Urban Services Planning
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Lecture 21
Primary and Secondary Waste Collection Part I

Welcome back. In module 4, we will talk about waste collection planning for urban areas. And in lecture 21, we will talk about primary and secondary waste collection and this is the part 1 of this particular lecture.

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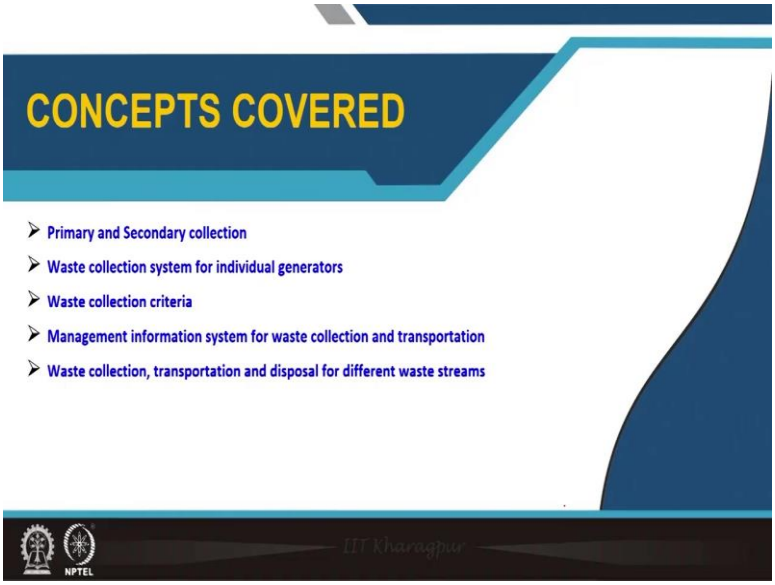

So, the different concepts that we will cover in this particular lecture are on primary and secondary collection, waste collection system for individual generators, waste collection criteria, management information system for waste collection and transportation and finally, waste collection transportation and disposal for different waste streams in an urban area.

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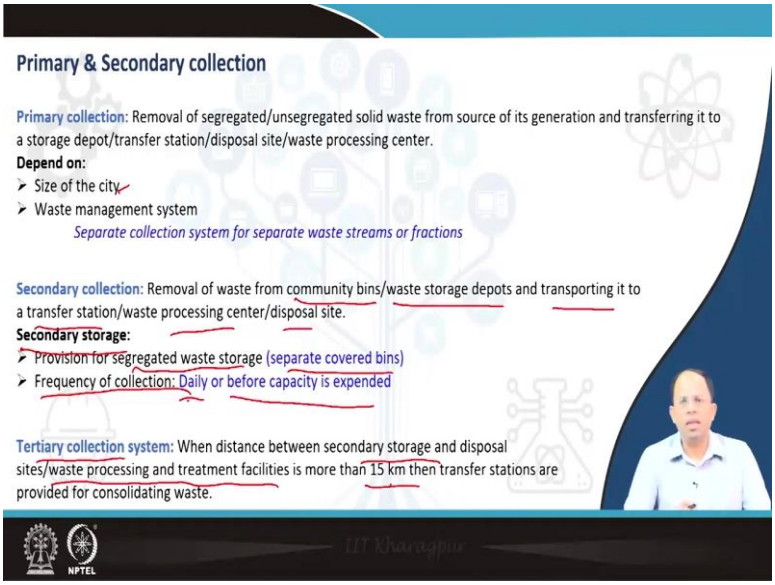

So, there are actually even though we have talked about primary and secondary collection actually there are three stages of collection that is possible for municipal solid waste transportation as well as collection and transportation that is primary collection, secondary collection and tertiary collection.

Now, the primary collection reference to removal of any kind of waste either segregated or unsegregated from the sources, the sources could be either the households, the sources could be some restaurants, sources could be some institution or any kind of sources or generators has to be considered.

So, removal of waste from those sources and transferring it to a storage depot or it could be a transfer station or it could be a disposal site or it could be a waste processing center. So, that means, I after I collect the waste from suppose household then I can directly take it to a waste processing center or I can directly take it to a disposal site or I could take it to a transfer station from where the waste is loaded into larger lorries and then taken to the disposal site.

Or we can take it to a storage depot where the waste stream is stored for some time and then it is collected from there and then taken to a waste processing center or a disposal site or to a transfer station from where subsequently again it the waste is transferred to a disposal site or waste processing center.

So, that means, that primary collection is where we are initiating the collection of waste that is from the source of generation to the next stage whichever it is. Now, how the system would be designed like should I go take the waste directly to a storage depot or should I take it to a

transfer station or to the final disposal site it depends on the size of the city that means, if the city is very large of course, the waste collection happens in different stages.

But if the city is small then in that case the waste which is collected from a neighborhood is directly transported to even the landfill site. So, it also depends on the waste management system that is when we talk about waste management system you we have earlier learned that the waste that is collected in municipal area is segregated into different types of waste and also based on the different kinds of generators we can segment the total waste that is being generated into different waste streams.

