Urban Services Planning
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Lecture 17
Waste Generation Part II

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Welcome back. In Lecture 17, we will continue with Waste Generation. So, the different concepts that we will cover in this lecture are on waste minimization, extended producer responsibility, waste minimization steps that could be taken by ULBs, source segregation, segregation of waste at the overall urban level, residential segregation, non-municipal solid waste, we will take a global outlook on that, and we will do a case study on waste segregation practiced at Corporation of the City of Panaji.

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So, when we talk about waste generation, automatically the first thing that comes when we consider hierarchy of waste management or hierarchy of, when we say integrated solid waste management, the first thing that we need to think about are the three R's, that is to reduce, then recycle, reuse. So, these are the three R's that we talked about.

So, within that the first one is to reduce at source and to certain extent also reuse as well. So, both these particular strategies are very, very important and then these particular approaches has to be adopted by every ULB. So, what are the different aspects or components of this particular strategies?

The first thing that we have to be, has to conduct is to improve the awareness among the people and also, we have to conduct several educational programs, and this is not only targeted for the residential population but also for the different commercial establishments, it could be also targeted towards all the industrial establishments that are there in an urban area.

So, we are not talking about very large industries because large industries are, should be responsible for their own waste generation and own waste management and disposal. But for small industries which are like garages and other things, which are there inside the urban areas, so, ULBs actually does a lot of hand holding for managing this kind of waste. And for them also, ULBs can conduct awareness as well as educational programs.

So, what are these awareness and educational campaigns, programs are for? It could be for domestic composting that ULBs may encourage the domestic composting process that is it may encourage people to do composting at their homes and use the compost in their, in their

gardens and all. So, they can teach people how to do composting, they can even help them provide some kind of structures or they can make them available so, that people can buy those kinds of structures where they can do composting.

Then campaigns for reducing use of specific non-recyclable or non-reusable or toxic material. They may ban, they may also ban certain kinds of things. Like for example, in many places, products such as single use plastic has been banned in India, right? So, that means we can either ban or we can also say that certain specific things which are not that good for the environment, which cannot be recycled, you should gradually reduce use of that. So, we can create some programs on that.

And finally, also certain things like we can also create awareness campaigns on promotion of materials substitution, that means, already there are certain things which people use, but if there are some alternative better materials which they can replace that with. So, for example, instead of using normal batteries, if you use rechargeable batteries, then probably you do not generate so much amount of waste.

So, these are the different kinds of educational campaigns or awareness campaigns that would be conducted. Along with that we can also do bans, our ULB can also specific bans on specific products for certain areas. Then it can also encourage green procurement. Green procurement means, it encourages buying of materials which are more green, or more sustainable or more environmentally friendly.

For example, they can say that they can promote use of paper bags, or they can promote use of like rechargeable batteries, so, these are more, get a better or better substitutes for the actual ones. And along with that is also extended producer responsibility. So, we have already discussed EPR earlier.

So, the broad term has been explained that the producers of certain goods and all should be responsible even beyond the consumption pays, and they should conduct certain programs or certain measure or they should take some measures, so that they are able to take care of the waste that is eventually generated or they can, we will do a little bit of more discussion on this in the subsequent slides.

So, in addition, to that, we can go for the on-site business and industrial, industry assistance programs. For example, within the businesses, within the industries, there could be certain campaigns or certain programs which could be run, both by the industry or maybe some NGO

or some other organizations, where they may promote use of E-office so, that paper is not utilized.

And the government can also make some laws that certain kinds of things could be done by E-office, then at least they can make those things allowed, instead of keeping paper printouts and all this and also double-sided printing can be made mandatory. All these things could be also taken at the office level or at the business level.

Then involving supermarkets and retail stores. For example, we can, the supermarkets is where a lot of people come to shop. And because that is where people undertake buying decisions, that means they actually buy certain things over there. So, we can educate consumers on what are the better choices, what are the greener choices, what are the better packaging material or how they can reduce packaging material, or how they can reduce the use of plastic all these things could be both taken care of in the supermarket as well as in retail store. So, a lot of programs could be generated as per that.

Then promoting materials exchange and reuse programs. For example, used furniture, used, vehicle, used many items. If we can create a program in the urban area, sometimes there are as you know that there are mobile phone applications, like certain brands are there which actually help us to exchange products, right? So that could be also facilitated at the ULB scale also.

Like for example, ULB provides a transportation system for some heavy material like for example furniture and all. So, that service ULB made that service available so, that people once they decide to buy a used material that could be easily transported, right? So, that is how you can promote exchange.

And then, the other two aspects that ULBs can also take, these are more prohibitive ones, that means either they can institute a pay as you throw program, that means the institute, the ULB can create some laws or bye-laws in this case, which says that if you throw this quantity you would be charged so much amount, if you throw a bigger quantity, you would be charged at a much higher rate, right?

Similarly, if you throw certain kinds of items, you would be charged also extra for those items. For example, construction and demolition waste, I can charge extra because these are a waste which weighs a lot compared to the normal residential waste and so on.

So variable waste management charges that means we can also fix different charges for different income groups, we can fix charges as per different areas of the city based on what kind of services we are providing. And also based on what amount of garbage people are throwing we can set variable charges. So, these are some of the strategies using which waste can be minimized.

