

Integrated Waste Management for a Smart City
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Module-04 Lecture-18
Storage of Solid Waste

Okay. So welcome back. So this is the third module of week 4. So we have, we will start looking at, as I said at the end of the previous module, we will start looking at the storage, collection and transport and of the waste. So far if you remember from the class, in the very first week, we kind of gave you an overview. I gave you an overview of the like a typical integrated waste management system.

We talked about the different components of the waste management. Then in the second week, we talked about what are the waste properties, how we get the quantities as well as the quality of the waste. We talked about the statistics involved with the data during the third week. And we also looked at the rules, regulations, the Swacch Bharat Mission, MSW management rules, how the Smart City initiative, how the waste management is important from a Smart City initiative as well.

So after having all that as background, now once the waste is produced it has to be collected. As per the MSW management rules, it requires to be a source segregation. So if in ideal once we implement this rule at the ULB level, we will have two ways of like two bins or two plastic bags or whatever we, ULB chooses to have, one for the wet waste, one for the dry waste. And then this household hazardous waste either can be collected once in a quarterly like three months or we can have a designated place somewhere in the city or the town where people can go and drop off this household hazardous waste because that quantity is very small.

So in terms of the collection, in terms of the storage, what are the different things needed for a smart city, in terms of what are the different components that will be needed and how it is doing, how it is being done globally, what are the global practices, what we can learn from a global practice, that could be kind of focus of this particular module. So let us start it, let us start looking at one by one.

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The screenshot shows a presentation slide titled "Storage of Solid Waste". The slide has a yellow background and a blue header. The title is in bold black text. Below the title, there are two main bullet points. The first bullet point is "Solid waste is stored in a variety of containers". The second bullet point is "The type of container used is a function of:". Below this, there are six sub-bullet points, each preceded by a minus sign. These sub-bullet points are: "The type of waste stored", "Time limits for storage", "The amount and density of the waste", "Method of collection and transport", "The frequency of collection", and "Local regulations or ordinances". The first two sub-bullet points are circled in red. The slide also features logos for IIT KHARAGPUR and NPTEL ONLINE CERTIFICATION COURSES at the bottom. The NPTEL logo is on the left, and the IIT KHARAGPUR logo is on the right. The text "NPTEL ONLINE CERTIFICATION COURSES" is in the center. The slide is displayed on a screen with a Windows taskbar at the bottom showing various icons and the time 5:13 PM on 6/5/2017.

Storage of Solid Waste

- Solid waste is stored in a variety of containers
- The type of container used is a function of:
 - The type of waste stored
 - Time limits for storage
 - The amount and density of the waste
 - Method of collection and transport
 - The frequency of collection
 - Local regulations or ordinances

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So when we say storage, the solid waste actually is stored in a variety of containers. So if you look at globally, people use variety of containers to store solid waste and that depends on the type of container, is a function of the type of waste they store. If it is, as you go in a construction side, you will see big big dumpsters that are being used. So type of waste, so the type of waste they store is important.

Then the time limit, whether we are collecting the waste every day. If you are doing day-to-day collection, actually sorry, if you are doing every day collection, that is a luxury in many western world. We do not have every day collection of garbage. Typically, it will be once a week or maybe once like twice in a week but not more than that. It is usually, it is, most of the places like I have lived in Auckland, New Zealand and also in US couple of places and few place like two or three places, three places in US and in Toronto area. Everywhere I had once a week collection.

But that, there since the temperature usually does not go as high as in Indian context, we can live with once a week collection. (Otherwi) in the Indian context, what will happen especially for the food waste, wet waste, if we have once a week collection, most of the food waste will get degraded in our house itself and it will create lot of foul smell. So in that context, we may have to go for more than once a week collection.

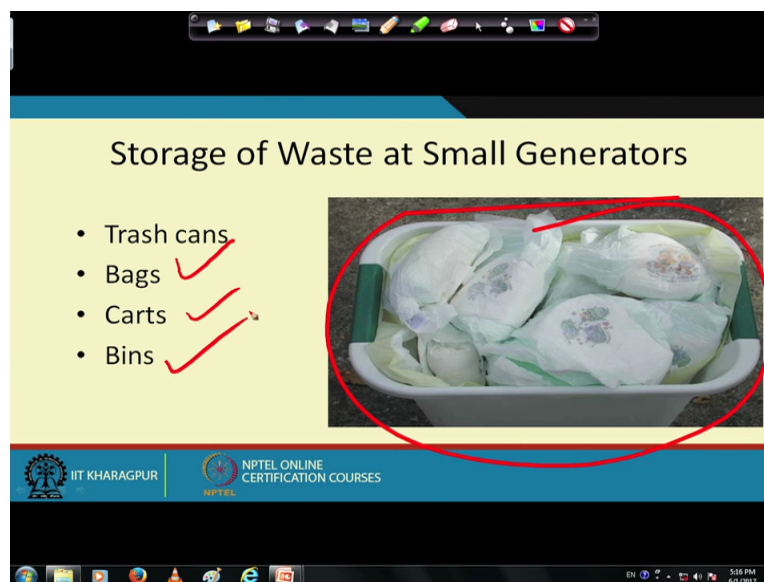
But again having a daily collection is actually a luxury in the, like a many developed countries cannot, is not able to afford to do daily collection. So that is, so you should actually feel good

about it that somebody comes to your house every day and collect the garbage from there. So for the wet waste maybe daily collection might be done. For the dry waste, it cannot wait. Dry waste can wait because now we have to have two separate trucks to collect these two garbage.

So it is, so the time limit of a storage, so if you do a weekly collection, you need a bigger storage. If you do a daily collection, you need small storage. So those things are there. The amount and density of the garbage, if the garbage is too fluffy, you need a bigger container. It cannot compressed down, you need a bigger container. Then how will you collect and transport, that is also important. Frequency of collection, we talked about that. And there should be some local rules and ordinances are also there in terms of how it needs to be stored.

And also in this particular set of, this in this particular module, I will show you lots of pictures, the pictures from typically, from around the world actually you will see the garbage pictures. And that will give you lot of examples of how the waste is stored and collected at different places.

