Introduction To Multimodal Urban Transportation System
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Lecture - 44
Urban Transport & Sustainability: Parking Studies

Welcome back friends. Now that you have been introduced to the topic of TDM or travel demand management and we have looked at two class exclusively on pull and push measures. In this class, we are going to introduce you to parking studies, which is one way of pushing people out of their vehicles by having good parking management strategies that would disincentivize use of your private motorized two wheeler or four wheelers.

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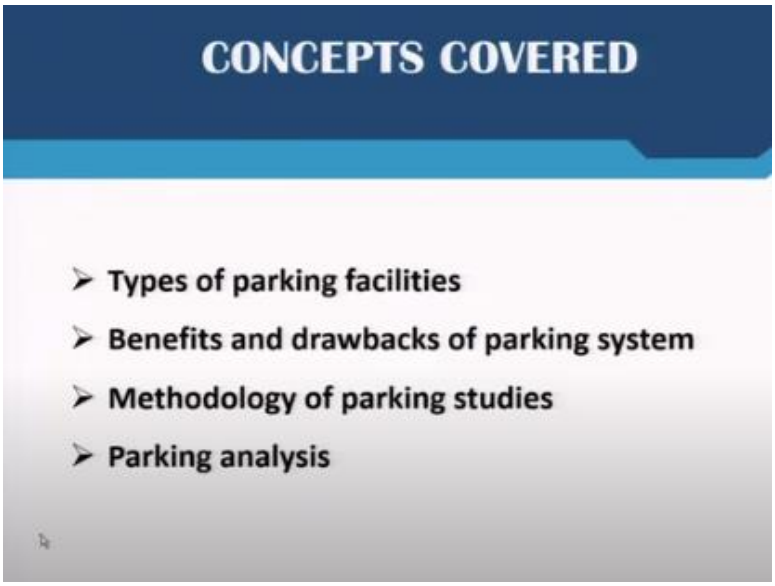

So in this class, what we are going to look at is the different types of parking facilities, to give you an understanding where parking can be managed, how it can be managed? What are the benefits and drawbacks? How do you actually carry out or conduct parking studies that will enable you to then implement these push measures for your cities and give you an example problem of how parking analysis is done.

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So parking is a phenomenon in urban areas in every city or town in India that is growing. It is either has already become a problem or is a ticking time bomb as they say is going to become a problem in the very near future, right. Because the growth rate of the rate at which our ownership or vehicle ownership is increasing.

And also the rate at which we are using our private vehicles, all of these, these two factors are actually increasing the demand for parking facilities. But on the other hand, when you look at the supply side, you see that most of the demand for parking is at areas which are in prime locations, right?

People want to go to a mall, which is in a high land value price area, and park their vehicles and use the mall facilities or they want to go to a shopping center which is in the CBD and want to park their vehicle there. But all these parking facilities require lots huge land. And the prices of the land are very high. So you cannot just provide free parking at these places, right?

The malls have adopted to providing parking, either in underground or over ground facilities. But they do charge for parking. So this whole concept of free parking is slowly is either has disappeared, or is going to disappear in the very near future. The other type of parking that usually used to be rampant in most of the urban areas in our cities, is on-street parking. And it used to be rampant.

Meaning people used to just park their car on the street and just go and do the shopping and come back. I mean, this type of informal on-street parking is also going to go away. More and more cities are now adopting to some sort of a paid system where you would pay for the parking even if it is on street. On-street parking actually helps in calming the traffic or helps in reducing the speed of the traffic that is flowing on that road.

So on-street parking sometimes is beneficial. But it has to be regulated, it has to be priced so that people do not misuse parking and just park their vehicle for the entire day. Because that space is very valuable, right. Especially in Indian conditions, because of the street vendors and that vending is their means of livelihood if you take up that space for a parked vehicle, most likely their livelihood gets affected.

So here is a conundrum that do you want to allow vehicles to park and access the more established shops? Or do you want to actually allow street vendors to have access to people along the streets so that they can gain livelihood right? So that is also something that we face, especially in our urban areas in India as to where to provide for parking or where not to provide for on-street parking.

So when we talk about parking, you should be able to distinguish between these two types of parking. One is on street, one is off street. Off street is generally at designated garage where you either it is over ground or underground. You park there, it is a dedicated facility. Whereas on street is if you are parking along the street.

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So this is called on-street parking, you are right along the street. Sometimes you will have on-street parking on both sides of the road. These are usually in residential neighborhoods. Then automatically what happens is that the width of the road gets reduced for the through vehicle and automatically the speed of the vehicle also gets reduced.

So often you will see residential areas encouraging on-street parking on both sides, so that the traffic automatically is calmed or the speed of the traffic is lowered. And hence it becomes safer for people in the residential areas.

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And these are off-street parking, whether you are in a surface lot, these are called surface parking lots or whether you are in a structure or a garage, where you are

parked at different levels, over ground or above ground. Also bicycle parking just as we looked in the last lecture is becoming important and they also require dedicated bicycle parking spots.

They may be along with in the same structure as the motorized vehicles but at least within the structure, they have a dedicated space for bicycle parking.

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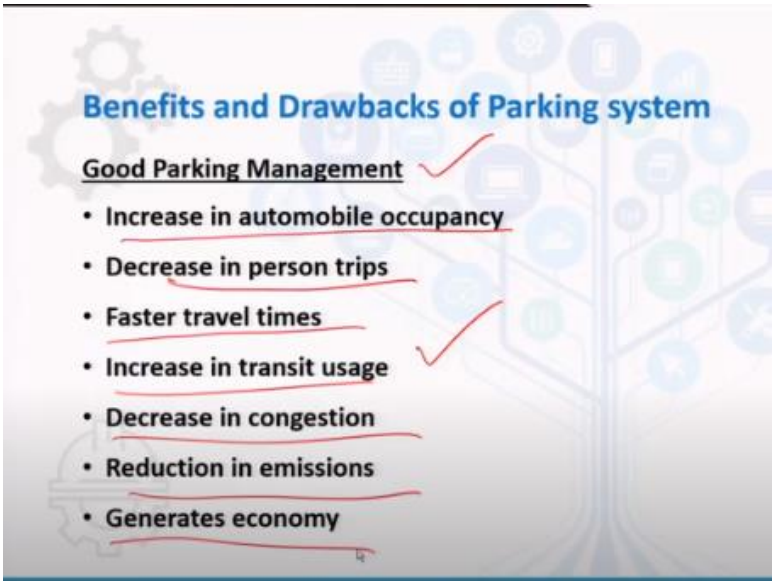

So what happens when you implement good or when you have good management of these parking? It increases automobile occupancy. Meaning now there are more and more people who are carpooling, for example. So good parking management meaning usually this parking good management means your good pricing policies, right. Now there were three friends of you, three of your friends decided that you want to go out on a weekend and have and watch a movie.

