

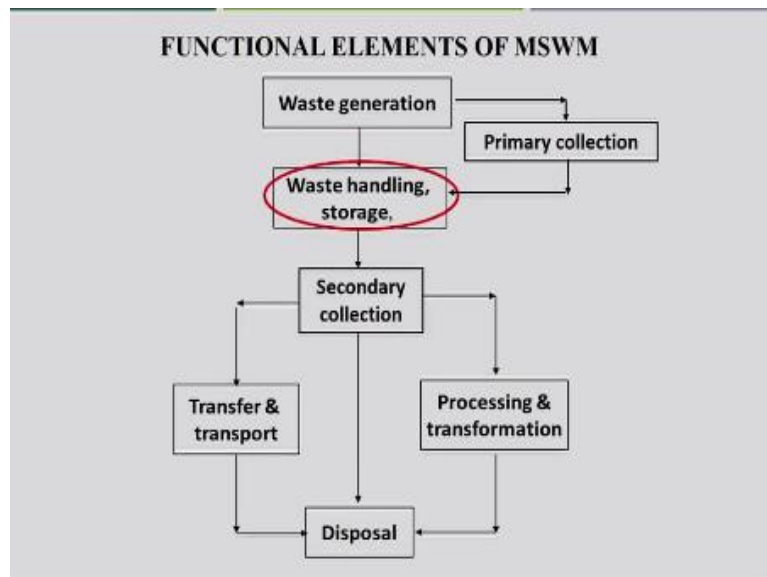
Municipal Solid Waste Management
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Lecture - 07
Handling, Separation and Storage at Source

Hello, students today we will start a new model, model 4 that is waste handling, separation, storage, and processing. So in this model, we will discuss the collection of waste from the sources, especially household or commercial areas, how to handle the waste and separate, some issues, and how best we can store the waste on to the source so that the collection and treatment will be beneficial.

We will discuss the source processing methods like biological treatments and how it can be possible and how best we can treat the dry waste at the source. That we will discuss in the next class.

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So this was our functional element diagram, where we are now in the second functional element, waste handling, storage and separation, and processing at the source. So before collection, there is a primary collection and secondary collection. In this lecture, we will discuss handling, separation, and storage at the source.

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HANDLING AND SEPARATION OF SOLID WASTE

The handling and separation of solid wastes at the source before they are collected is a critical step in the management of residential solid waste.

Waste Handling

In general, handling refers to the activities associated with managing solid wastes until they are placed in the containers used for their storage before collection or return to drop-off and recycling centers.

Separation

The separation of solid waste components at the source of generation is one of the most positive and effective ways to achieve the recovery and reuse of materials.

The diagram illustrates the process of waste handling and separation. It features three main components: 1) A house labeled 'Household/communi' with a red arrow pointing to a worker. 2) Two workers in green uniforms collecting waste into bins, with red arrows pointing to a bin. 3) A bin with 'WET WASTE' and 'DRY WASTE' sections, with red arrows pointing to the workers and the bin.

So first we will understand what is meaning by handling and separation. So is the handling means how best you can handle the household or commercial area. Now in India, the way our constructions of the buildings are changing, because earlier the bungalows were there different houses located. So it was very easy to reach every family. In India, most of the cities are coming with apartments. Even if you go small district or 3801taluka level, lots of apartments are coming. Mostly in an apartment, there could be 10 flats, 20 flats or maybe 50 flats and there are different numbers of families residing in those apartments. I think it becomes difficult for house-to-house collection system and how best we can store the waste in those apartments. We will discuss here handling and separation. This is also very important once it is coming out from the apartment, the handling, storage, and also the separate will be one of the important issues because in the apartment to collect waste, it is very difficult for the crew to visit every flat in the apartment. So the apartment people have to come up with some kind of idea of separation in their locality itself.

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Before Swachh Bharat Mission, how people are handling and separating the waste. You can see in the photographs. It clearly shows how it was difficult for handling such kind of waste. There was no proper handling and no proper separation was conducted scientifically and even storage was not available before Swachh Bharat Mission.

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You can see here an unsegregated municipal waste collected from the bin by the collection crew from the rag pickers or some crew members from the corporations.

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So this is one news report which shows that unsegregated waste should not be collected from July. And also this was one of the photographs that come up in Noida.

