Introduction To Multimodal Urban Transportation System

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Lecture - 50

Public Bicycle Sharing (PBS) System With ITS

Welcome back friends. So in this last lecture module of this ITS lecture series we will give you another example of how ICT devices can be used in a transportation service.

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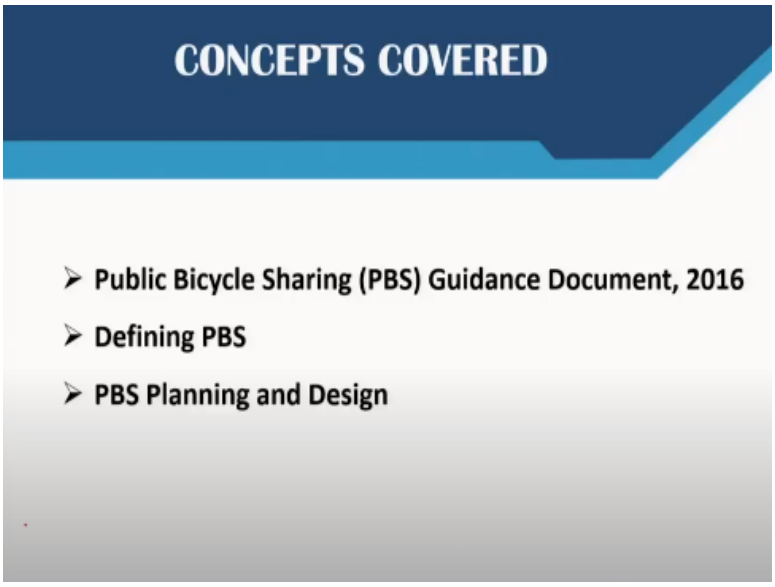

In this case, we are going to talk about public bicycle sharing, and how ITS is helping in the rise of public bicycle sharing and in that way it is helping in the sustainable development of transportation in urban areas.

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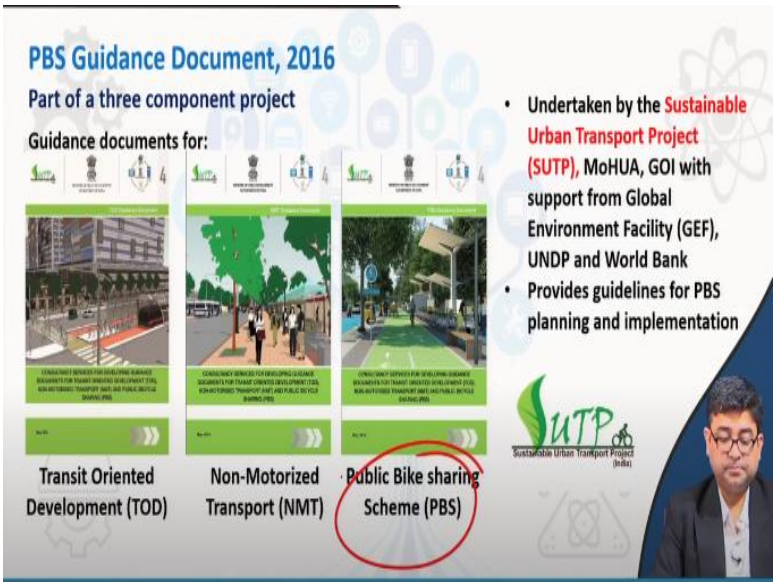

So when we talk about public bicycle sharing system, what we primarily mean to say is that these are the bicycle sharing systems that you can use by paying a fee, and you do not have to worry about owning a bicycle, or you do not have to worry about the maintenance of the bicycle. You just have to pick it up from a certain spot, drop it off at another spot which is closer to your destination. In this way, you are not only using a green mode of transportation, but you are also taking up less space to travel in the urban area and both of those help in reducing congestion as well as improving the environment. So that is what the public bicycle sharing system is. There is a guidance document that has been developed by the Ministry of Housing and Urban Affairs Government of India, which tells you how to plan and implement for a public bicycle sharing system. So that is the major source which we have used. And since it is developed by Government of India, there is a lot of applicability to the Indian scenario in this document.

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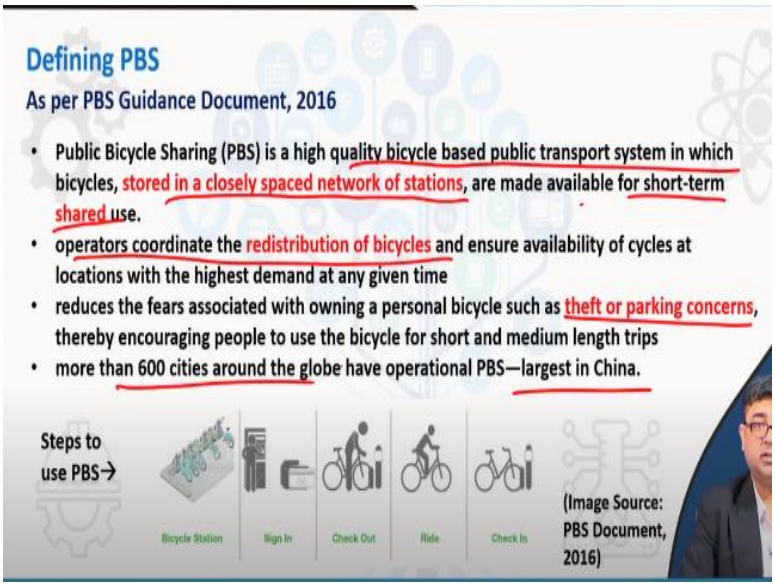