And all of you three would come in your own vehicle and park and go to the movie. But now that you know that parking is so expensive, maybe now you decide that well let us not take three different vehicles let us carpool together and go in one vehicle, right. So that increases the vehicle occupancy. So good parking management increases vehicle occupancy. It decreases person trips.

Now in single occupancy three trips are being reduced to one trip of multiple occupancy, right. So single person trips are reduced. That causes faster travel time. So now three vehicles, there are two vehicles less on the road. All three friends of you are

carpooling. So congestion goes down. Now if you aggregate it up to all of the people in your city, you may see that there may be very few or there may be a significant decrease in the number of vehicles on that road.

And maybe the travel times increase, right or delay is decreased. Increase in transit usage. Now if you have good parking, like we have looked at Park and Ride facilities, remember, right. So we have looked at Park and Ride facilities where you can now come and ride a transit or a high speed transit system. You can park your car right there and not take your car inside.

Because again, maybe there is congestion pricing that is associated with it. So all of these strategies, good parking strategies, good spots where your parking garages are located, enable high transit usage. Looked at decrease in congestion. Automatically, emissions are reduced because fewer number of vehicles are on the road. And it also generates economy. This is I think I remember talking on this topic earlier as well.

But usually when parking management or good parking management strategies are being adopted, the local shops get really anxious saying that, well now if you are going to charge for parking, maybe people are not going to come to our shops and hence our revenues are going to go down.

But what has been noticed actually is that you need to provide them good parking at a location that does not affect the circulation of traffic in these CBD areas. If you do that, the revenues will not go down of these shops. People will still come to those shops, but will come in alternate modes now. They would not just abandon the shops because these shops have been there for a long time.

They have established a good name for themselves. So people usually do want to go to those shops. But now they would come using a different mode maybe or a metro maybe on Ola, Uber or something or some other sustainable mode. Maybe bicycle, maybe public bicycle sharing system. So they would just come in a different mode. And this has been noticed where you apply good parking management.

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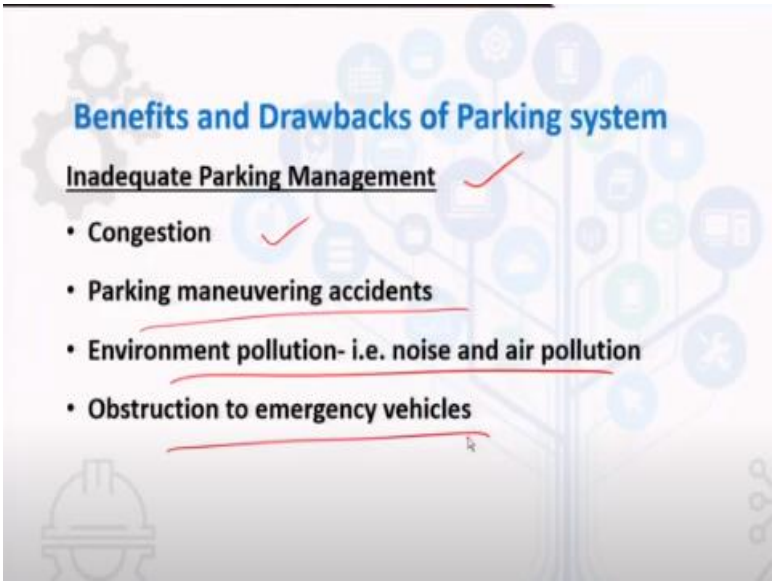

Alternatively, if there is inadequate parking management that would cause congestion, parking maneuvers, maneuvering accidents. So if you do not have, especially this happens when you are coming out of a parking garage or a parking structure, for example. And if you do not have good sight distance, then you pull out of a garage very quickly at high speed.

Then you may immediately face an accident once you come out. Or even when you are parked on street. Usually, not many of us are adept to parking, parallel parking. So usually you bump into the car in front of you or behind you and then may cause accidents when you are pulling out of that spot.

It has also been noticed that when you are parking on street, especially when you are parking on street, when you open the door to get out, you usually do not see or usually not very focused on the pedestrian or the bicycle that may be just going past your door and you may open actually the door on a pedestrian or bicyclist. So that is another type of accident that may happen if you do not if you are not very vigilant, and you do not have good parking management strategies in place.

Noise pollution, air pollution would increase because now people are using their private vehicles and such and as such they may be obstructing emergency vehicles as well. So good parking management is one of the so parking you see is actually parking pricing is actually a push measure. And there are some parking strategies that may also attract you to public transport for example.

So it may also be a pull measure. So it is some kind of a hybrid TDM measure, which can sometimes act as a pull and a push measure. Mostly it is a push measure, because you are pricing these parking and allowing and disincentivizing people from using their car.

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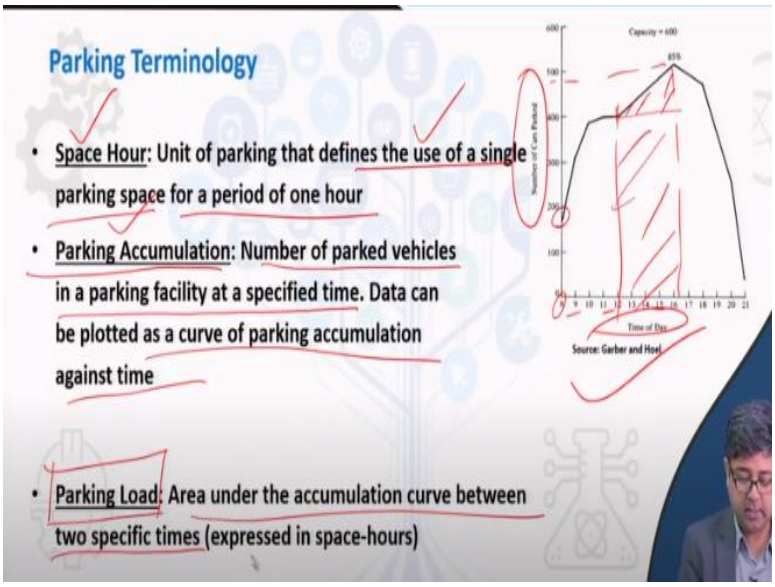

So some of the parking terminologies that you have to be, you have to be knowing in order to conduct or carry out analysis, we are going to look at, we are going to look at them very quickly now. The basic unit for parking is called space hour, because you have to define the use of a single parking space for a period of one hour. So usually, it is not how many vehicles park, but it is usually how many vehicles park per one hour, right.