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So such as small generator, people typically, at a household level, you can use a trash can like the you see in the picture, there could be a simple trash can that can be used or it can be bags, it could be cart, it could be bins. So there are different things that could be used. In the next module, I will try, I will show you a small video where you will see how the waste is collected from the carts like automated waste collection that is being done in some place. And that is

where we need the, we need to take our ULBs too. Our ULBs also has to go to that level in maybe a decade or 15 years or 20 years from now. But we need to start working towards it. So storage of waste at a small generator, so different things can be used for that.

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There could be different types of garbage bin. Here you can see the garbage can and the recycle bin. And here as you can see here, so there are different pictures. All the pictures are a bit, I will try to explain them one by one. So in this case over here, on the left hand side on the top, this is your non-recyclable waste which needs to go to either to a waste-to-energy plant or to a landfill. This is the recyclables which is in a recyclable container, so they will be collected separately. So they will get collected separately and then they will go in separate trucks.

Here what you see is this two is again the refuse, the green bags. And here you see this pink or the purple, pink like pink bags. So both of these are actually, the picture is from Auckland, New Zealand and why this different color bag? It is because of the fact that these are two different vendors. So this is being done by private parties. So the private, and it is in the downtown area of Auckland, New Zealand.

So the truck will come in and they will spot their bags. So their bags are all green in color. So for this metro waste, the (garb) their truck will come and only pick these green bags. And this company's truck will come and pick the pink bags. So it is already prepared. As you can see, it is prepared refuse bag, so you have already paid for this. So you have paid for these bags when you

purchase it and they typically, they are actually almost like a dollar or dollar and 50 cents for one bag. So it is not waste disposal. This is actually their waste disposal fee and which we will talk about that in the class as well. So they are different ways they are done.

And then these recyclables, the cardboards and other things, they do not charge any money for those recyclables. Recyclables are collected free because the municipality will make money out of that. So that is why their collection is done for them, there is no charge for it.

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Other examples, you could have wheeled carts and here again different types of wheeled carts. There could be private parties or public, so here you see a set of pictures where all these different wheeled carts and if you can look carefully, these ones have some stickers on top of them which tells them different types of recyclables going in there. So one could be for paper, one could be for plastic, one could be for glass, one could be for cardboard. So there are different types of material will go into different types of these containers and that is how they are source segregated. So once the truck will come, the different types of truck will come and take one of these, amount of these trucks.

These are non-recyclables. These are the just refuse garbage, non-recyclable ones, sorry, (non) yeah non-recyclable. These are the wet, as you can see mostly food waste, picture is there like the green waste and they, it is in the green cart. It is collected, it goes to anaerobic digester plant

or a compost plant as the case may be. Here these are again green cart mostly for the green waste.

This blue cart is for the recyclables and in the blue cart, it says very clearly. See you can, as you can see this is, this picture actually coming from the lid of this over here and as you can see, it very clearly says what can go in here. There is a listed what are the items, only these items go into this bin. Not all the items goes into this bin.

So that is, this kind of information although after having a lot of community engagement and like a newspaper advertisements and everything, still they have put a nice sticker on top of top cover so that when I am putting them, when I am getting this lid off and putting the garbage in, I can look at okay, this material should it go in here or should not it go in here. Because it, that helps in terms of proper source segregation. So we need to those kind of education happening in the ULBs, in the Indian context as well. So they are, so these are the different. Some of the other, I will show you some other examples here as well.

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So this is another one where you can have here the recycle, these two are the recycle bins and where even the recyclables are (separa), have been put into two different containers. And what are these containers? One container is for fibers as you can see all this fibrous material like a paper, office paper, newspaper, cardboard. Most of the western world actually, nobody comes to your house to buy this old paper, there is no kabadiwala coming to your house to buy the paper.

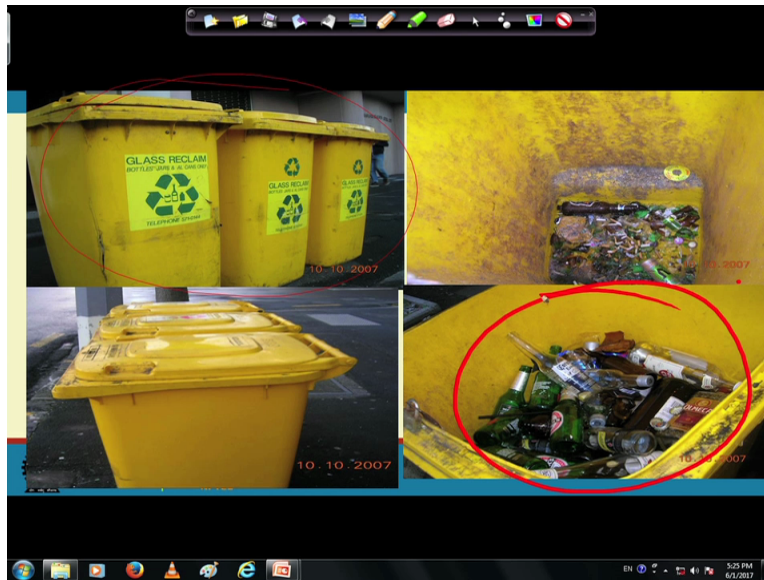
So actually that is, to put things in context, say when I went abroad for my masters and PhD study and later on I lived there for quite some time and there first I was, I used to work in Delhi before that. So in Delhi if I sell, the Times of India used to be really thick and Hindu as well used to be really thick. I do not know these days how they are, how thick they are but it is, so if I sell three months of Times of India or Hindu newspaper, I can pay the bill for one month. So it used to be that much of (newspa) like price of the paper from these kabadiwalas we used to get.

But when I went to US and then I get this newspaper, there was no (rag-pick), there is no kabadiwalas to come and pick it, I have to just throw it in the recycle bin. So first few days, I had very hard time throwing it without getting any money because in India we are used to getting money for everything. So even if we have a very old cellphone, we will just stick to it, we will just wish that we get some money out of that because that is kind of I would say our mindset.