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Indicative List for Segregation of Household Wastes					
BASIC SEGREGATION					
Wet waste (green bin)	Dry waste (Blue bin)				Domestic Hazardous
	With further sub-segregation				
Food wastes of all kinds, cooked and uncooked, including eggshells and bones, flower, fruit and waste including juice, vegetable peels and household garden/plant wastes. Soiled tissues, food wrappers, paper towels; fish and meat	Paper cardboard & cartons	Containers & packaging of all kinds excluding those containing hazardous materials Compound packaging (tetrapak, blisters etc.) Plastics	Rags Rubber Wood Discarded clothing Furniture	Metals Glass (all kinds) Inerts Household sweepings and inerts (not garden, yard or street sweepings)	E-waste, Hazardous wastes (paint, oil, chemicals and solvents, pesticides and their empty containers), Household medical waste, Batteries, Lights bulbs, tube lights and Compact Fluorescent Lamps (CFL), Car batteries, oil filters and car care products and consumables

Source: Adapted from Manual on Municipal Solid Waste Management (First Edition), Central Public Health and Environmental Engineering Organisation (CPHEEO), 2000, Ministry of Urban Development.

Before Swachh Bharat Mission also it was proposed that waste has to be segregated into three parts and has to be handled at the source itself in three different segregation ways. So the first was the wet waste, that is in the green bin where I think you can say is most of the kitchen waste should be stored or get separated in the green bin where the food waste, all kind of cooked food, uncooked waste, vegetable peelings can be stored. Normally these biological waste will have more moisture that has to be stored in the green bin. Another segregation is for dry waste that will be stored in a blue bin which is also further segregated. This blue bin is used for all kinds of dry waste that include paper, plastic, rubber, leather, metal, glass. Again further segregation is also

possible because there would not be any moisture. It is possible at the source or some community level. And one more important segregation was domestic hazardous or household hazardous waste that includes most of like E-waste, paint, oil, chemicals are cleaning chemicals that are included in the household hazardous waste which again has to be separated into another bin.

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For household segregation, we need to have three different waste segregation bins. The first one is for wet waste for the household level which will mainly store kitchen waste. For dry waste, a blue bin will be used and for domestic hazardous waste yellow bin will be used.

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Once it is segregated, it will be collected by the local authority or corporations in a segregated way for the treatment process, recycling process, or disposal purposes.

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Here, you can see under the Swachh Bharat Mission collection vehicle has been used for waste collection where a green bin is used for wet waste, and a blue bin is used for dry waste. For household hazardous waste, an everyday yellow bin is not provided since waste generation is not very large. It is mostly collected once in a week or two times in a week or alternate days of the week.

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This is another photograph. You can see here, the photograph (FL) that is a wet waste and (FL) that is dry waste. So that they both waste can go for the different treatment

processes. The wet waste will go to the biological treatment facility like composting or biogas production facility and for the dry waste, it will go to the recycling facility or combustion facility. Most of the dry waste including paper, rubber, leather, plastic, and combustible matter can be treated for waste to energy facilities incorporation.

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So again that was for household waste. For the commercial area or educational institute, we can have these kinds of facility especially in institutions like colleges, universities, hospitals, or airports, bus stands can have these kinds of facilities. The three different dustbins for dry waste, wet waste. I think you can see in the picture where special dustbins have been provided for segregation and sub segregation of dry waste like paper, plastic, glass, or other kinds of waste.

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There is another picture which you people might have seen in the airports or after Swachh Bharat Mission implication in lots of bus stands, railway stations, and airports that have come up with these kinds of different colors of dustbins for the different waste, segregated waste storage. So this is for wet, dry, and hazardous waste.

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This is for commercial areas. You can see for dry waste collected bin from the small shops after the Swachh Bharat Mission.

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WASTE HANDLING AND SEPARATION AT RESIDENTIAL DWELLINGS

The three classifications of residential dwellings most commonly adopted are:

- Low-rise (under four stories)
- Medium-rise (from four to seven stories)
- High-rise (over seven stories)

➤ **Low-Rise Dwellings**

- The residents or tenants of low-rise dwellings are responsible for placing the solid wastes and recyclable materials that are generated and accumulated in and around their dwellings in storage containers.
- The homeowners or tenants are responsible for transporting the containers filled with wastes to the street curb for collection.

