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Solid waster management plan in Haryana: (Special reference on Bahadurgarh city)

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Abstract
Human actions generate waste materials that are often cast-off because they are considered useless. These wastes are usually solid, and the word waste suggests that the material in useless and unwanted. However, many of these waste materials can be reprocessed, and thus they can be converted in a resource for some industrial production or energy function, if managed properly. Historically, management of solid waste has been an engineering function. It is associated to the development of a technological society, which, along with the benefits of mass production, has also created problems that necessitate the disposal of solid wastes (George T. and Frank K, 2002). Waste management has become enormous amount of waste, and maximum people want to preserve their life style, while also shielding the environment and public health. State legislatures are searching for means to reduce the mounting amount of waste that Indian homes and businesses through away and to reuse it or dispose of it safety and economically.
Recently, government has come forward with various rules and regulations dealing with solid waste management and other agenda related to the same in urban centres. Various programmes and schemes have been started by the government of India. Swachha Bharat is an example of such schemes in which the government awards rank to the villages and municipalities throughout the country and these ranks are being assigned on the basis of cleanliness. Indore city of Madhya Pradesh has bagged the tittle of 'India's Cleanest City', fourth time in a row in Swachh Survekshan League 2020. Every year, prior to Mahatma Gandhi birthday, cleanliness drive of two weeks is carried out in all the government and private institutions across the country.

Keywords: Solid waster, management plan, waste materials

Introductions
Bahadurgarh city generates approximately 106.78 MT tones of waste daily. The ability of local governments in handling and managing the growing quantities and types of waste produced these days, is not at par. This waste has become a threat to the environment and human health. In the past, the residents of the City of Bahadurgarh have usually not been required to segregate their waste. Participation of residents of the city is vital in educational and awareness programmes which benefit our community. More and more, involvement of people is to be legislated in responsible programming related to waste management.
Various factors play a significant role in the entire solid waste management system of Bahadurgarh city : such as:-

- The city has experienced some influx of population with time as number of emigrants has been increasing rapidly due to the industrial development in the city. In concurrence with this growing population, the need for processing of residential waste has and will continue to increase.
- The contemporary waste collection system is outmoded and this system necessitates a refurbishing or replacement with a new system which will help in making a cleaner city.
- The disposal site situated at Nayagaon does not meet all the standards set by the government of India although it has just started in 2007.
- To prolong life of the landfill, there is a need to reduce the amount of waste which is reaching to the disposal site.

MSWM Proposal for Bahadurgarh City
After identification of the problem and the date required has been collected, it is much easier to formulate a plan to handle the municipal solid waste as it will become apparent which

streams make up the majority of solution to the problem. Then, it's just a matter of deciding the most efficient way to implement the plan. The whole plan for managing the municipal solid waste in the best possible way has been given in the following steps:-

Segregation of Waste at the Source

The segregation of waste should be done at the source as the waste is composed of different types of toxic and non-toxic wastes e.g., kitchen waste, paper, glass, chemicals used for toilet and floor cleaning etc. It is important that the disposal of these types of waste is done separately and the segregation of these waste at source should be made compulsory. If not done at earlier stages, the process will be more expensive and resource consuming. For the segregation at source, different waste storage bins to be provided by the municipality to households e.g., green bin for kitchen waste, blue bin for dry waste and red for hazardous waste. The dry waste can be segregated later at the recycling or processing centre.

Advantages of Waste Minimisation

Waste minimization has the following advantages:

- Reduced volume of waste for disposal.
- Reduced costs of collection and disposal.
- Longer life of disposal sites.
- Reduced environmental and health impacts.
- Reduced costs through more efficient use of resources.
- Requirement and Placement of New Bins

There are only 19 waste bins of different sizes in the city of Bahadurgarh. It has been derived after the calculation that the collective capacity of the existing waste bins is 79.6 MT and because of this more than 27 MT of municipal solid waste does not have a suitable destination as the total waste generation is approximately 106.78 MT/Day. So, there is an imperative requirement of more community bins to be placed at opposite locations. The present plan has been designed for total 150 Mt of MSW as the waste will keep growing in the near future. Suitable location for waste bins based on different parameters have been optimized in the proposal plan.