That is the basic unit for parking because we want to utilize the space to the maximum. We want to have maybe fewer spaces, and that all those space is full all the time rather than have lot of spaces and only have half of the space is utilized for the majority of the time, right. So space hour is the unit of parking that defines the use of a single parking space for a period of one hour.

So that is an average period of one hour of parking. Then what is parking accumulation? The number of parked vehicles in a parking facility at any specified time. So that is parking accumulation. Data can be plotted on a curve against time. So

this is the most common parking accumulation curve that you would see. You will see that the number of cars parked on the y axis and this is the time of the day.

So you will see that as say this is the 8am in the morning, 9:10. So at 8am in the morning, there are just fewer than 200 cars. But at for example, at 4:30pm there are almost 500 cars parked at the any type of facility, **so** any type of parking facility. So this is called a parking accumulation. Now if you want to know the parking load. Parking load is nothing but the area under the accumulation curve between any two specific times.

So if you are asked to determine the parking load of a structure between 12pm and 4pm, then you just need to convert this into different triangles and rectangles and squares and just calculate the area under that curve. So you just calculate the area under that curve and that is the parking load. Again is expressed in terms of space hour.

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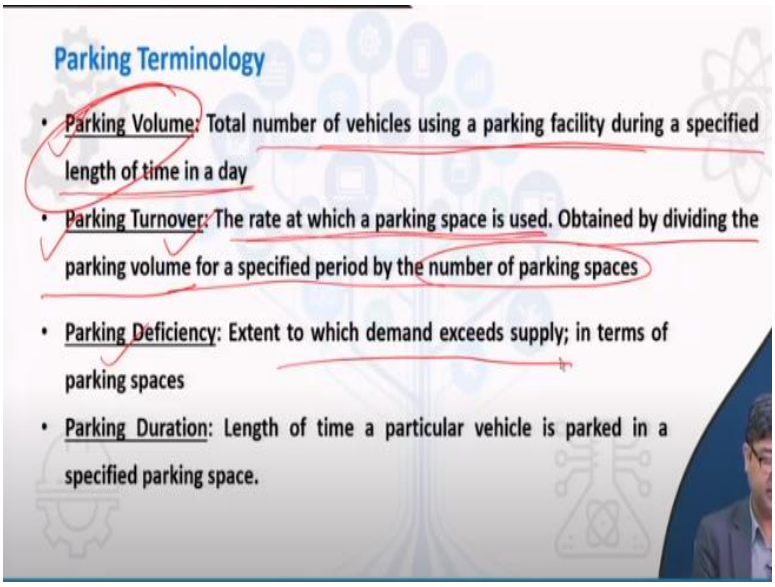

The next is parking volume. That is the total number of vehicles using a parking facility during a specified length of time in a day. So that is just parking volume. So you see the difference between a parking volume and a parking load for example. So you have to be very careful when you use these terminologies.

So we know of these elements in the back of our mind, but now that you are learning this course, make sure that when you use, make sure that you use specific

terminologies at specific points in time, so that you are clear in your communication during the during constructing of a parking garage or whatever it is. So parking volume is the total number of vehicles using the facility during a specific length of time in a day.

Parking turnover is an important thing, is the rate at which a parking space is used right? That is what we were, I was telling you just earlier. We are always interested of utilizing a space to the maximum. So this is the rate at which a parking space is used. It is usually obtained by dividing the parking volume for a specified period by the number of parking spaces.

So that is obtained, that is the ratio of parking volume to number of parking spaces. That is the parking turnover. Parking deficiency is the extent to which demand exceeds supply in terms of parking spaces. So you have to, we will tell you how to calculate parking demand and parking supply. So if demand exceeds supply, then you say that there is a deficiency in parking.

And parking duration is simple length of the time vehicle is parked in a specified parking space.

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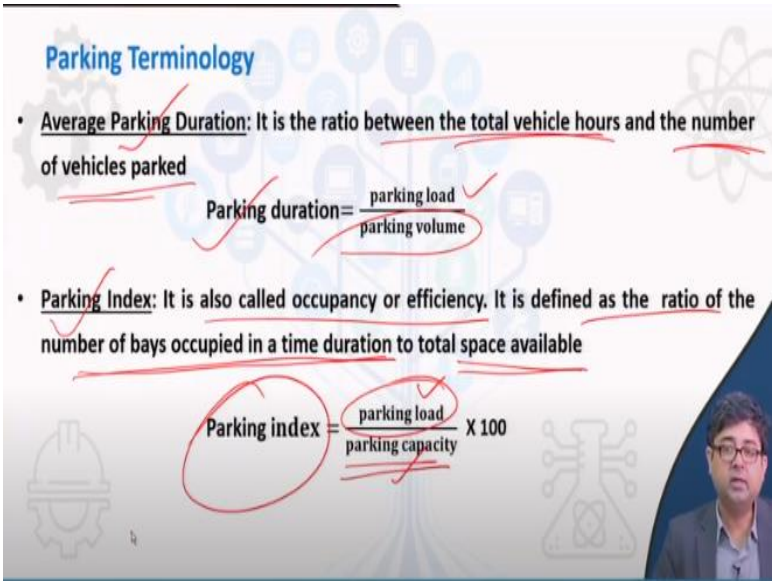

Average parking duration however, is the ratio between the total vehicle hours and the number of vehicles parked, right. Average vehicle, so what you want to do is total vehicle hours meaning the parking load, remember parking load expressed in space

hours. So that is the total vehicle, total vehicle hours and the number of vehicles parked. So number of vehicles parked is parking volume.

