Municipal Solid Waste Management
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Lecture - 06
Factors Affecting Solid Waste Generation Rate

So hello students. Today, again we are starting another lecture on Generation of Solid Waste. So in the previous lecture, we discussed generation, how important to measure the quantification of the quantity and volume of waste not only for the disposal but also for the treatment and transportation or collection of solid waste.

Now we will extend the same discussion and in this lecture, we will discuss one very important issue about I think in the previous class also I explained the difference between generation rate and collection rate. And also a very important issue that is the factor affecting the generation rate. I think everyone knows about the three R in Municipal Solid Waste Management.

That three R's are reduce, reuse, and recycle. So here, we will see that what are the different factors will affect the generation rate and how these three R's like reduce, reuse and recycle is the possible quantity of the waste or generation of the waste.

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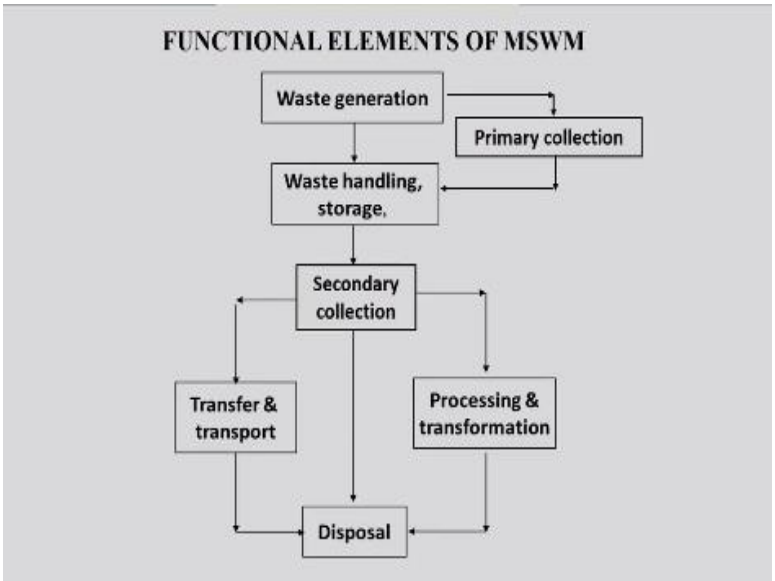

So the same way the waste generation is the first functional element of MSWM. And here this lecture is factor affecting solid waste generation rate.

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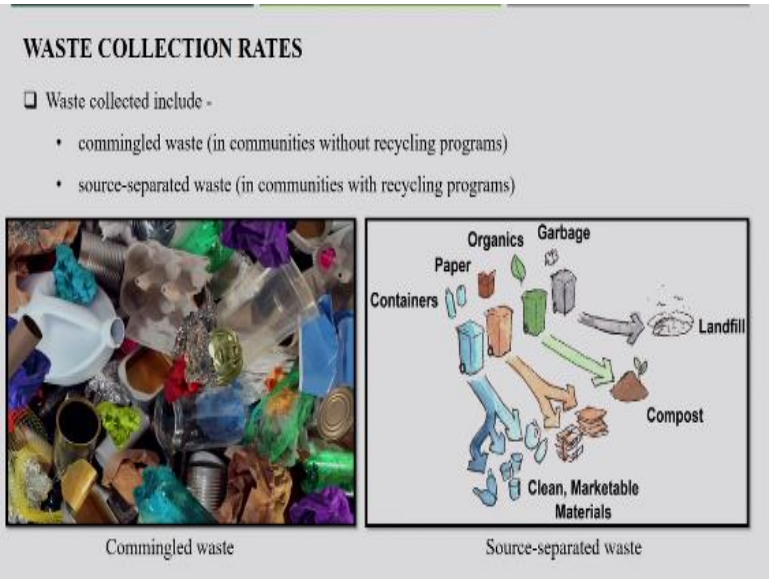

So we will start with the first, the waste collection rate. Waste collected includes commingled waste or mixed waste. This is the mixed waste and before Swachh Bharat Mission in India, most of the cities have this kind of collection system. Entire waste is mixed together, whether it is dry, wet, metals, glass, paper-plastic, and even household hazardous waste also including in the same waste.

That was the collection we normally call is the commingled waste collection system in the community without a recycling program. And now under Swachh Bharat Mission, this was the major thought behind the Swachh Bharat Mission where waste collected in a source-separated way. Here, the dry matter especially the paper and different dry matters easily get recycled.

The organic waste, which is highly degradable will go to the compost plant or biogas production plant. And the remaining one will go to the disposal site. The waste will only go to the disposal site which is not possible to recycle, not possible to produce any kind of product out of that. That was the thought behind the source-separated waste collection system, which is majorly proposed under the Swachh Bharat Mission.

