

## **Suitable Locations of Waste Bins: A Study of Bahadurgarh City, Haryana**

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### **Abstract:**

**Background:**In a developing country like India, the quantity of Municipal Solid Waste (MSW) has increased with improved life styles and social status of the populations in the urban centres. An assessment has been made that per capita waste generation is increasing by about 1.3% for each year. However, there are deficient infrastructure and resources for the MSW management in many urban areas of the country. Suitable services to dispose most of the MSW from households are not up to the satisfactory level. The rapid increase in the generation of MSW leads to management issues in addition to environmental impact.

**Materials and Method:**In the present study, GIS has been used for investigating adequate number and positions of existing collection bins in Bahadurgarh city of Jhajjar District, Haryana, India. The proposed numbers of collection bins along with the total capacity of carrying waste have been assessed according to MSW generation in the city. Then the optimal locations have been found with reference to existing bin locations, road network and population density. Moreover, based on the public preferable walking distance to drop the solid waste in the collection bins, and as per the guidelines of CPHEEO, a proposal has been prepared for the city.

**Results :**As Bahadurgarh is not a planned city and no particular model with one distance can be followed, so three different proximity distances such as 200m, 150m and 100m around existing and proposed bins have been generated and found the optimal distance. As a result, the entire area was covered by 78 waste bins with distance of 200, 150 and 100 meters around the collection bin with 99%.

**Conclusion:**The proposed bin locations suggested some modifications in existing system and which would recommend best possible collection services.

**Key Word:** MSW, GIS, CPHEEO, DTDC

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### **I. INTRODUCTION**

Waste management issues are coming to the forefront of the global environmental agenda at an increasing frequency, as the population and consumption growth result in increasing quantities of waste (Chalkias and Lasardi, 2009). Better Municipal Solid Waste (MSW) management plans are required for developing urban cities in India. With the growth of urban population ranging between 3 to 3.5% per annum, the annual increase in overall quantity of MSW is assessed about 5%. In order to facilitate MSW management, the enhanced options are to be provided for initial functions of MSW such as collection and transportation. As it has been clear that the collection of municipal solid waste is a public service that has important impact on public health and the appearance of towns and cities. Unfortunately, many urban administrations seem to be losing the battle of coping with the ever-increasing quantities of waste. Fundamentally the effectiveness of a solid waste management system depends mostly upon the proper location of bins, estimation of the waste generation and their onsite storage capacity. Amongst developing countries, the Indian scenario reveals that households are responsible for dumping waste into temporary storage bins while as per Municipal Solid Waste Rules (MSW 2000), municipal authorities in urban settlements are responsible for organizing house-to-house collection of wastes. The municipal authority in general selects corners of the roads for the placements of the bins, according to their convenience. The positions of the bins are changed frequently either due to remoteness or extremely densely populated, some of the locations are not properly or adequately attended, resulting in more trips. According to the Indian guidelines, the spacing between bins should not be more than 500 m and the maximum distance between collection points, i. e., households and bins should be 250 m. In order to achieve the best waste collection efficiency, it is essential to find out the optimized locations and the number of bins to be placed. Solid

waste collection faces a range of challenges, and the difficulties faced by one city can be very different from those experienced by another.

The report of high-power committee on urban MSW Management in India stated that there is no system of segregation of organic, inorganic and recyclable wastes at the household levels (Planning commission 1998). MSW in cities is collected and transported to designated disposal sites, which are normally located at out-skirts of the city. In most of the areas, the MSW collection is disorganized and less than 25% of the MSW produced is actually collected for disposal and the remaining 75% is allowed to remain, causing health hazards and pollution to the environment (Velumani, A., 2014). The environmental and cost effectiveness of the functions would be achieved and analysed with adopting scientific technology like Geographical Information System (GIS).

**Objectives:**

The objectives of the study are

- i. To review current MSW management practices including waste generation, location of collection bins, type and size of collection bins.
- ii. To find and allocate new collection bins based on MSW generation using GIS and
- iii. To find the optimal proximity distance for the collection bins by generating buffer zone.

Thus, the study helps in analysing the present MSW collection issues and used as a decision supporting tool for efficient collection of MSW in Bahadurgarh city.

**Study Area**

Bahadurgarh, known as the "Gateway of Haryana", Sub district/Tehsil, a city and a municipal council located in Jhajjar, a district in the state of Haryana, India. Bahadurgarh city is situated on Delhi-Hisar National Highway number 9 at a distance of 2 Kilometres from Tikri border (Delhi). It is located on the intersection of 76°55'25" East Longitude and 28°43'50" North Latitude. The Najafgarh town and Nangloi, which are important settlements of National Capital Region (NCR) Delhi, are located at a distance of 10 Kilometres and 14 Kilometres respectively. The town of Bahadurgarh is very well linked with Delhi and other important towns of Haryana such as Rohtak, Hisar by National Highway No. 9 and Railway line.