So parking load by parking volume gives you the average parking duration. And there is something called a parking index which is actually the occupancy or the efficiency of the system of the entire parking system. It is defined as the ratio of the number of bays occupied in a time duration to the total spaces available. So this is parking capacity or the total spaces that are available.

And this is the parking load on the top or the number of bays that are occupied in a time duration. So you always want your load and capacity to be equal so that you have a parking index as close to as possible to one or hundred so that then you are efficiently running your parking system, right.

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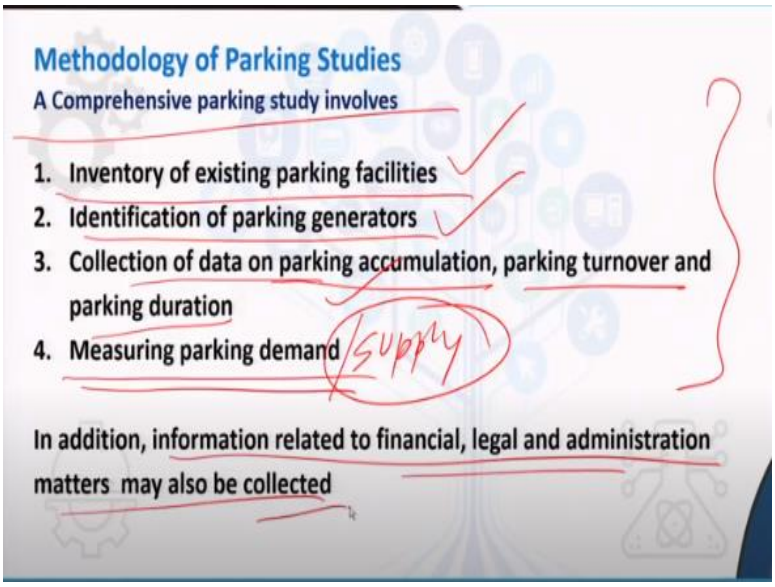

So those are some basic terminologies and we will get to some example problems at the end of this lecture, which will allow you to understand these basic terminologies in a numerical way. But let us just look at how you carry out parking studies. Again parking is taught as a part of traffic engineering courses.

And you do have a few traffic engineering courses on NPTEL as well, where they go into much more detail about how to do all of this. However, since we are looking at it from the point of view of sustainability and parking management, and push and pull

measures, so we are going to just give you a overview of how to conduct these parking studies.

First of all, you have to have an inventory of existing parking facilities in your CBD for example. Maybe if you are given a task that determine how much deficiency of parking we have for our CBD. So that is maybe the exercise that you have been given as a traffic engineer or as a urban transport planner, and you have to carry out this exercise. What you would do is at least first know how many parking facilities are there.

What are the inventory, what is the capacity? Also identify who which are the parking generators, right? Where people actually are going to after they are parking their vehicles. So those are the land users that are generating the need for parking. So those are called parking generators. So are they going, majority of them are going to the mall, majority of them going to the movie theater, majority of them are going to restaurants.

So what where is the parking demand? Who are these generators that are generating this demand? So you have to identify those generators. Then you have to collect data on parking accumulation, parking turnover and parking duration. You have to know how long on an average people are parking for, right. How long are the parking for? For one space, what is the turnover, right?

And then you have to see during two periods of time, how much actually accumulation is there. What is the entire load of parking? How many spaces actually is needed? Based on this need then you can carry out your parking demand and parking supply as well. So this has to be demand and supply that you need to carry out, that you need to analyze to see that well on an average people are parking for 35 minutes.

And during the peak demand time there is there are 500 vehicles, such vehicles that need to park. So now do I have enough spaces based on the turnover? Do I have enough spaces that will cater to that demand? So that is what you have to measure when you are measuring parking demand and matching it with the supply. If the

supply is less than you say that well we have to provide this much amount of this many more parking spaces.

If the supply is sufficient, you say that for the next five years, we have enough supply. Maybe there are some demand management strategies that we need to do. So always do parking analysis for at least the next year, two years, five years. Do not only do it for today. Because if you know that a new residential complex is coming or a new movie theater and a multiplex is coming then you have to incorporate that into the demand analysis so that you provide enough capacity for them as well.

Okay, in addition, information related to financial, legal and administration matters also has to be collected. Because how much would you charge if you were to subsidize for parking, which is not often encouraged in the modern urban transportation world. But still people do subsidize for parking. So if you had to do that, who is going to pay for the parking.

All of that all of those situations have to be also worked out. Because as we are only focused on the transportation aspect, we are telling you about these points. But these are important to go along with them as well.

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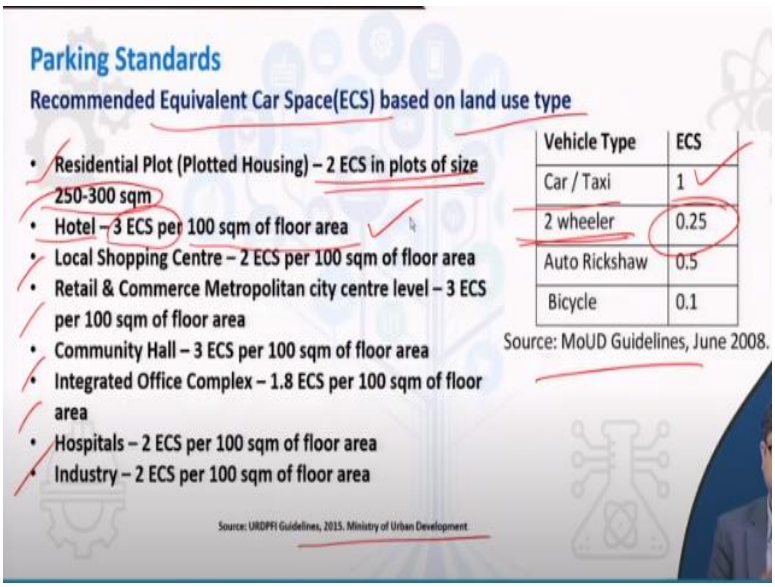

Usually, there are certain standards that have been developed in India that allows you to at least estimate how many spaces the parking spaces you would need. Usually, the Ministry of Urban Development has developed all these guidelines, and they are

given in the form of what is called an equivalent car space, and based on different types of land uses. Equivalent car space is nothing but spaces measured in terms of one card unit, right.