We, and there have been unfortunately that mindset has been taken advantage of by some companies in the past where they have even said that you give me garbage, I will give you money and then I will make profit as well. So and then these days those companies have been bankrupted, there is nowhere near in the garbage business, so and they created a lot of nuisance in the Indian waste management industry.

So here in terms of coming back to this particular picture, so here what you see is two different containers, one for fibers. Two different recycle bins, one for fiber, one for container. The fiber one is the orange bin and the container one is the blue bin. So all the containers goes here, all the fibers goes here. Then two different trucks will come and they will get collected and then they will be taken to a material recycling facility for further (treat) further processing.

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So they will, and then you can also have like a glass. Glass is collected separately. In many places, you will have the glass. This picture again is coming from New Zealand, Auckland, New Zealand where you see the glass is being reclaimed separately. And I will show you like for some of the smart cities in India you will see similar pictures in next module or the module after that of how what is the present situation in India and what are the initiatives taken up in there from the Indian context.

First, I am trying to show you what is happening in a global context. Then, we will look at the Indian context. So then, we will discuss how we need to go from the present Indian context to the global level, that is how it will make our cities as like smart cities too. Auckland for that, for your information, Auckland is one of the first city in the world which went towards a Smart City program. So this, we have this glass reclaimed.

Here glass, even there is glass is being collected separately. And some places here what you see over on, if you look at this glass picture which you over here, many places even they have gone for different colored glass. Here all these three like a different color, usually the glass is green, clear glass and the amber colored. These are the three typical glass color we see.

So but many places even they have gone for separation of the glass as per color. Like why, how these things are done? Why these things are done? Because if you separate them by color, you are actually making the material more, you see I am using the word material now, they are no

more the waste, they are materials because they are recycled material. And that material is cleaner and when I say cleaner because it is only white glass.

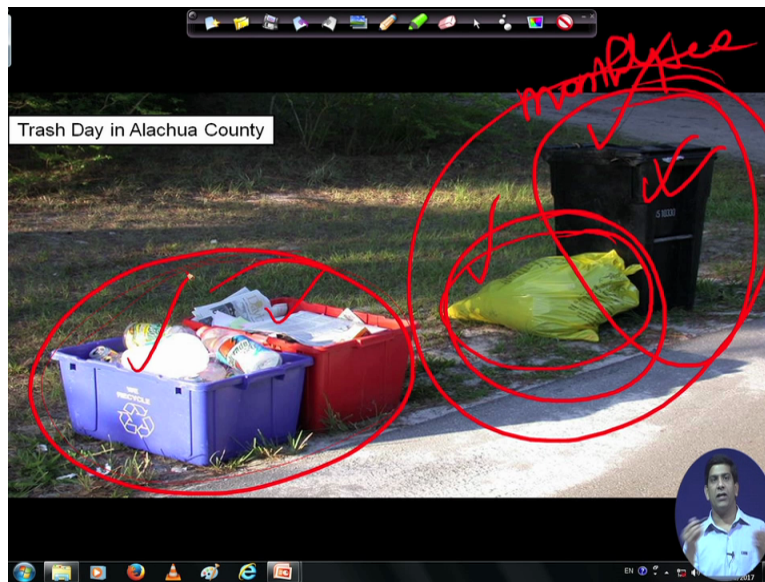
So that facility does not have to separate but we have to put separate bins, we need to get, collect it separately. So there is a cost associated with that. So we need to do a financial analysis, of economic analysis to see whether we should have this glasses source segregated by different color or we should take all the glass to one location and do the segregation by ourselves over there and which one works better from a techno-economic feasibility standpoint.

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Yard trash which is like the trash from your gardens, lawn that can be taken up in a bag and this is a compostable bag. So this whole bag can go into a compost plant. Sometimes they left in the side of the road and then it gets picked up as well. So that is a typical yard trash.

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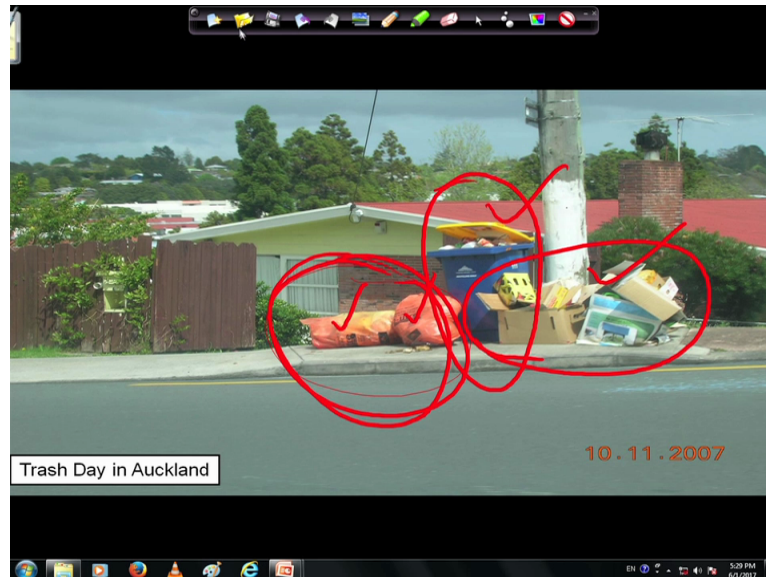
So again the previous, we saw this picture earlier. So this is the recycle, this is example from Florida, outside my residence over Florida. These are my like the garbage produced from my household. So here you see this is, these are the recyclables that is over there. Then what you see on the green colored is, it is a prepared bag. And on next to the green color what you see is your this trash can. So every house, they get a standard size of a trash can and you can choose the size of the trash can. Say if you have a big family, if you have 10 member family, 8 member family, 6 member family, you will produce more garbage. So you can go for a bigger trash can.

If you have a smaller family, you can go for a smaller trash can. And waste is collected once in a week over there. So for this, this green, this black one has non-recyclable and so things like food waste and other waste all mix together, so whatever waste is produced in the week gets filled up into this container. Once this, if the container gets filled up, then if we have the leftover waste left, then we go and buy this prepared bag from a local grocery store and then we put this waste in here.

