, health risks, and limited access to social protection. Integrating the informal sector into formal waste management systems, providing training, infrastructure, and legal recognition contribute to these issues while maximizing the potential for sustainable waste management.

The theoretical discussion above establishes that there are a multitude of aspects that affect generation of waste. There are also many factors that contribute to effective waste management. This paper takes the position that human settlements, to be livable need to look at the production and disposal of waste generated on a daily basis with a proper theoretical foundation. It is by doing so that proper, culturally compatible and efficient systems of waste management can be implemented in cities, villages and vernacular settlements alike. If it not done so, India with such a massive human population will turn out to diminish the quality of life in its human settlement spaces, whether urban or rural.

Research Methods

This research examines the factors affecting the generation of household waste in settlement spaces in India with the aim to establish the relationships between different factors and their impact on solid waste generation. It employed two research methods. First, it carried out a document survey. 18 documents were examined.

It also employed interviews: a form of survey of opinions to gather the views of experts.

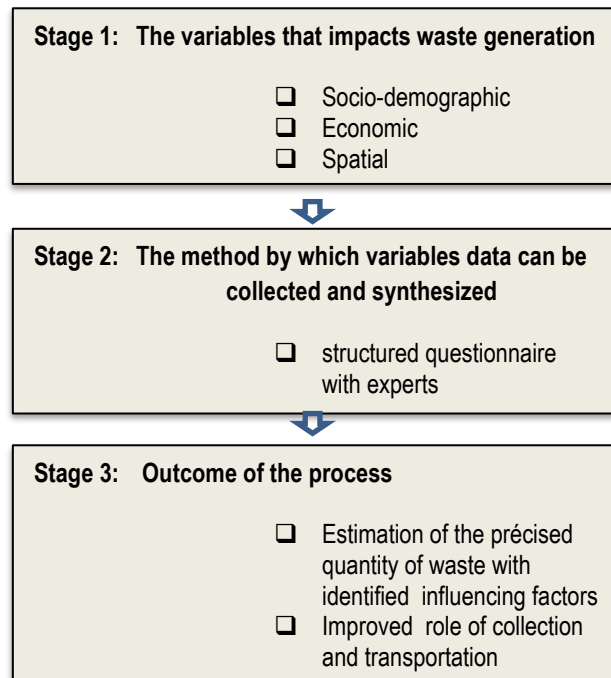


Fig 2: Flow chart of the Methodology

Source: Author

Interviews: Expert Opinion Survey

A survey was conducted to gather insights and perspectives from individuals who have specialized knowledge and expertise in a field related to waste and waste management. The survey was aimed to capture the opinions, judgments, and insights of experts. The experts comprised of urban planners, infrastructure planners, academics, a SWM Consultant Company, ward councillors, supervisors and some stakeholders of SWM. They were interviewed through a structured questionnaire. The factors which were identified through literature were verified and rating given in terms of its feasibility of getting data, relevance in SWM system and applicability in other areas. Some of the observations or opinion taken regarding different factors are listed below.

Findings 01: From the Document Survey

18 documents were examined. The following list mentions the documents and the factors that they mentioned as having a strong influence on waste generation.