So the car unit is taken as the base and for one car you would need one space, so that ECS is 1. Whereas for two wheelers, you would need only quarter of that space. So that means that you can park four two wheelers at the space that is provided to park one car. So that is the kind of units ECS determines. And you are, different standards or different guidelines are developed for that.

So if you have a residential plot anywhere between 250 and 300 square meters, you should have or you should provide for two ECS for those plots. So that should be sufficient. So this is all done based on lot of studies that have been carried around India. And parking has been parking demand and supply has been measured at various land uses.

And based on that, based on those large number of studies, all of this has been given. So for example, hotel, if you have a hotel of hundred square meter of floor area, then you would need three equivalent car spaces per every hundred meters. So if you have a 800 square meters of floor area, then you would need 8 into 3 24 equivalent car spaces.

So you can do all those calculations for all the different types of land uses that are given here. That gives you an estimate at least in the back of your mind what you need. Now these may vary and you may have to do your own thing. For example, the hotel maybe not in an urban area, but in a suburban area. Maybe that changes the requirement for your car, your parking, number of parking spaces.

Then you may do your own calculation, but at least you know that this is the guidelines that are available to you.

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Then where do you prohibit parking, right? You also have to know when you are doing parking management you also have to know where to provide parking, where not to provide parking, right. Near intersections, parking is discouraged. On-street parking is definitely discouraged. But also large parking structures are also discouraged to be very close to the intersection.

And narrow streets you would not encourage on-street parking. Maybe at the max you would have on-street parking on one side of the street but definitely not on both sides. On pedestrian crossings or I would also say, unfortunately on sidewalks as well right, you would see in many urban sidewalks in India, people have just parked their vehicles.

So that is not a parking space, not a parking spot, not for parking your bicycle, not for parking your two wheeler, not for parking your car, definitely not. So these are not places where you should park and there should be prohibitory signs put up so that people actually although they may seem common sense, but then common sense is not so common as they say, right.

So putting up signs, prohibitory signs of no parking does help. Of course, it has to be enforced as well. Near large structures, you should try to avoid, for example, providing parking for every structure has to be kind of done away with, right. If you have multiple offices in one area, every office having dedicated parking for itself is not a good idea.

Maybe four or five office complexes can now together build one parking structure and have all their employees to park at this common parking spot, or common parking structure rather than everybody having their own structure, right? That just adds up to space. Entrance of driveways, driveways that opens up to a street, along those points you should not have parking.

Of course, we have already told you limit free parking time and have parking meters all over the place that allows you to charge for how much time you want to park on the street, right. Maybe you have free parking like for example, if you go to some of the airports around India, you would see that there is some free parking that allows you to wait for say 30 minutes for the flight to come and then you just pick up your relative or friend whoever is coming.

But if you want to park for longer than 30 minutes, maybe for example, the flight is delayed and but if now your parking is more than 30 minutes you have to pay. So there may be some free parking but not all the time for longer periods of duration or longer durations.

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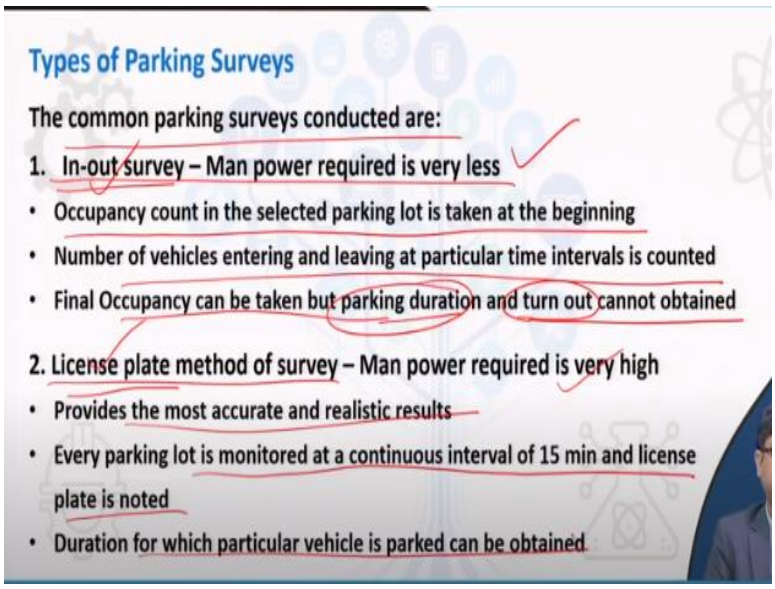

Okay, so there are some common parking surveys that are conducted. One of them are in and out surveys, whereas the other one is license plate method survey. Again, this is just a quick overview of these. Manpower required is very less in this case for in and out service. Whereas, if you are looking at license plates, for example, to

understand which vehicle has gone in at which time and if the same vehicle is coming out of a parking structure at a later time.

And if you are looking at license plates, then you need to have a lot of manpower whereas if it is just an in and out survey, this vehicle went in this vehicle came out you do not care for the particular vehicle tracking. Then you need lesser manpower. But an in and out survey is conducted for a different reason and a license plate survey is conducted for a different reason.

In and out surveys are conducted in order to know that the occupancy count in the selected parking lot, in order to calculate the occupancy count or the number of vehicles entering and leaving at a particular time interval is counted and the final occupancy can be taken. But parking duration and turnout cannot be obtained. So if you have to have if you have to calculate the parking turnout or parking duration in and out service, do not allow you to do that.

So if you studied those a little bit in detail or if you have taken any traffic engineering courses, you would know why that happens. Whereas in when you do a license plate survey or carry out a license plate survey, it is the more accurate and realistic results. Every parking lot is monitored at a continuous interval of 15 minutes and license plates are noted.

Again when you are noting license plates in order to have security or privacy what usually is done is only the last four digits or the last two digits of license plates are recorded. So that they cannot be tracked back to the owner, duration of a parking vehicle can be obtained. So this is a much more comprehensive way of conducting parking studies, the license plate method of survey.