So like we said public bicycle sharing system is a high quality bicycle based public transportation system in which bicycle is stored in closely spaced network of stations are made available for short term shared use. These are the bicycle that you use, or somebody else can also use. In short it is for shared use for short term, this is usually you cannot rent it for more than a day or two days or three days. It is usually hours, couple of hours or 30 minutes or something like that. The operators make sure that the there is a good redistribution of the vehicles between the different stations that are there so that a scenario should not arise that out of all of the stations only two or three stations have a lot of bicycles whereas the other stations are either empty or have no bicycles. Then that system is not efficient. So the operator has to ensure that there is good redistribution of bicycles in all of the stations. There are ITS devices again, that guards against theft or parking concerns. You do not have to worry about this bicycle being stolen because it is the operators' concern and the operators has have installed or tried to install ICT devices that guard against theft or anything like that. In China we are already seeing that more than 600 cities are using these public bicycle sharing systems.

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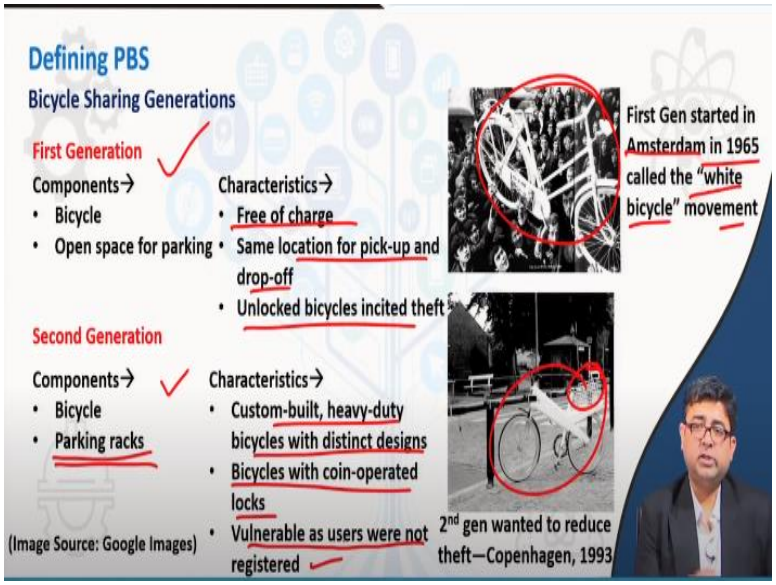

They however they had started way back way back in the 1960s when Amsterdam in Netherlands started what is called the white bicycle movement. The white bicycle movement had bicycles painted in white. At that point in time it was free of charge. Same location for pickup and drop off. So wherever you took the bicycle or borrowed the bicycle you had to drop it back off at the same location. However, these bicycles did not have any lock, so it was prone to theft. Those were kind of the first generation of bicycle sharing. After that, we move to more custom built and heavy duty bicycles with distinct designs. Maybe there was a carrier for your daily needs, daily grocery needs for example. Now they started to be operated using coins or certain amount of fee was being charged for their operations. There were parking racks that were available so that they could be tied to the parking rack or some sort of mechanism to avoid any kind of theft. They were vulnerable as users were not registered. So even in the second generation, nobody knew who was using these systems because the user who was trying to use it, they were not registered in any database or anything. So anybody could use it. So again, that was one thing that was not available in the second generation PBS systems.

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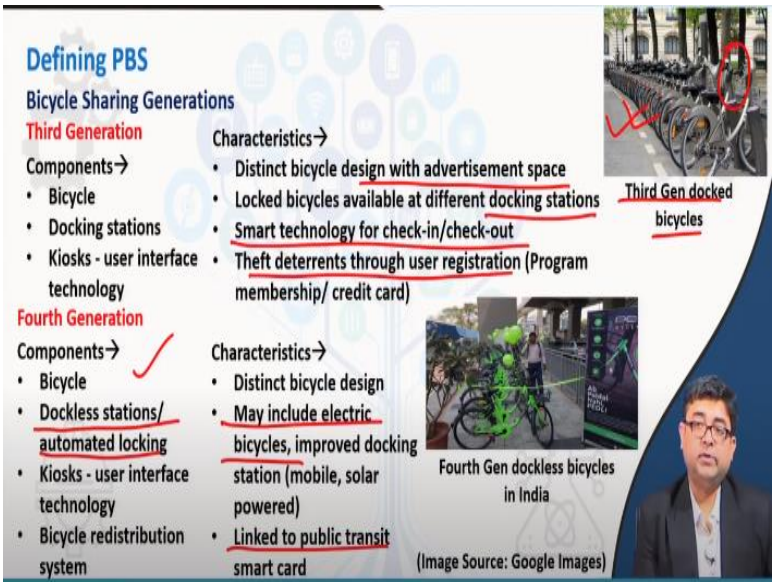