78 locations have been decided to place or build new waste bins in Bahadurgarh city after calculating all the possibilities. These waste bins will be with different service areas 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 as a substitute of 132 or 103. Operational and maintenance cost will also go down with the proposal to a desired scale. There are reasons behind this selection of area to be served. Some sections of the unplanned older city at Line par in northern part and in the southern part like areas around Bhagat Singh Market and Quila Mohalla have narrow roads. For such localities, the distance between waste bin and household has been decided to 100 and 150 meters due to lack of space available for a waste bin. The size of waste bin in these areas with narrow roads will be smaller to accommodate the collection vehicles to load the waste and clean the waste bin on regular basis. These total 78 locations are found enough to cover almost all the parts of residential areas of the city except minor exceptions.

The requirement of the total number of waste bins with service area of 100 meters is 21 in Bahadurgarh City. 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 temporarily be stored in these bins. Six locations have been finalized to place waste bins with 150 meters service area. The size of the waste bins with 150 meters buffer has been finalized 1.5 cubic meter or one metric ton. So, these bins can carry 6 tons of the total waste of the city. The total 27 MT waste can be stored in these proposed smaller community bins which are given in table 1.

Table 1: Proposed Waste Bins in Bahadurgarh City

Areas Covered	Number of Waste Bins	Service Area (In mtrs)	Capacity/ Bin (in MT)	Total Capacity (in MT)
Line Par-Vikas Nagar, Hari Nagar, Ashoka Colony, Shankar Garden, New Basti (left of Railway Road before Railway Station) Nehru Park, Southern part of the city-Basant Vihar, Areas of Sabzi Mandi Road, Shastri Nagar, Quila Mohall and Dharampura.	21	100	1	21
Netaji Nagar, Nehru Park, Sector-6, Adarsh Nagar, Shakti Nagar, Basan Vihar	6	150	1	6
Different parts of the city	39	200	1.5	58.5

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. Out of these 51 bins, 39 bins with the capacity of 1.5 MT each can carry the total 58.5 MT solid waste and are proposed in different parts of the city (table 6.1). Apart from these bins, 12 bin locations have been finalized on the major and peripheral roads for placing bins with larger capacity (detailed locations given in chapter 4). These 12 bins are the larger covered cemented bins which can carry the entire waste generated in the city. These are proposed on the wider roads where enough space would be available to load the waste with loader without creating any nuisance for the traffic flow. The following table 1.2 shows capacity of these 12 waste bins:-

Table 2: Proposed Large waste bins with Capacity in Bahadurgarh

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

These 12 large waste bins carry the total 105 MT of solid waste. Apart from these, 8 cemented waste bins are already existing at Line Par in front of Railway Station with the capacity of 5 MT each. Thus, the total waste carried by these large bins in 145 MT. 5 Mt out of the targeted the drain cleaning, street sweeping and the commercial areas such different markets of the city. This waste will be collected and go directly to the recovery station or the disposal site and will not carry all the waste generated in the city. These proposed locations will cover almost all the residential areas of the city.

Transportation Network from Solid Waste Collection Points to the Disposal Site

In the first view, there are no fixed routes of the vehicles for the transportation of waste from different collection points in the city to the disposal site at Nayagaon. The transporting vehicles collect the waste from the collection points on the basis of the demand of local residents and amount of waste generated and then deposit it at the disposal site at Nayagaon.

- The transporting vehicles play an important role in success of the whole solid waste management system. The collection efficiency of the total waste completely depends on the type and capacity of the transporting vehicles. The transport fleet of the BMC consists of the following:
- 10 Big tractors with size of 6/11*4 ft height (approx. 2.5 tons)
- 1 Swaraj Mazda with size of 3.3 cum (approx. 3 ton)
- 10 Mini tractors with capacity of 6/6 (1 ton)
- 15 Cycle Carts
- 2 Loaders
- 1 JCB

The ten big tractors take at least two trips daily from the collection points to the disposal site and more trips depend upon the amount of waste on collection points. Mini tractors and cycle carts are used for the house to house collection of waste. Two loaders are used to lift the waste from the open collection points and load that waste in the big tractors for transportation to the disposal site. The transporting vehicles play an important role in success of the whole solid waste management system. The collection efficiency of the total waste completely depends on the type and capacity of the transporting vehicles.