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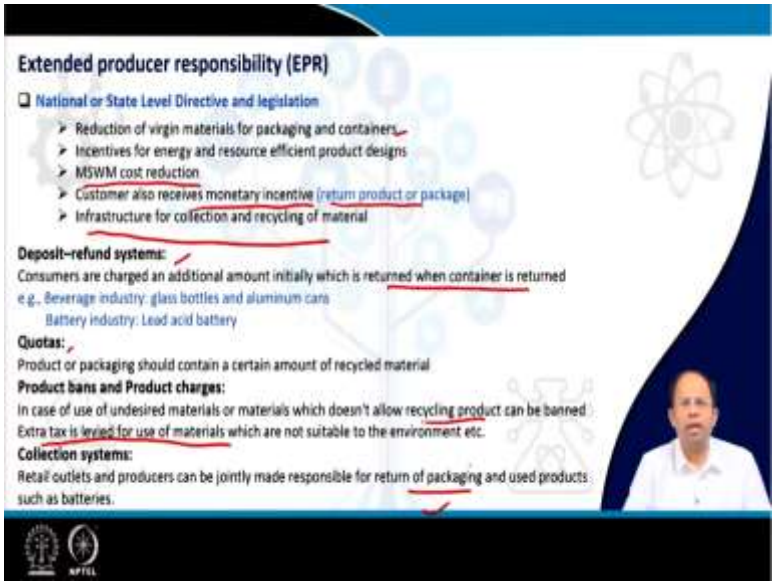

Now, coming to extended producer responsibility, we already had an earlier discussion on this as we just was explaining in the previous slide. But in general, the benefits of this extended producer responsibility are manifold. There are many benefits of it. And usually this as you can see that it helps a lot, but without any kind of law, any kind of legislation, people or businesses are usually not, will not do this kind of programs.

Why? Because it costs money. The producer wants to be responsible for the product, beyond the consumption phase, it has to invest money in that. It has to charge extra for that. So, usually, there has to be legislation which facilitates this. So, at national or the state level, there has to be some directives of legislation which say that there is mandatory EPR task that has to be undertaken by certain businesses or certain establishments.

So, what are the benefits of this? So, definitely, if I do this kind of programs, then definitely some amount of recycling will happen that will lead to reduction of virgin materials or that means raw resources we take from the environment that will be reduced, because we are recycling or we are reusing something.

Particularly this will be true for packaging and containers and so on, like we have talked about aluminum cans being recycled by beverage companies. So, in that case, that means we are, that means we are reducing mining of aluminum for the mines, we are reducing virgin material.

Then incentives for energy and resource efficient product design. So, that means there has to be some big tax cuts or some kinds of incentives given to the producer if they adopt some alternative material which are more environment friendly. Maybe the cost will increase, but it would be much better.

Then overall, because we are reducing the total amount of waste, the MSW in cost reduction will happen, lot of packaging and all these things, if the companies themselves take it back and for further recycling and all, definitely that does not handle, needs to be handled by the municipality or the ULB. So, in that case there will be cost reduction for the municipality, sometimes these kinds of programs result in customers also getting some amount of monetary incentives.

For example, if they have to return a product like suppose use, after use of paper they have to return it so, that it could be recycled, and they get paid for that. So, this could be also beneficial for the customers as well. And finally, to make this all happen the role of the ULB is to provide some sort of infrastructure or a collection center so, that this kind of recycling can take place or this kind of collection of this material can take place. So, that eventually it goes for recycling.

So, this promotion part or provision re-infrastructure part is the role of the ULB which has to be undertaken to support this EPR initiatives. So, what are the different types of EPR initiatives in general? One is the deposit refund system, where consumers are charged an additional amount initially, which is returned when the container is returned.

Same goes like if I drink a cold drinks in a glass bottle, then the retailer does not charge me anything, because I am returning the bottle there itself. But if I take the bottle away to my home, then I will be charged extra money, but when I return the bottle again back, then I will be given back that amount of money. So that is, this kind of schemes are there. And that actually helps in, I mean, that means the customer gets a return and that encourages them to undertake this kind of an exchange activity.

So, the other, the next item is quotas. This is another EPR initiative, where the product or packaging should contain a certain amount of recycled materials. So, that means there could be a mandate from the government that any product that a particular company or a particular sector produces, they should have a certain amount of recycled materials by law. So, in that case, they are bound to do some amount of recycling.

Then product bans and product charges. So, we can, in case some material is used which is not good, then actually I mean, there could be those material could be banned by the ULB or by the government, then can say that yeah, this particular material is harmful to the environment, this cannot be recycled. So, there is, this material should not be used.

So, even though it is of lower cost, but because it cannot be recycled, overall cost is actually higher. So, in that case, we can actually ban it or in other way, if I cannot ban it because immediately we cannot, there is no alternative supply and all other issues are there, economic issues are there, production issues and all these things are there, then instead we can charge some extra tax if this material is not suitable for the environment. So, either you can deter by charging extra tax or you can ban it all together.

Finally, there are collection systems, which are retail outlets and producers can be jointly made in retail outlets, producers can be jointly made responsible for return of packaging and used product, such as batteries.