Then came along the third generation bicycles, which you might have seen in many of the cities. They are docked bicycles, they are distinct with design and advertisement space. So lot of advertisement was done to popularize these bicycle systems. They had different docking stations. Smart technology was used now to check in and check out. So maybe there was an app for each of these design, for each of these PBS public bicycle sharing systems in your city. And these apps allowed you to pay a fee and through the app, you could just unlock the system. So there was no need to have any manual locks on them as well, and theft deterrent through user registration. To use the system you had to first register on the website, give your bank details, give your information and only then you could use the system. So theft was then minimized, because now that your information was already in the database, and if anything had happened to this bicycle, then you would be automatically charged for it. And the fourth generation which is the latest generation that are being used are again going back to dock less stations and automatic locking. So it started, the first generation did not have any parking, and they were kind of dock less. But to increase security and safety we put in docking stations in the third generation. But now we have gone back to dock less, but with more technology. Now we have the technology that allows us to lock a bicycle remotely once the once the time that you have already paid for is up. We have technology that can automatically lock your bicycle and then so you do not actually need a docking station to dock it. You can just park it outside your home. Once you are done at the evening and the based on the GPS transponder on the bicycle, the system would know that this is one bicycle at this location which is

available. So anybody going past that location can look it up on the app and say that okay, I can pick it up from here. The technology is improving day by day and this is that is why we are trying to show you this as an example of how ICT is used in improving the efficiency of the system as a whole because bicycle is a green transportation and by encouraging green transportation we are improving the system efficiency. So may include electric bicycles as well. So now you have these electric scooters which can be used as public bicycle sharing systems. These smart cards are now linked to the public or actual public transport as well. So the same cards that you use for Metro for example, may be now used for your public bicycle sharing system as well. So that gives some seamless integration between different types of public transportation modes as well.

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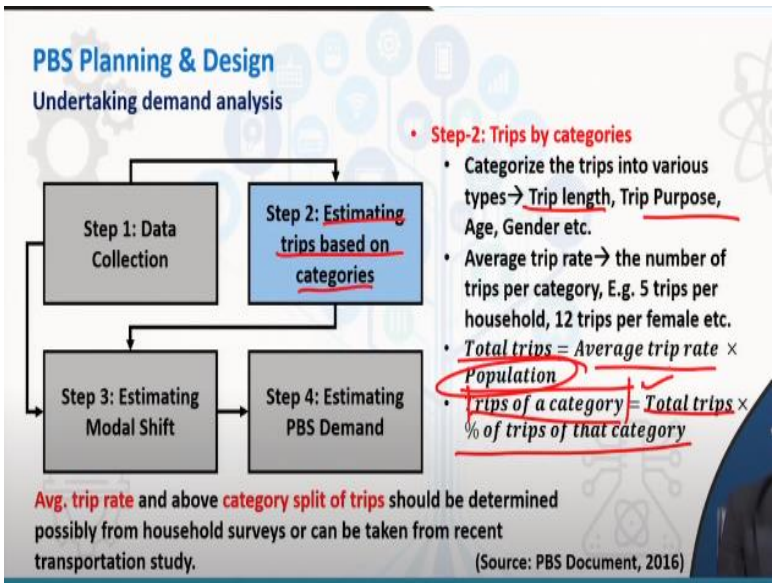

So the first step in order to understand or plan and design for a PBS system is to know what the demand for these PBS systems is. So if your city want to design or develop a public bicycle sharing system, you would want to know how many people are out there in your city, who would actually want to use this. For that you have to collect some data. Data is usually collected by sampling certain number of people in in your city's population. That sample to those people you can hand out questionnaire surveys, asking them where do you want to use them? For how long do you want to use if there is a system that is available, public bicycle system that is available? What are the different purposes for which you use this system? So different questions could be asked through which you would be able to gauge or estimate how much demand there is for the system. You can either do household travel surveys as well or intercept

surveys on streets as well. You the next step after data collection would be to estimate the trips based on different categories. So based on different trip lengths for different purpose how many trips will people make. So for example, the total trips will be equal to the average trip rate times the population. For example trips for a certain category. So work related trips will be given by the total trips that you would make. So in a day maybe you make five trips. So five trips a day times the percentage of trips in that category meaning, how many percentage of trips are you or you as a society making. So if you know the percentage of work trips that are being made, and you also know how many total number of trips that are being made, and if you multiply it, that is a very simple way of understanding how many trips per category you can make. So it is essential to know these things because you know, there is an issues in public bicycle sharing system in the redistribution of the bicycles. So in the morning, suddenly if everybody takes their users PBS, and wants to access the metro station. All of the cycles will now be at a docking station around the metro station, and none of these bicycles will be there in the neighborhoods. So anybody else who wants to use it in the morning, may not find a bicycle there. So that is why you want to know for which trip purpose you want to use it. So the minute you know that there is a big demand for what trip purposes, after the work time is done, you would then want those bicycles to be redistributed back into the all the other docking stations. So that is why you want to know it.

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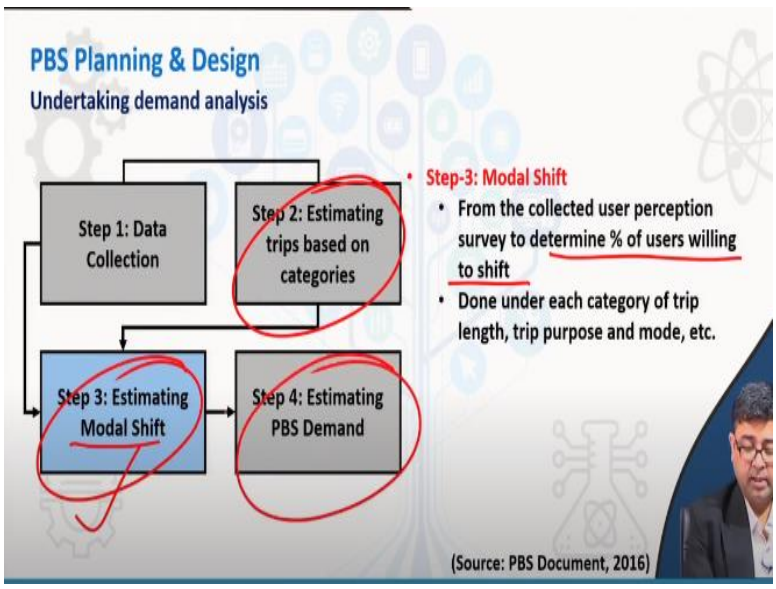