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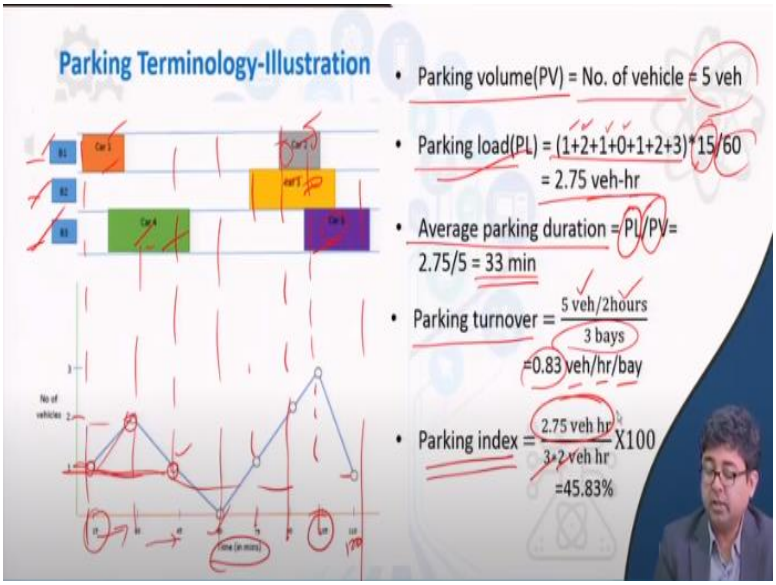

Now if you were to go back to our terminologies and try to understand them in the form of a simple example problem. What is shown here is there are three parking bays, okay? B1, B2, B3. And during different times of the day, different vehicles are coming and parking in these bays, right. So at, say the 15th minute of any hour, there is only this car number 1 that is parked.

So that is why this accumulation curve shows you that there is only one car. Whereas in the 30th minute, you would see that even this car is parked. So car number 1 is still parked, whereas another car has come, which is car number 4. So now you have in the parking accumulation curve, you have two cars. As the time goes now you see that in the 45th minute, car 1 is no longer there, right car 1 has already gone.

The 45th minute there is no car 1, but there is only car 4. So again, the accumulation curve drops down to showing one car. In the 60 minute, there are no cars, so zero. In the 75th minute, there is another car that has come into bay 2 now. Similarly, the 90th minute there is another car that has come at bay 1 again. This is a different car. This car 1, this is the car 2.

However, the peak number of cars that are there at any point in time is three, which is at the 105th minute where there is another car, car 5 that has come on bay 3. And car 3 is still parked and car 2 is still parked. Whereas at the end of the second hour or at the end of this should be 120 there are only one car left which is the car number 5.

So this is a very, very simplistic way of understanding how to measure or how to estimate or how to calculate different statistics or measures that we have introduced to you earlier. So now if you look at if somebody asks you, what is the parking volume given this situation, all you have to understand, all you have to say is how many number of vehicles are there, right.

So the parking volume for this two-hour period is 1, 2, 3, 4, 5. So there are 5 vehicles, total volume is 5. However, what is the parking load? What you have to do is for in order to calculate the parking load, you have to calculate the area between each of these the parking accumulation curve right. So the parking load the first one is 1, then it is 2, then it is 1. Because all of them are in 15-minute periods.

So the 15 is in the outside. Otherwise you had to multiply each with its own duration. Then at 60 there is none. So on and so forth. You multiply each of them with 15 and parking load is given per hour. So it is 2.75 vehicle hours. So if anybody wants you to or asks you what is the parking load at such a parking structure, you would say that again remember the units are always space hour.

So you have to say in terms of vehicle hour. So there are 2.75 vehicles, vehicle hours of parking load in this parking facility. The next term that you would want to calculate is the average parking duration. Remember average parking duration is nothing but parking load by parking volume. So the average parking duration is 33 minutes at this parking structure. What is the parking turnover?

In order to calculate parking turnover all you have to do is you have to know the parking volume for that given amount of time. So this is two hours. Parking volume for the given amount of time and how many bays are there. We are talking about three bays. So the parking turnover is 0.83 vehicles per hour per bay. That is the parking turnover. Finally, in order to calculate the parking index or the occupancy or the efficiency, you would have parking load on the top.

You already know the parking load is 2.75 and you divide it by the number of bays that you have and for the entire period which is two hours. So it is the parking load by the number of bays, all divided by the number of hours that we are talking about. So

this parking structure is has a parking index of only 45. So 45% efficiency this is working on. Remember parking index is also called the occupancy or the efficiency.

So it is working only at 45% efficiency. So there is a lot of space still available at this parking structure for vehicles to come and park. So that is a quick illustration of the terminologies that we have introduced you to.

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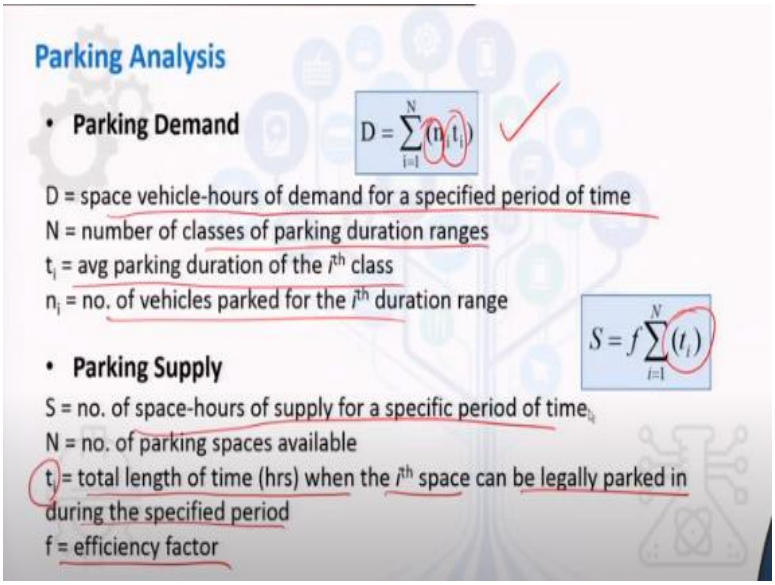

And now if people were to ask you to calculate demand and supply of parking, we will show you a quick example of how you do that. Usually demand is nothing but summation of the number of, the number of vehicles that are parked for a specific amount of time during that entire day, right. Demand is the space vehicle hours of demand for a specific period of time.