**II. DATA BASE AND METHODOLOGY**

The present study is based on both spatial and non-spatial data which was obtained from census of India and other government offices:

<i>Spatial Data</i>	<i>Non-spatial Data</i>
-Toposheets at a scale of 1:50,000 -Municipal Council map of Bahadurgarh city -Town and Country Planning Map of Bahadurgarh city -GPS points and photographs from the field -Google Earth Satellite Image	-Census of India 2011 -Existing SWM system detail i. e. generation of waste, number of storage bins, number and type of vehicles for transportation of waste, waste disposal site etc.

**III. METHODOLOGY**

- Geo-referencing of Municipal Council Map with topographical map.
- Fieldwork carried out to survey the field by using GPS.
- Generation of base map and related database from topographical maps of Survey of India and satellite data.

**IV. RESULTS AND DISCUSSION**

Presently two types of primary MSW collection systems are followed in Bahadurgarh. In the first, old system, the owners and occupants of residential houses and of commercial establishments are responsible for depositing MSW in the receptacles provided by the municipal authority. But the implementation of MSW Rules 2000 reassigned the responsibility to municipalities to provide door-to-door collection (DTDC) of segregated waste. The segregation of waste does not exist in Bahadurgarh city. The DTDC system has been implemented in some parts of the city since July 11, 2017. However, due to operational problems, such as lack of staffing and resources, BMC has not replaced the old primary collection system, the alley system completely. Therefore, at present, both collection systems coexist. But in the DTDC system, the waste is collected from houses and transported to municipal waste receptacles or collection points through cycle carts or mini tractors.

There are some waste bins and collection points fixed by the MCB in the city. Most of these collection points are open dumping points. This encourages the residents to throw the waste on streets. The waste

receptacles placed on the collection points are not sufficient in number and size. Most of the time these community bins overflow with the waste; most of the households, shops and commercial complexes do not allow the Municipal council to place the dust bin in their premise.

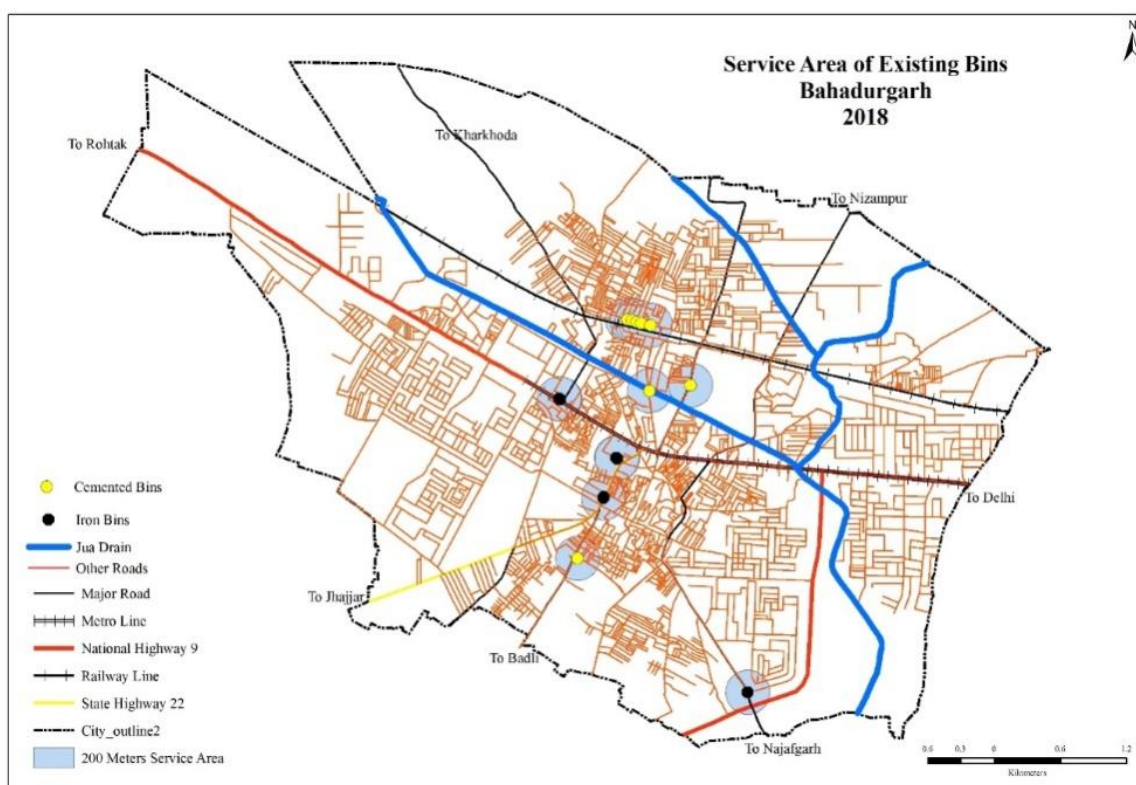
The total population of the city is 170676 within the area of 29.5 km<sup>2</sup>. Total number of households in the city as per the census of India 2011 is 34910. There are only 19 waste bins in the whole city including 8 iron bins with the size of 3 cubic meters. There are 11 cemented waste bins with different sizes as shown in the Table A

**Table:1**Waste Bins in Bahadurgarh

Sr. No.	Number of bins	Size	Structure
1	8	3 cum	Iron
2	1	15/20	Cemented
3	1	10/20	Cemented
4	1	15/10	Cemented
5	8	10/10	Cemented

Source: BMC, 2018

**Fig:1**Service Area of Existing Waste Bins in Bahadurgarh



These bins are not sufficient in terms of population and area. There are places where 2 or 3 iron bins have been placed adjacent e.g. near old court and civil hospital on Delhi-Rohtak road. 8 cemented waste collection points are very close by at line par in front of railway station. The total number of waste bins seems to be insufficient as per the waste generated in the city.