Then you want to know how many percentage of people are actually willing to shift to public bicycle sharing system for the amount of money that you are going to charge. It

is all well to know that okay, there are ‘n’ number of work trips that happen. And out of those total proportion of trips these many trips are work trips. This many trips are leisure trips. That is all well and good. But you also have to know for different amounts of money that you are going to charge. How many people are actually willing to pay for that? Making the system free means that that is the best way to have a system, but it has to be self-sustained. So it should not depend on subsidy from the government for example. So you have to always charge some amount of money. Otherwise it cannot be self-sustainable. People usually cross subsidize it and bring money from some other transport modes, revenues and invested in public bicycle sharing system, that is another way of doing it. But let us for simplicity sake say that they are going to charge for your PBS system. And so for different levels of charging for example, if you have 10 rupees per half an hour, how many percentage of people would be willing to use your bicycle sharing system versus if you just charge one rupee for half an hour. So if 10 rupees versus one rupee for half an hour, what is the difference in the percentage of people that are willing to use your system. Again after you know the trips based on different types of categories, you have to know how many people are willing to shift from different modes for different amounts of money that you are going to charge. Modal shift meaning they may be now taking auto rickshaw, but suddenly the price is a very competitive price with to an auto rickshaw. Maybe they will shift from an auto rickshaw and come to using a public bicycle sharing system. So what is their demand as well? It does not always have to be shift from some other mode. It can be latent demand that is there in the system and now you are provided a new mode. So people may want to come and use that mode as well. So you want to know how many such people are there. Based on all that you will get a demand for the entire system.

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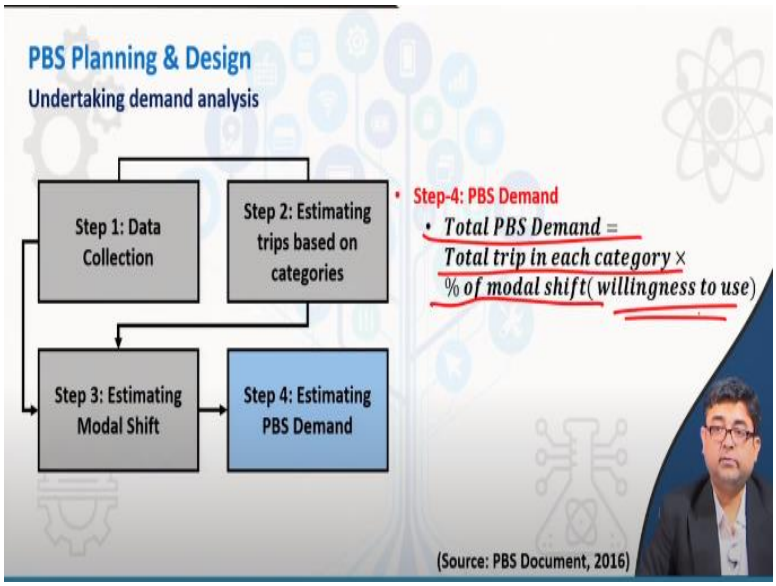

The total PBS demand will be then total trips in each category times the percentage of modal shift or willingness to use. Now once you know that you can plan and design these things. These are not operational level details that you are getting into, there is nothing in place for your city, yet. So you want to plan something. So these are all planning level analysis that are that we are looking at.

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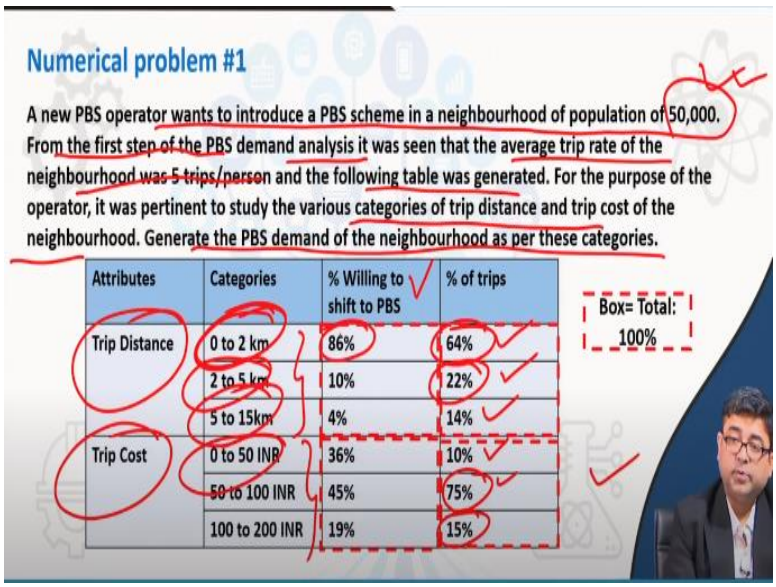