Now, what are these waste streams? Waste streams may include waste coming from market, waste coming from bulk generators, waste coming from households. So, these are the different waste streams and each of these waste streams based on the rules that are on the bylaws of that particular municipal body, people have to do certain amount of segregation of this waste and that segregation also plays a role.

Or this what kind of segregation is adopted in that particular urban area that plays a role in what kind of primary collection system that we will decide. The next comes a secondary collection system. Now, once the waste is taken to a storage depot or if the collection system is like a community being like instead of door-to-door collection we have a system like some areas of the city where door to door collection is not possible.

Or what take for example a very hilly area and also a dense settlement in a hilly area the roads are too narrow for any kind of vehicle even our hand cut to move inside. So, in that case, the generators have to get to bring their waste outside that particular area and store it in maybe a community bin and from there we will collect the waste or take for example a slum area. So, here the density is very high and the roads are very narrow so keep this for people to when they throw away their garbage.

They cannot throw it directly to, they cannot transfer the garbage directly to a waste collector. So, they have to bring it to a community bin from where the waste is eventually collected. So, removal of waste from this kind of community bins or the waste that is brought to waste storage depot why are they primary collection system, these two kinds of waste can be now collected from this storage areas.

And then finally transported to either waste processing center or a disposal site or an intermediate transfer station, where from where the waste is further consolidated and then

eventually transferred to a waste processing or disposal site. So, this is the secondary collection system. Now, secondary collection also records the waste to be stored for some amount of time that means, it is this is known as secondary storage and secondary storage also needs to have the capacity that so, that waste remains segregated.

So, somebody is segregating the waste as the household level. Now, when you bring it to the community storage of or you bring it to this waste storage depot in that case the waste needs to be again stored in the same way. So, similarly, we use separate covered bins over here and segregated waste is stored in different bins or different containers. And as far as the types of segregation that this particular urban body encourages or is has made mandatory accordingly, we will do the segregation.

Now, it also depends on the frequency of collection that means the secondary storage the size of the storage, we have already discussed this earlier in our previous lecture that the size of the storage is decided based on the area from where the waste is collected, the quantity of waste generated by that particular area, the kind of segregation the practice and finally, the frequency of collection.

Why it is important? Because if I collect the waste every day, then the quantity of waste that needs to be stored is definitely less than if I collect every two days or every three days. But usually in our weather conditions, we need to collect the waste daily otherwise particularly organic waste at least we need to collect daily otherwise, the waste start decomposing and it will create very unsanitary or unhealthy conditions.

So, either it has to be daily, but in some cases in certain kinds of waste, we can also consider that based on the capacity is there that is the capacity is expanded or the capacity is filled, we can do the design of collection frequency according. Finally comes the tertiary collection system. So, as you understand we have been talking about transfer stations. So, tertiary collection systems refer to transfer of waste from this transfer stations to the final disposal site or the processing waste processing certain kinds of waste processing centers.

Now, when it usually the rule is when the distance between secondary storage and disposal sites or waste processing and treatment facilities is more than 15 kilometers then transfer stations are provided. But there will be other criteria as well, but for the time being we can consider that distance is the only criteria that is being considered.

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Now, talking about collection when we are talking about primary collection, usually this involves collecting waste in two ways you can say that means the waste is collected from door and as per MSW rules. Waste has to be collected from door to door or for certain kinds of larger unit complexes and all at least from the gate of the complex.

So, that is the basic rule. Now, usually this involves a neighborhood or a locality or a particular ward. So, that means there are certain areas in the locality which has got wide roads, certain areas, which are very small roads. So, all these things should be considered when I choose what kind of vehicle, we should employ for collecting this waste. There are other considerations as well that we will learn later.

So, waste usually for primary collection is collected could be collected by both non-motorized vehicles or motorized vehicles. Non-motorized vehicles, as you understand is something like a push cart as you can see over here, that means it is a hand drawn cart which is being pushed by some human beings and then you can actually take it to in very small roads and so on. So, why we like choose a pushcart, why not a motorized vehicle such as this small LCV that you can see over here. So, why between these.

So, how do we make these judges? This we will learn later on. For the time being we say that both these systems could be employed. Now, that means this is the waste that has been generated at our households from there I can either transport waste via pushcarts or I can collect the waste via pushcarts or via this LCV's. Now, after the collection is done then the waste needs to be transported, transported to where?

It is usually transported to the non-motorized vehicles is suitable for transfer to waste storage depot or secondary storage. So, that is usually a secondary storage depot is a as you can see that we have kept a metal container over here and this is located at certain locations in that collection zone and the waste collection vehicle this particular pushcart or the waste collectors can take the pushcart to this particular bin and they can unload the waste.

Or in case of LCV use of LCV the same can happen as we have seen earlier LCV's can also may have some tipping here, they usually come and align themselves with this particular bin and they directly empty their waste into this particular bin. But because these are LCVs that means, they have got they can ride for a longer distance unlike a handcart which cannot be pushed for a long distance.

So, if required a motorized vehicles can directly transfer waste to transfer station disposal sites waste processing center instead of secondary storage. So, they can take it to a secondary storage or from here directly they can send it to the transfer station or if required if the city is small they can even go to the directly to the landfill site or to the processing plants or the waste product treatment centers.