**Requirement of New Bins**

According to BMC, the population projected for the year 2016 is 213565. The average per capita waste production in the city is 500 grams/day. The total production of waste in Bahadurgarh per day is:

$$\begin{aligned} \text{Total production of waste in Bahadurgarh} &= \text{Total Population} \times \text{Per Capita Waste Production} \\ &= 213565 \times .50 \\ &= 106,782.50 \text{ kg per day or } 107 \text{ MT/Day} \end{aligned}$$

**Table:2**Capacity of existing waste bins in Bahadurgarh.

Sr. No.	Type of Waste Bin	Capacity in MT	Number	Total Capacity in MT
1	Iron	2.2 tons (3 cum)	8	17.76
2	Cemented	10	1	10
3	Cemented	7	1	7
4	Cemented	8	1	8
5	Cemented	5	8	40
6	Total		16	82.76

Source: MCB,2018

The above calculation shows that the collective capacity of the existing waste bins is 82.76 MT and because of this more than 24 MT of Municipal Solid Waste does not have a suitable destination. This waste remains on the streets or on the open dumping points in the city. The total waste generation is increasing rapidly in the city due to its tremendous population growth. The establishment of industries in the Modern Industrial Estate (MIE) has attracted population from different parts of the country. Most of this is the labour class population living in the outgrowths of unplanned areas at line par in Bahadurgarh where heaps of solid waste can be seen on the plotted land. This population leaves their homes in early in the morning for work and does not have synchronization with the DTDS of waste collection. They throw their waste on any of the nearby place they find to drop that easily.

### Setting-up the New Waste Bins

It is clear that there is presence of lacunas in the existing system. It has been derived from the primary survey that the households do not find a waste bin nearby to drop their waste and the existing waste bins do not serve the entire area, which has to be served. The existing bins are not evenly distributed in the city. Many of the localities do not have a single community bin to drop the waste. Most of the waste bins are overflowing, larger capacity bins are required. If portable containers are used capacity can be increased by adding another container. Deficiency of the waste bins leads to the open dumping on streets or open spaces by the households and commercial complexes. So, there is an urgent need of more community bins to be placed at proper places. Here, suitable locations for waste bins based on different criteria have been optimized. Following assumptions have been considered before finding optimal locations of waste bins: -

- The land use pattern of the city has been taken into consideration
- Residents are supposed to use the waste bins existing in the city.
- Residents of the city are free to use DTD or the self-disposal system.
- The average waste generation has been taken into consideration for every household.
- It is also assumed that the amount of waste will keep increasing in the coming future.

So, the requirement of new waste is set up by keeping in mind 150 MT of municipal solid waste/day in Bahadurgarh.

The location of waste bins is determined keeping in mind, various factors such as: -

- Population
- Amount of total MSW generated
- Household density
- Availability of space
- Area to be served
- Road network

### Land uses for consideration

There are some land uses like schools, hospitals and religious buildings where it would not be advisable to place the bins in close proximity. These land uses are related to sensitive issues like health and sentimental values of the citizens. So, these land uses are considered for the inconvenience due to proximity of the waste bins and should be made free from the waste bin proximity. The situation being such that due to dense land use in the city, much distance cannot be demanded for buffer for a land use to the waste bins. A distance of 20 meters is suitable to maintain a distance from municipal waste bins and open dumps to these land uses. This distance can act as barrier in transfer of odour and flies from the garbage (MSW Rules,2016).

### Environmentally sensitive areas

It is seen that water sources often get polluted due to waste dumps. A distance of 10 to 15 meters is sufficient to avoid the rolling or scattering of garbage from a bin into the water stream. It is advisable to

construct boundary fence on both the sides of the drain to check the dumping of waste into the drain. On the basis of the above said criteria, some sections of the existing road network have been identified as suitable locations for the setting up of new waste bins. The location of waste bins has been chosen by try and error method. Ultimately self-judgement has been applied to choose a point. Prime target was to cover all the sections of the residential areas in the city.