Requirement of Waste Transporting Vehicles

It has become clear after analyzing the existing system of waste collection and transportation that there is a dearth of vehicles to improve the collection efficiency. There is a requirement of five trucks with hydraulic container with a capacity of minimum 7 MT and if possible, with cover. These will be highly apposite for both kind of loading either manually or with loader. This type of vehicles will be used for collection of waste from the proposed large cemented waste bins (Proposal given in the chapter 4) on the wider and peripheral roads. The following image displays this kind of waste transporting vehicles.

Pic: 1.2 Proposed Hydraulic type of Vehicle for Waste Transportation

Proposed New Routes for Waste Collection

Two types of routes have been optimized in Bahadurgarh City for the transportation of municipal solid waste:-

Route type 1: Shorter Routes

This type of routes are the shorter routes which aim to assist in the primary collection of waster from the smaller waste bins and disposing it in the large waste containers. The transporting vehicles on these routes will be of small size as owned by the BMC (pic 5.4). The mini tractors with the capacity of 1 to 1.5 MT will move on these roads as in the areas across line par do not have wider roads to move a larger vehicle than these mini tractors. These tractors are used for the door-to- door collection of waste in the city. These mini tractors can carry on their work during the day in the residential areas as there is no problem of traffic congestion in these areas.

Route Type 2: Longer Routes

The second type of routes area the longer routes which will connect all the proposed and existing large cemented waste containers to the disposal site situated at Nayagaon. These longer routes will not cross the busiest roads of the city except few exceptions where there is no chance for adopting any other route. Following map shows the proposed new waste transportation routes:

Cleaning of Waste Bins

The larger cemented waste bins are to be cleared twice a day. Once in early morning before 8:00 o'clock and once on the onset of evening in between 3:00 to 4:00 PM. During these collection hours, the traffic on the major roads will be the least especially in the morning. The proposed 5 trucks with larger capacity of minimum 5MT capacity and the existing big tractor-trailers will move on the roads for the waste collection from these larger cemented waste containers the loading time at each collection point is assumed to be 20 minutes when the loading is done manually. Two sanitary workers will accompany the truck along with one driver. The speed limit of the vehicles will be 20 km/ hour. The details are given as below:

- One big hydraulic truck will start collection from the two bins located at sec-16 on Delhi-Rohtak Road. Only one truck will suffice as of now because these areas do not have much residential sectors. After collection, it would leave the Delhi-Rohtak road and move towards the disposal site via sec-7 road.
- One truck will collect waste from the collection point located at city park near metro station, and one big truck will start collecting the waste from civil hospital on Delhi-Rohtak road and will move on the disposal site via sec-7 road.

Table 3: Cleaning of Waste from Large Collection Point

Location of Collection Point	Type of waste Collecting Vehicle	Capacity of Vehicle	No. of Vehicles
Sec-16 A+B	Tractor-trailer	3MT (approx.)	1
City Park	Truck	7MT (Approx.)	1
Civil Hospital	Truck	7MT (approx.)	1
Krishna Nagar	Tractor-trailer	3MT(Approx.)	1
Old Court Road	Tractor-trailer	3MT (approx.)	2
Line Par	Truck	7MT (approx.)	2
Line Par	Tractor-Trailer	3MT (approx.)	3
Ramnagar	Truck	7MT (approx.)	1
Bus Stand	Tractor-trailer	3MT (approx)	1
Specific Areas	Tractor-trailer	3MT (approx)	2

- One tractor-trailer will transfer the waste from Krishna Nagar waste bin to disposal site at Nayagaon and two tractor-trailers will be assigned to the same for the waste bin at Old court road leading to Surya Nagar.
- Two big hydraulic trucks and three tractor-trailers will collect the waste from the cemented waste bins situated in front of railway station line par. The amount of waste coming in these waste bins is higher and needs clearing in morning. So, five vehicles have been awarded to these waste bins to collect the waste.
- One big truck will transfer the waste from the waste bin at Bus Stand and move on to disposal site via Najafgarh road.

The following table shows the approximate time to be taken by one vehicle from the collection point to reach the disposal site situated at Nayagaon.

Table 4: Time to be taken by Each Vehicles for waste transfer (approx.)

Location of Collection Point	Distance from Disposal Site (in kms)	Time to be taken to reach Disposal Site (in months)
Sec 16 A+B	8.8	46
City Park	9.4	48
Civil Hospital	5.9	38
Krishna Nagar	4.2	33
Old Court Road	5.0	35
Line Par	7.1	42
Line Par	7.0	41
Ramnagar	7.1	42
Bus Stand	6.3	40
Western Jua Drain	8.0	45
Mela Ground (Badli Road)	4.3	33
Mela Ground (Balaur Road)	4.8	35

- Tow tractor- trailers have been proposed for the waste collection in the commercial areas around the Delhi-Rohtak Road, Railway road and Bhagat Singh Market.