Now, once the waste reaches the secondary storage then starts the secondary collection. So, usually this involves larger capacity vehicles of course, it should be bigger than a wheelbarrow and bigger than a small LCV. Because this involves a larger container. So, we use other kinds of vehicles and as you can see that this is one sort of a skip loader that you can see over here.

That means, this system actually lifts the container this metal container from over here and loads over itself and then transferred to use and this vehicle can then move directly to the landfill site or the processing center or to a transfer station in case the distance to this landfill site is too much. Now, why this small weekend is suitable? Because in that case again this is still a part of the city that means this storage look the secondary storage is within the neighborhood itself we cannot take in very large lorries usually.

And also in urban roads, we cannot take very large lorries inside the urban area, there are a lot of restrictions in terms of movements or larger vehicles during different times of the day. So, usually, we ended up using intermediate sized vehicles such as you can see in this particular picture. So, usually, these vehicles transferred the waste from secondary storage or tertiary collection points to the waste processing or disposal sites.

So, that means sometimes what happens these kinds of containers metal containers are placed at these secondary storage points where all these wheelbarrows bring their waste or the self-service bring the waste. Sometimes in case of waste which is generated by a market or waste which is generated by like C and D waste which is usually of a larger quantity.

In that case, we can place these containers of several parts of the city or like community bins, they those are spread over several parts of the city and directly this vehicle goes to those particular points loads this particular waste this particular container into it and then transfer it directly to the transfer station or the processing site. So, that can also happen.

So, the choice of vehicle what sort of vehicle we will choose depends on the quantity of waste that is being transported, it depends on the travel distance that how far away I should transfer the waste. So, if it is too far away, then I will choose a vehicle accordingly, but if it is very, very far away, then I have to transfer it to a transfer station and so on.

Then road widths if the road width does not allow me to choose a certain kind of vehicle I cannot. Road conditions, maintenance facilities of that particular vehicle for example, I buy a very expensive vehicle belonging to a very expensive brand, but there is no maintenance facilities for that brand over in this particular city.

So, there is no point of buying that particular vehicle. So, all these decisions come into play when you choose what sort of vehicle has to be bought for this kind of waste transportation. So, as we can see from secondary storage, we use this kind of a vehicle and this vehicle can transport the waste transfer station or to the processing plant directly.

And finally, from the transfer station we use larger size vehicle as you can see over here, it this is also a compact truck which is being utilized but this is a much larger size. And using this kind of a truck we can actually send the waste to a processing plant or disposal site or the landfill site. So, that is how the overall system works.

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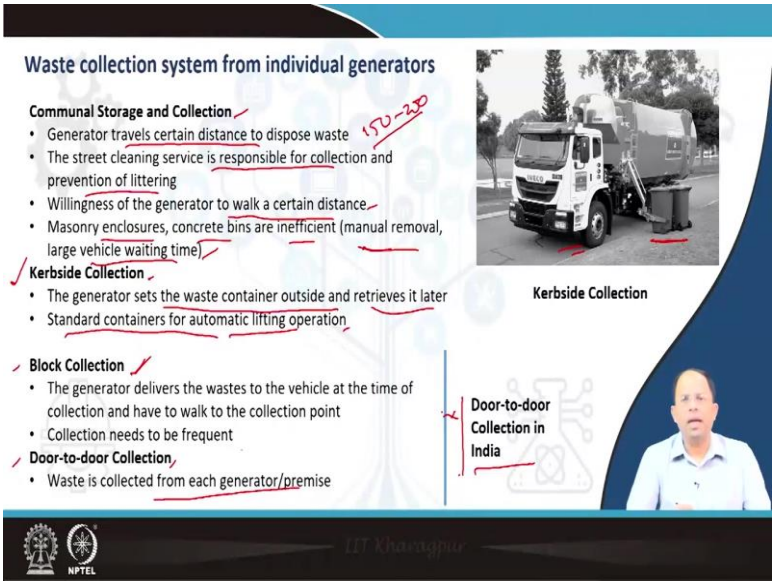

Now, talking about the collection system as we are discussing like peep in certain cases where door to door collection is not possible, we have to set up community bins from where we have to collect waste or in some cities earlier before these rules came in there were community bins all over Indian cities and it was the job of the municipal body to send vehicles to each of these bins to transport the waste.

So, this system exists in many parts of the world still and in as we are discussing, along with this door-to-door collection system parallelly the community bin collection system also exists. Because in many parts of the city, we have to provide community bins, and sometimes we give community bins as a secondary option.

Even though those if we can manage it in a proper way, then the waste, the secondary storage facilities also have community bins permanently placed. And some people can directly bring the waste to this particular bins as well. So, community storage and collection system is there. But in this kind of system, there are some positives and some negatives, the generator needs to travel a certain distance to dispose waste.

And as we understand that people are unwilling to walk more than 150 to 200 meters roughly, that is the range after that, if the bin is too far away, people will not carry the garbage, they will just throw it into the municipal drain. So, that if we cannot get a place bin set too far distances. If we do not, of course, when this we are talking about if we do not have a door-to-door collection system.