Residents responsible

Residents responsible for transporting the containers filled with wastes to the street curb

Low-Rise Dwellings

Now here the waste handling and separation at residential dwellings. So normally the residential area we can classify it in three different waste like low-rise buildings, medium-rise, and high-rise buildings. So normally first we will go for a low-rise building. Normally, in a low-rise building mostly now is an apartment.

Apartments will have societies and these societies have to look upon waste storage and segregation along with the security, water supply, sewage collection. But I think most of the apartments in India are a small size and this apartment does not have their special society. So this society is not looking after the waste collection. In that case, every flat owner or house owners should store the waste in their house and again has to be disposed of the locally available dustbin provided by the local authority. Normally that kind of collection we call a curve service. In the curve areas which could be a maybe 100 meters or 200 meters far from your apartment and households will be responsible to dispose of the waste on to those located dustbins.

But I think the bigger apartments which will have 50 families or 100 families will have their society and the society can plan how best they can collect the waste, and how best they will be able to segregate in their apartment area. So here households or tenants are responsible to dispose of the waste in the nearby located dustbin.

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House to house collection is practiced after SBM came to force

Residential containers are placed at the street curb

Or suppose the house to house collections are there and if the local authority can visit your house particularly, they can collect segregated waste.

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➤ **Low- and Medium- Rise Dwellings**

Typical solid waste storage locations include basement storage, outdoor storage, and occasionally, compactor storage.

Basement Storage

- The building owner provides a basement storage room or area for the storage of solid waste.
- Residents carry their waste and recyclable materials to the storage area and deposit them in the appropriate containers.
- The maintenance staff is responsible for transporting the containers to the street for curbside collection.




Now for low and medium-size buildings, it is a very good idea to have the basement storage. So these basements can provide a special kind of storage area for the waste and also can provide some kind of segregation facility into the apartment basement itself. You can provide some maintenance staff and maybe these households are located in this apartment they can pay for these maintenance staff for collection of the waste also and for segregating the waste and can be easily stored into the basement area.

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Outdoor Storage

- In many low-and medium-rise apartments, large waste storage containers are located in special enclosures.



Large waste storage containers are located in special enclosures

But if those kinds of apartments do not have the basement area available for the storage of waste they can go for outdoor storage. If some kind of outdoor area is available, they can store their waste and the benefit of outdoor storage is that vehicles

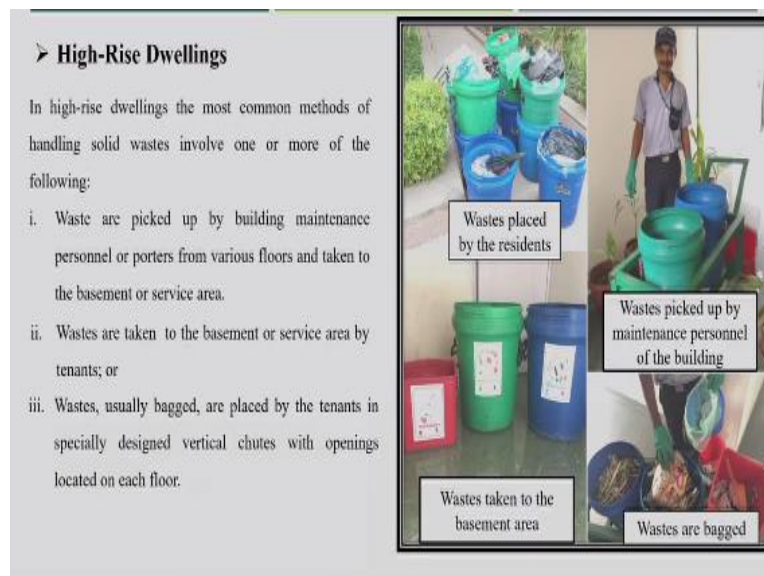
can come directly to those outdoor areas which are very close to the main roads and can easily collect the waste.