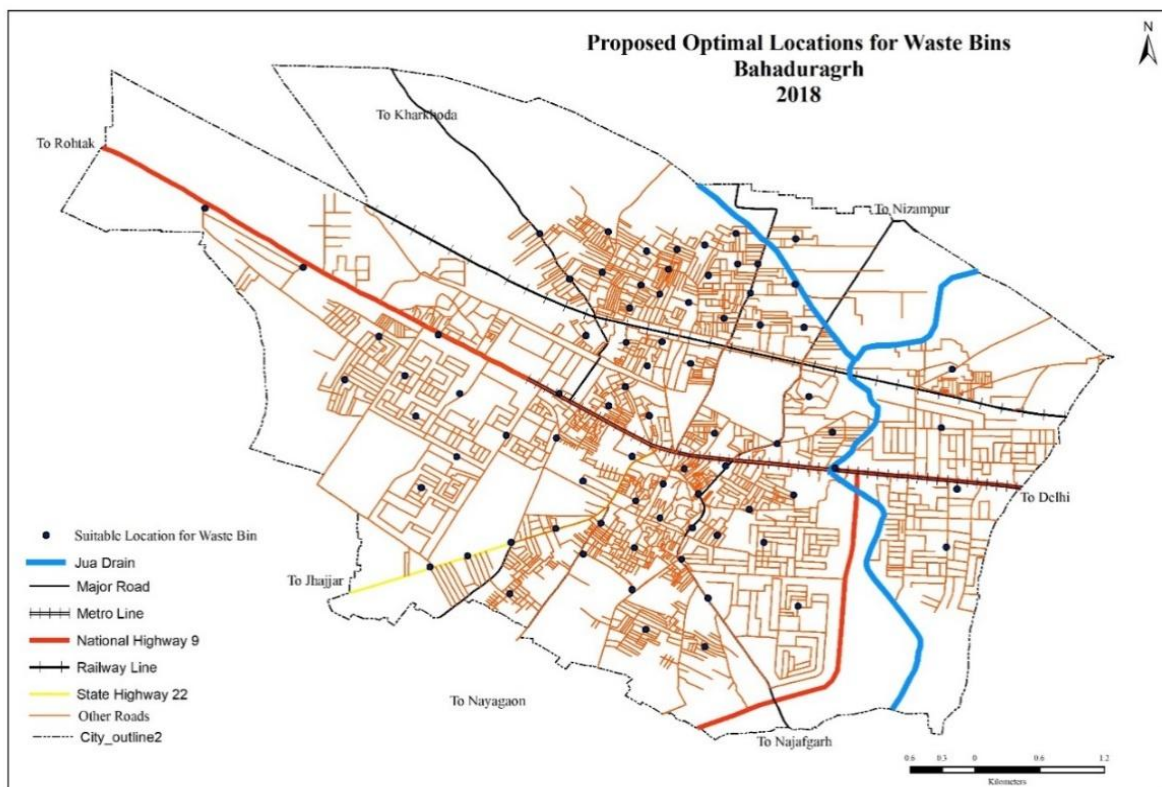
### Selection of Area to be served

According to CPHEEO, 2000 (the organization which works under the Ministry of Housing and Urban Affairs, Govt of India) the maximum distance between a household to a waste bin should be 250 meters. This limit is set to take care of the public convenience. If it is believed that people would prefer a distance of 100 meters for a waste bin then the work results in 132 total waste bins for the entire city of Bahadurgarh. It would take 4 minutes for an individual to throw the waste in a waste bin and come back if an average casual walking speed of 1 km per 20 minutes. If we take a distance of 150 meters for a waste bin then the work results in 103 total waste bins for the entire city of Bahadurgarh. It would take 6 minutes for an individual to throw the waste in a waste bin and come back. It seems to be easy and convenient for residents to use a waste bin at 100 or 150 meters but when it comes to establishment, the cost matters.

At the same time, keeping in mind the standard norms for convenient distance, if we take a distance of 200 meters for a waste bin then the work results in 66 total waste bins for the entire city of Bahadurgarh. It would take 8 minutes for an individual to throw the waste in a waste bin and come back.

After calculating all the possibilities, 78 points have been finalized to place or built waste bins in Bahadurgarh at a distance of 100 meters, 150 and 200 meters. Compare to the distance of 100 and 150 meters for all the bins, establishment cost can drop to about 41% and 25% respectively as the authority will have to set up only 78 bins instead of 132 or 103. Operational and maintenance cost will also go down according to desired scale. There are reasons behind this selection of area to be served. Some sections in the older city at Line Par in northern part of the city and in the southern part areas around Gadhi Market and QuilaMohalla do not have wider roads. Due to lack of space for a waste bin, the distance between waste bin and household has been decided to 100 and 150 meters. The size of waste bin in these areas with narrow roads will be small to accommodate the collection vehicles to load the waste and clean the waste bin on daily basis. These total 78 locations are found enough to cover all the parts of residential areas of the city except minor exceptions.