The street cleaning service is responsible for collection and prevention of littering. Now, as soon as the community bins system is utilized, the community bin is placed in the street. And that means the street cleaning service becomes responsible for this particular bin and the littering around it. So, that means the responsibility goes from the generator to the street collection service. In the door-to-door collection system, what happens?

The generator is responsible for storing the waste properly, and then transferring it to the transport vehicle. But here it is the responsibility of the street cleaning service to manage that particular bin. Then willingness of the generator to walk a certain distance. Of course, that plays a big role. Masonry enclosures sometimes as we have learned earlier that this kind of bins could be metal containers, masonry enclosers, concrete bins, and so on.

So, this has evolved over time now we prefer metal containers because those could be directly loaded into the vehicles. But earlier, we used to have machinery enclosures concrete bins are still used in many areas. And these are inefficient because it is difficult to remove, you have to remove everything manually, it is and that means that the vehicle has to come and wait over there.

And then physically, some people have to unload the garbage into the particular vehicle. So, that it is not only it is unhygienic and on site, aesthetically looks bad, but it is also involves a lot of time. So, time means you will spend a lot of costs the vehicle could have been the primary use of the vehicle is to transport waste.

So, that means the more time it spends in transportation, it is more effectively utilized, the more time it stands at a particular location its utilization rate drops. So, that you have to understand while you design, what kind of system you are going to put in an urban area. Then coming to Kerbside collection, this is a system which we see in some cities.

And sometimes usually we see it in developed countries, the generator sets the waste container outside and retrieves it later. So, that means the waste generator usually put the container outside into the street in the morning and then the vehicle comes in uses this kind of arm to live the waste at over the vehicle, empties the container and then again push back the container and the container is again taken back by the generator inside.

So, of course the containers should be standard otherwise automatic lifting operation cannot happen. So, that means this has to be of certain dimension certain sizes only then this kind of operation can be happened, but you have to understand this. This kind of system required,

this is possible when? That means that transportation is more that means this large vehicle is coming from door to door and picking up your garbage and then going.

So, of course, the vehicle size can be small or large, but at the end of the day what it means you have to travel a larger distance. So, in case the density is very low, and also that area is relatively affluent that is the case when we will go for a Kerbside collection system. Otherwise in Indian conditions we usually do not see this kind of system because neither our areas are low density neither our population is that much affluent.

So, that is why Kerbside collection could be an option but only for very small or only for very specific areas. Then in Indian condition usually we see two variants that is block collection or door to door collection. Now, what is block collection? In this case the generator delivers the waste to the vehicle at the time of collection and have to walk to the collection point and collection needs to be frequent that means every day at least every day, at least the vehicle should come once and then it should collect.

Otherwise, what happens? The generator will have to store the waste inside their home and that will lead to the decomposition happening in the home that will result in a lot of varmints a lot of rodents and so on. So, usually every day waste is to be collected, but the most important thing is that people have to come out of the waste from their house, they have to walk a little bit come to the collection point which is marked even on the road.

And then they stand there, the vehicle comes at a certain point of time, they picks up the waste and then they go and in door to door collection waste is collected from each generator or each premise. Now, Indian system door to door collection in India is actually a mix of both these systems, it is neither a block collection system neither a door to door collection system, usually we see what happens?

The waste collector comes to your area more or less the comes at a certain time he will blow the whistle or he will blow the whistle in the sense he just he does not climb up the stairs in your house sometimes. Sometimes he does climbs up your stairs and comes to your door to collect the waste. Sometimes they just do not remain outside and then they will blow the whistle and hearing the vessel you can come outside and you can put the vest inside that particular vehicle.

So, in some places door to door collection in India is actually a block collection, in some places door to door collection really happens that means the collector comes to every house

and then takes away the waste. So, it is we can say both block collection and door to door collection are a mix of this happens in Indian conditions.

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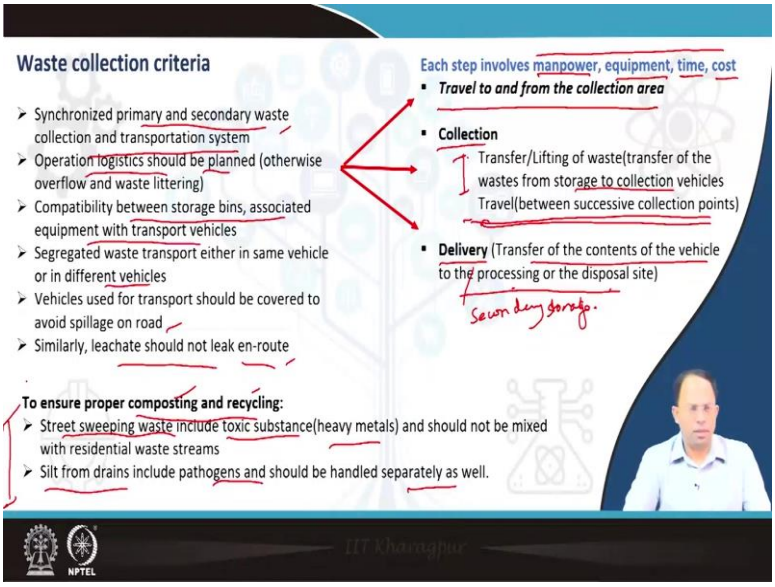

Now, we will talk about certain waste collection criteria. So, these are basic general rules or these are basic steps that we have to follow when we design our waste collection service. So, the first thing that we have to think about is to synchronize primary and secondary waste collection and transportation system.