So, that means, we decide the collection, we design a collection system where in the retail itself, like when you go to buy in a supermarket there will be a counter where you can also return back batteries and all these, where the producer will directly take it from there. So, this kind of collection systems are there, and which is adopted in many countries and even in our country many of retail chains have adopted these kinds of practices.

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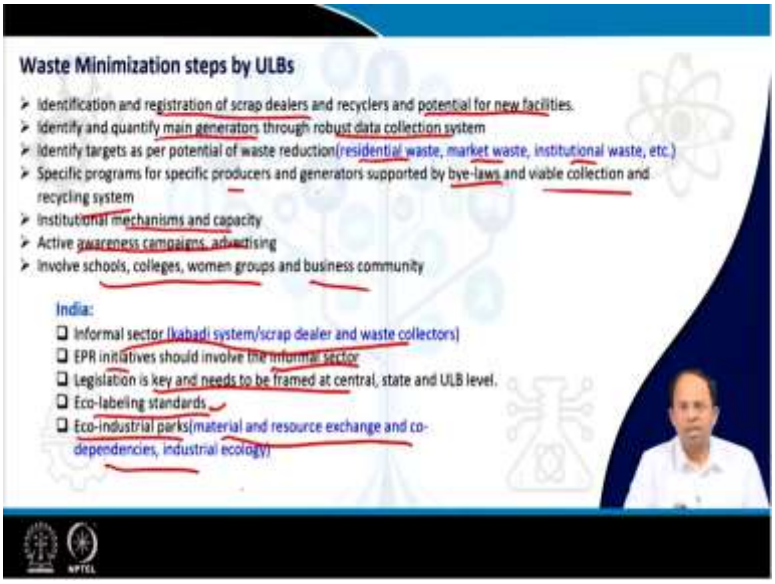

So, what kind of steps the ULB can take? So, we have discussed about the different strategies for waste minimization or reduction. We have talked about EPR. Now, what do the ULBs need to do? So, what are the things that ULB should facilitate? So, the first thing is the ULB in our country there is a very informal sector of kabaddi system or scrap dealers or waste collectors.

So, what the ULB can do initially is to identify and register this kind of scrap dealers and recyclers. So, that the information is available with everybody, and it can also decide, and it can make this information available via any channel, via social media or via some sort of campaign or via just a website and say that this is where this kind of recycling is happening so that people can have more access to those kinds of systems.

Similarly, if some kind of recycling like we have different waste into the municipality. Now, certain recyclers are there but other scrap dealers or other recyclers or other kinds of products are not there. So, we can also determine what is the potential for setting up new facilities as well. So that is the role of the ULB.

So, the second role is to identify and quantify the main generators through robust data collection system. So usually, ULBs do collect the garbage, but they also need to collect the data that is data on how much amount of garbage has been generated, where it is generated, who is generating what, what is the characteristics of the garbage and so on.

So, that robust data collection system if it exists, then we know exactly that how much amount of garbage is being generated and what kind of garbage and what kind of recycling

we can do so, this would be easily get to quantify that. So, that is another role of ULB. Then, we have to also identify targets as per that potential of waste reduction.

Like for example, how much reduction can happen at the residential level, how much can be happen at the market level or at the institution level and accordingly, we have to design specific programs or specific, different kinds of producers or generators we have to design separate approaches. And this approaches has to be supported by municipal bye-laws and viable collection and recycling system.

So, that means not everybody is suitable to do every kind of recycle. Similarly, not everybody is, will do it, if there is no law. So, for different generators, different producers, we have to create different sets of laws, or we have to provide different infrastructure so that this kind of recycling is facilitated or eventually we can reduce the amount of waste.

Then to support all this the ULB should have its own institutional mechanisms and capacity has to be upgraded so, that we can deal with this kind of new systems or this kind of, we have to create new departments to deal with this. Then a big part is of course creating awareness campaigns, advertisements and so on.

And sometimes we can involve schools, colleges, woman's group and even and the business community of that urban area, so that this can actively be this kind of recycling programs or this kind of waste minimization programs to be taken. So, the other aspects specific to India is, because we have a very informal sector and all for this particular scrap dealing and all, then this EPR initiatives that we were talking about earlier, this should consider this informal sector as well.

Because EPR initiatives, usually involve the big businesses and institute's and all, so they may not consider this informal system and they only look for commercial alternatives for recycle, collection and all this but maybe we can also involve the informal sector in our country, or informal scrap dealers, so probably that would be, that may lead to lot of economies of scale or that may attain lot of benefits.

Now, legislation has to be framed as we have discussed, then we can go for eco-labeling standards for us to be level that how green it is or how environment friendly it is so, certain eco-labels that should be coming up, but there has to be some standards for that, otherwise anybody can claim my product is green.

So there has to be some standardizing organizations, which will tell that yes, this product is so much green or this is the energy rating of the product. So, that ULBs or in the country we can actually develop this, then some are there already. And then, we can go from eco-industrial parks, that means in our country, whenever we are setting up industries, let us instead of setting up standard industries we can set up eco-industrial park, where we bring together industries which can depend on each other.