Table 1: Factors influencing solid waste generation

Source: Author

| DOCUMENTS EXAMINED | DESCRIPTION OF THE ASPECTS REFERRED TO | FACTORS | CATEGORY |
|--|---|--------------------------------------|--------------------------------|
| Beigl, (2004) Intharathirat & Salam, (2015) | Population density, household size, individuals in a dwelling; age, gender, income, and ethnicity of the people | Demography | Social |
| Buenrostro, et al. (2001) | A particular group of people with same races, religious and origin that may have different culture from other groups of people of a country | Ethnicity | |
| Dyson & Chang (2005) | Social behaviour, beliefs, traditions of a particular group of people | Culture | |
| Triguero et al. (2016) | Willingness to segregate waste at the household level, cleanliness of the surrounding open spaces | Attitudes and behaviours | |
| Kahn et.al. (2016) | Spatial data/land use map, Nearness to the CBD, major markets | Location of the area within the city | Spatial |
| Vetter-Gindele et.al, (2019) | built up area, housing type | Housing Typology | |
| Chithra (2016) | Type of use of land (residential, commercial, institutional and others) | Land use | |
| Vetter-Gindele, Braun, Warth, Quynh Bui, & Bachofer (2019) | Detached, semi-detached, row housing, multi-storey apartment etc. | Building Type | |
| Mukhtar, Williams, & Shaw (2018) | Collection coverage, collection system | Waste collection System | Waste management system |
| Jones et al. (2010) | Efficiency, human resource | Available infrastructure | |
| Mukhtar, Williams & Shaw (2018) | Strictness, fine charges | regulation | |
| Mukhtar, Williams, & Shaw (2018) | Segregation process, taxation, campaigns | Waste Management Issues | |
| Kahn et.al. (2016) | Frequency and amount of waste collected by the informal sector | Informal sector | |
| Jones et al. 2010 | Rewards offered for appropriate or desired actions | Incentives | |
| Pickerin and Shaw, (2015), Emery et al. (2003) | Visual condition of neighborhood is affected by improper solid waste dumping | Visual quality | Environmental |
| Siddiqua A. et.al. (2022) | Air quality of the neighborhood | air quality | |
| Ejaz et.al. (2010) | Vehicle and pedestrian movement | Street Condition | |
| Ejaz et.al. (2010) | Blockage of drains due to dumping of solid waste | Waste water drain condition | |

Table 2: Expert's opinions on the factors
Source: Author

| Factors | Responses | Inferences |
|--|-----------|---|
| Demographic profile (Age, gender, education, occupation, monthly income, ownership status, duration of stay in that place) | | The demographic factors were rated high in terms of feasibility and applicability of the data in different areas. |
| Attitude towards environmental condition (willingness to segregate at household level, cleanliness of the surrounding open space) | | Attitude towards environment condition was found to be one of the important factors for waste management. It was rated high in terms of feasibility, relevance and applicability of the database. |
| Awareness about SWM (Knowledge, response, perception & information on SWM) | | Awareness of SWM is also rated high; that is people who have awareness tend to generate less waste and also participate in waste segregation. . |
| Housing Typology (Private housing, Government housing, Apartment, Mixed Use (residential/commercial)) | | According to the majority of the experts housing type is very much feasible to get the data. |
| SWM ISSUES (Segregation process, taxation, campaigns, fine charges) | | According to the opinions, SWM system by the local authority plays important role in SWM. In terms of feasibility and relevance and applicability it was rated high. |

Discussion

According to the experts, there were 5 main factors such as demography, attitudes towards SWM, awareness about SWM, and housing typology which were found significant in determining the quantity of the generation of waste. These factors were verified in terms of the feasibility of collecting data, relevance to the study and applicability in the context of the site of waste generation.

Demographic factors were found to be most feasible in collecting data, but rated low in terms of applicability. Attitude towards environmental condition was given the highest ranking by the experts in terms of feasibility of data as well as applicability. Awareness of people is rated low in terms of data feasibility and applicability in determining the waste generation. Housing typology received low rating towards feasibility, relevance and applicability. Solid waste management and its related indicators are found higher in terms of feasibility, relevance and applicability of the data.

Conclusion

It is noted that both the examination of documents and the opinions survey through the questionnaire produced similar outcomes. They divulged and confirmed that the generation of waste is dependent on two main factors: Social aspects of the people such as demography, Spatial aspects such as housing conditions, housing density etc. Waste management however is dependent on the attitudes people have as well as the systems of waste management available.

It also divulged that the current system practiced in India which is merely a general calculation without identifying the amount of wet and dry waste of data based on solid waste quantity does not provide a clear picture of the quantity of waste generation. In most of the urban local bodies, there is a lack of a database on waste production, that include different influencing factors such as awareness, attitude and other waste management issues. No proper management of waste can be done without such details.

Solid waste collection and disposal method are also dependent on the quantity of different types of wastes. Often, waste quantification using social and spatial parameter are studied in discrete ways but not integrated by which more realistic data of municipal solid waste can be generated. The expert interview identifies the importance of those factors considered.

This study has weaknesses in terms of not focusing on any particular type of settlement system such as the urban settings, rural settings, informal settings and vernacular settings. Such a focused study would have produced more clear relationships between the aspects and water generation and management. Nevertheless, this study identified relevant influencing factors, and their level of significance by statistical analysis and results can be utilized for preparation of predictive model for calculation of accurate waste quantities in human settlements in India.

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