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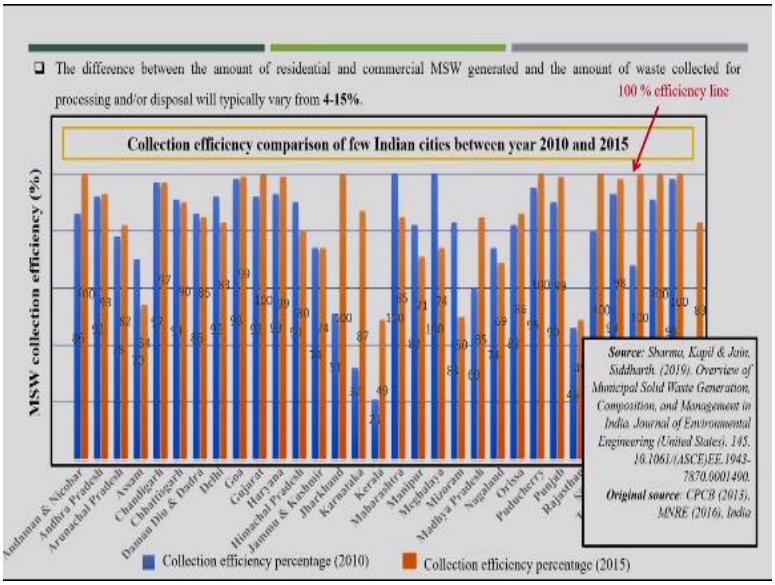

Now if you see the difference between the collection rate and generation rate, most of the study says that it is the variation varies from 4 to 15%. And especially I think this is globally we can say that the difference between collection and generation rate goes to 4 to 15%. But India, because our collection frequency is not that high.

We will see in the few slides the collection efficiency of different cities or different state of the state of India. But globally, we can say that goes up to 15%. But in India, it may be the more than 15% difference between the generation rate and collection rate. So if you see this one figure where it was given the collection efficiency comparison of a few Indian cities between the year 2010 and to 2015.

So is a 100% collection line. If you see that, the collection efficiency percentage in 2010 in the blue color and another color that collection efficiency percentage in 2015. So if you see here, some of the states already in 2015 achieved 100% collection efficiency. But some of the states like Maharashtra, where the earlier the collection frequency was very high, but now the collection efficiency has been reduced.

Maybe is because of more waste generation because of commercialization and industrialization.

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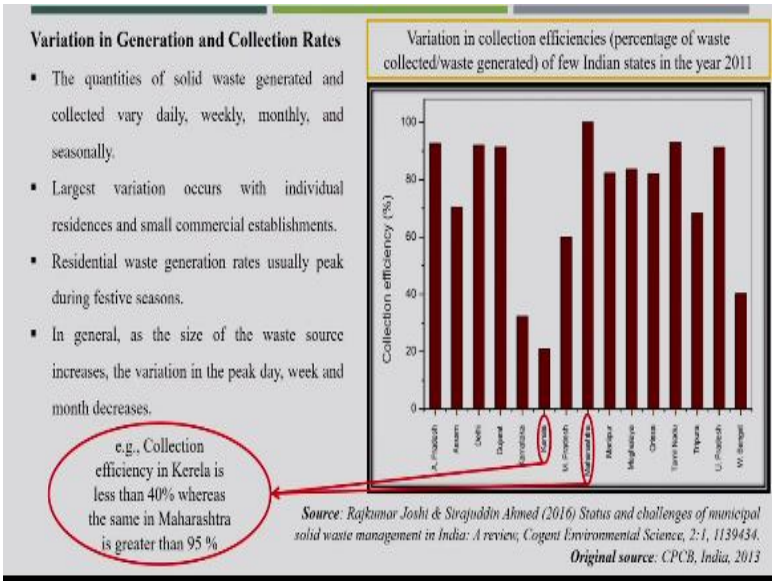

And I think these are the few points where we can see why there will be a variation in the generation and collection rate. The first point is the quantity of solid waste generated collected vary daily, weekly, monthly, and seasonally. That we already see in the generation.

The quantity production itself is a vary not only with the monthly or seasonally, but in the daily also the waste generation is getting varied or is getting changed. And the largest variation occurs with individual residences and small commercial establishments. That is another point where the small residence and the small commercial establishment lot of variations will be in the generation rate.

And also the generation of residential waste generates rates usually peak during the festive season. That is another and India's lot of festivals. In these festivals events or festival season, a huge amount of waste is getting produced and different compositions also changing. So because of that your collection rate also is varied a lot.