And since we have already, we are paying for this as per our monthly fee, there is a monthly waste disposal fee, so you are paying for this for that. For this part, we are we have already bought the bag. so we have bought the bag, so we have paid for it while buying for the bag. So this is how we pay for this collection of this part.

Recyclables is the city will make money out of that, city will sort out these different components, these components and will sell it and make money. City do not charge any money for you, from your house to collect it. So city collects it for free but then they make money and they do not share any money with us. And but that is how city improves its waste management system. It is kind of a tax that you are paying for, so for the waste disposal.

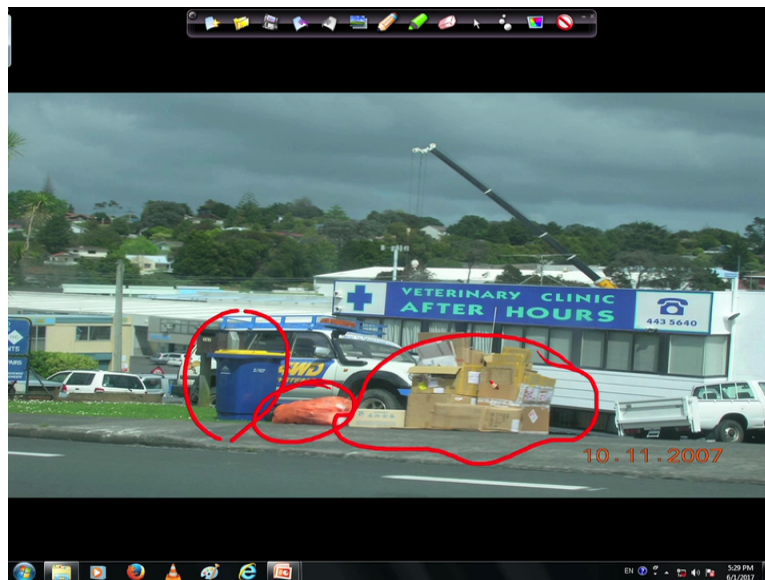
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And this is again Trash Day in Auckland as you can see over here. Auckland has a hilly area, so the streets are not flat. Many, as you can see from the backside as well, there is lot of, it is kind of similar Manali kind of terrain. So that is why you see this kind of stuff over there. So here again these are prepared bags with the refuse, with the garbage which will go to the landfill.

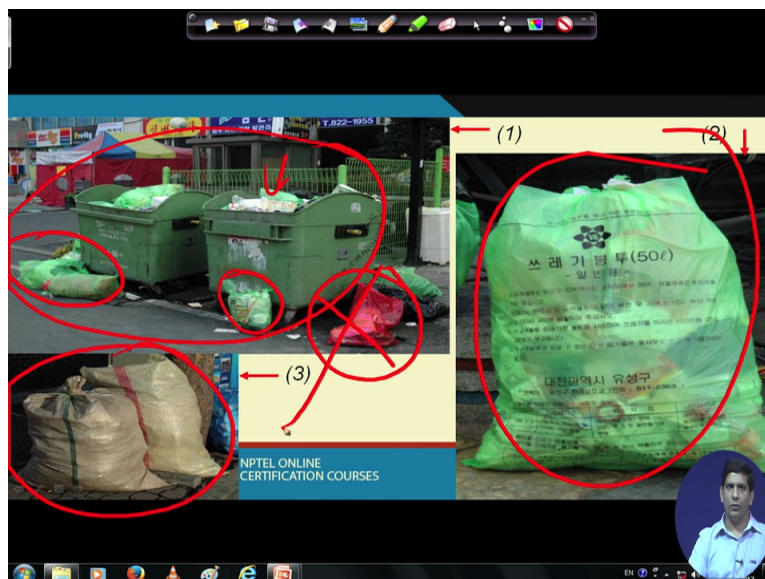
This is the recyclable which goes to the containers and these are some extra-recyclables which has been put on the side and they will be collected as well. So we are not paying anything for this and this. We are paying for this by when we buy these bags. When you buy these bags, you pay for that. So based on more waste you produce, more bags you need to buy and that means more waste disposal fee you are paying. So you are not paying directly. So there is no cart here for trash, it is only bags, prepared bags so that you are paying directly by in terms of purchasing of those prepared bags. And we will talk about some of these monitory, how these monitory things work with that as well.

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This is another picture here, again this, you have this recyclable stuff over here. This is a regular refuse and these are the cardboard. This is from a commercial area, so you all those lot of cardboard boxes and other things which is ready for to be picked up.

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This is from South Korea. Here, as you see some problems like we see in India. Here again, they do buy prepared bags. As you can see these are the prepared bags. Over here, that is a prepared bag and then this is for the yard waste over here. That is another kind of prepared bag. Here where the food waste needs to be decomposed, needs to be thrown but people have thrown it,

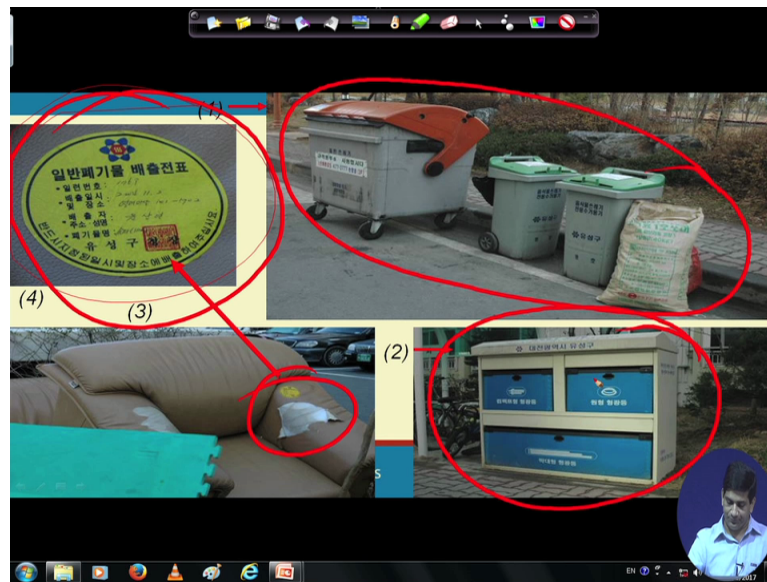
people have not thrown it directly in here. There are some things at the bottom which should not happen, kind of we see in Indian context quite a bit.