That means if I do not synchronize these two that means we keep on the primary system works independently and the secondary system works independently that cannot happen. If that happens, then what happens? The waste bins will overflow, there will be some cases when even the waste the number the waste collection happens at a different frequency does not consider the amount of waste that has been generated.

So, there is no coordination between these two systems and that leads to littering that leads to overflow of waste bins and it leads to other problems as there. So, that means the best possible system is we will discuss that data that is the waste the secondary vehicle comes the sorry the primary vehicle comes the handcart comes out this LCV comes directly empties the waste into the container and this container is immediately lifted as soon as it gets filled.

Immediately lifted by a vehicle or vehicle is waiting for that and it is taken to the final disposal center or the processing center disposal site of the processing center. Now, that is the best possible system. But this requires a lot of coordination. That means a lot of operation

logistics has to be planned so that that exact timing has to be matched. But that is why synchronization is important, but it does not happen everything.

So, it may happen that the waste is collected in the morning from the neighborhood it is brought to the center in the afternoon maybe the vehicle comes and take this waste away. So, that means the entire day's waste has to be stored for certain amount of time that needs to be transported. So, we need to decide on what is the appropriate size of this secondary collection vehicle.

So, it would be able to transport all this waste or if it is more than one container that means we may have to bring multiple vehicles or we have to plan the route the schedule of the secondary collection vehicle so that it comes twice and takes up this container in two trips. So, all this planning needs to be done. Compatibility between storage bins, associated equipment and transport vehicles.

Obviously, it has to be compatible, why? Because the systems we are trying to make everything very, very mechanical that means we are trying to reduce the human involvement. So, the vehicles the pushcarts come in. They directly unload into the metal container so the system has to be such that it could be it could do that.

So, that means that height of the opening of the metal container or where the secondary storage and the height and the way the tilting mechanism of that particular handcart operates, it has to be at certain height so that we can directly transfer. If it is not then what happens? It first it gets unloaded into the ground then using some system we can actually lift it and then put it back into the container. So, it increases time it increases inconvenience increases manpower requirement and so on.

So, all these different and the same goes like the metal container has to be directly lifted into the vehicle which you transport it or if this is a community bin or if it is some sort of a storage system and it needs to be emptied into some vehicle or compactor vehicle maybe in that case directly, we have to leave this waste this particular container and lift the waste into that particular vehicle.

So, in that case also there has to be some standard sizes some standard lifting mechanisms as we have discussed earlier. So, this compatibility has to be there and then segregated waste transport is either in same vehicle or in different vehicles. So, either the transport vehicles should have that segregated compartments or we have to bring in different vehicles or

somethings two push carts or two storage vehicles can come each taking different kinds of waste.

Vehicles use for transport should be covered to avoid spillage on road and similarly, leachate coming out from the waste or the moisture that comes out of that waste while it is being transported that should be avoided. So, these are some other primary concerns that we should be careful about. Now, each state primary collection, secondary collection, tertiary collection, each step involves certain manpower requirement, certain equipment requirement.

And, of course, some time requirement and because we are using different equipment, different vehicles, the cost also is different. So, we have to consider all these different factors when we compare between different systems. That other party's what are the things involved in a collection system both for primary collection as well as for secondary collection that is the travel to and from the collection area both primary vehicles need to travel to the collection area and bring back the waste.

Same goes for the secondary vehicles as well. Now, travelled to and fro. So, that means to and from that means there is a travel time involved there is a distance involved. So, as accordingly, we have to decide how many vehicles are required, how many trips will be planned, what is the cost that we will spend?

Then the collection system it involves like in case the primary collection the vehicle comes in front of your door or it comes near your house and you have to put the garbage inside that takes certain amount of time. So, or in case of secondary collection system the loading unloading part that is the transport or lifting of waste transfer of the waste from storage to collection vehicles that also needs to be considered.

So, this requires some amount of time some amount of manpower, then for travel between successive collection points, that means from one point that is from one door to the next door or from one group of buildings to the next group of buildings or from one secondary storage to the next secondary storage.

There is travel between successive collection points or one community bin to another community bin the vehicle has to travel. So, depending on the distance of this we have to decide on what sort of vehicles are suitable? Because if the distance is long, it is better to use motorized vehicles, but if the distance is short, if you use motorized vehicle then probably the vehicle clutch, the vehicle systems will deteriorate fast.

So, these are some of the considerations and then also requires time to travel between these particular points, then finally, delivery that is transfer of the contents of the vehicle to the processing or disposal site or to the secondary storage as well. In case of primary collection, the vehicle unloads to secondary storage, in case of secondary collection the vehicle unloads to the processing or disposal side that also requires some time.