**Fig:2** Optimal Locations of Waste Bins in Bahadurgarh



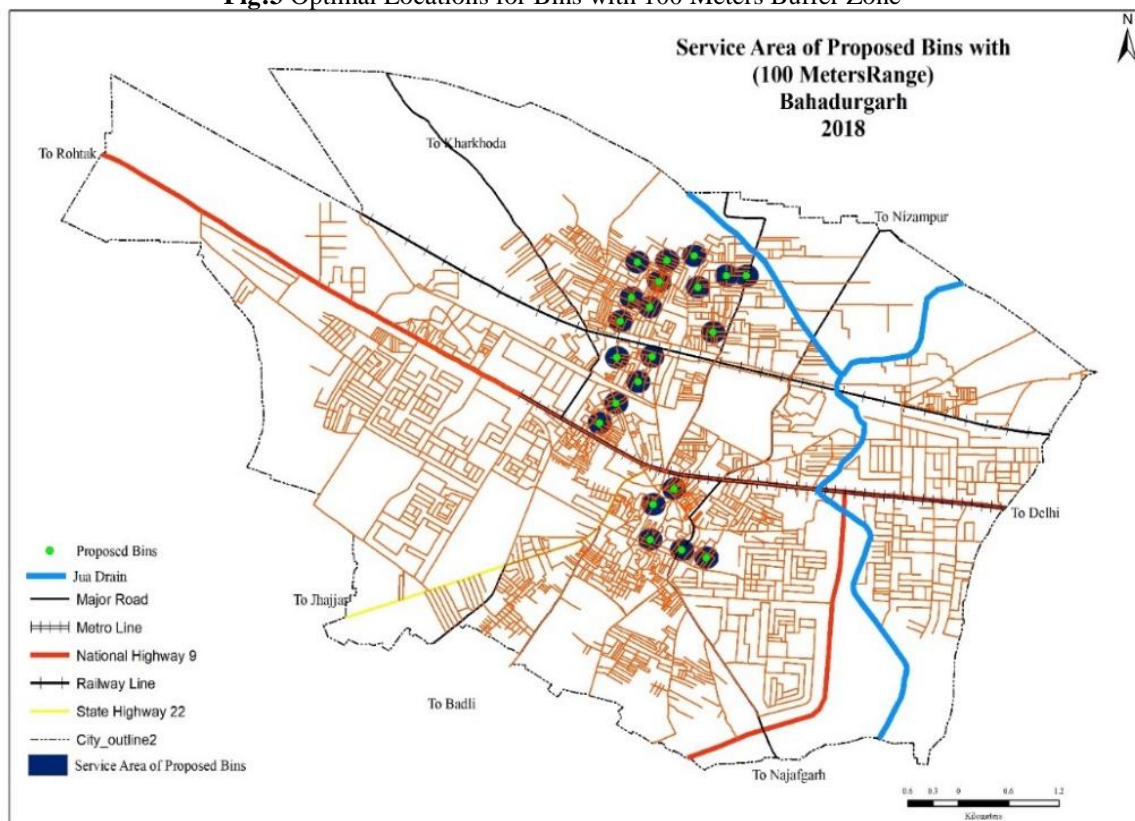
### Waste Bins with 100 Meters Range

The requirement of the total number of waste bins at a distance of 100 meters is 21 in Bahadurgarh city. There are some parts in the city where population density is high but space availability for a large waste bin is a problem. In those areas, the size of the bin and the maximum distance between a household and a waste bin has been reduced to one metric ton and 100 meters respectively.

As the size of a waste bin with a 100 meters buffer is 1.5 cum or one metric ton, 21 tons of the total waste can be temporarily be stored in these bins. This waste is further collected by the sanitary workers through mini tractors and dumped at the larger bins situated on peripheral roads. These waste bins should be made of metal and moveable.

The following map shows the waste bins in northern and southern parts of the city at 100 meters distance:

**Fig:3** Optimal Locations for Bins with 100 Meters Buffer Zone



**Table:3** Waste Bin Locations with 100 Meters Range

Sr. No.	Areas Covered	Number of Waste Bins
1	Line Par-Vikas Nagar, Hari Nagar, Ashoka Colony, Shankar Garden	11
2	New Basti (left of Railway Road before Railway Station)	3
3	Nehru park	2
4	Southern part of the City- BasantVihar, Areas of Old SabziMandi Road, Shastri Nagar, QuilaMohalla and Dharampura	5
5	Total Bins	21

