



“A Literature Review on Solid Waste Management: Characteristics, Techniques, Environmental Impacts and Health Effects in Aligarh City”, Uttar Pradesh, India”

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Abstract. India is known as one of the most heavily settled countries in the world. It appears to be the second country to have the highest number of residents. With the total population of about expected data 1.37 billion in 2019. The management of Municipal Solid Waste (MSW) in India has encountered problems. Each year, the population grew by 3–3.5%, as this factor arises, the rate of solid waste generation also rise up to 1.3% in Aligarh city, Uttar Pradesh a large number of ingenious factors like, rapid urbanization, rapid population density, rapid commercialization, uneven living standards and also enlargement of industrialization has created destructive consequences in terms of biodegradable and non-biodegradable waste generations which are estimated at about 415 tons per day.

This paper emphasizes the waste characteristics, techniques, adverse environmental impacts, health risks, poor waste management practices and also problems associated with the solid waste management system at the municipal level.

The findings from this study indicates failure of the existing facilities due to lack of concern, high volume of waste generation, deficient collection space, delayed sanctioning of new landfill sites and a number of open-dump sites which generate fires. The innuendos of the waste management practices in the city are discussed.

Keywords: Sources of M.S.W · Component of M.S.W · Health risks and sustainable approaches

1 Introduction

“Let us keep our city clean”

In recent years fast population growth, increase in urbanization and industrialization in India has created severe problems for solid waste management in cities. The increased level of consumption characteristics of the population of cities lead to generation of enormous quantities of solid waste material. The impacts of such pollution are felt both at local, as well as, at distances from sources. Domestic and industrial discharges lead to contamination of air, eutrophication with nutrient and toxic materials which in turn lead to degradation of air, land and affect flora and fauna badly. Since olden times municipal bodies remained responsible for keeping the roads clean, collect city garbage and to carry out its safe disposal. Most of the elected bodies of the Indian cities employ largest number of employees for the purpose of cleaning the city, but only 50–70% of the waste generated is collected by the staffkeeping aside the tendency of nonworking of the employees. Many estimates of solid waste generation are available but on the average it is projected that under Indian conditions the amount of waste generated per capita will rise at a rate of 1–1.33% annually (Shekdar 1999). So, at present if we follow this presumption the calculated per capita waste generation on daily basis is 583.36 g in 2016. At such a stage solid waste generation will have significant impact in terms of land required for disposal of waste as well as methane emission. Such a large quantity of solid waste requires well managed system of collection, transportation and disposal. It is required that we have proper knowledge about the nature of waste material, its collection and disposal along with recycling and energy generation potential. The traditional routine approach to solid waste management is normally municipal bodies handle all aspects of collection, transport and disposal and this has emerged as a reality of mixed success all over the world in advanced or developing cities. The search for more efficient and economical solid waste collection agenda in most of the urban areas has taken shape adopting several directions towards better partnership with communities along with private sector combining adequate economic policies, e.g., recycling credits by paying the recycler, land-fill disposal levies at land-fill sites designed to minimize the quantity of waste being land-filled and product charges like packing tax to disallow over-packaging. Cities have a wide variety of arrangement under their control to lessen environmental burdens. Legal approach and restrictions on the quantity of pollutants a factory can discharge of minimum air and water quality standards are being particularly proved effective in monitoring pollution in many parts of the globe. The efficiency depends mainly on good enforcement capacities and proper monitoring procedures where urban growth pressures and pollution issues are far greater. The present scenario of solid waste management in Aligarh city shown in Table 1.

Table 1. The present scenario of solid waste management in Aligarh city.

Functional element	Detail
Segregation of storage at source	Generally absent, waste is thrown on streets
Primary collection	Does not exist, waste is deposited on the streets and picked up through sweeping
Waste storage deposits	Very unscientific, waste is stored on open sites/ Masonry enclosures. A few containers are however, in use
Transportation	Manual loading is open trucks/ Partly dumper placers
Frequency of removal	Irregular/Alternate day/ Once in three days/ Once in a week
Processing	No processing is carried out except A to Z municipal power plant
Disposal	Unauthorized dumping in open space

(Source solid waste management, NEERI vol. 35, 2004).