So, when I plan the interoperations travel time, loading unloading time, travelled between the collection points time, travel for take time taken by the generated to put the garbage inside the vehicle or from this primary collection vehicle to the secondary storage. So, all this involves time so that has to be estimated.

Now finally, to ensure proper composting and recycling in urban areas, the normal waste stream that the waste that is collected from different generators. In addition to that, we have to consider street sweeping waste as well as silt from drains. So, street sweeping waste includes a lot of toxic substances like heavy metals and should not be mixed with residential waste streams.

So, there has to be a separate collection system for this. Similarly silts for drains include pathogens and should also be handled separately because we cannot mix this waste into the normal composting and the recycling stream they need to contaminate the entire, fertilizers that will be produced. So, that is why we have to have separate collection systems for this particular kinds of waste.

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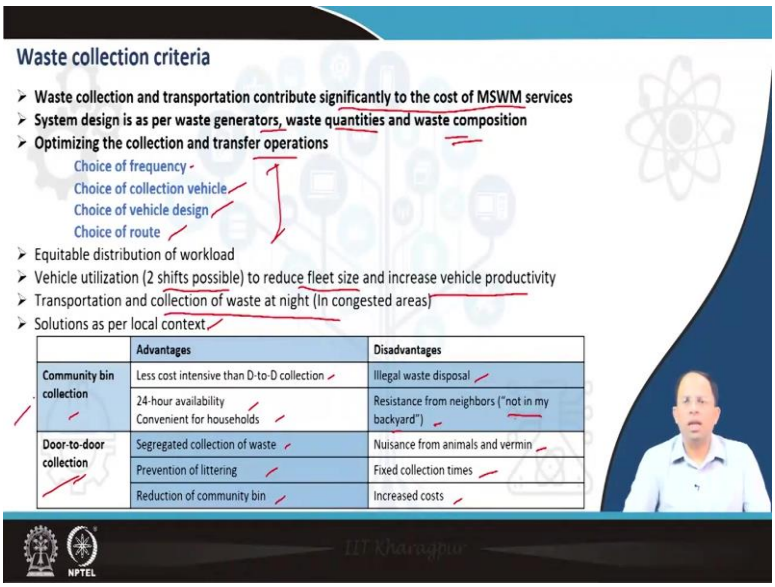

So, overall, as we can understand the waste collection and transportation contributes significantly to the cost of municipal solid waste management services. So, actually, this is the most costly part of the system. And system design is as per waste generators, waste quantities and waste compositions which we have learned. So, we have to consider this to design the system and we have to optimize the collection and transfer operations.

So, there has to be synchronization between primary, secondary, tertiary collection and we have to overall optimize the system. So, when we optimize the system, it has to be optimized for a chosen frequency of collection as per the kinds of waste composition, what kind of waste is generated, we have to choose what sort should be the frequency of collection, the choice of the collection vehicles.

What sort of vehicles we should collect depends on, what sort of terrain, what sort of cities characteristics, what sort of waste segregation policies? Choice of vehicle design the segregation policies determine how many compartments should be there in the vehicle and so on. So, this is vehicle design. Choice of routes, which routes vehicle should take.

So, these are some of the things we have to determine in waste collection operations. Then the other is we have to also ensure in other aspects, that is there are different workers engaged in this collection system. And actually, most of the people engaged by the ULP or by contractors are in this particular collection and transportation system, so equitable distribution of workload amongst the employees, so that has to be thought up.

So, that means that when I am designing the system, that means every, we should also talk about the workload or the productivity of the employees as well as that of the vehicles. Vehicle utilization, if possible, human beings can work for eight hour shifts maybe but for vehicles, it could work for the entire day. So, maybe two shifts for vehicle and that will reduce fleet size and increase vehicle productivity.

Transportation and collection of waste at night in congested areas in large cities, waste collection could be done at night as well. And a solution should be as per the local context. Now, here we have just discussed about the advantages and disadvantages of community bin collection and door to door collection system, we have more or less discussed this already.

So, community bin collection is of course less costly, it is available 24 hours and it is very convenient for the houses, whereas problems are illegal. If it is a little bit far away, then people just throw it garbage away. It is illegal waste results in illegal waste disposal.

Sometimes there is a lot of resistance like people do not want the community bin near their house. So, not in my backyard NIMBY.

So, that kind of protest will always happen. In case of door-to-door collection, segregation of waste happens, that is beneficial in community bin collection usually segregation is does not happen, we can put different kinds of containers but usually that does not happen. Prevention of littering in case of D-to-D collection, reduction of community bins in an area that as we discussed some community bin still remains.

So, but it increases chance of animal and vermin infestation inside houses. The collection time is fixed. So, that means you mix on the collection on a particular day and then you have to store that waste and also it increases cost. So, these are the positives and the negatives about these systems and accordingly our city in India we will try we as per rules we have door to door collection, but we have to also do community bin collection in certain places.