### Waste Bins with 150 Meters Range

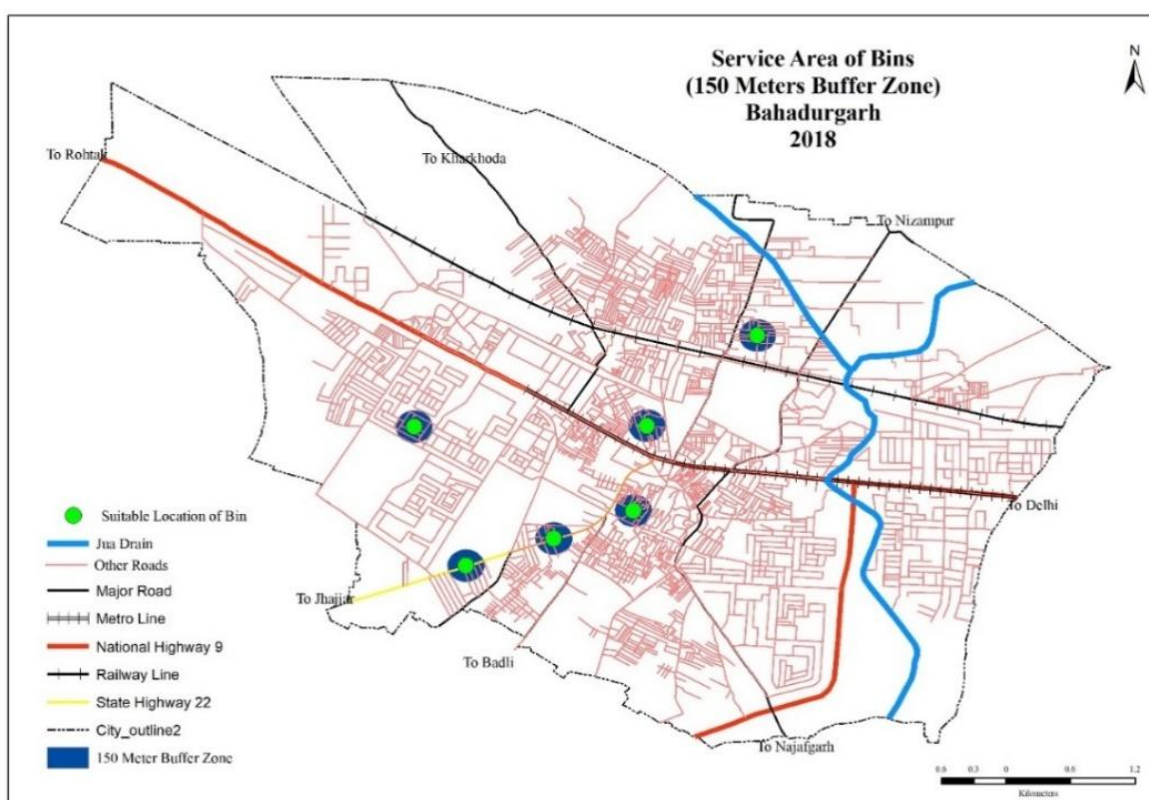
In some parts of the city, there are waste bins which serve an area of 150 meters around them. Some road sides have been found appropriate for placing the waste bin. Total 6 points have been finalized to place waste bin with 150 meters buffer zone. The following table shows the areas covered by these waste bins:

**Table:4**Waste Bin Location with 150 Meters Range

Sr. No.	Areas Covered	Number of Waste Bins
1	Netaji Nagar	1
2	Nehru Park	1
3	Sector 6	1
4	Adarsh Nagar	1
5	Shakti Nagar	1
6	BasantVihar	1
7	Total Bins	6

The size of the waste bins with 150 meters buffer has been finalized 1.5 cubic meters or one metric ton. So, these bins can carry 6 tons of the total waste of the city. These waste bins should also be metallic and movable.

**Fig:4** Suitable Bin Locations with 150 Meters Serving Area



**Waste Bins with 200 Meters Range**

The optimum number of waste bin locations to cover the entire residential areas of the city at a maximum coverage area of 200 meters along with the bins at shorter distance is 51.

**Table:5**Bins with Capacity

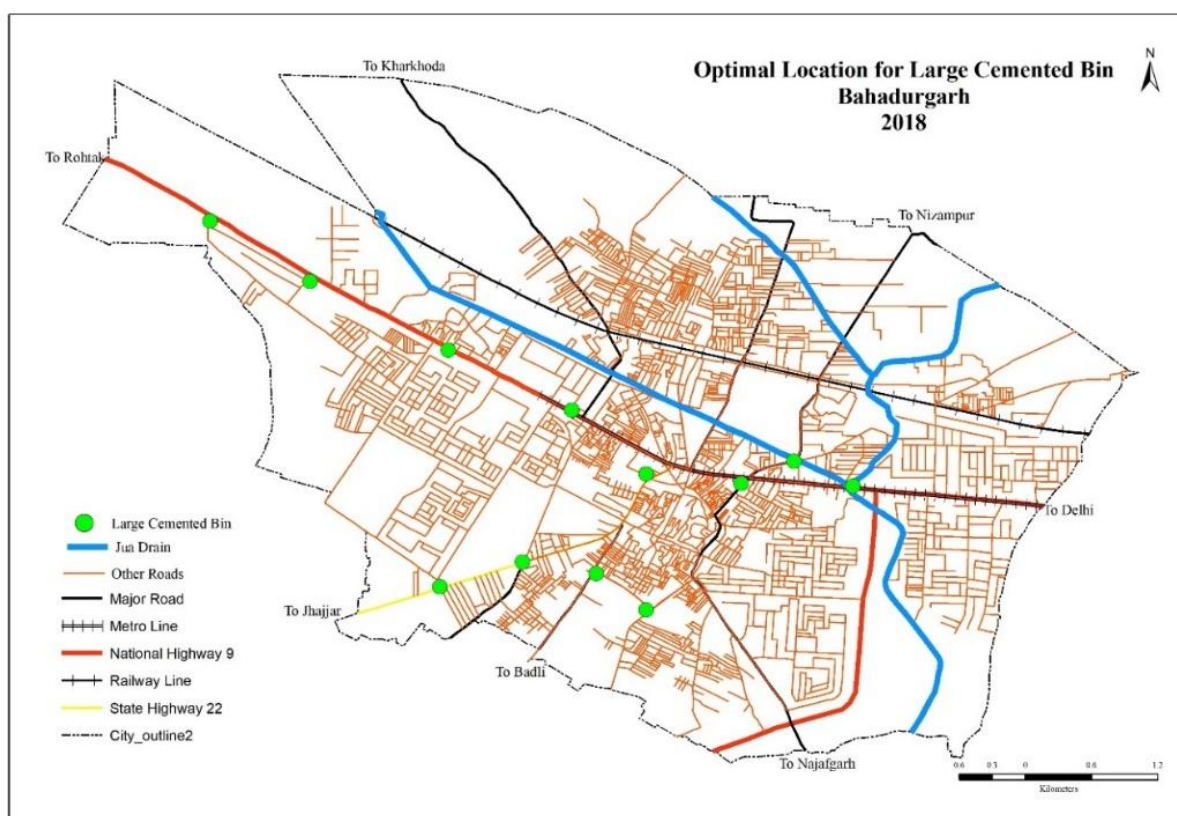
Service Area (in meters)	Number of Bins	Capacity/Bin(in MT)	Total Capacity(in MT)
100	21	1	21
150	6	1	6
200	39	1.5	58.5
Total	64		85.5