N is the number of classes, number of classes of parking duration ranges, right. Some vehicles may park for a fewer amount of time, some vehicles may park for longer amount of time. So that is all the number of classes you may want to divide that. T is the average parking duration of that class of vehicle. And n i is the number of vehicles parked for that duration.

So if you just sum this product, you will get the parking demand and for the parking supply, it is a function of how many space hours of supply is needed. Is the total length of hours when the ith space can be legally parked during the specified hour. So

if one space it could be only one space that is available, but it is always available, then the supply is good.

But if that space is available only for during the during an entire hour, it is only available for 5 minutes and the rest of the 55 minutes it is part that means the supply is less. So that is what is called is called a t i. F is an efficiency factor, which is constant, sometimes assumed for different structures.

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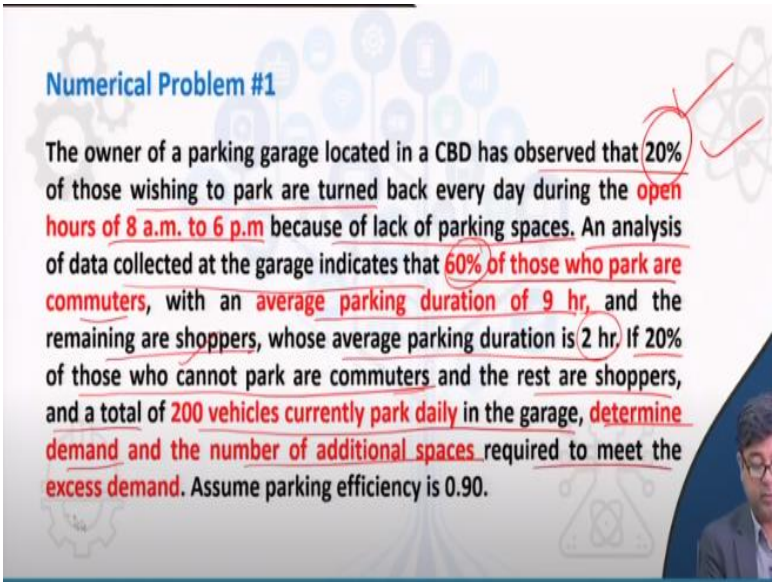

So if you are given a problem where you are said that the owner of a parking garage located in a CBD has observed that 20% of those wishing to park are turned back every day during the operational hours of 8am to 6pm because of lack of parking spaces. So 20% of the people wishing to park are getting turned away. An analysis data collected at the garage indicates that 60% of those who park are commuters with an average parking duration of 9 hours and the remaining are shoppers.

So 40% are shoppers whose average parking duration is 2 hours. So you have conducted a study of that parking area or parking structure and you have found this out. If 20% of those who cannot park are commuters, remember 20% are being turned away.

And 20% of those 20% who cannot park are commuters and the rest are shoppers and a total of 200 vehicles currently parked in the garage determine the demand and the number of additional spaces required to meet this excess demand. Two things you

have to determine. What is the demand and what is the additional spaces that are required because you know that people are getting turned back. Assume that the parking efficiencies is 0.9.

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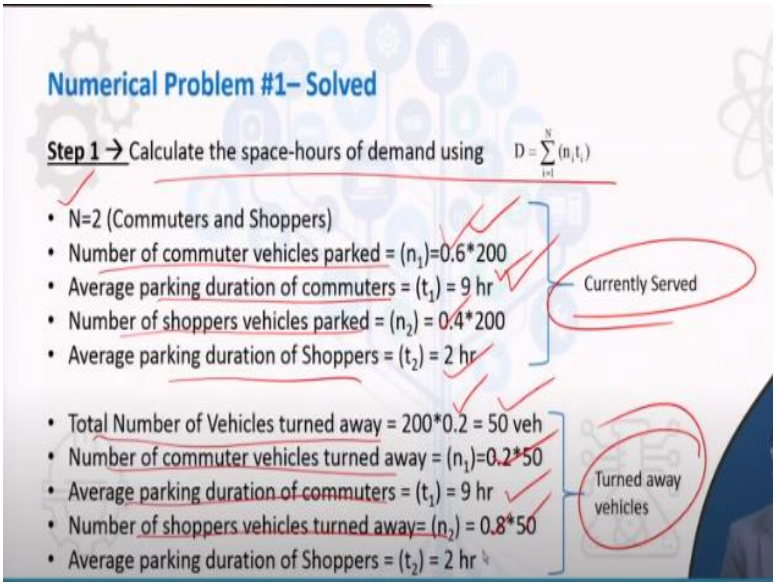

So all you have to do is first you have to calculate, do the calculations to determine the demand. You know that there are two categories of parking people there. One are commuters and one are shoppers. So the number of commuting vehicles you already know is 60% right, 60% of 200 vehicles are daily parked. So that is 0.6 six times 200. Average parking duration of these commuters of the commuters are 9 hours, right?

They are 9 hours. And number of shoppers are, so 60% are commuters, so the 40% are shoppers, and they are parking for an average of 2 hours, right? So they are parking for an average of 2 hours. That is currently being served. So these are the people who are currently being, are currently utilizing the parking facility. Whereas people that are getting turned away, who are these?

Total number of vehicles getting turned away are 20% right? 20% of 200 are getting turned away. So that is 50 vehicles. Out of those 50 vehicles, how many are commuters? 20% who cannot park are commuters. So 20% are commuters, right? So 20% of 50 are commuters and you know that the commuters on an average park for 9 hours. And the rest of shoppers. So 80% of 50 are shoppers.

And you also know that they park for 2 hours. So this is a first calculation that you do to know that who are being served and who are being turned away.