In general, the size of the waste source increases the variation in the peak days, week, and monthly decreases. When a lot of amount of waste is getting generated in the small localities also the variation also will be less in that case. So this is one another graph. Well, we will see that the different states of India have the collection efficiency. Now I think some of the states like they already achieved high collection efficiencies.

But I think still some of the states like Kerala, the collection efficiency in Kerala is less than 40% whereas the same in Maharashtra is greater than 90, 95%. That is the CPCB report.

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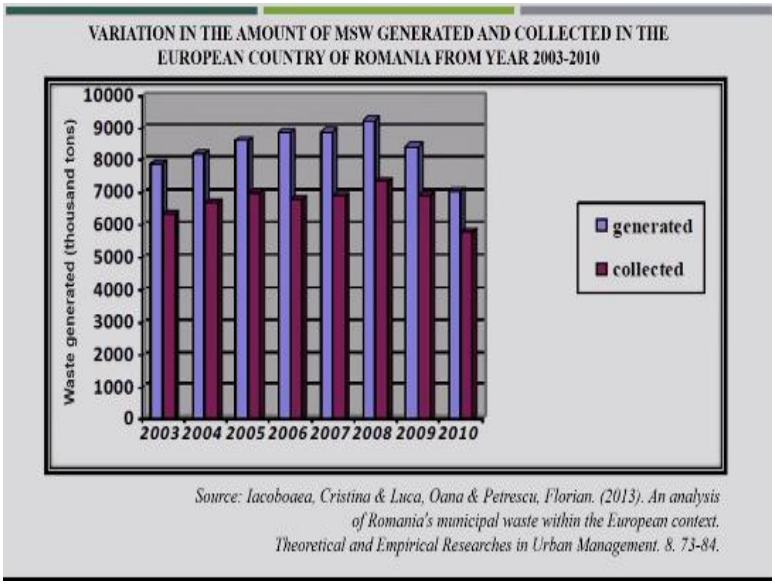

Now this is another one more example the variation in the amount of MSW generated and collected in one of the European countries named Romania from the year 2003 to 2010 where you will see that they have a generation in thousands per ton was in 2003 and was it in 2010 the variation was 15%, 20% variation was there in the generation rate and collection rate.

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Now we will go for the factors affecting waste generation rate. This is one of the very important issues how based and once we know what are the factors affecting generation rate or collection rate, we will be able to reduce the waste at the source. So once you are able to reduce the waste at the source, it is very easy to go for a collection system and easy to get disposed of for treatment.

The first effect is the effect of source reduction on waste generation. Now, this is the first point to decrease unnecessary or excessive packaging. So now you see that I think in the online purchase lot of packaging materials are coming. So if you reduce these unnecessary or excessive packaging is easy to reduce the waste quantity also. So now here the reduction of online shopping and packaging is unnecessary.

Whatever is unnecessary that if you can ban or you can reduce that easy to reduce the quantity of solid waste. Now, this another point is substituted reusable products for disposable single-use products. Now we recently that India had banned single-use plastic. So similar way these disposable items especially in the festival seasons, we are using a lot of disposable materials which once is usable after that it is going to the disposal site.

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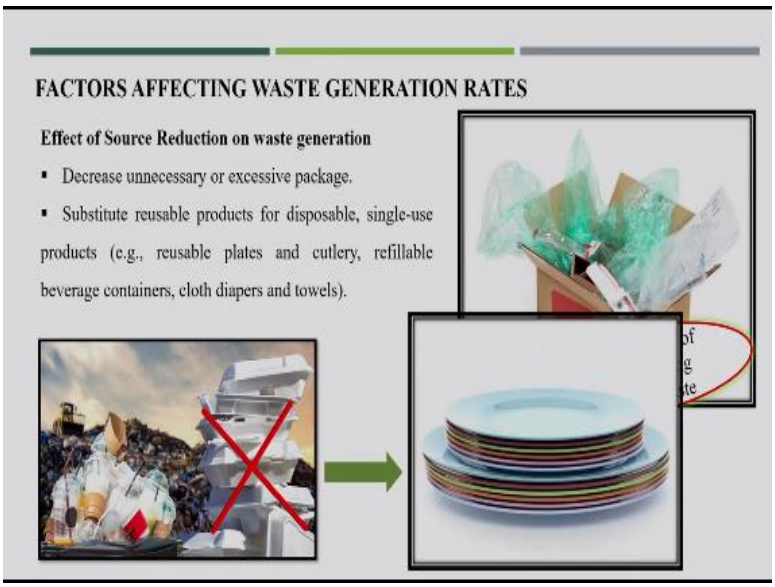

So if you can replace the reusable plates or reusable materials, so we can reduce a lot of quantity of solid waste at the disposal site.