So say for example, a new PBS operator wants to introduce a PBS scheme in a neighborhood of population 50,000. So there is a neighborhood 50,000 population. From the first step of the PBS demand analysis, it was seen that the average trip rate of the neighborhood was five trips per person. So in this neighborhood, every person on an average makes five trips per day. That is what the average trip rate that was

noticed. And the following table was generated. For the purpose of the operator it was pertinent to study the various trip categories of trip distance and trip cost of the neighborhood. Now generate the PBS demand of the neighborhood as per these categories. The operator said that the trip categories that the categories that I want to classify the data is based on trip distance and trip cost. So he designed three different categories for trip distance and three different categories for trip cost this was the table based on the questionnaire survey that he had designed. So what he found out was out of the 50,000 trips that are out there 64% of the trips made are within 0 to 2 kilometers. 22% of the trips made are between 2 to 5 kilometers. 14% the trips that they make are between 5 to 15 kilometers. Similarly, he wanted to see how much do they pay? The trip cost is 0 to 50 INR. 10% the trips are within 50 rupees. 75% are within 100 rupees. Whereas, between 100 to 200 there are only 15% of the trips. So he has got all that data and he has also got the willingness to shift to PBS data. Now that he knows that 64% of the trips are between 0 to 2 kilometers they say that 86% of such people say that they will shift to PBS if the distance is between 0 to 2 kilometers. (refer time: 17:56)

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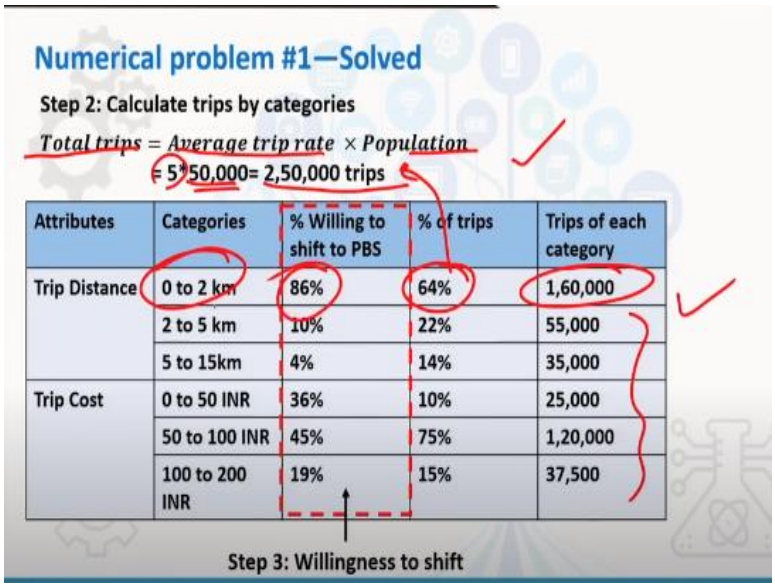

Once he gets all of this, how do you calculate it? So now you know that the total trips are average trip rate times population. The average trip rate is 5 trips per person. The population is 50. So 2, 50,000 total trips are coming out of that neighborhood. If 250,000 trips are coming out of that neighborhood, and if you know that 64% of those trips are between 0 to 2 kilometers. So if you just do 64% times 2, 50,000 you will get

this value. Similarly, you will get all of those other values. Now you know the trips in each category, and you know how many of them are willing to shift.

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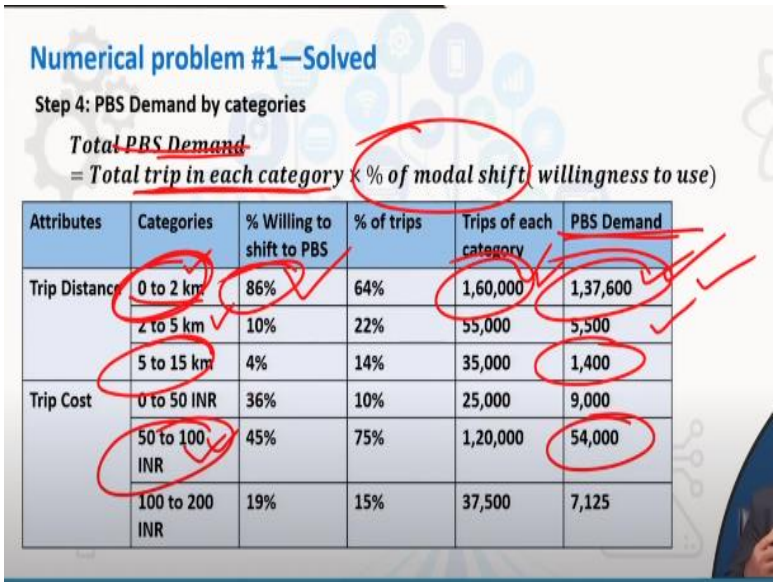

Attributes	Categories	% Willing to shift to PBS	% of trips	Trips of each category	PBS Demand
Trip Distance	0 to 2 km	86%	64%	1,60,000	1,37,600
	2 to 5 km	10%	22%	55,000	5,500
	5 to 15 km	4%	14%	35,000	1,400
Trip Cost	0 to 50 INR	36%	10%	25,000	9,000
	50 to 100 INR	45%	75%	1,20,000	54,000
	100 to 200 INR	19%	15%	37,500	7,125

Then all you do is you multiply the 1,60,000 with the 86% and then you get the PBS demand for each of these categories. So the total trips in each category, so this in 0 to 2 kilometers category the total trips are 1,60,000 and the percentage of modal shift is 86%. So it is 1,60,000 times 86 you get this as your PBS demand. So now you know that if you put in a system PBS system in your city, the number of most likely the number of trips between 0 to 2 kilometers is going to be 1,37,000 trips. So that is going to be the majority of the trips that is going to happen. So you would say this is what I need to focus on. I need to focus on the very short trips in my neighborhood. So then you can think about where to put in your docking stations, how to distribute your docking station locations? Which are the ideal locations based on the distances that are very short? If you go more than 15 kilometers, there will be only 1400 people that are going to use it. So you are maybe not targeting that population at all. You are targeting majorly 0 to 2 kilometers and a little bit of 2 to 5 kilometers as well. And based on cost, you are also seeing that anywhere between 50 to 100 rupees, there is a demand of 54,000 people. So up to 5 kilometers, if you charge 100 rupees that means, you get a rate for 1 kilometer. And based on that, you can charge based on number of minutes. So you can do all your calculations for your planning level design of your PBS system, right. So this gives you an idea of how public bicycle sharing system is planned and designed.