2 Study Area

The Aligarh is an ancient city in the north Indian state of Uttar Pradesh is situated in the middle of doab-the land between the Ganga and Yamuna rivers, at a distance of 130 km Southeast of Delhi on the Delhi- Howrah rail route and the Grand Trunk road. Aligarh lies between latitude $27^{\circ} 54'$ and 28° north and Longitude is 78° and $78^{\circ} 5'$ east, shown in Fig. 1. The Aligarh city is spread over an area of about 36.7 km^2 . The area lies between the Karwan River in the west and the Senger River in the east and is a part of central Ganga basin. It is the administrative headquarter of Aligarh division. Aligarh is mostly known as a university city where the famous Aligarh Muslim University is located. The Aligarh city is an important centre of lock smithy and brassware

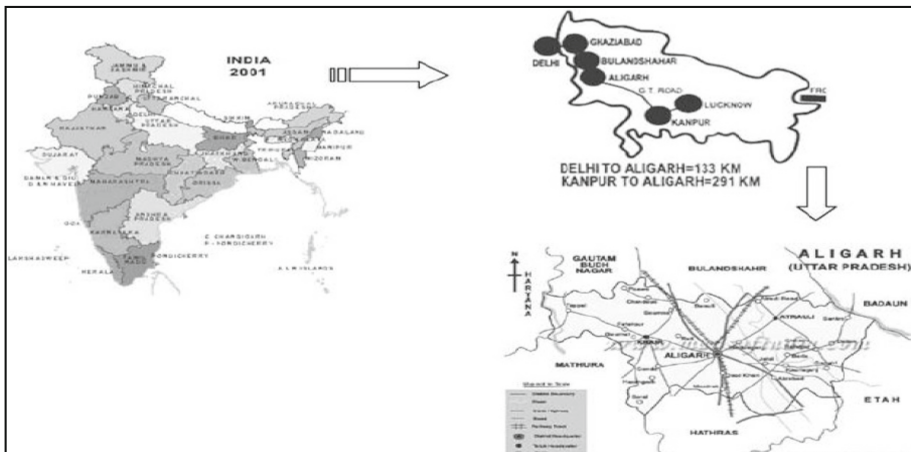


Fig. 1. Location of the study area (Aligarh city), Uttar Pradesh, India.

manufacturing. There are a total of 5506 industrial units in Aligarh city, of these; there are 3500 small scale industries, 2000 medium scale 6 large industries.

3 Objectives

The purpose of this study is to assess the current practices and state of solid waste management systems (SWMS) in one medium-sized Indian town, identifying main issues and problems to its ineffectiveness, inefficiency and to gain some suggestions and recommendations to improve the SWM infrastructure and practices in such Indian towns. Municipal solid material generation and their disposal is a major and critical issue in almost all municipal cities of India. It can harm local environment, as well as, pollute underground potable water. It may also become responsible for dissemination of various diseases in urban areas and its peripheries. Present investigation has been planned to include the target of municipal solid waste management by reducing the quantity of routine production of waste and proper disposal of waste along with recovery of materials and energy from solid waste. All such practices do not have much requirement of any kind of specific raw material and energy inputs technological processes. The proposed investigations have the following objectives of the study for proper management of municipal solid waste in Aligarh city:

- (1) To estimate quantum and prevailing treatment practices of municipal solid waste in study area.
- (2) To analyze various properties and environmental impact of municipal solid waste in study area.
- (3) To develop strategies for suitable collection, segregation, recycling treatment methods for municipal solid waste in study area.
- (4) To assess the use of municipal solid waste through eco-friendly methods and application of municipal solid waste for different uses in study area.
- (5) Develop strategy for mitigation of carbon-di-oxide potential through municipal solid waste disposal methods with the updated data in study area.

4 Scope of the Work

1. The study involves door-to-door survey in the residential area of the Aligarh city.
2. The primary data collection including: -

- Generation of the solid waste in the Aligarh city.
- Source of the solid waste in the Aligarh city.
- Quantity of the waste generated in the Aligarh city.
- Health Status of the city in the Aligarh city.
- About the disposal methodology of the waste in the Aligarh city.
- Help in the comparison of the previous data.

4.1 Methodology

A medium size city, Aligarh, having a population estimate 1.36 million in 2019, and situated 130 km from the capital city of India, Delhi, was selected for this study. An extensive literature review was conducted to establish a theoretical framework. Field visits were conducted to collect the primary data and to understand the solid waste management of the city.

5 Effects on Poor Waste Management

Health issue is the major problem in India as many of the disease came from the pollutions made by them Health issue arise due to poor waste management in study area for example is malnutrition, especially the children which is the condition that develops when the body does not get the right amount of the vitamins, minerals, and other nutrients it needs to maintain healthy tissues and organ function. (Medical dictionary, 2012) Furthermore, health issue such as dengue, fever, Hepatitis, tuberculosis, malaria, pneumonia, and also poor sanitation due to poor waste management. Due to poor waste management by the authorities, availability of clean and safe water is minimized because of people threw rubbish at the river and the quality of living will decrease.

6 Technique Action

6.1 Municipal Solid Wastes Collection

State government should enforce new strategies which prohibit littering of municipal solid waste in cities towns and urban areas. The following steps shall be taken by the municipal authority.