And then the most alarming thing over here is having this bag, this should not be there at all because that is the red bag, that is the biomedical waste. That should not be mixed with municipal solid waste. So but for some reason, it has been thrown over here which should not happen. In Indian, in India also it happens more or less. And many times these people, these small childrens and people working as the rag-pickers, they get needles in their hand, they get poked by needles and other things, the blades because of people throwing away biomedical waste especially from these small clinics in residential area.

Those small small clinics they have, many times they just throw their garbage along with municipal solid waste. For this big, one thing I would like to state here that biomedical waste is a separate, is managed separately. It is not part of the municipal solid waste as such. It is a separate rule, there is a biomedical waste management rule. Biomedical waste as per the rule in India and in most places in the world, biomedical waste needs to be incinerated, it needs to be burned. So all the big hospitals, India are supposed to have a biomedical waste incinerator or they should have an arrangement with waste incinerator where they can send their waste.

But that is the what the rule requires them to do. But there are lot of small small clinics and small small like a hospital, nursing homes which may not be following these rules and that is why these things are coming up into the municipal solid waste stream and our friends in terms of the rag-pickers who help, they actually does a lot of work in terms of waste management in the country and they many times they get poked with all these and they get sick because of getting exposed to all these like needles, contaminated needles. Those things make them sick. So that is like this is again scenario in Korea not as good as what you saw in New Zealand or in US, but they are getting there.

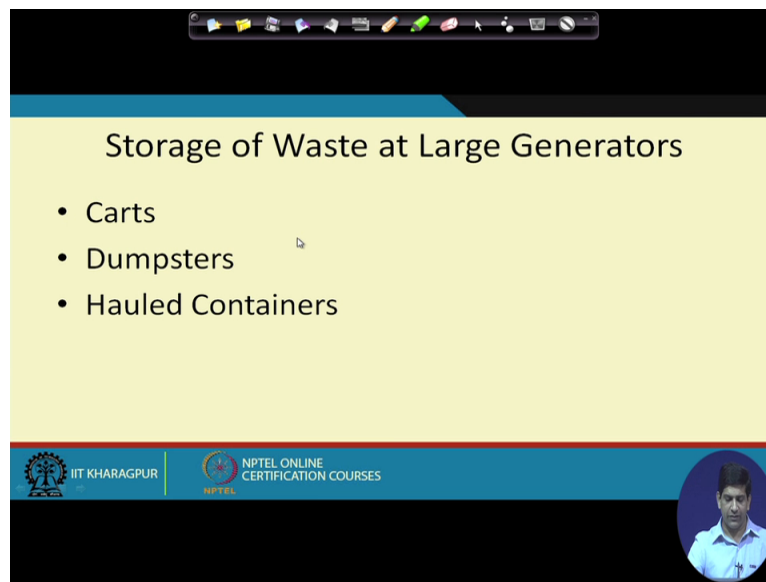
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And so in there, there are some other initiatives there as well. If for the furniture, if you have a big furniture, you have to buy a sticker and you have to put a sticker on the furniture and then only the furniture will be picked up. The furniture will be picked up and taken away as you can see over here. And then this is for the food waste and this is little bit better than the previous picture. And this is the food waste and also some other yard waste and other things which is needs to go to a anaerobic digester or a compost or those kind of facilities.

In Korea and when we say Korea, we are talking about South Korea. When in general, when we say Korea, it is we are referring to South Korea. When we say North Korea, we say specifically North Korea. So in Korea, that waste, food waste is banned from landfills, you cannot throw food waste in the landfill, very similar to MSW Management Rules 2016. So they have done it much earlier than us. And then this is for electronic waste. This is for like not I would say more in terms of the electrical fittings from the home. CFLs, tube lights and other things can go in this container. So when you, so that is in terms of different like at household level or at secondary collection point.

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And in terms of the large generators, if you have a large generator, you can have cart, you can have dumpsters, you can have hauled containers. And I will show you pictures and explain each one of them and it will make you clear.

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So this is the dumpster for a mixed waste. This is typically, you will see in a shopping mall area. On the back of the shopping mall, back of a big like a Big Bazar or a V-Mart or those kind of places, you will see on the back where they will have like typical similar stuff in say US and Canada. And other places you will see that they will have these big big trash cans where the

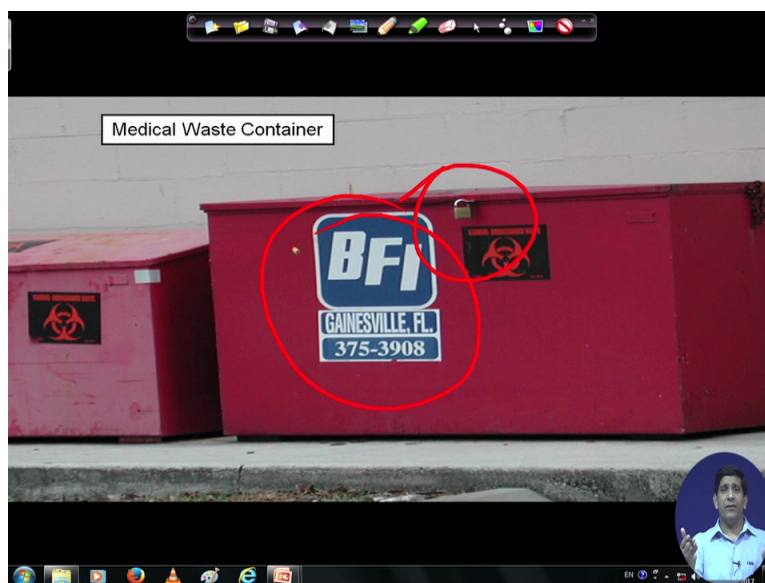
waste will be decomposed there. And here this is the mixed waste. Waste will be separated at the recycling facility, so they are just collecting all the waste together and it will be taken to the recycling facility where it will be separated.