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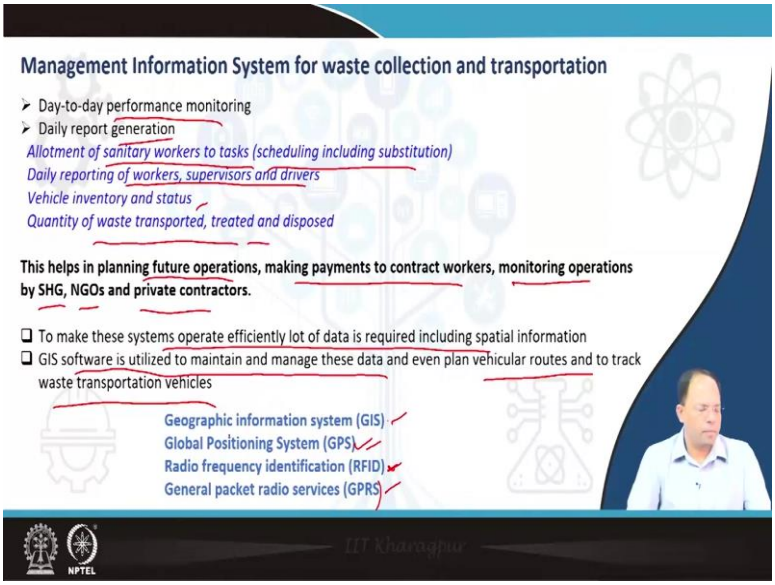

Then coming to management information system for waste collection and transportation. So, this is where the IT systems comes in or as you know that geographic information system, Global Positioning System GPS, Radio Frequency Identification, GPRS systems. So, GPRS is for transferring the data between the point of date generation and the servers and so on.

Whereas RFID is a radio tag that means you can identify that when you come to a house there are some cities which we this has implemented. The work needs to scan the RFID tag attached to that house. So, that gives a confirmation that waste collection has happened in that particular house.

So, the authorities can also keep tag on if the waste collection is happening properly. Or similarly, when containers are transported from one area to another week. Container may have this RFID tag which helps us to track the movement of the container and also return it to the location where it should go back to.

So, all these systems can be facilitated by using RFID technology and GPS is the location of vehicles and all if they are following the particular route and all that could be determined and GIS is overall data management to store both spatial data as well as non spatial data together in the same format so that we can make better decisions.

So, usually this kind of systems are employed to for day-to-day performance monitoring, daily report generation this could be report about allotment of sanitary workers to different task, which is scheduling of such activities to different workers and also substitution in case somebody is absent we have to substitute somebody.

So, this could be done this request a complex allocation system, which is better to be handled by a computer, daily reporting a worker, supervisor, driver. So, we can keep track of who is coming and who is not, vehicle inventory status, quantity of waste transported treated, disposed. So, we can keep all these records for which will help us to plan future operations, make payments to contract workers, based on the work they have done, monitoring operations by self-help groups NGOs and private contractors by the Urban body.

So, all this is facilitated by incorporating this kind of smart IT systems. So, of course, a lot of data is required and that requires not only data, but the data management system. Usually, GIS software is utilized to maintain and manage this data and even plan vehicular routes and to track waste transportation vehicles. So, we will give you examples of this.

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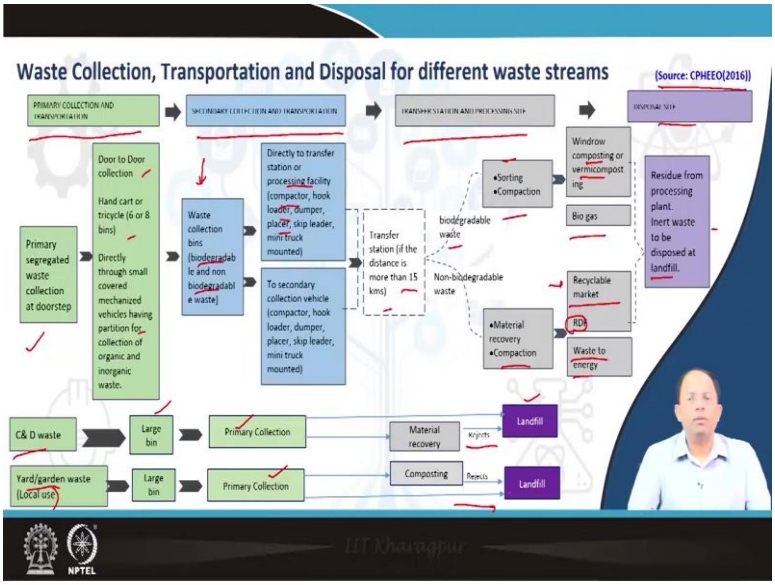

Now, this is charts given by CPHEEO and also, I have augmented it a bit. So, this actually shows the different waste streams that are there in an urban area and what kind of waste collection transportation final disposal is undertaken. For example, green refers to over here as primary collection, blue the secondary collection part, this grey is transfer station and the processing part and finally, the disposal is in this magenta.

So, the first waste stream is the primary segregated waste collection that happens at doorstep. So, this is the first question. So, door to door collection. Usually, we can go for handcarts with six to eight bins or directly to small covered mechanized vehicles having partition for collection of organic and inorganic waste.