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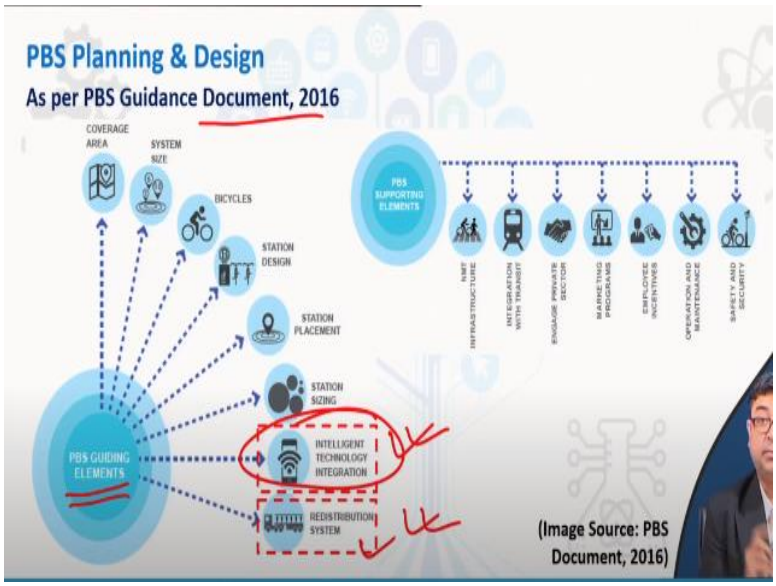

Now when you look at the guidance document, what it also tells you that some of the of the different guiding elements that are there in a public bicycle sharing system, ITS in technology integration and redistribution system are very, important. So we have already discussed about redistribution systems. Now let us look at the focus of our topic, ITS. So how does intelligent technology integration help your PBS systems, right.

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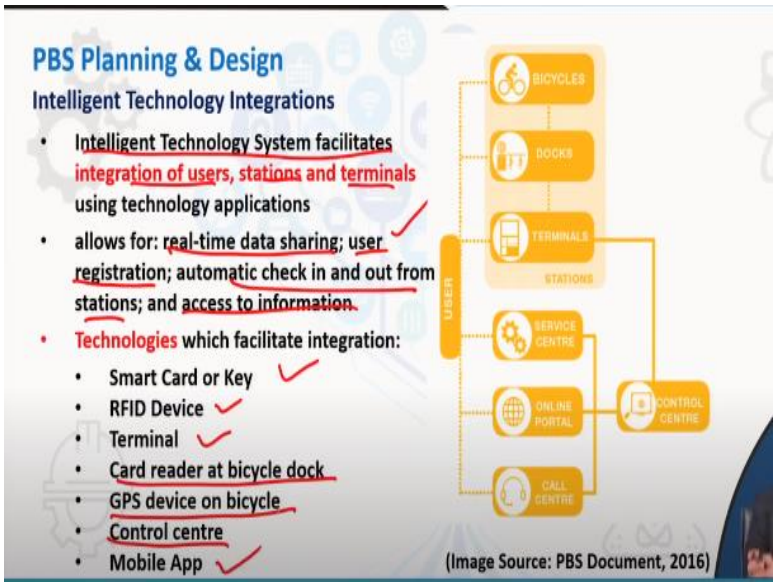

Intelligent technology systems facilitate integration of user stations and terminals. In this case, you have three entities that you have to integrate. The user who is trying to use the bicycle sharing system. The stations from where he or she will be taking the bicycle to and from. The stations meaning usually the origins and destinations and the

terminals are actually the dockless. Or if they are dockless then that is one less thing that you have to worry about. But if you have particular docking stations, then they have to communicate between the stations, the users, as well as the terminals. So it allows for real time data sharing. With GPS transponders now, you can real time track where the bicycles are. Users are already registered. So you can you can automatically charge them if they go beyond how much they had registered up for. So for example, when I started to use, I said that I wanted for 30 minutes. But while I started using it, one thing came after the other. So I kept it for one hour. But now that I am already registered user, and the system knows about my bank information. So when I put it back after one hour, it can automatically charge me for the extra hour as well. And you can do automatic check in and check out at the stations because you can remotely say, okay I am going to come and pick up a bicycle at station A at 9:30am. So you just show up at the station and the bicycle may be already reserved for you. And then you can just take it out from there and go on your way. Of course you have access to informations. So the technologies that are used here are smart cards or smart keys. You do not have to have a physical key to unlock it. You just need to have an RFID code or an RFID tag most likely to just open it or even you can remotely open it through, an app or something like that. A terminal with a docking station that docks the bicycle, so that also has to be automatically locked and unlocked. Based on it there is a card reader at the bicycle dock, GPS device on the bicycle. Obviously, there is a control center that is monitoring all of this TMC for example, and also a mobile app.