For example, products or byproducts from one industry could be utilized by the another industry. So, immediately in the near neighborhood. Otherwise, what happens? If it is far away, then either you have to transport it, which makes it unviable or the product may be of such nature that it may not be transported, we have to treat locally. So, all these issues are there.

So, sometimes industrial ecology is one area which we can focus on, and we can improve this via setting up of eco-industrial parks, where material and resource exchange and co-dependencies has to be considered while setting up these industries and we can set up industries which complement each other.

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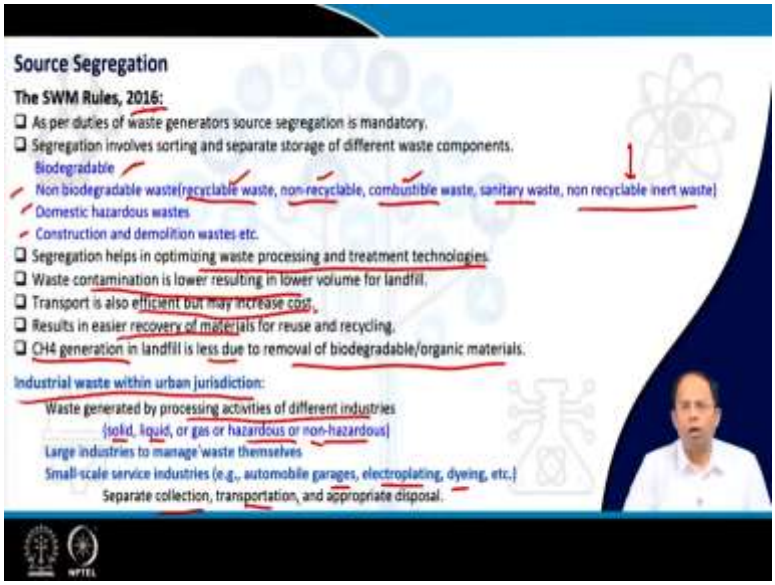

Then, once we have done with minimization that the next strategy that ULB should look at is source segregation. That is first we reduce the type of waste, the total amount of waste that is generated, then we look into how do I separate the different categories of waste. Now, as per solid waste management rules 2016, as per duties of waste generators, source segregation has been made mandated, that means everybody has to segregate.

Now what is the amount of segregation, that is again a different issue. By law we have to do a certain amount of segregation, but municipalities which are progressive or ULBs, which are progressive they can go for further segregation. Now, why this segregation is important?

Now, segregation of course, involves sorting to be done at the household level, but sometimes households are inefficient, that means people may be casual, they may not be doing it in such a way so, there should be other facilities which actually take up the sorting of solid waste that is generated in urban areas.

And particularly we can depend, the households more or less do the sorting, if it is mandated by law, but sometimes bulk generators, which generates lot of quantity of waste, they may do sorting but because there are a lot of actors involved, there are a lot of people involved in the collection process over there and so on, there may be some issues.

So, we can take this waste to a sorting center, we can actually separate the waste into different waste component. And why we have to do that, because if we do that segregation will help in optimizing waste processing and treatment technologies. So, that means for each type of segregated waste or each waste stream, we know exactly how much amount of waste is generated, what is the character of that particular waste, like for example, if I am taking out combustible waste then, I need to understand what is the energy content of that waste.

So, based on that I will take a decision, should I take it to a insulation plant or do I have to do some further processing to remove moisture. So, all these things we have to consider. So, but obviously, this segregation, if you do not do segregation, nothing of this is possible. So, as per MSW rules, we are supposed to divide our waste stream into biodegradable waste, non-biodegradable waste.

Sometimes biodegradable is called as wet waste because there is a lot of moisture in it. Non-biodegradable waste is called dry waste, because usually there is no moisture but sometimes there can be. Then, comes a domestic hazardous waste which we have defined earlier and construction and demolition waste.

So, within non-biodegradable waste, further we can have recyclable waste that means waste which could be recycled, non-recyclable waste, combustible waste, sanitary waste and non-recyclable inert waste. So, this may be dirt and certain things which we cannot neither recycle, neither we can burn it.

So, things which we can burn, we may burn it, we may not burn it. So, you know the characteristics, there are certain amount of energy content that has to be there, but as a policy the ULB may decide that I will not set up a incineration plant, because incineration leads to pollution. But even whatever methods you take to reduce the amount of ash content that goes into the emission, still it happens.

So, I may decide that I will not go for a incineration plants, so, there is no question of combustion, but if I can generate a lot of energy by combustion and even though there is some pollution but the energy that I will generate compensates for that because otherwise this energy would have been generated via, through burning of coal which would have generated further emissions.

So, in that way we can decide on this nonbiodegradable waste could be further segregated into these categories and accordingly we take the waste according to those particular facilities or centers those would be processed. For example, recyclable waste could be taken to a sorting center from where it would be, certain material could be recovered from there. Then non-recyclable material can go to the landfill site, combustible waste can go to the incineration plant and so on.

So, obviously, if I segregate waste, then the contamination is also low, that is we do not get contaminated waste in each of the facilities or centers. So, that means I do not need to do sorting in house. So, if I have a compost plant, that means I am going to use the organic components and I am taking it to a compost plant where it will be converted to fertilizer.