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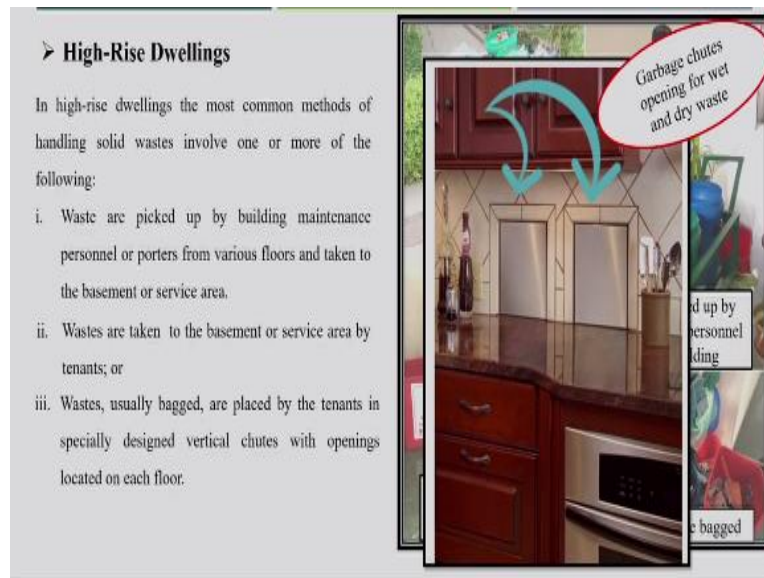
Like here this mechanical unloading of the waste from using a collection vehicle can be possible.

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In the case of high-rise buildings is again difficult for waste collection and segregation. So it is possible that the special kind of maintenance staff has to be provided by the high-rise dwelling people or those kinds of residence in those buildings has to be provided some kind of maintenance staff to collect the waste, to pick up the waste from the household area from each flat of that particular building and proper storage also.

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If the proper area is not available especially the basement area you can provide the garbage chutes opening for wet and dry waste on each floor is possible.

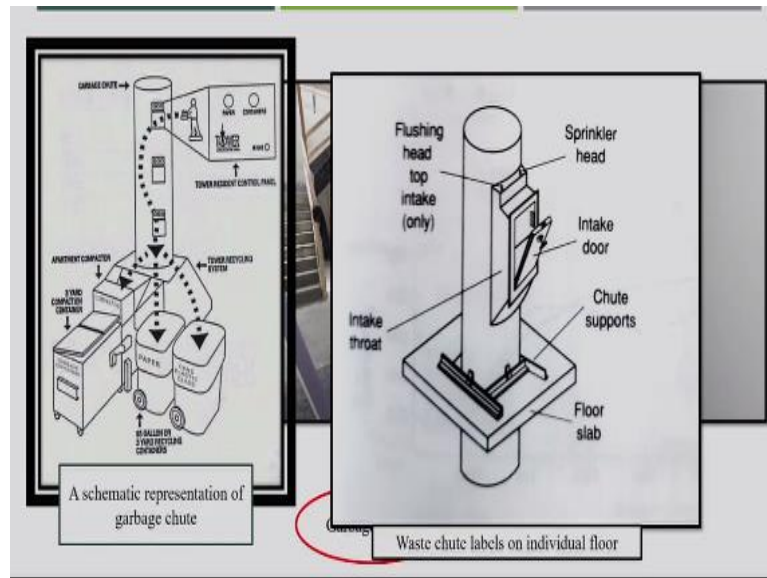
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These are some of the photographs. This is the vertical chute that is provided onto each floor. So the residents on each floor can dispose of the waste on the same floor and that also can be possible in a segregated way. We can have different openings for dry waste and different opening for the wet waste.

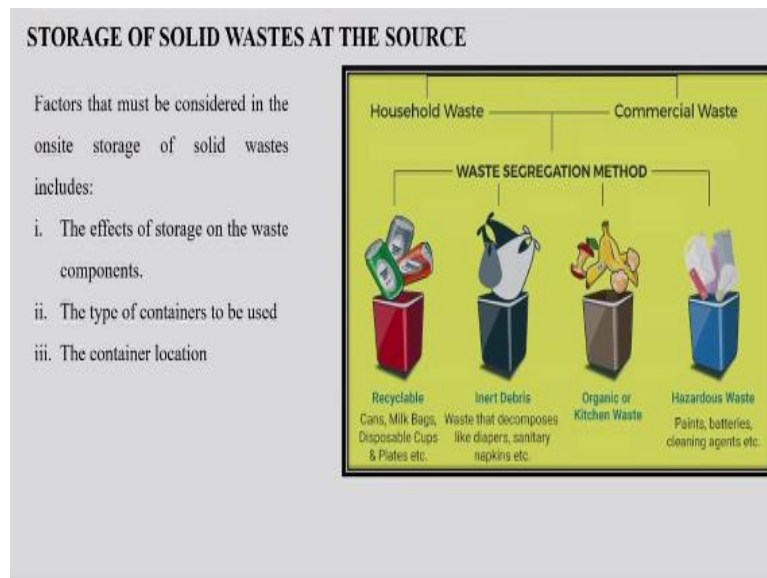
Only the larger size of waste cannot be put into this chute that can be again stored or dispose into the basement areas. But most of the waste from the residential area can easily dispose of this chute.