1. **Organizing house-to-house collection of municipal solid wastes:** Through any of the methods, for example community bin collection (central bin), house-to-house collection, collection on regular pre-informed timings and scheduling by using bell ringing of musical vehicle (without exceeding permissible noise levels), Planning a systematic way and united effort for collection of waste from poverty areas or localities including hotels, restaurants, office complexes and commercial areas. Bio-medical wastes and industrial wastes shall not be combined with municipal solid wastes and such wastes should follow the rules separately specified for the purpose. Horticultural and construction or demolition wastes or debris shall be separately collected and disposed off following proper norms. Similarly, wastes generated at dairies shall be regulated in accordance with the State laws. Stray animals such as dogs and cats shall not be allowed to move around waste storage facilities or at any other place in the city or town and shall be managed in accordance with the State laws. The municipal authority shall notify waste collection schedule in neighborhoods.

2. **Segregation of municipal solid wastes:** Segregation materials should be done by municipal authority by promote recycling and reused waste by create or organized an awareness programs and campaign. The municipal authority shall take in charge phased programs to ensure community participates in waste segregation programmed. For this purpose, the municipal authorities shall arrange regular meetings at quarterly intervals with representatives of local resident welfare associations and non-governmental organizations.
3. **Storage of municipal solid wastes:** Municipal authorities shall establish and maintain storage facilities in such a manner as they do not create unhygienic and in sanitary conditions around it. There is some example criteria shall be taken to establishing and maintaining storage facilities.
The quantities of waste generation should be counted in order to create enough storage facilities in a given area and the population densities. Furthermore, a storage facility shall be so placed that it is accessible to user. Storage facilities to be set up by municipal authorities or any other agency shall be so designed that wastes stored are not exposed to open atmosphere and shall be aesthetically acceptable and user-friendly.
4. **Transportation of municipal solid wastes:** Vehicles used for transportation of wastes shall be covered. Waste should not be visible to public, nor exposed to open environment preventing their scattering and unpleasant smell. The following criteria shall be met is the storage facilities set up by municipal authorities shall be daily attended for clearing of wastes. The bins or containers wherever placed shall be cleaned before they start overflowing.
5. **Processing of municipal solid wastes:** To minimize burden on landfill the municipal authorities shall adopt suitable technology or combination techniques to process the municipal solid waste. The biodegradable wastes shall be processed by composting, vermicomposting, anaerobic digestion or any other appropriate biological processing for stabilization of solid waste. Mixed waste containing recoverable resources shall follow the route of recycling. Incineration with or without energy recovery including pelletisation can also be used for processing wastes in specific cases. Municipal authority or the operator of a facility wishing to use other state-of-the-art technologies shall approach the Central Pollution Control Board to get the standards laid down before applying for grant of authorization.

7 Health Effects Due to Solid Waste

Over 3.6% annual growth in urban population and the rapid pace of urbanization, the situation is becoming more and more critical with the passage of time. Lack of financial resources, institutional weakness, improper choice of technology, and lack of support from public, towards Solid Waste Management (SWM) has made this service far from satisfactory. Waste generation ranges from 200 Gms to 500 Gms per capita per day in cities ranging from 1 lakh to over 50 lakhs population, as shown in Table 2.

As per above table per capita waste generation in Aligarh should be in the range of 270 gms (approximately). The larger the city, the higher is the per capita waste

Table 2. Waste generation per capita

Population range (in lakhs)	Avg. per capita waste generation gms/capita/day
1–5	210
5–10	250
10–20	270
20–50	350
50 & above	500

(Source www.jnnurm.com/india)

generation rate. The total waste generation in urban areas in the country is exceeded 39 million tons a year-by-year 2001, and estimated at 62 million tons a year-by year 2025. It is estimated that about 80,000 metric tons of solid waste is generated everyday in the urban centers of India. At present about 60% of the generated solid wastes is collected and unscientifically disposed off. The uncollected solid wastes remain in and around the locality or find its way to open drain, water bodies, etc.

The above information suggest that environmental pollution (specifically air pollution, water pollution and pollution due to waste) is a major health risks to humans, which is to be tackled on a priority basis. It is also essential to prepare compressive national health profile database on health effects due to pollution with respect to urban cities.

Solid waste not only affects the person living nearby it but also it used to affect other too. Actually solid waste due to the formation of the leachate and gases affect the water under the landfill site and also the air around it. Due to the formation of methane and other gases at the landfill site the atmosphere get distorted suddenly and harm the surrounding environment.