Now if the waste is not properly segregated, automatically there will be lot of mix items in that, this organic matter or that biodegradable waste, so I have to first set up a center where I can take those things out. Then I have to put it, for making of compost. So, that means this contamination would be lower if I do the segregation properly.

Transport is also efficient that may increase cost. Transportation is efficient, why? Because we are taking each kind of waste separately, but because we are now breaking it into different categories, and we are not utilizing the full capacity of the vehicle, because the volume is now reduced, then there may be an increase in cost, but overall, it improves efficiency, then it is, this obviously if I segregate it is easier to recover the materials for reuse and recycling and finally the methane generation in landfills is less, due to removal of biodegradable and organic matter.

So that means if the organic matter, bio degradable matter goes for composting, automatically, that does not need to go to the landfill and that will reduce the amount of methane generation.

So, in addition to all this kinds of waste, we also have industrial waste and particularly waste that is generated within the jurisdictions of urban bodies. And this waste can be generated by processing activities of different kinds of industries. Some could, it could be solid, liquid or gas, it is based on the state of that particular waste or this waste can be either hazardous or non-hazardous.

So, there are different ways so, for hazardous there would be some way to handle it, for non-hazardous at least for municipal bodies can at least handle the non-hazardous part. So, large industries manage the waste themselves. Whereas small scale industries, this is where the ULB has a role to play.

And for example, like garages, electroplating industries, dying industries, like coloring where you can paint and all, they generate lot of waste but these are all within the urban area, even within residential areas as well. So, municipality can design a separate collection, transportation and disposal options for this kind of industrial waste that is generated in urban areas.

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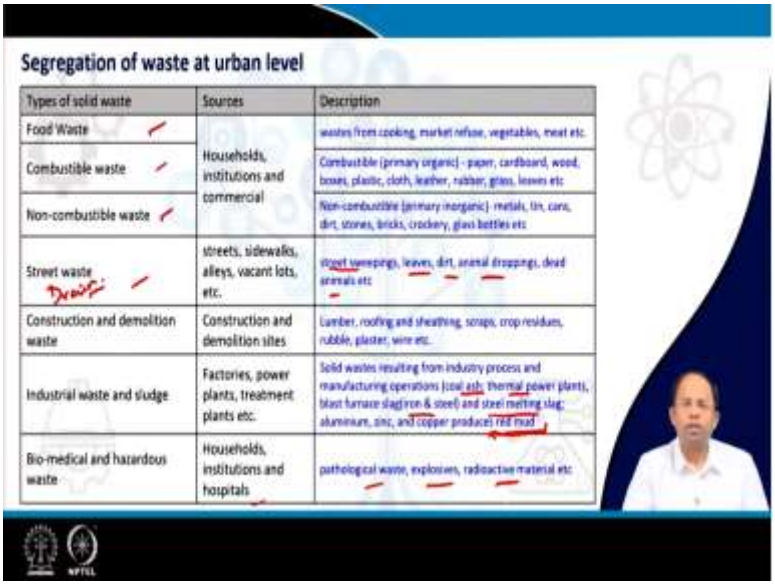

So, let us take a look at the different kinds of waste. So, you can see there is food waste, combustible waste, non-combustible waste, street waste, and within street waste there is, it is

collected from the different kinds of streets and the parking's and the vacant plots. It includes street sweeping, leaves, dart, animal droppings, dead animals and so on.

So sometimes street waste also will include the drain waste. So, drain waste is the when municipal workers clean the drains, they will lift the sludge that is accumulated there and put it on the street. And the municipal workers are supposed to clean this as well. But if you put this sludge inside the normal waste stream where there are lot of leaves and all and probably you take it to the compost plant, then it will be contaminated, because this sludge will contain lot of pathogenic bacteria and so on. So, we have to be careful what we should take together and what not.

And this gives a list of what kind of broad items are included in this kind of waste. Say for industrial waste and sludge, solid waste resulting from industrial processes, manufacturing operations, such as coal ash, which comes from thermal power plants, blast furnace slag which comes from iron and steel plant, and steel melting's slag, then aluminum, zinc and copper produces some sort of red mud which has to be also stored.

So, we have seen in many Indian cities where there is an aluminum smelter or a plant which melts aluminum and produces something. There is huge areas which are covered with this kind of red mud. So, these are dumb sites, which looks very bad also, but this is a byproduct of this particular process.

So how do I handle all this? And even though the industry will buy some land in that urban area, it will start dumping over there or it may buy some land just outside the urban area and it may dump their waste over there. But how, there has to be certain measures taken from the ULB side also to handle this kind of waste so that they could be disposed of with proper areas with proper lined areas so, that contamination does not happens in terms of leachate or other air pollution and so on.

Biomedical waste and hazardous waste could be includes pathological waste, explosive radioactive materials, and these are collected from household, some from households, some from institutions and hospitals. And this could be taken to specialized facilities where they would be treated.