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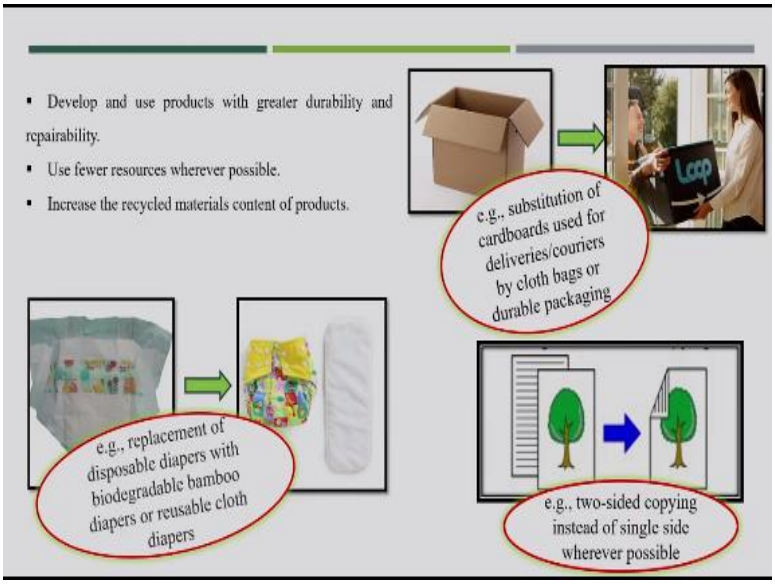

Now another point in this same reduction, source reduction development use product with greater durability and repeatability. Now we see that most of our packaging materials are coming into the cardboards. If you can give these packaging materials in reusable or durable or reusable packaging, those kind of packaging can be useful for some other purposes.

So that because of this a lot of waste can be reduced into the disposal site. So use fewer resources wherever is possible. See here is another example, if you use the paper on one side or both the sides, obviously, the paper production or paper waste will get reduce very easily.

This is another example that increases the recyclable material content of product like the replacement of disposable diaper with biodegradable bamboo diaper or reusable cloth diapers that is another very important material is coming to the disposal site. these kind of waste is generally called as household hazardous waste, this is very difficult to get treat and very difficult to dispose into the municipal disposal sites.

If you can replace such kind of material with the recyclable material, obviously, once it gets cleaned, those diapers can be useful for the degradation process. Maybe we would not be able to produce the compost out of that, but at least it would not get disposed into the disposal site. It will get degrade wherever is possible. So obviously the total quantity of waste generation, not only the waste generation but also collection also will get reduced.

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So this is the second point of the effect of recycling activity on waste generation. This is one of the very important factor to reduce the waste generation or collection. The very first point is the extent of recycling in the community level and affect the collection rate. So now, you see what kind of waste is getting generated. Now first we will see the dry waste which are highly recyclable.

Now first is the cardboard and paper board which is highly recyclable. If you get separate out its source itself and getting collected to source separated waste is getting collected and easily can go for the recycling process. Another is glass, highly recyclable. Plastic, if it gets separated at source and if it is not mixed with other wastes, other wastes can be easily recyclable.

The office paper, newspaper, magazines, all these papers are recyclable. And whatever metals such as, aluminum, tin cans, these are all recyclable. So if it is getting segregated at source itself and specially getting collected and directly go to the recycling facilities. So it would not go to the disposal site. Obviously the quantity reaching the disposal site will get reduced very easily.

Even your collection frequency also will get reduced. Now another waste from the same household that is wet waste also is getting produced. That is having larger quantity because of more moisture content, but easily degradable.

Once I think if you try to degrade at source itself, whether is a source or household level or is a community level, if you are able to reduce this waste, you need not to provide the collection for such kind of waste if it is getting degraded or if it is getting treated at community level itself. So, we need not to have the collection, need not to require any space into the disposal sites.

So this is one of the important factors. By that way we can easily reduce the waste.

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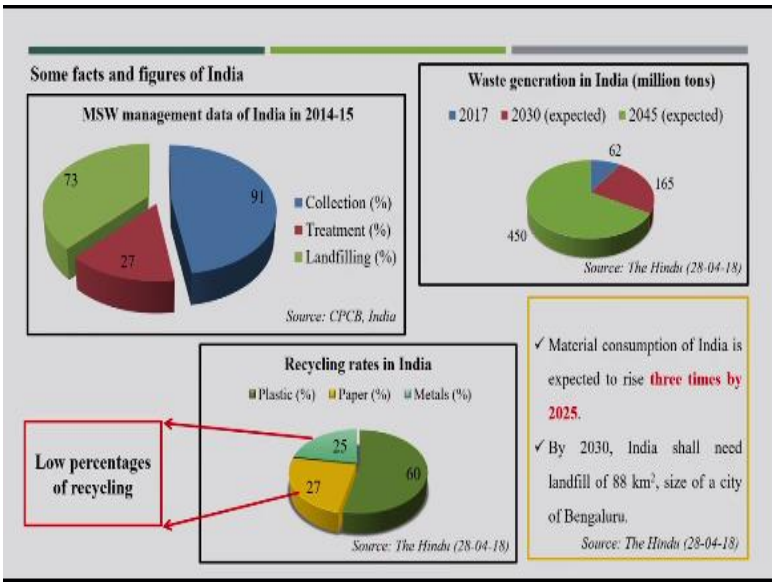