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And directly it is getting stored into the dustbin and the dustbin can be hauled by the local authority. So in that way, on each floor, you can provide some kind of opening so that waste can be disposed of easily.

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Now once you handle it, we found the proper storage facility which needs to see what are the factors considered before finalizing the onsite storage of solid waste. That is also a very important one. So the few factors like the effect of storage of waste component, another factor type of container to be used.

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STORAGE OF SOLID WASTES AT THE SOURCE

Factors that must be considered in the onsite storage of solid wastes includes:

- The effects of storage on the waste components.
- The type of containers to be used
- The container location
- Public health and aesthetics

Location of containers in narrow roads

50 m each

And the container location. This is also very important. The difference between the distance between the container location and especially the public health and aesthetics for the city apartments.

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- Public health and aesthetics

Underground storage of segregated wastes in a European country


This you can see the underground storage, is highly attractive.

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➤ **Effect of Storage on Waste Components**

An important consideration in the onsite storage of wastes are the effects of storage itself on the characteristics of the wastes being stored. These effects of storing wastes include:

- Biological/microbial decomposition/putrefaction: Causes odor, attracts flies, forms leachate.
- The absorption of fluids (spread of moisture over the entire mixture, paper will absorb moisture from food, garden trimming. If there is no lid, waste can absorb water from rain).
- The contamination of waste components: motor oils, household cleaners and paint contaminate and reduce the value of individual components for recycling.



So we will go one by one. The first factor is the effect of storage on the waste component. You see that especially developing countries like India are still producing a large amount of biological waste. I think most of the report says that 50 to 60% is biological waste. But I believe that maybe in the festival season or in the winter season, it is possible to increase the biological concentration up to 70 to 80% in some of the cities.

So we need to be serious about it and is a very important issue before the storage of such kind of waste wherever at the household level or apartment level or at any community level. Because these biological waste will go for degradation and this degradation start within six hours of the storage and the odor will get a start within 24 hours.

And if you store more than 24 hours, the odor will also produce, leachate will also produce and because of that lot of flies also will get produced into those waste. You can see here if you store for a longer period in this biological waste flies will grow and also leachate will produce.

Cleaning is very difficult and is known to be very hazardous because it contains lots of metals and a lot of organic matters. BOD of this leachate can go up to 50,000 milligrams per liter compared to the human feces where BOD is 200 and 300 milligrams per liter. And another point is that the absorption of fluid is possible that once these kinds of leachate will produce.

And if you mix both kinds of waste, if you dispose of the commingled waste like dry waste also along with the wet waste, this fluid or leachate may absorb onto the dry matter. Like, suppose paper and plastics are there or rubber, leather are there along with the biological waste, whatever the fluid or leachate has produced from the biological waste will also get absorbed onto this dry matter.

And once it is getting collected, this paper, plastic that is already contaminated with the leachate becomes hazardous and is very difficult to again go for recycling. In India, you know the rag pickers are collecting the fresh kind of material.

They will not collect this kind of dry matter whether is a very good quality of plastic or paper or rubber, leather that is already contaminated with leachate. Another important point is the contamination of waste. Because in the household lots of toxic waste is also generating, a lot of chemicals also we are using in the household area.

These chemicals like oil, paint, cleaning chemicals, will also get mixed with this kind of waste. So once everything is mixed together, it is very difficult for the collection also. Not only for the collection but also for the treatment and disposal. That is why in India I think if you are not very good at segregation at source, the entire waste will go to the disposal site that is dumpsite which is very difficult to get treated. Even the collection is also very difficult in that case.

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- c. The contamination of waste components: motor oils, household cleaners and paint contaminate and reduce the value of individual components for recycling.