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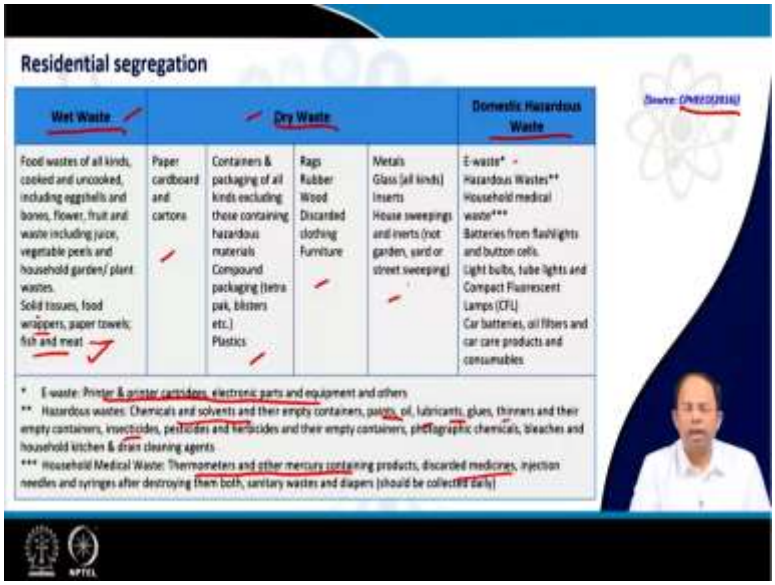

Now, this table is given by CPHEEO in the manual for solid waste handling and management. There you can see that for residential segregation there we have to segregate as per wet waste, dry waste and domestic hazardous waste. And as we have discussed earlier also domestic hazardous waste includes e-waste, e-waste is printer, printer cartridges, electronic parts and so on.

Hazardous waste which includes chemicals and solvents, paints, oil lubricants, glues, thinners, herbicides, insecticides and all this. Batteries from flashlights and button cells, light bulbs, tube lights, CFL bulbs, lamps, car batteries, all these things are part of the domestic hazardous waste.

So, this all has to be dealt with and household medical waste includes thermometers and other marketing containing products and discarded medicines and so on. So, as you can see that wet waste is pretty, we know that it includes the different kinds of food items or different kinds of after cooking whatever the rejects that are coming out like egg shells, vegetable peels, all these things comes out along with that we can have paper towels, some wrappers, your food wrappers which are biodegradable, fish and meat which also can be when they are thrown away so all this becomes part of the wet waste.

Now, still some wrappers and all these things remain in the waste stream. Usually, people are not able to throw it separately, if they want to throw the whole packet away, they will throw it together. So, that is why even in a compost plant, we require some sort of sorting activity that has to be taken up before even the composting process can start. So whatever segregation we do, some amount of materials still remains.

Now for dry waste the manual suggests like we can further categorize it, like for example, if our ULB is able to achieve basic segmentation like wet waste, dry waste and hazardous waste, then if they feel that there is further possible to engage people to do further segregation, they can even segregate as per paper, cardboards and cartons as one category.

Other kinds of containers and packaging of different kinds like tetra packs, plastics, this could be another category. Then rubber, wood, discarded clothing, furniture, this could be one category. Metal and all these things and the other inert waste this could be one category. So, it depends on what categories the particular ULB will create. But you can do some categories like this.

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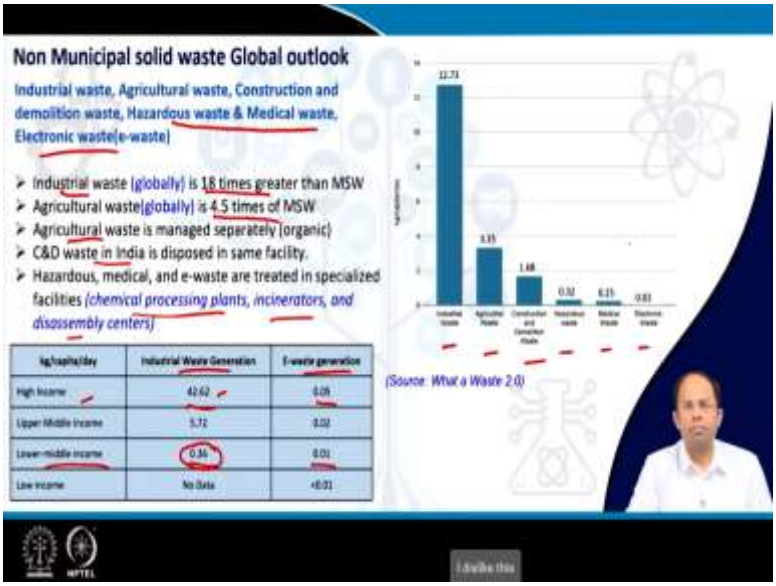

So, coming to the non-municipal solid waste that means, which as we have discussed like C&D waste, or agricultural waste from the surrounding areas, industrial waste, these are not part of the municipal waste stream, that means ULBs do not deal with it directly. So, but this is a significant amount of waste, even the electronic waste, the hazardous and medical waste like from hospitals, directly the waste goes to specialized treatment facilities, where these are actually autoclaved or incinerated some kind of processes could be undertaken.

Now or electronic waste can go to the manufacturer back and they can have some setups for taking out certain chips or certain metals and so on or it could go for informal recyclers as well, where they take out some again, some material from that particular PCB boards and other components and all.