So another I think here I am giving some facts and figures of India why we have to promote more recycling or more treatment facilities at household level or community level. So if you see the waste management data in India by 2014, 15 your collection is 91% but treatment is only 27%. But most of the waste goes to the disposal site. This is the status in 2014, 15.

In current scenario, collection efficiency has increased because of Swachh Bharat Mission. But I think most of the waste goes to the disposal site. Now here some prediction is given. The waste generation in India by 2030 and 2045 is expected. See that currently the waste generation is 42 million tons in 2017.

Now is currently 65 to 66 in 2019 and 20, a million tons per day. Now you will see that in 2030 the expected waste will be 165 million tons and in 2045 the waste generation will be 450 million annually. So you see that how difficult will be the management of solid waste if you do not properly propose the recycling facilities.

Now here you can see that the material consumption in India is expected to rise three times by 2025.

And by 2030, India shall need landfill of 88 square kilometers that is the size of Bengaluru. That much size of disposal site will be required to dispose the waste in 2030. But you see, currently in India recycling of plastic is in proper condition which is more or less 65% and for paper it is 60% and recycling of metal is not in good percentage. So that is what by seeing these facts and figures, we can easily understand why India has to be focused on more recycling. And especially these recycling or treatment at the household level or community level.

Because if you can do it in these both ways, whether it is a household level or community level, not only we can reduce the size of the landfill site, but also we can reduce the cost of collection or transportation. That is one of the most costly processes in municipal solid waste management.

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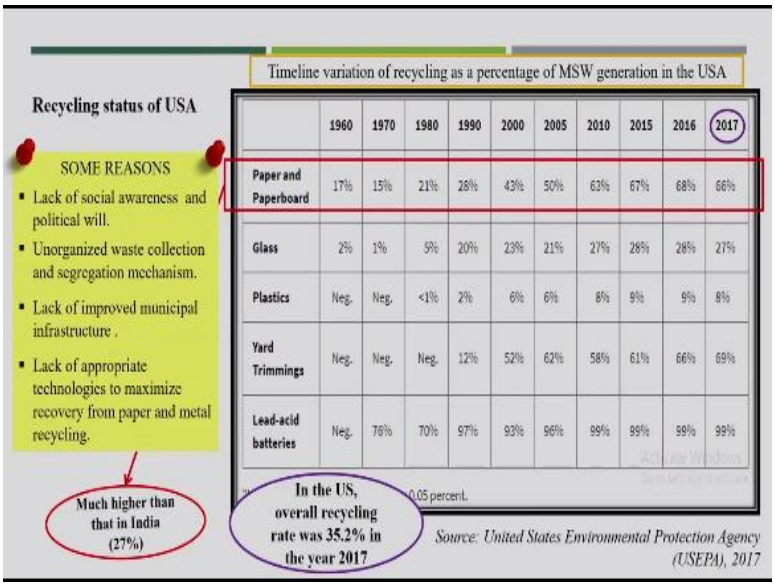

Now, this is one more data from the recycling status of USA. You will see that in US overall recycling rate is 35 to 35.2% in the year 2017. That is much higher than India. But I think every country not only India but every other country whether is a US or Europe or Asian countries should propose more recycling activity to reduce waste.

I think in previous slide everyone has seen that most of the waste whether it is paper, plastic, rubber, leather, glass, metal, all are recyclable matters. Only the important issue is that all these materials has to be separated if it is found in the mixture. And that is only possible when you are able to collect it from the source, these collected matters and how best you are able to collect it and send it to the recycling facility.

There are some reasons why we are not able to promote more recycling because of social awareness and political will. That is also one very important point where we are not extending our recycling facility. The other point is the unorganized waste collection and segregation mechanisms. In India, especially this recycling is managed by the informal sector. You know about the rag-picking, which is very high in India.

I think there are some reports which say that, in Delhi 10% of waste is getting collected by the rag pickers and the population of rag pickers goes more than 10 lakhs. And these rag pickers are targeting only the recyclable matters. But if these recyclable materials are contaminated then it makes a problem.