8 Discussion

Despite all efforts being made by the local municipality within their limited resources, the solid waste management situation in Aligarh is still not adequate. The waste is being dumped on low lying or open areas in the outskirts of the city without engineering and scientific methods. This situation of SWMS can be compared with other Indian towns of similar size. Management of municipal solid waste in the Aligarh city is far from satisfactory. There are problems in the solid waste management practices prevailing in the study area at every level, such as collection, transportation, processing and disposal. Mismanagement of solid waste is a matter of serious concern for public health and environment.

The generation of the organic manure to promote derivation manure from waste to reduce the quantity of waste going to landfill sites and also to help agricultural production, shown in Table 4. Aligarh Municipal corporation (AMC) tied up with A 2 Z for processing of 250 MT of garbage daily, out of which 42.5 MT of composted per day are produced by microbial composting. AMC has further extended the waste processing facility to take one step ahead for sustainable waste management and to reduce the load on landfill sites. The following Field photographs (Figs. 2, 3, 4, 5, 6, 7, 8 and 9) are collected from study area.

9 Field Photographs

See Figures 10 and 11 and Table 3.



Fig. 2. Shows drains at Jamalpur, Aligarh.



Fig. 3. Shows cleaning drains at Goolar road, Aligarh.

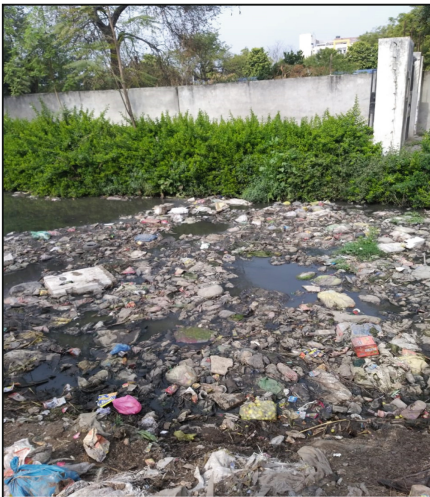


Fig. 4. Shows drains at Jamalpur, Aligarh.



Fig. 5. Shows garbage FM tower near, Maheshpur.



Fig. 6. Goolar road Aligarh.



Fig. 7. Shows Trommel at A2Z Aligarh.



Fig. 8. Shows MSW spillage on the road (Bara Dwari).



Fig. 9. Pratibha Colony, in front of Nigam Workshop, Aligarh, U.P.

Table 3. Shows composition of waste

Composition of waste:	Percentage (%)
Organic	50
Recyclable	15
Silt & sand	15
Construction	10
Other waste	10

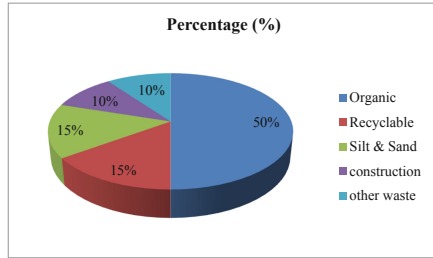


Fig. 10. Graphical representations on composition of waste in study area.

Table 4. Shows composition of manure.

Composition of manure:	Percentage (%)
Moisture	20
Particle size	91
Total organic matter	17.2
Total organic carbon	10
Density	0.95
Total nitrogen	0.48%
C:N ratio	10.65
Phosphores	0.4
Potash	0.4
Color	Black or brown
Odor	Odorless

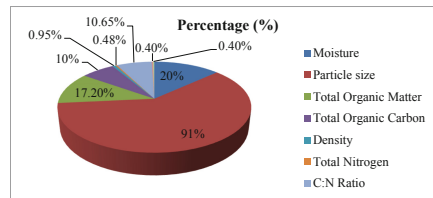


Fig. 11. Graphical representations on composition of manure in study area.

10 Conclusion

Some suggestions would be helpful in improving SWM system in Aligarh city these are as follow:

1. Open waste storage sites and other unhygienic street bins should not be allowed.
2. The placement of waste receptacles should be correct.
3. Door to door collection of waste must be made mandatory that will allow minimum of waste on roads and streets.
4. Land filling must be done properly after consideration of all the aspects of present and future of the city and its health
5. Alternative and better options for proper waste disposal method must be adopted regularly based on the needs and situation of the area,
6. There must be total ban on stray animals who wander on the roads which include cows, bulls, dogs, goats, etc. and these animals must be regularly trapped without any political or community influence. It will solve many of the problems associated with waste disposal.

7. Segregation of household waste at the source would reduce the burden of solid waste significantly while at the same time improve the supply of composite serving the nutrient poor farmer near Delhi.
8. Proper maintenance of vehicles and other equipments.
9. Government should adopt 4R's (Reduce, Reuse, Recycle and Resource Recovery) principle.
10. Government should increase the number of composting and energy generation plant.

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