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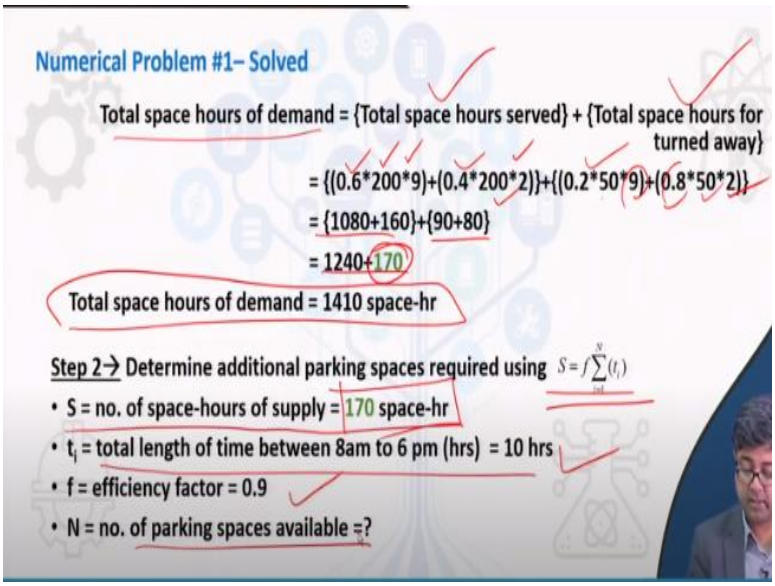

Now if you had to calculate the total hours of demand. So demand include the people who are currently getting a parking spot plus the people who are being turned away because they are still wanting to park but are getting turned away. So that is the demand that is unmet. So you have to add both of these demands, right? So total space hours being served plus total space hours of turned away.

So it is nothing but space hours being served is 0.6 times 200 times 9, right? 0.6 times 201 n 1 into t 1 right; n 1 into t 1 for this category plus n 1 into t 1 for the shopper category plus the total number of vehicles being turned away is 0.2 times 50 times 9 n 1 t 1 again and 0.8 times 50 times 2. So you get to these values. So your total hours of demand is 1410 space hours.

Now if you want to know the additional supply that is needed, you already know the equation for the supply and you know that the number of space hours of supply is, now you know that how many hour to be served, right? That is 170 hours of demand is not being met. So now we have to provide supply or we have to have spaces available for that many number of space hours.

So 170 space hours are to be met. Total length is 8am to 6pm, right. This is available, it is open for 8am to 6pm. So that is 10 hours. Efficiency factors is given. All you

need to know is number of parking spaces available. So N is something that you have to know.

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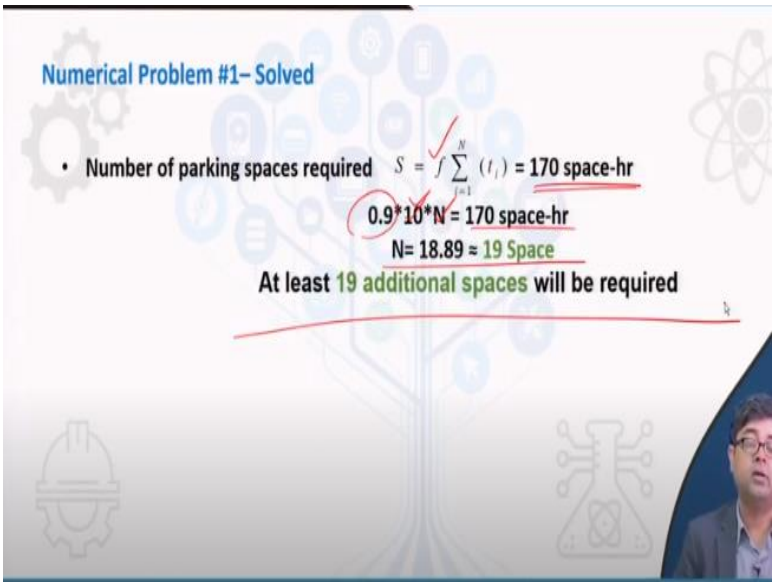

So this is given to be 170. So if you say that 0.9 is the efficiency factor, 10 hours of space hours. So you know the hours, you need the space. Is equal to 170. So you must calculate that saying that now you need 19 additional spaces in order to meet the demand that is getting turned away. So this is a very simple problem in order to understand how to calculate supply and demand for parking at a parking structure.

And we have also shown you an example problem that gives you the understanding of how to calculate the efficiency or occupancy of a parking facility.

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I hope these two have been helpful in order for you to understand how to develop your parking strategies for your city. The references are given here.

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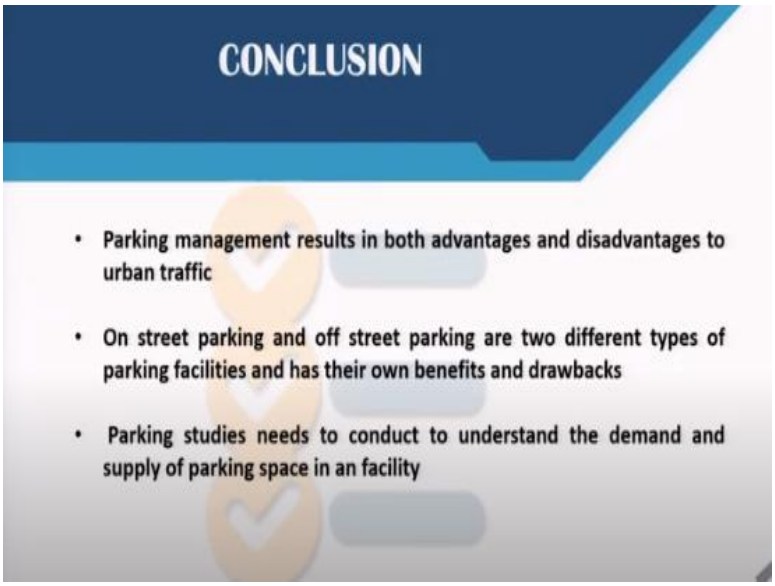

In conclusion, what I would say is that parking management results in both advantages and disadvantages to the urban traffic. So you have to have good parking management strategies in order to maximize the advantages. On street and off street parking are two different types of parking facilities that have their own benefits and drawbacks.

And parking studies needs to be conducted in order to understand the demand and supply. So we have given you examples of all of these, real life pictures of how parking actually benefits or is a measure of travel demand management that can benefit the use of sustainable transportation modes. Thank you very much for your attention.