If we are purchasing a dustbin and we are packing the dustbin with plastic and then if we are disposing some biological waste or kitchen waste into it, the biological waste will get degraded easily but the plastic will get degrade easily. Such kind of plastics are also not collected by the rag pickers and even no one will collect such kind of plastic that is already contaminated. Now suppose if you want to go for recycling of such kind of plastic bags it has to be cleaned properly and then only we can go for recycling one. But most of the rag pickers would not collect such kind of plastic and that is the problem now.

So that is why under Swachh Bharat Mission the collection is proposed that the household collection has been proposed and that is in the three different parts. The dry waste is getting collected separately. Wet waste is getting separately. So both waste would not get mixed together. And also the third type of waste that is household hazardous waste like paint or diapers has to be collected again separately.

These should not be mixed with the dry matter and also not with the wet matter also. And it has to be collected same way to the treatment facility or recycling facility.

Another lack of improved municipal infrastructure. Now you see that if you are proposing more recycling or treatment facility at the community level, obviously a lot of infrastructure is required.

Why I am saying that infrastructure? Suppose at household level, the residence people are able to segregate the waste. We need to provide the proper separated collection facility. Means you will be required different kinds of vehicles for the collection of different kind of materials like for wet waste you will be required four different vehicles. For dry waste a special collection system is required.

Maybe your collection mechanism also has to be changed. And again, we need to be ready for the treatment facility or recycling facility. If you are able to segregate at household level and if you are able to collect it, you need to have the recycling facilities available. Your biological treatment facility should be available. These kind of infrastructure is required with the municipal. Then only your segregation will be more beneficial. But I think most of the corporation do not have this kind of infrastructure facility and most of our policies also is not incorporating that this is a management system. So in order to have one compost plant, you need to have proper segregation followed by proper treatment facility also is required.

Now these are lack of appropriate technologies to maximize recovery from a paper and metal recycling. This is also very important. Suppose, you are able to segregate at household level, you need proper technology, proper treatment facilities for that kind of material, those material recycling.

So I think these are the few reasons and in Swachh Bharat mission there are lot of infrastructure that has been provided to the corporation and few corporations have already started the segregated waste collection followed by the treatment. But only small quantity of waste will reach to the disposal site. But I think again, we have to propose more recycling and treatment facilities to reduce the waste to reach to the disposal site.

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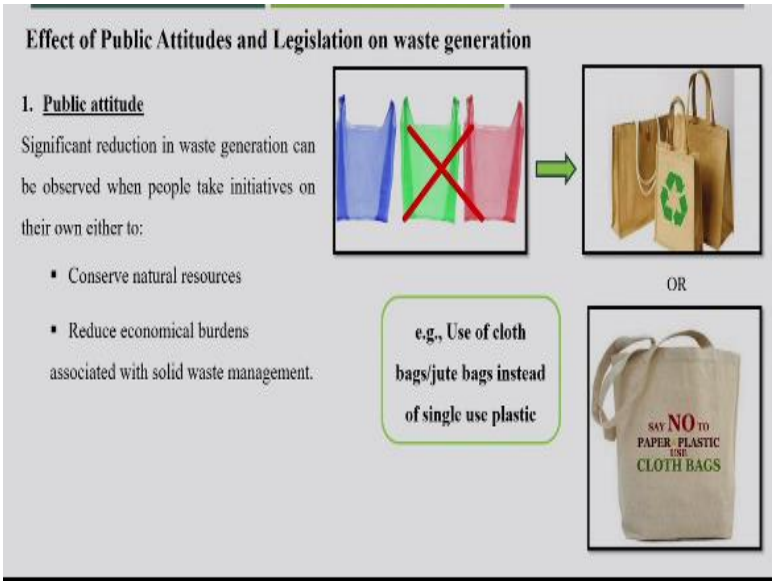

Now this is another factor that is the effect of public attitude and legislation on waste generation is also important. First we will see the public attitude. This is very important again that significant reduction is possible in waste generation when people are well aware about the natural resources and reduce the waste generation.

So here is one example like if public attitude will change by using these kind of plastic bags and will get replaced by the jute bag or cloth bags, obviously the waste generation will be reduced which is depend upon the public attitude. So under Swachh Bharat Mission, there are lot of activities that have been planned to increase the awareness. This is another important issue in waste management after the segregation that is awareness. People should be aware, they should know that once they are using such kind of material, what could be the problem, what could be the problem with the disposal site or what could be the environmental issues if they are using such kind of materials for the utilizations.