Out of these 51 bins, 39 bins with the capacity of 1.5 MT each can carry the total 58.5 MT solid wastes. Apart from this, 12 bin locations have been finalized on the major and peripheral roads for placing larger bins with more capacity. These 12 bins are the larger covered cemented bins which can carry the total waste of the city. These are established on the wider roads where enough space available to load the waste with loader without creating any nuisance for the traffic flow. The following table show the locations and capacity of these 12 waste bins:

**Table:6**Optimal Locations for Large Waste Bins in Bahadurgarh

Sr. No.	Location of Bin	Capacity in MT
1	Sector-16(a)	5
2	Sector-16(b)	5
3	City park (near Metro Station)	10
4	Civil Hospital	10
5	West Jua Drain	10
6	MLA Office (near canal)	5
7	Krishana Nagar	10
8	Old Court Road	5
9	Parnala Road Ramnagar	5
10	Badli Road Mela Ground	10
11	Bus Stand	5
12	Ballor Road Mela Ground	25
13	Total waste Bin=12	105

**Fig:5**Optimal Locations for Major Cemented Waste Bin in Bahadurgarh



Along with these 12 waste bins with the total capacity of 105 MT of solid waste, 8 cemented waste bins already exist at Line Par in front of Railway Station with the capacity of 5 MT each. Thus, the total waste carried by these bins is 145 MT. 5 MT out of the targeted total 150 MT is being left out of these bins. It is assumed that this much waste will come out of the drain cleaning, street sweeping and the commercial areas. This waste will go directly to the recovery station or the disposal site and will not come to the community bins.