So, what it says is that is that means there is significant amount of waste that is generated which is beyond the residential or commercial or the standard waste that is generated in urban areas. So, to give you an idea, industrial waste globally, is almost 18 times greater than MSW. Agricultural waste is about 4 point times more than municipal solid waste.

Then C&D waste in India at least, we do not have a separate system for handling it, even though some new setups are coming up, some factories and all these things can do some further processing on C&D waste for using them. But usually, in most cases, C&D waste goes into the same landfill as normal municipal landfills.

So, during the estimation of the size of the landfill, we have to consider both kinds of wastes. Then hazardous medical waste are treated in specialized facilities such as chemical processing plants, incinerators and disassembly center. To give you an idea, if you look at the waste generation e-waste as well as industrial waste generation, you will see that different countries also generate different amounts of this waste.

For example, very high-income countries, they generate a lot of industrial waste, why? Because these are industrialized country, they have a lot of industries which produce lot of goods and they sell it all over the world. So, obviously, per capita waste that is generated is 42 kilogrammes. Why? Because they are generating this items and they are exporting it to all over the world or maybe for local consumption as well.

E-waste is around 0.05 KG per capita, whereas if you go to the lower-level countries, you see that this value like lower middle income countries, where India is, this value comes to 0.36 KG per day per capita. So, you can see that is this also is an indicator of the industrialization level of our country.

And similarly, you can see e-waste generation is also low 0.01. So, over here you can have a idea about what is the overall percentage or what is the share of industrial waste, agricultural waste, construction and demolition waste, hazardous waste, medical waste and electronic waste in the overall waste stream which is beyond the municipal waste.

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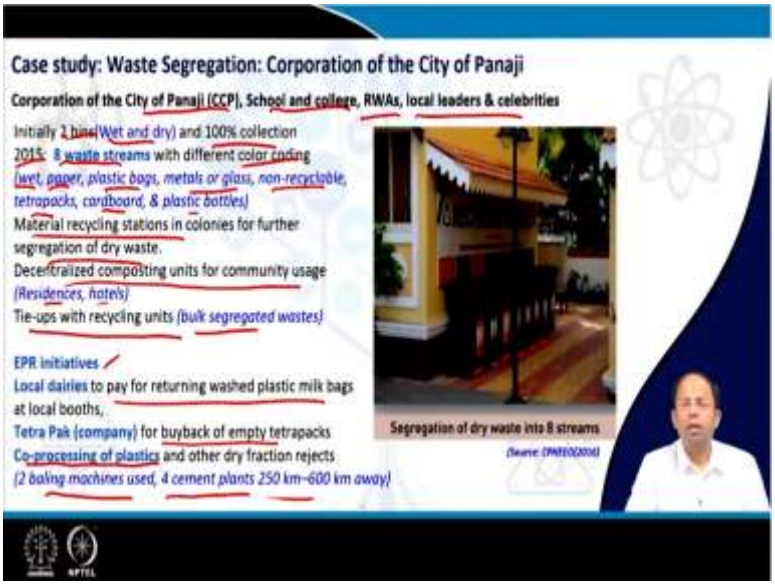

So finally, we end our lecture with a case study. This is for the corporation of city of Panaji. And usually, they have adopted a lot of measures so that they can reduce waste, they can do proper segregation of waste, so we will talk about that. So, corporation of the city of Panaji and along with schools and colleges in that area, this residential welfare associations, local leaders and celebrities together they have come up to create a very comprehensive, integrated solid waste management plan for the city.

Their idea was to reduce the amount of waste or at least not to send waste to landfills or to reduce it significantly. So initially, they initiated this segregation, they said two bins were provided for wet and, collection of wet and dry waste, and they achieved 100 percent collection. But after that in 2015, when they were saying that well, everything is fine, people are doing segregation and all, they further divided into eight streams, like eight waste streams.

What are those? And each with different color coding. This is for wet waste, paper waste, plastic bags, metal or glass, non-recyclables, tetra packs, cardboards and plastic bottles. Now why specifically these eight categories. There is no mandate on that, you can decide on this, but why it is determined like this?

Because as per the schemes or the opportunities that is there in this will be, you can decide that if I take out tetra packs, then probably, I have some way to actually sell those tetra packs or reuse those, or recycle those tetra packs. Same goes for metals or glass and so on. So, that means as per the opportunities or the facilities or infrastructure that you have, you can decide on what level of segregation you have to go for.

So, in this image you can see different colors are utilized as shown, each color represents a different kinds of items, this eight kind of categories in which you have to put your waste. So, every material recycling centers where stations were set up in every colony so, that people can go and put materials which could be recycled, certain things even, like for example, they can return some amount of hazardous materials as well. So, these kind of recycling stations were set up.

Then decentralized composting units for community uses. So, this was also set up at residences and hotels can actually do composting locally. Then they did tie ups with lot of recycling units so, that was bulk segregated waste for different kinds of bigger generators and all can be directly taken up by those recycling units.