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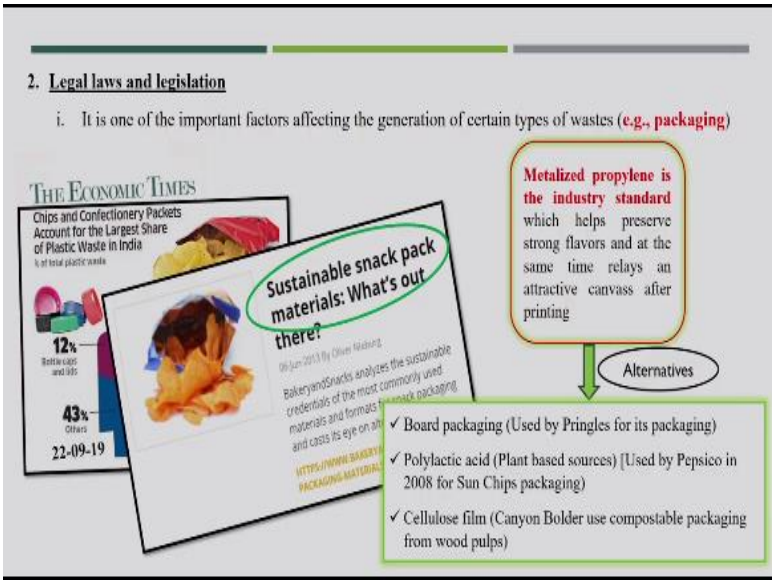

And another point into that legal law and legislation which is also an another important factor. If your legal laws or your regulation or legislation says how best we will be able to do packaging so obviously we will be able to reduce the packaging waste material. And here you can see the chips packets and most of the plastic is produced by the chips packet, PET bottle, your garbage bags, packaging, bottle caps.

These kind of different materials or different ways the plastic is getting generated in India. So here another news have come about sustainable snack material. I think this is the major problem from which we are getting large amount of plastic material. So because why we are using the plastic here because the metalized propylene that will help to preserve the strong flavors in the food.

And that is why I think these plastic is using for the packaging material. But now there are some alternatives. Might you heard of bio plastics which are getting produced from the biomasses, biomass material and easily get degradable? So I think that could be one of the alternative from the plastic materials. These are not the single use plastic, but very difficult to dispose such kind of plastic, this packaging material.

So I think now, there are lot of research that is going on like bio plastics or polymer based plastic or poly lactic acids or PLA based plastics that can be a one of the alternate for the packaging plastics.

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This is another point of encouraging the purchase and use of recycled material by allowing different pricing. Also we can reduce the waste generation. Like you see this news that the waste from your online deliveries choking Bangalore. So these kind of packaging material are getting produced that is a major garbage problem was in the Bengaluru.

So why we cannot propose such kind of packaging material, which are highly durable also and can be reused also very easily. This kind of material we do not dispose into the garbage bins. So use of durable and reusable or recycling packaging at different pricing could be possible.

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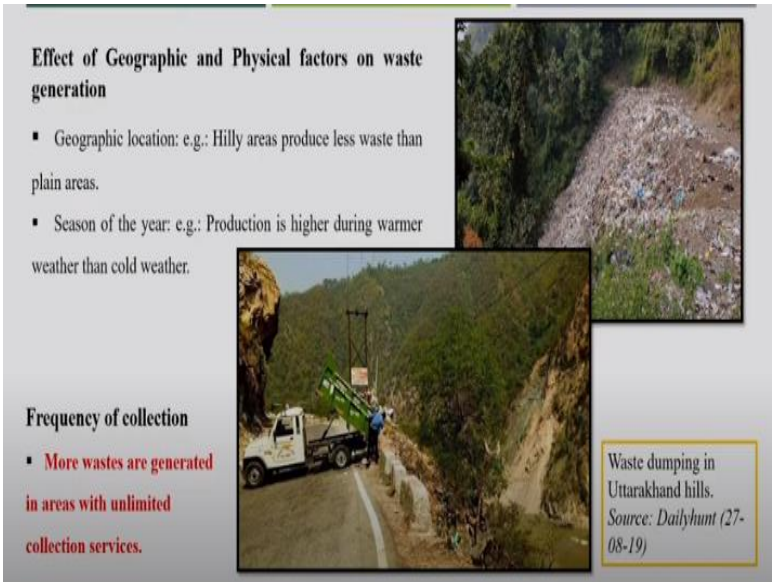

Now another point is effect of geographic and physical factors on waste generation. So the geographic locations is normally explained in this way, hilly areas produce less waste than the plane area. And maybe because of that availability of materials in the plane area is more. So obviously the more waste is getting generated compared to the hilly stations. And also the season based.