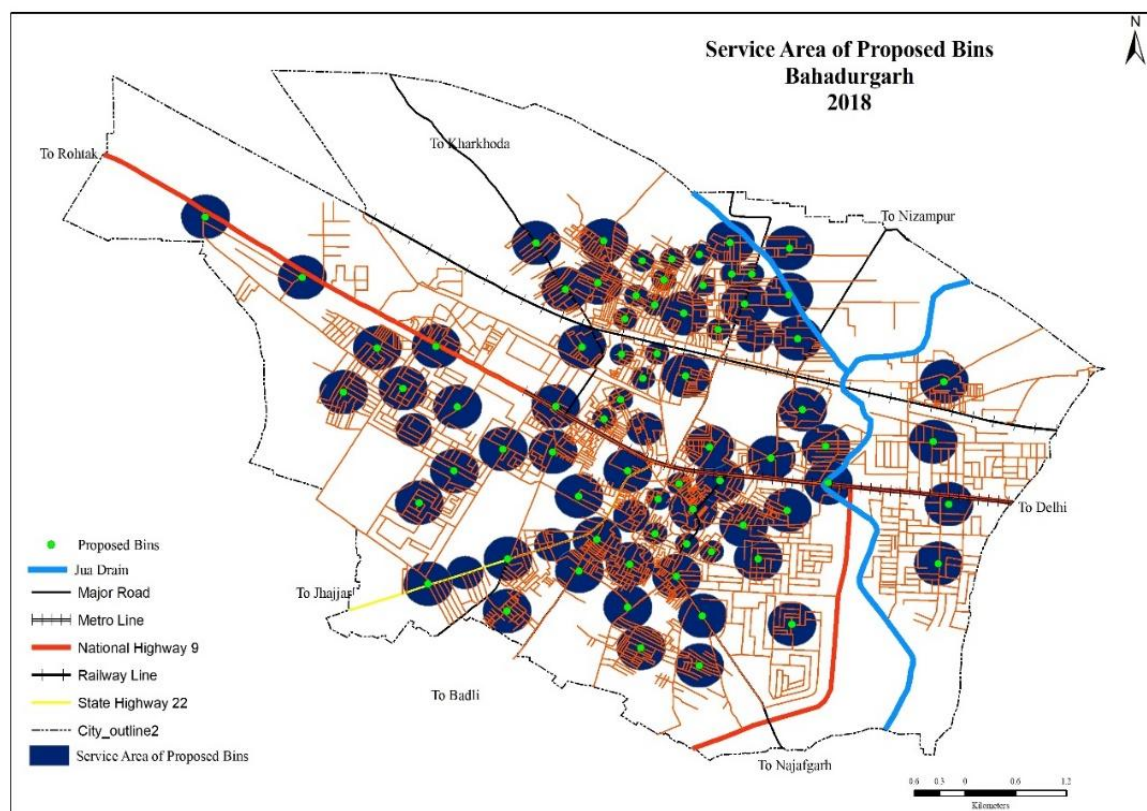
**Table: 7** Larger Bins with Capacity

Sr. No.	Service Area(in meters)	Number of Bins	Capacity/Bin(in MT)	Total Capacity(in MT)
1	200	6	5	30
2	200	5	10	50
3	200	1	25	25
4	Total Bins	12		105



So, it becomes clear that the proposed 78 bins would be sufficient to carry all the waste generated in the city. The proposed locations will cover most of the parts of the city.

**Fig: 6**Service Areas of Proposed Bins in Bahadurgarh



The service area of proposed waste bins shows that almost all the parts of the residential areas can be served with the proposed waste bins except some areas. The areas which are not under the service area of a waste bin do not have enough space for a bin to be placed. The residents have to either walk a little more or to adopt the DTDC system provided by the BMC in the city. The existing cemented waste bins at Line Par in front of Railway Station and at the Mela Ground Ballor road are newly constructed bins and cannot be removed. These bins are constructed on the only space available at Line Par. The bins at Line Par serve a wide area where it is difficult to place a waste bin. The residents themselves and the cycle carts dispose the waste in these bins and then it is loaded and sent to its final destination through the tractors by the sanitary workers appointed by BMC.

### Specific Areas

There are some specific areas have been identified in different parts of the city. These areas do have specific needs of solid waste management and require specific solutions for that. The type of waste coming out of these areas is of mainly two types:

➤ *Biodegradable Waste*- This waste can be termed as organic waste and it can be used for producing manure through composting. This type of waste comes out from the places like vegetable and fruit markets at Jhajjar road and Railway road, hotels and restaurants.

➤ *Recyclable Waste*- This type of solid waste can be reused and recycled easily. This waste comes out of the commercial areas like Railway road market, Gandhi market, Indira market, Kabaddi market and the shops along both the sides of Delhi-Rohtak Road.

So, these areas need specific type of waste bins. Cemented covered waste with a size as per the requirement can be built in the vegetable markets situated on Jhajjar road and Railway road. The covered waste bin will not let the organic waste get rotten in rainy season. Waste bins for the other commercial areas are shown in the picture 4.1. These types of waste bins are easily available in market at reasonable prices. These are also available online on [indiamart.com](http://indiamart.com) at a rate of Rs. 800/- and more or less as per the quantity of order to be placed. These waste

bins are for segregated waste e. g. dry and wet waste and can be fixed at a particular distance covering 5-6 shops minimum in order to avoid theft of these bins.



*Pic:4.1 Waste Bins for Commercial Areas*

In this way, the whole waste of the city can be stored in all these 78 waste bins and no waste will remain in open on streets or on plotted land.

## V. CONCLUSION

The final outcome in the effort to find suitable location of waste bins seems to be economical and easy to implement in the city. There were several aspects taken into consideration in planning the waste management by evaluating the bin allocation. First was to analyse the location of the existing waste bins in the area. The requirement of new bins has been calculated. In the areas, where larger bins cannot be placed, smaller bins with shorter distance have been proposed. The planning concern was to verify the convenience and inconvenience of the users from the existing bin location. This was done by checking the location of bins for a convenient proximity distance for all the users and also for the inconvenience to the users due to close proximity of the bins to sensitive land uses. The planning of waste bin allocation also included the segregation of waste in two categories i. e. biodegradable and recyclable waste and for this, the provision of recyclable bins was proposed. The proposal was intended to provide the recyclable waste collection bins to those areas which generate recyclable waste. The identification of those land uses was carried which generate recyclable waste and then find the suitable location for placing those bins so it would be convenient of the users. It is proposed that all the waste bins should be with two compartments for segregated waste. Residents should be encouraged for depositing segregated waste in the bins. As per the requirement and considering different factors various types of waste bins have been proposed in different parts of the city. The main aim is to provide good SWM facilities to the citizens which could maintain a healthy and clean environment in the city in an economic way. GIS has helped in achieving this in terms of suitable location of waste bins. There can be lot of advancements in the system in the coming times but presently, it has to be carried in stages according to the availability of resources for the city

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