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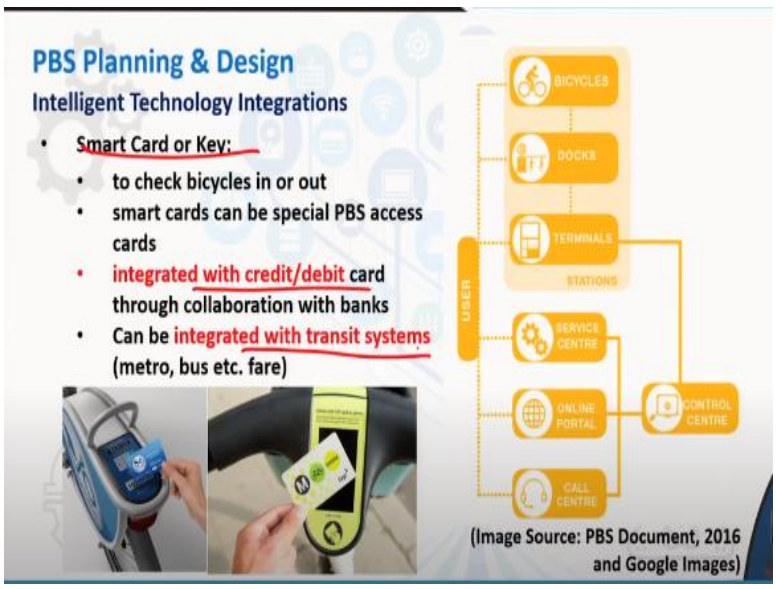

These are some of the examples of how various smart cards or keys looks like. These are all images taken from different parts of the world and are some are Indian as well. So you have such cards that you can either punch in a code or you can just tap it and you can unlock the bicycle and take it for use. These are integrated with your credit or debit cards and sometimes are also integrated with your public transport system in the in the city. A Metro Card or something can also be used here. So this is how usually you unlock and start using the bicycles.

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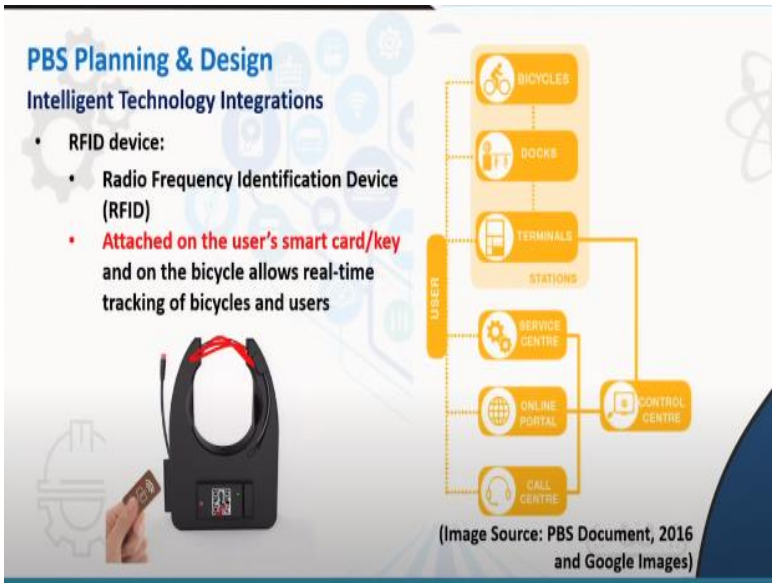

Nowadays, you are also getting RFID locks. So these are smart locks on the bicycle. These are the locks on the bicycle, and you just tap your RFID tag, and it unlocks and then you can take it. You can just have dock less stations, but have smart locks on the bicycles.

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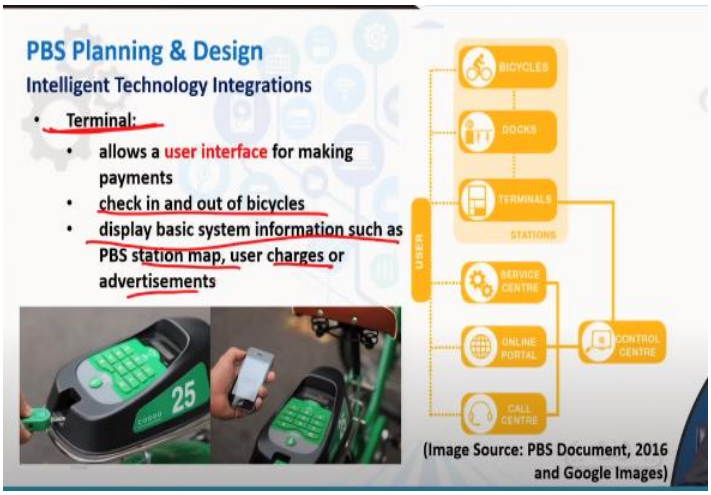

The other place where you have to integrate is the terminal itself. It allows to check in and check out, of bicycles. So one has to know, if I am a user, I have to know that this terminal has two or three bicycles available for me. Only then I would walk towards it or go towards it or then I would go towards the other direction where other terminals have bicycles available. So these terminals also have to be smart. They have to have some display information such as map, station map or user charges and also space for advertisement. So you might have encountered many of these around for example, metro stations or around certain transportation hubs. Also large malls nowadays, are having these terminals.

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And now the latest generation bikes also have GPS tags associated with them that allows for real time monitoring. This this really helps in reducing theft as well. So when at night, maybe it is a dock less system. You have taken the bike from the metro station to your house, but you have just parked it outside your house. Now through the GPS transponder, everybody knows where it is. When it comes to redistribution, then tomorrow, the operator or carrier can come in and collect the bike from front of your house.

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Of course, there will be a TMC, Traffic Management Center or in this case a public bicycle sharing system management center, which does all the data crunching and data analysis behind the scenes. This especially is needed because it helps in redistribution of the bicycles. It can see using the GPS tags where most of the bicycles currently are. And maybe based on the time of the day, it has to take a certain call that these bicycles have to be put in other locations.