The production of waste is higher during the warmer than the cold weather. Here also the very important point is the biological waste generation. Obviously in the winter season we will get lot of vegetable matters or food material. So obviously, the large amount of biological waste will get generated in the winter season compared to the summer

But in the warmer season, I think the compositions will be more dried compared to the biological nature of the waste. There is one photo you can see, the waste dumping in the Dehradun or Uttarakhand in the hilly area. And another point is frequency of collection. So here we can see that more waste are generated in the area with unlimited collection services.

This is very important factor for waste generation. Suppose, I will give some example onto this. Suppose your collection frequency is very high. Suppose once in a day waste is getting collected from your house. So obviously, you know that every day somebody is coming and collecting the waste. So you need not to worry about how much waste you are generating at the household level.

Because you know that next morning somebody some crew member will come and collect the waste from my house or from that particular locality. But if you reduce the collection frequency, maybe once in a day or alternate day or once in a week, you know that next morning, nobody is coming to collect the waste. Only once in a week, maybe in Sunday somebody is coming and waste is getting collected. So you know that by Monday, you will start to reduce the waste. You will try to reduce the waste, especially biological waste because you know that the biological waste odor and leaching will get start within few days maybe two days, three days. You will try to reduce the biological waste. But also that is not good to reduce the collection

frequency once in a week. Obviously your waste generation will get reduced in large percentage once your collection frequency is reduced.

I can give one example of Shillong city, which is a hilly city in northeast India where most of the location, waste is getting collected once in a week, maybe because of their transportation is not that good in the hilly areas. So the big sized vehicles are not able to go on every day. So Sunday they are providing the collection of the waste. So obviously people are trying to reduce the waste onto the weekdays.

So that large amount would not get stored at their house for the collection on Sunday. But I also do not say that if you reduce the collection frequency once in a week that is very difficult for the household people or commercial facilities. But alternate day collection, is possible and the collection frequency in different ways.

The dried waste need not be collected every day. But wet waste will get collect every day. So obviously because you cannot store it for one day or two days these biological waste onto the household level. So wet waste collected daily and dry waste once in a week or alternate days. So obviously your waste generation is possible to reduce by managing proper collection frequency.

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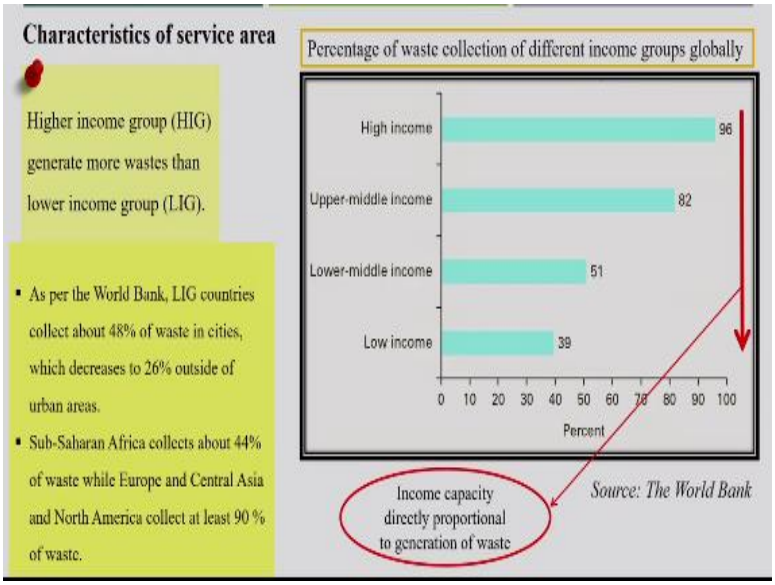

This is another one factor that we are seeing, that waste generation and characteristics of the service area. You see there are some data where we can see that the high income group countries or high income group areas are generating large amount of

waste compared to the low income countries. Like here we can see that is the World Bank, LIG country collect 48% of waste in the city which decreased to 26% outside of the urban area.

So here also I think once you know the characteristic of that particular city, also we can understand what kind of compositions are changing, what kind of waste generation and different sources is getting changed. And specially in India because whatever the policy is adopted by one city is very difficult to implement in another city. Because every city has different characteristics, different commercial facilities, different festival, different seasons. So based on that we can have different policies and different recycling facilities could be possible to adopt for the different city.

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So I think we will close this lecture by understanding the different ones. So I was telling about that reduce, reuse and recycle. So in this lecture we have specially seen that there are lot of factors by which will be able to reduce the generation. Obviously, many times Government of India has proposed three R policies and many city has adopted that.

But I think it was very difficult to accept that proper segregation was not adopted everywhere. Now under Swachh Bharat Mission waste is getting already segregated at household level. Now if you adopt these three R policies like Reduce, Reuse and Recycle policy at household level or community level, we are able to reduce large

amount of waste which is unnecessarily going to the disposal site. So thank you for listening.