Because of these problems, house to house collection of segregated wastes are practiced after SBM came to force.

Toxic waste contamination

Because of this problem, in Swachh Bharat Mission, house to house collection of segregated waste is practiced.

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➤ **Types of Containers**

The types and capacities of the containers depend on:

- The characteristics and types of solid wastes to be collected.
- The type of collection system in use.
- The collection frequency.
- The space available for the placement of containers.

There are two types of container systems:

- Haul container system:** Containers used for the storage of wastes are hauled to the processing, transfer or disposal site, emptied and returned to either their original location or some other location.



Haul container

The next point is the type of container which is also very important. One type of container, because one of the costliest events of entire solid waste management is a collection of the waste or collection and transportation of waste. And some of the reports say that 80 to 90% of the fund is required for only collection and transportation of solid waste.

Obviously, we need to think about what kind of dustbins has to be provided. What kind of dustbins or container has to be provided into the sources or onto the sources so that the proper collection would be possible. There are two types of the collection system. One is a haul container system or haul collection system where the entire dustbin is getting hauled onto the vehicle. It can be used if the waste generation is very large.

It is possible to get hauled onto the vehicle and will go to the treatment facility or disposal facility.

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And this is another kind of one haul container. You can see that these entire dustbins can be hauled onto the vehicle.

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➤ **Types of Containers**

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- The characteristics and types of solid wastes to be collected.
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- The space available for the placement of containers.

There are two types of container systems:

- Haul container system:** Containers used for the storage of wastes are hauled to the processing, transfer or disposal site, emptied and returned to either their original location or some other location.
- Stationary container system:** Containers used for the storage of wastes remain at the point of waste generation except when moved for collection.



Stationary container

So another kind of container is a stationary container. These containers are not getting hauled. Here the waste is getting hauled from the container. So in older days, you have seen in India, where special location used to be provided by a corporation where households used to dispose of the waste. And by providing 4-5 crew members they used to haul the waste into the vehicle.


But now under Swachh Bharat Mission, the hauling container is not possible, the corporation is providing these kinds of the stationary container. Now here container is not getting hauled but I think it was good to have the proper location where the waste is getting stored and getting collected by the local authority.

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➤ **Container Storage Location**

Container storage locations depend on the type of dwellings or commercial or industrial facilities, the available space, and access to collection services. In low-rise dwellings the containers are usually placed at the side or rear of the house, alleys, where alley collection are used or some common location specially designated for that purpose. Generally they are kept:

- Where waste generation is more.
- Where traffic is low.
- Distance between containers should not be more than 500 m.



Now, another point is the container storage location. This is a very important issue in most of the cities or most of the corporation's area because of where to locate the dustbins. Because they need to look at the proper collection and transportation from those areas where containers have been located.

In most of the cases, how best corporation is finalizing the container location that was the major two thoughts where the waste generation is more and where the traffic is low. I think these are the few points where the corporation is thinking. And see in India, nobody wants to have these kinds of containers, dustbins near to their household area. And now space is very important in the city area.

So there was a thought in Swachh Bharat Mission, can it possible that any city without dustbin. And that was very good though if the entire city does not have these kinds of dustbins or containers in the city. Means the thought was that whatever we had discussed into the handling and separation at source, your vehicle is directly reaching to those residential areas and collecting the waste.

So that is also a very good idea. But is a very costly process where the vehicles are reaching the individual houses and collecting the waste and going to the disposal or treatment facilities. That was very difficult. Corporations are trying hard to reduce the number of dustbins locations in the city because of Swachh Bharat Mission.

But for small cities like taluka or district where the population is low in the number of residents or number of households are less, in that case, it is possible that rather than planning for big size collection vehicles they can have simple auto tipper. And these auto tippers can visit each house and can collect the waste.

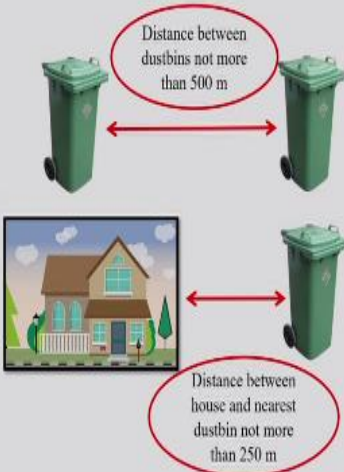
Where the collection distance also or that the distance from the city to the treatment facilities also just only two kilometers or five-kilometer that is not very costly. We cannot only reduce the number of dustbin's location from the city but also the city can be planned without dustbin also. So we have to wait for such kinds of implications when the city will come up without dustbin. But before that, we have to discuss what should be the distance between the container. This is not like based on the rule or regulation.