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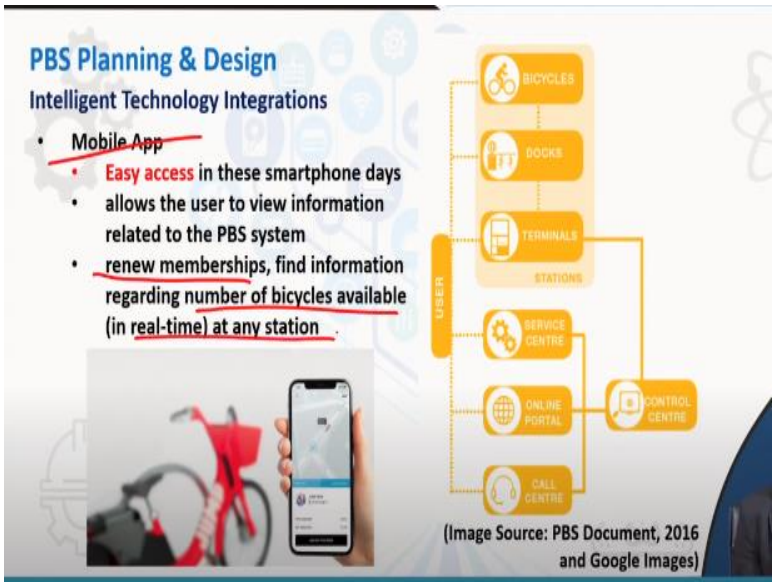

Then they can easily instruct the operators to move it to a different location. In the era of mobile apps that can be easily used to the new membership. Find information regarding number of bicycles available in real time at any station. So this remotely, you can start planning for your PBS trip as well.

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Redistribution, as you see, this is a major operating cost that goes into any kind of PBS system because this requires manual shifting of your bicycles from different terminals, or maybe one terminal to different terminals. Because otherwise, there will be a scarcity of bicycles at some terminals. And this may lead to an inefficient system.

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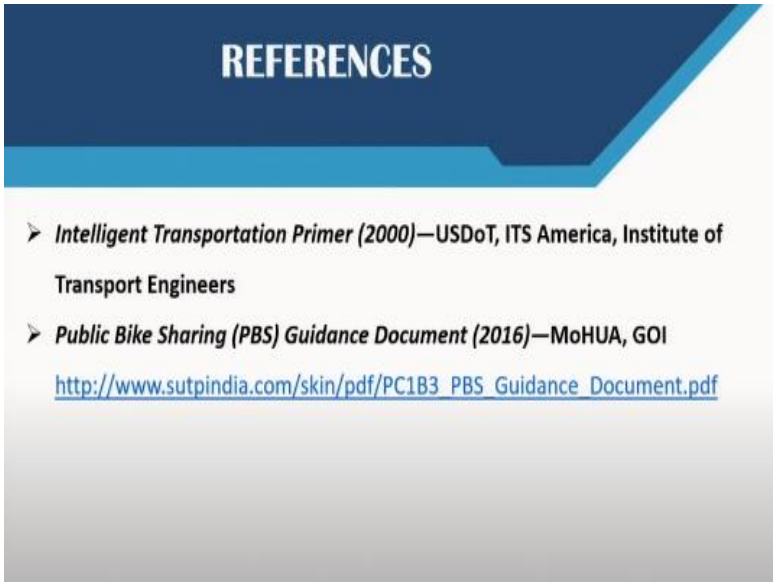

So that also brings us to the end of this five lecture series or this week of lectures on ITS. Hopefully you have enjoyed listening to the ITS. Many of you might be looking at an ICT type of interface with transportation for the first time. So hopefully, you are you are enthused by this new area in transportation, and you will take it up with much more rigor later on. So hope you enjoyed this week's lecture series.

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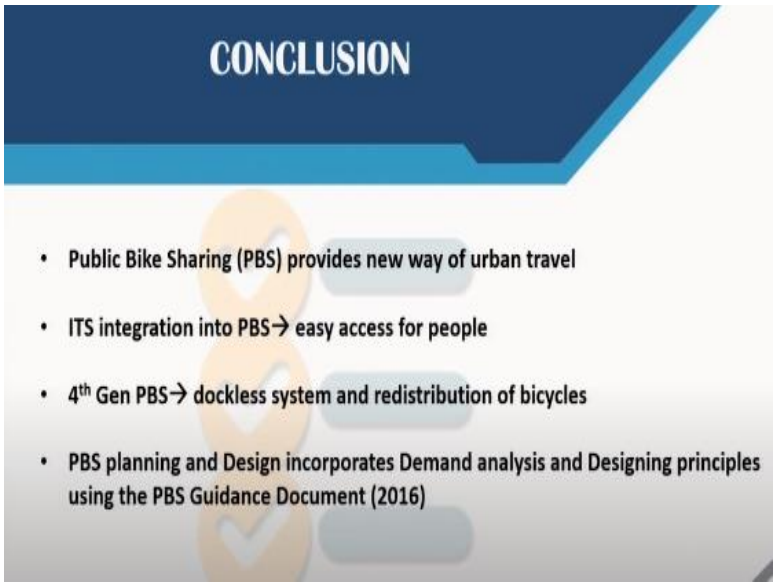

Just in conclusion, in this lecture what we looked at is the public bicycle sharing system and how can it help grow in your city. You can now use ICT to plan for your PBS trips along with your other public transportation trips as well because there can be an integrated smart card that will allow you to use to both the PBS as well as the public transportation systems. Thank you very much for your attention.