The loading time is included in the total time to be taken by all the vehicles and is considered to be 20 minutes for one vehicle.
The collection points located at the mela ground on Badli Road and Balaur road can be cleared ay any time in the day after clearing the waste from the above-mentioned collection points and before and repeat clearing starts as there are no issues related to traffic congestion.

Coordination and Synchronization
Coordination and Synchronization is the spirit of any planning. The sanitary department of any city, for an effective solid waste management plan, requires coordination with the other development plans for the city. Therefore, it should by synchronized with the overall planning for the city. Only then, economic and feasible solution for the generated municipal solid waste can be established. In this way, the sanitary department will be able to strive effectually for funds and other resources for the execution of the plans.
So, the coordination is required with the other departments to make it a successful venture and a regular synchronized of all the aspects of the planning is also essential.

Summary and Conclusion
Optimization of Transportation Routes
The ultimate fate of MSW in Bahadurgarh is reaching to the disposal site and no recovery or recycling station comes in between from the collection point to the disposal site. It is the responsibility of Municipal Council of Bahadurgarh to collect the waste from different waste collection points and transport it to the bigger collection points or directly to the disposal site at Nayagaon through whatever the vehicular fleet available to do the same.
There are no fixed routes of the vehicles for the transportation of waste from different collection points in the city to the disposal site at Nayagaon. Transporting vehicles collect the waste from different collections points on the basis of the demand of local residents and amount of waste generated and then deposit the same at the disposal site situated and Nayagaon. The vehicles generally follow route as told by the BMC Authority:-

Route Number 1
Primary Collection Points or the Waste Bins: Dumping Station at Mela Ground on Balaur Road- Balaur Road to Naya gaon-Disposal Site

Route Number 2
Primary collection points or the waste bins- badly Road-Naya gaon-Disposal Site

Route Type 1: Shorter Routes
The first are the smaller routes which aim to assist in the primary collection of waste from the smaller waste bins and disposing it in the larger cemented waste bins. The transporting vehicles on these routes will be of small size as possessed by the BMC. The mini tractors with the capacity of 1 to 1.5 MT will move on these roads as in the areas across live par do not have wider roads to move a bigger vehicle than these mini tractors. These tractors are used for the collection of waste from the source in the city. These mini tractors can carry on their work during the day in the residential areas as there is no problem of traffic congestion in these areas.

Route Type 2: Longer Routes
The second type of routes are the longer routes which will connect all the larger cemented waste bins to the disposal site situate at Nayagaon. These longer routes will not cross the busiest roads of the city except few exceptions where there is no chance for adopting any other route.
Cleaning of Waste Bins:
The larger cemented waste bins are to be cleared twice a day. Once in early morning before 8:00 o'clock and once on the onset of evening in between 3:00 to 4:00 PM. During these collection hours, the traffic on the major roads will on the least especially in the morning. The proposed 5 trucks with larger capacity of minimum 5MT capacity and the 10 existing big tractor trailers will move on the roads for the waste collection from these larger cemented waste bins. The loading time at each collection point is assumed to be 20 minutes when the loading is done manually. Two sanitary workers will accompany the truck along with one driver. The speed limit of the vehicles will be 20km/hour.
The municipal council of Bahadurgarh has a huge amount of waste daily to deal with. As the population of the city is increasing rapidly so is the rate of waste generation. The

major issues in the whole SWM in Bahadurgarh are related to the community storage, its collection and transportation. The disposal site situated at Nayagaon will serve the purpose for the coming years. So, finding a new disposal site can be put on the back burner but there is a requirement of efforts to be made to reduce the total waste reaching to the disposal site. If the proposed plan in this study is materialized then, the existing site will serve for an extended period than it is to be expected.

The present study has been an attempt to find some easy solutions to the present problems in dealing the solid waste in Bahadurgarh city. The study has some limitations but if the proposed solutions are adopted then the problem will not be that big to deal with in the coming time. The amount of waste can be reduced to a great extent through the proposed methods. Improved collection efficiency will keep the city stress clean and the proposed disposal site will be safe for the environment and will serve for a long time.

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