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And then there could be like even source separated. So here as you can see, this one is for the dry cardboard, dry flattened cardboard. So it is dumpsters for recycled cardboard. So this kind of things you can also see in many of these facilities.

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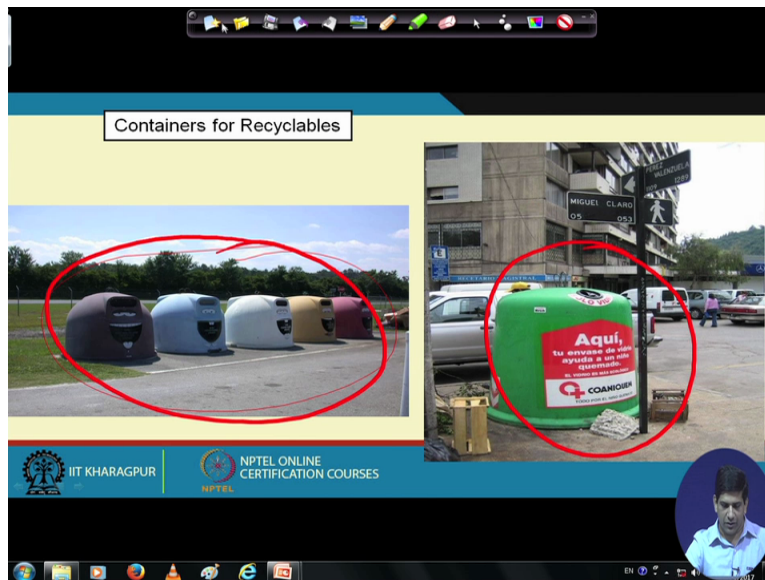
Medical waste container, this is you will see in many of the like say commercial place where they have some clinics. And so there is a medical waste container will be there and this medical waste container as you can see over here comes with a lock and key so that it is secure. So because it is infectious waste, it so we do not want this to be gone into the wrong hands. And this BFI is the company which manages that.

So this is people who have contracted with BFI, so they will come from time to time once it gets filled, kind of goes closer to filling up, they will be given a call. These days many times what they have done is they have a sensor. So these, they are now smart bins. They have sensors in there where once it goes to say 80 percent or 90 percent towards that level, the sensor sends a message to the BFI person in charge for that particular area saying that this particular bin based on the Bin ID, they know where they are located.

This bin is almost full, it is time to replace it or time to empty it and they will come and do that. So those things are also used. So waste management actually is becoming very high-tech. And there is one video, if you are interested on waste management, I do not think we can play because that is almost like an hour and 20 minutes video. I can put a link in discussion board some time but I cannot play that video as part of this course.

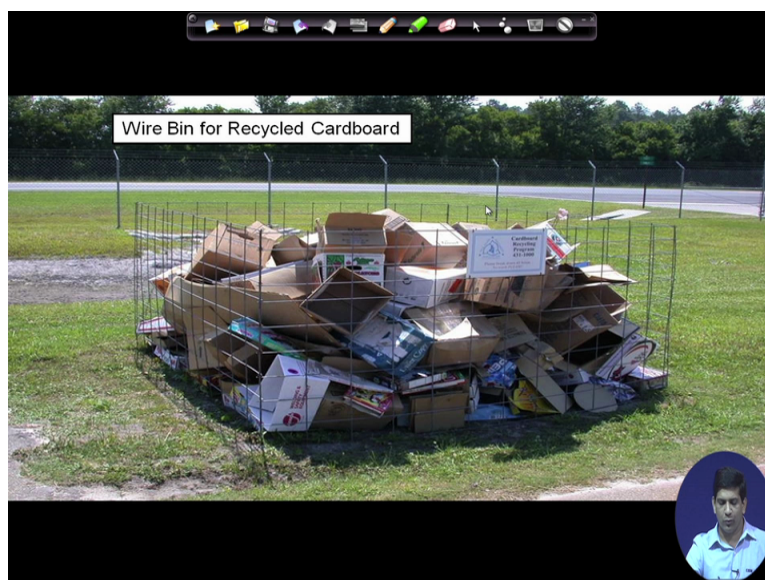
But online, but you can always go and watch that. It is, some places, it is available for free. Even if it is not available for free, it is only one dollar. So one dollar is 60-70 bucks, around 70 rupees. So not, but it is called secret life of garbage and it was made couple of years back, but it is a very good one, it is a really nice one. It goes kind of all around the world and gives a good overview of waste management. And we watch that, typically we see that video during the first week of our lecture here at IIT Kharagpur when I am doing like on-ground class. So we watch it because it is really informative about how the waste management is changing and the challenges associated with at the global level.

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This and then containers for recyclables, we, you see around, you go around the world and you see lots of different types of containers. They just make it look little bit fancy, make it attractive so that people will come and try to use this for different recyclables. This is again another recyclable container. This is from Chile, Santiago which is the capital of Chile in South America. So that picture comes from there.

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And then waste bin for recycled cardboard. This is one of the waste disposal site, waste where people can come and drop off. Usually in a semi-urban area or rural area, they will have this kind

of facility. So this is a barbed wire fence, so you just put all the cardboards here, from time to time the truck will come and pick it up and take it for like for processing and selling it off.