So, both LCVs or we have pushcarts to be utilized. So, then this waste is brought to the secondary storage where it is stored in biodegradable and non-biodegradable separate containers separate bins. From here the waste could be directly transported to the processing facility using compactors, hoop loaders, dumper places, we will learn about this kind of vehicles in the next lecture.

Then also to secondary this could be transported to a secondary collection vehicle which take it to a transfer station if the final disposal site is far away particularly 15 kilometers away. Again, from here the waste is divided into two parts biodegradable and non-biodegradable. Biodegradable goes to compacting sorry first goes to sorting centers and compaction could be done and then it could be taken to some composting plant or to vermin composting plants or to a biogas plant because these are biodegradable waste.

The non-biodegradable waste goes to a Material Recovery Facility from where certain materials could be taken out and recycled. Then it also is compacted and finally, it is taken to the recycle the material which is generated is some is taken to the recycle market, some goes to this waste to energy plants, some general to refuse derived fuels.

So, that means we can use them as fuel as well. So, this is where the final waste can go and finally, the rejects from all these centers and inert waste goes into the waste to this landfill site. So, this is how the waste travels in an urban area. For CND waste the construction and demolition waste usually it is stored in large bins in place of generation and then using primary collection or it could be a mix of primary or secondary collection.

The waste could be directly taken to the landfill site or to a Material Recovery Facility from where certain materials could be recovered. And finally, the rejects of the Material Recovery Facility also goes to the landfill site. Similarly for garden waste or yard waste, which is for most of it has to be used locally that is the mandate. The rest is stored in large bins.

Again, primary collection vehicles come in they can take it to a composting plant. And from there the rejects could go to the landfill site or if the waste is not there is no composting plant or there is no possibility of composting this kind of waste, then we can really take it to the landfill site.

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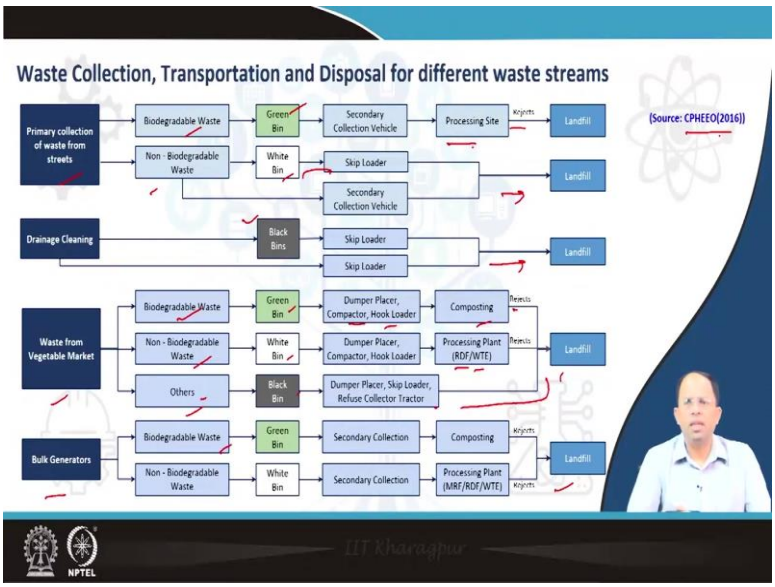

Then coming to collection of waste from streets, again this waste could be biodegradable and non-biodegradable. Biodegradable waste could be stored in green bins but non-biodegradable in white bins and some amount of non-biodegradable waste could be directly transported via

these secondary collection vehicles instead of first storing it and then loading it, whereas keep loaded into a vehicle, we can directly, the vehicle can you can still put the garbage into the vehicle directly and then it goes into the landfill site.

Whereas for biodegradable waste can go to a processing site like a composting plant. And then from there the rejects can go to the landfill site. For drainage cleaning, these are black bins because these are sort of hazardous waste. And again, we can use directly vehicles and then take it to the landfill site. These bins could be loaded by skip loader and take into the landfill site.

Waste from vegetable market either it could be biodegradable, some could be non-biodegradable and the other waste is all mixed waste and hazardous waste maybe as well. Again, as per MSW rules we use green, white and black bins and using different kinds of vehicles like damper places, competitors, hook loaders we will learn about this.

We will live these particular bins and take them either to the composting plant in case of biodegradable to the RDF or WTE plant waste to energy or refuse derived fuel plant from the non-recyclable waste, non-biodegradable waste and then the other waste can directly go to the landfill site. So, the rejects from this plant goes to the landfill site and the other mixed waste or hazardous waste goes directly to the landfill site.

Similarly, for bulk generators, there could be in bulk, biodegradable and non-biodegradable we follow similar processes and eventually the waste reaches to the landfill site. So, this is some suggestions given by CPHEEO of course, as per each city this will vary as per the waste composition as per the system that you are designing this will vary but this gives you an overall idea about how different kinds of waste needs to be treated in an urban area.

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So, these are some of the references you can study. To conclude, primary, secondary and tertiary correction is the most cost incident intensive part of municipal solid waste management. Collection systems have to be designed and optimized as per the different waste streams and disposal and treatment strategies adopted by the ULB. And finally, all the stages of the collection system has to be compatible with each other and synchronized to reduce cost and inconvenience of the common people. Thank you.