Then they initiated lot of EPR initiatives. So, local that had made tie ups with local dairies, so that they pay for returning the washed plastic milk bags at local booths, people were able to return the milk bags after washing them into the local booth and they used to get paid for that. Then tetra pack company, they made a scheme with them so, that they buy back their empty tetra pack so, that they can reuse.

Co-processing of plastics and other dry fraction rejects. So, two bailing machines were procured which bailed or compressed the waste into pellets, into square this items, square this compressed this plastic and other materials were formed into a rectangular square cube. And then it was taken to the cement plants which is around 250 to 600 kilometers away, where they were used in co-processing for generating energy or heat and so on.

So that is how the municipality did a lot of initiatives which can improve or segregation which can reduce the quantum of waste and so on. And they did have to tie ups and accordingly they also encouraged people to segregate.

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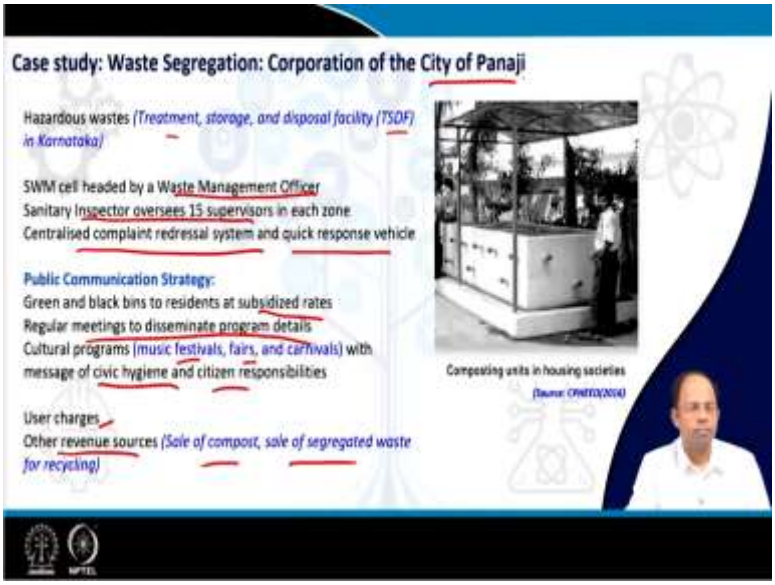

Hazardous waste were taken to a treatment storage and disposal facility, TSDF in Karnataka. Now, talking about the organizational structure of this municipality, this was headed by a Waste Management Officer. It has got a solid waste management cell and a sanitary inspector which oversees 15 supervisors in each zone. So, and similarly for each supervisor looked into certain number of sweepers or people who help in collection and all.

Centralize complaint redressal system and quick response vehicle. So, they also took in complaints and they had a quick response vehicle to address some complaints, like some sort of, some sort of spillage of garbage and all those things there were vehicle to actually address those.

Public communication strategy, green and black bins were provided to the residents at subsidized rates so, that they cannot do initial segregation. Then further for bulk generators it was further segregated into other categories as well. Regular meetings to disseminate program details, cultural progress were conducted like music festivals, fairs, carnivals with message on civic hygiene and citizens responsibilities.

So, you have to do overall, you cannot just say that people, ask people to segregate. You have to design systems, you have to promote, you have to create awareness campaigns, you have to make people participate in your programs, then only it would be successful.

And finally, usage charges were also collected for all these activities and all. And other revenue sources that the municipality also generated where from sale of compost, sale of segregated waste for recycling and so on. So, this is how it was, this is a very nice case study,

where successful waste minimization and segregation program was taken up by the city of Panaji.

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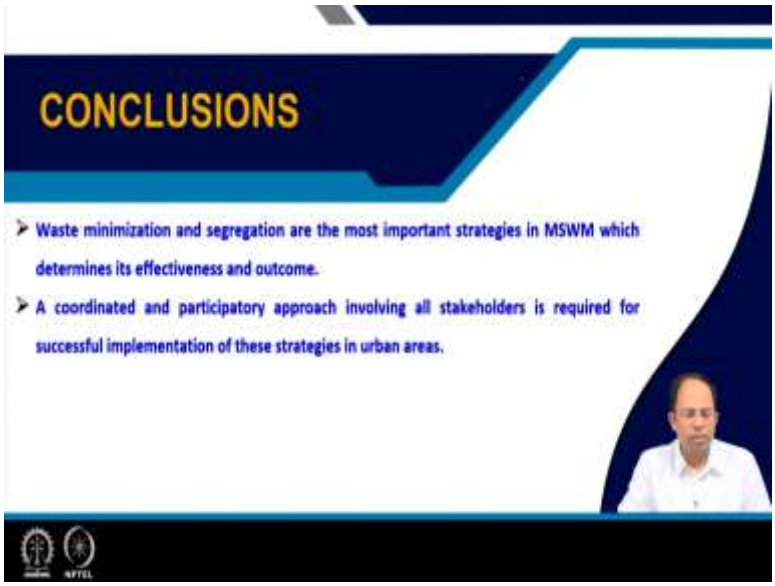

These are some of the references you can study. And to conclude, waste minimization and segregation are the most important strategies in municipal solid waste management, which determines its effectiveness and outcome. And a coordinated and participatory approach involving all stakeholders is required for successful implementation of these strategies, in urban areas. So, thank you.