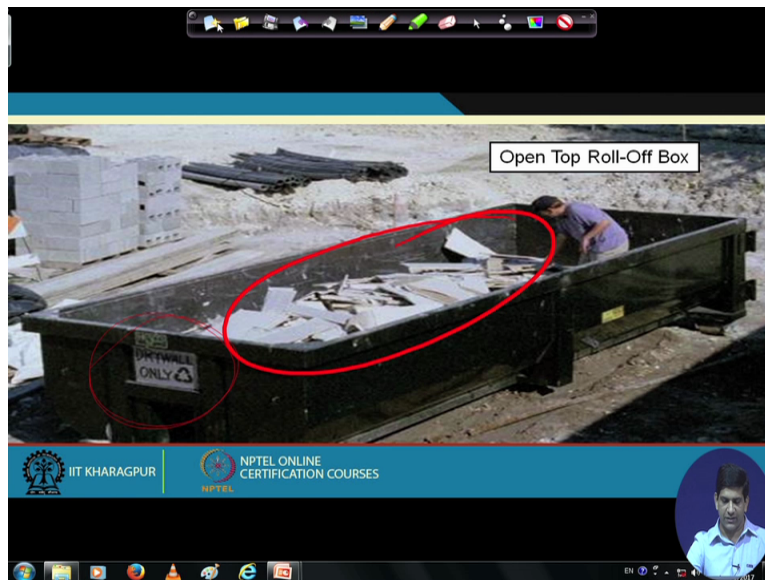
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Open top roll-off box, so this is another typically you will see it in a construction site. So here, all the construction waste is being dumped over here. So what will happen after it is dumped? There the, front part of the truck will come and it will put the hook on this side. It will put the hook in this particular area and take this container and then take it with it. So that is how it is taken away. So this is a, that is why it is called open roll-off box, it will be rolled off from that particular site and they will put a new box over there.

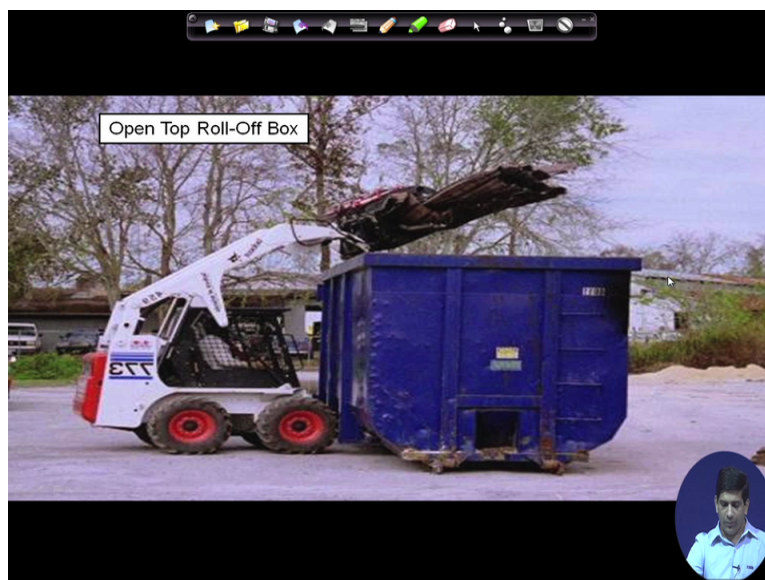
So this once it gets filled up, they get a call and they will come and take it and put a new, they will come up with a new empty one and take this filled one with them. So that is how, because it is too heavy to kind of empty it at the site. So that is why they do it on that.

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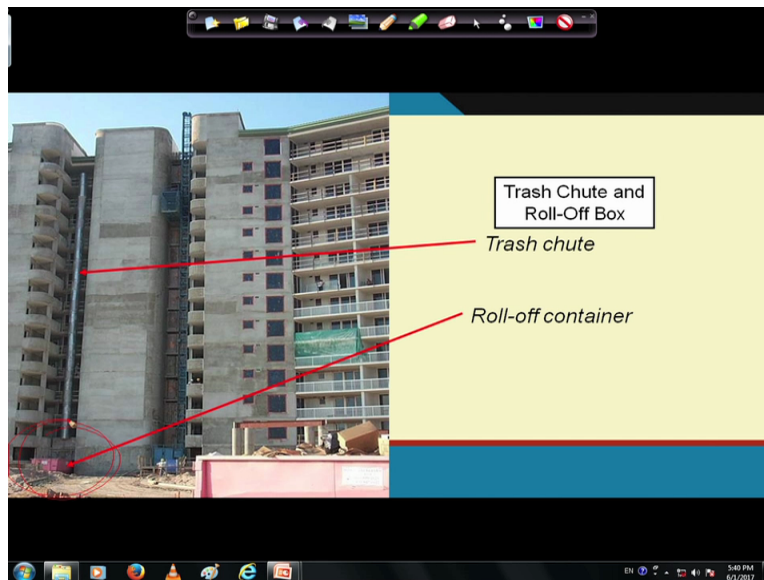
Then they have open top roll-off boxes where you can put and here only recyclables as you can see on this picture. And here it says only recyclables, you just put the recyclables here. Only recyclables needs to go and this is mostly cardboard, sorry, gypsum drywall which has been put over here. So that is again to recycle this construction waste.

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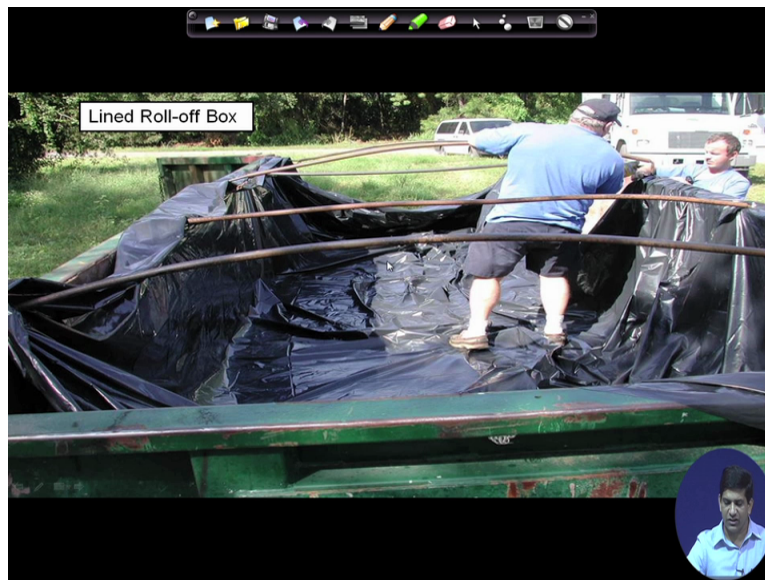
Open top, another example of open top roll-off box where you can collect something and dump it. So that is another example.