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- Where waste generation is more.
- Where traffic is low.
- Distance between containers should not be more than 500 m.
- Distance between container and house should not be more than 250 m.



But I think if it is good, that distance between the two dustbins should be 500 meters. And the nearest dustbins from any household should not be more than 250 meters. The simple thought is that if suppose there is no house to the house collection system, the tricycle rickshaw person can visit your house for the collection of waste. They should not travel so far to deposit the waste into the dustbin. So in 250 meters or 500 meters, they can easily dispose of the waste and they can make a number of trips in a day and can collect the waste from most of the houses.

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➤ **Public Health and Aesthetics**

- Public health concerns are related primarily to the infestation of areas used for the storage of solid wastes with vermin and insects that often serve as potential disease vectors.



Now another point is public health and aesthetics. This is also very important, because if you are locating several dustbins inside the city, obviously that would not be that aesthetic or not good for public health. If you are planning for those kinds of dustbin locations you need to be very serious about their collection frequency. And especially for the biological waste, your collection frequency should be once in a day.

If possible, you can extend the collection efficiency. But if you reduce the collection frequency like alternate day collection, obviously it is very problematic for the biological waste which will also come up with odor, leachate production, and flies and vermis. So you can see here this kind of waste is aesthetics.

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➤ **Public Health and Aesthetics**

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So are these aesthetics? Aesthetics are not good for public health.

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Some solutions..

- Proper sanitation (use of containers with tight lids, periodic washing of containers and storage area) can control the infestation of rats and flies.
- Aesthetic considerations are related to the production of odors and the unsightly conditions that can develop when adequate attention is not given to the maintenance of sanitary conditions.



Use of containers with tight lids

Here are some solutions. We can have this kind of storage facility for every container location and this is possible nearby your apartment. Even the tricycle person will come up to your household and can dispose of the waste in such locations. The use of containers with a tight lid, proper sanitation, periodic washing of those containers, and storage area can control the infestations of rats and flies.

The picture shows the use of containers with a tight cover. So aesthetic consideration is related to the production of odor and unsightly conditions that could be possible to produce into those locations.

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Some solutions..

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- Aesthetic considerations are related to the production of odors and the unsightly conditions that can develop when adequate attention is not given to the maintenance of sanitary conditions.



Underground waste collection bins in Europe

The underground waste collection bin is also possible. This is one of the photographs from Europe.

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Container Capacity

- ❑ A single household (family of 5 members): A container of 12-15 L for each dry and wet waste if the collection takes place daily. Wet waste container should be washed daily after emptying.
- ❑ Apartment complexes and large buildings:
 - ✓ 60 L (25 kg) high-density polyethylene (HDPE) bins for 12 households.
 - ✓ 120 L (50 kg) high-density polyethylene (HDPE) bins for 24 households.
 - ✓ 240 L (96 kg) high-density polyethylene (HDPE) bins for 48 households.



Now the last slide that is based on container capacity. For a single household, having 5 members in the family, they can have a container of 12 to 15 liter that is good for the waste storage for dry and wet separately if the collection takes place daily. And apartment complexes like large buildings can have 60-liter high-density HDPE bins for 12 households, 120 liters for 20 households, and 250 liter that is 96 kg HDPE bin for 48 households.

There are a few containers you can see. I think these are good. These kinds of containers you can use it in the apartment area. So this was the discussion for handling storage, handling, separation, and storage at the source level. These sources could be a household, could be an apartment, or some community storage. Now again, I think here, before starting the collection it is good to discuss some kind of processing facility.

Because in this lecture, I have talked about apartment storage. And normally in apartment lots of area is open. And it is possible to have some kind of processing, if not dry waste processing but wet waste processing could be possible. Maybe can have a small composting facility or some biogas facility, where some of the product can come out of this that can be possible to utilize for the apartment purposes. We will discuss this in the next module. Thank you.