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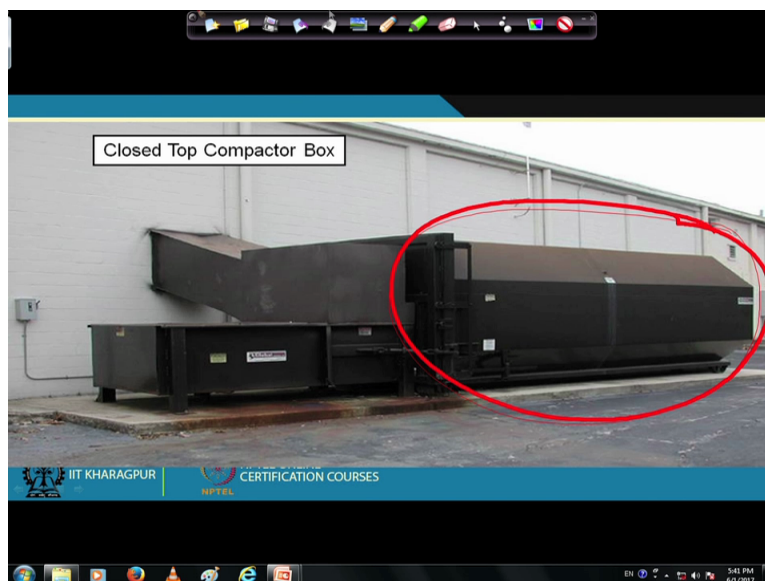
Many (countr) many places now especially even in some of the apartment complexes on campus here and some of we see that in Singapore a lot where they have this trash chute and roll-off box. So there is a trash chute on, for every floor there will be an opening and the people will jump, put the trash there and it will be collected at the bottom over here. So that is, there is a (rolloff), during the construction time, there is a roll-off container here. And where but after the construction is done, the same chute can be used for garbage collection from the houses and then we can put a big trash can here, big dumpster here and that dumpster can be emptied by the big truck coming in and collecting the garbage from time to time. So that is also used at lot of places.

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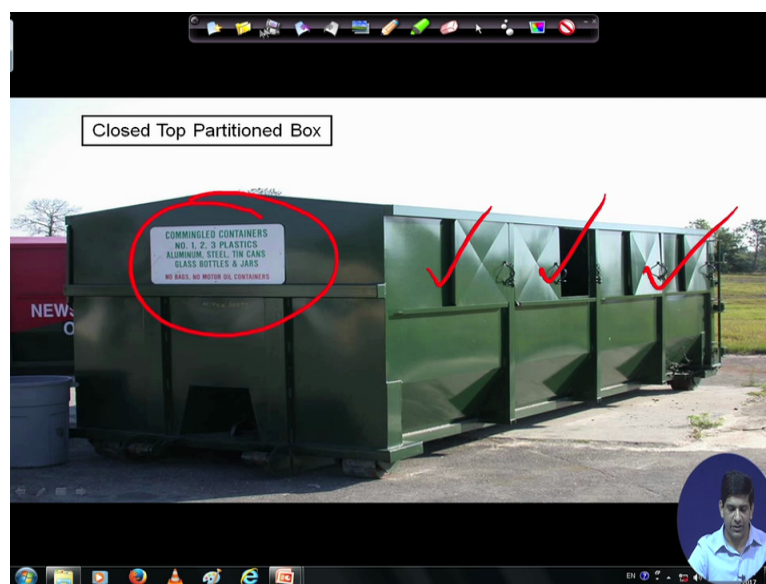
Lined roll-off boxes, some places they will have, they will use lined roll-off box especially if you are collecting something which is wet. If you have something which has some moisture in it, you do not want that moisture to be leaking along the road while you are driving it from this construction site or the waste generation site to the disposal or treatment site. It, there will be water falling down or the moisture falling off. To prevent that, you do this lined roll-off box, you put a liner in there.

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Closed top compactor box, this is another example in a, typically you will see in a shopping mall and a big shopping complex. What it is? It is essentially, this has a compactor in there. So it is a garbage collector portion here but it at the same time, it has a compactor. So it compacts the garbage in that. So it is, the garbage is compacted. So it will the, it needs to be emptied not that frequently. But it will be a compacted garbage, then this whole thing will be taken off and they will open it, they will take the compacted garbage out, put it in their truck and the new garbage can be added to that. So those kind of things are used.

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So again as you can see, there is lot of variety depending on where you are. Closed top partitioned box, here you can, this is for the recyclables. As you can see, you can have number 1, 2, 3 plastics, aluminum, steel and tin cans, glass bottles and jars. But there are, for plastics, this one can be used. For aluminum and steel, this one can be used and for glass bottles and jar, this can be used. So there are different containers. It is labeled on the other side. So that is where you can use these different partitions. So there are three different partitions here.

So that is, so let us, so we will kind of stop at this particular point and then we will start from our collection equipment in the next module. So as you can see, there are different types of waste storage can be done. That depends on whether it is a residential area, whether it is, even in the residential part whether we are talking about individual houses, whether we are talking about the apartment complexes.

If it is a commercial area, construction site, institutional site, so it is all depending on the requirement. Depending on the requirement, there are different types of container systems are available which can serve the purpose of having a source separated garbage as required as per MSW management rules. Things are happening pretty much in many parts of world. So same thing can be taken from but we need to put it in the Indian context, make sure it works in Indian context.

And as per doing a source separated collection, it is lot of education is needed. So lot of education, lot of outreach is needed to make people follow the rules and that is, that will be the most and one of the most critical component in terms of making it a success. So we talked about the storage. Then in the next module, we will start talking about how, now it is stored in a place, now how we will collect it? So we looked at, these are the different trash cans can be used to store it.

Now once they stored, when the trash can is full, whatever be the type of trash can, it has to be collected. So in the next module, we will focus on the collection part and subsequently on the other aspect of it. So thank you. Again keep, we will keep an eye on for your questions on the discussion forum and we look forward to interacting with you over there. And again if you have any issues, feel free to share with us. And thank you and see you again in the next video.