Introduction to Multimodal Urban Transportation System

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Lecture-23
Non-Motorized Transportation (NMT) Planning: Data Collection and Analysis in NMT Planning

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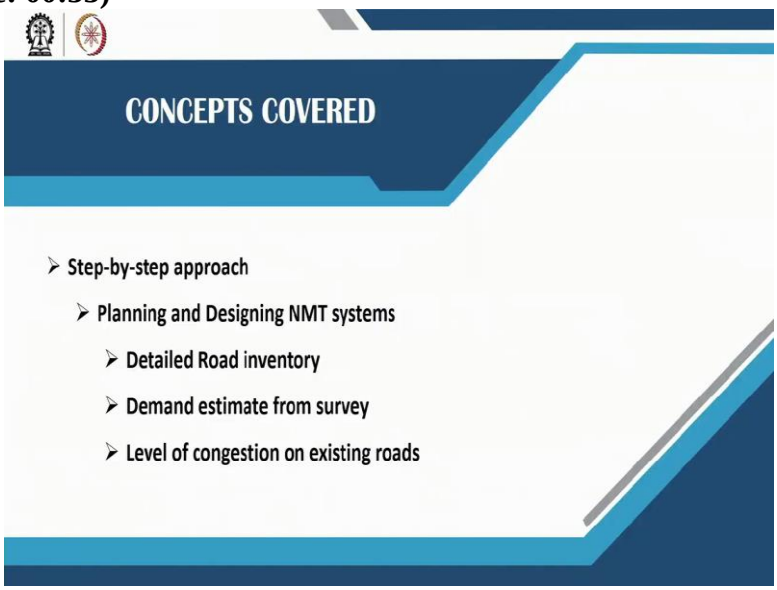

Hello friends and welcome back. We have looked so far at the first step of the 5 steps involved in non-motorised transportation planning. In this lecture, we will begin with working on the second step which is planning and designing of NMT systems and within that we will be looking at how to develop a detailed road inventory, how to conduct surveys in order to determine the demand for NMT systems and how to measure the existing level of congestion along the roads. This will determine the need for non motorised transportation and levels of motorised congestion on existing roads.

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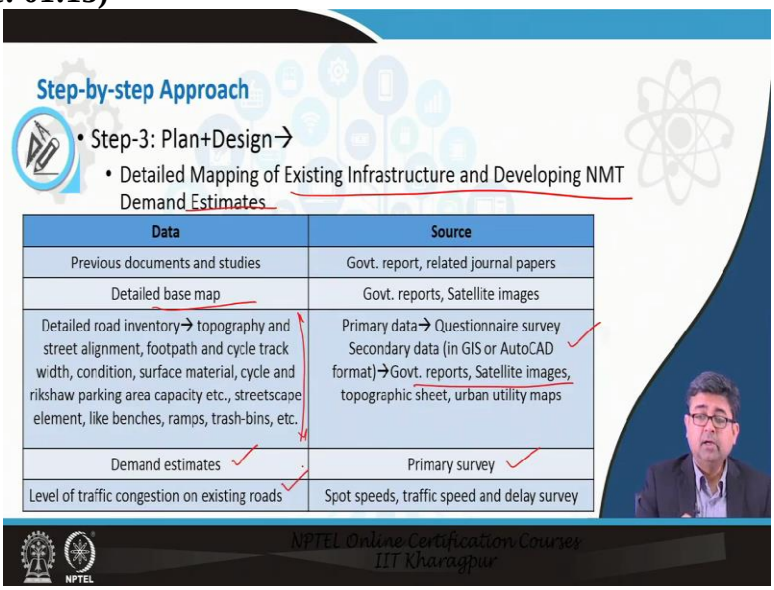

So, the first step in planning and designing is to develop a detailed map of existing infrastructure and also developing the demand estimate for NMT. We have to looked at how to map existing infrastructure already, based on different types of data that may be available in your CDPs and CMPs. Now, using that data, we have to determine the demand for non motorised transportation. The demand for non motorised transportation meaning how many people would want to choose the different types of non motorised modes for their different trips that they make during the day or night. So, you have options to choose different types of modes in your city when you can go from point A to point B; either using your car, or your two wheeler, or public transportation modes, intermediate public transportation modes, such as autorikshaws or also some non motorised modes such as bicycle, walking, etc.. Some cities also have cycle rikshaws. But you have to estimate how many people would want to probably use these non motorised modes. So, in order to know that, you have to estimate the demand for that and more or less people do conduct primary surveys in order to estimate that demand. Along with estimating the demand, you also have to have detailed maps of the infrastructure that is available in your cities, they can be obtained from different types of primary surveys or existing government reports. Satellite imagery is becoming much more widely used in India currently, with our growing information that is available from ISRO satellites, we are able to more clearly see what the urban infrastructure that is available. As the resolution becomes clearer and more and more pointed, we are able to even just look at a Google Earth image to understand how wide a road is or how wide a sidewalk is and for what distance is the sidewalk present along the road.

So we can get a lot of data from satellite images currently. For understanding the different levels of traffic congestion, we usually do spot speed studies or delay survey studies. This is essential to understand because once the congestion on the road grows; it is usually an indicator that non-motorised transportation use is less or there is a latent demand for non-motorised transportation maybe because we are already oversaturated by motorized modes. Hence, non-motorised modes has to be brought into the system. So, that is a kind of indication of when do we need non-motorised modes.

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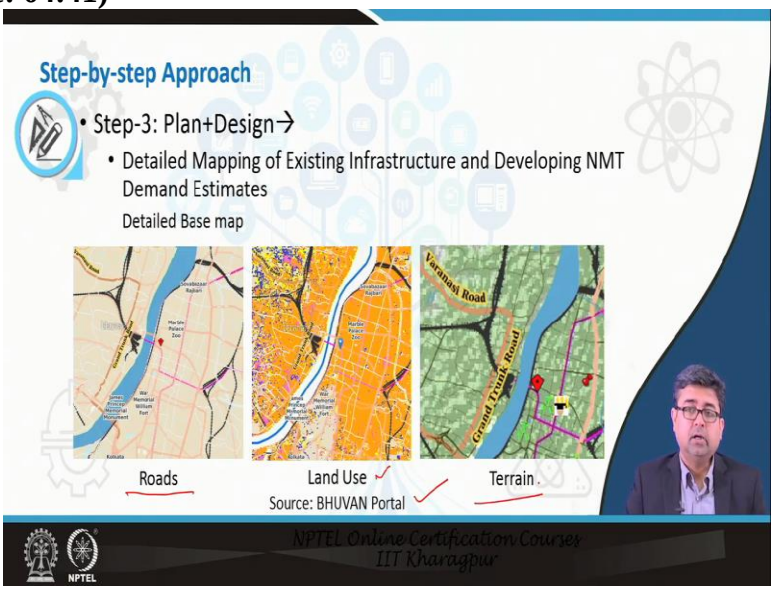

This is an example of different maps that can be produced using satellite imagery. This is available at the Bhuvan portal. So, you would see that you can identify what are the roads that are available in your area; you can understand the land use that is available. The land use is in different colors here, the orange color, the different purple colors, small yellow colors. So that gives you the different land uses. Also you can understand what kind of terrain you are in. So all of these are now very readily available from the different portals that are usually handled by ISRO or some other agencies like that.

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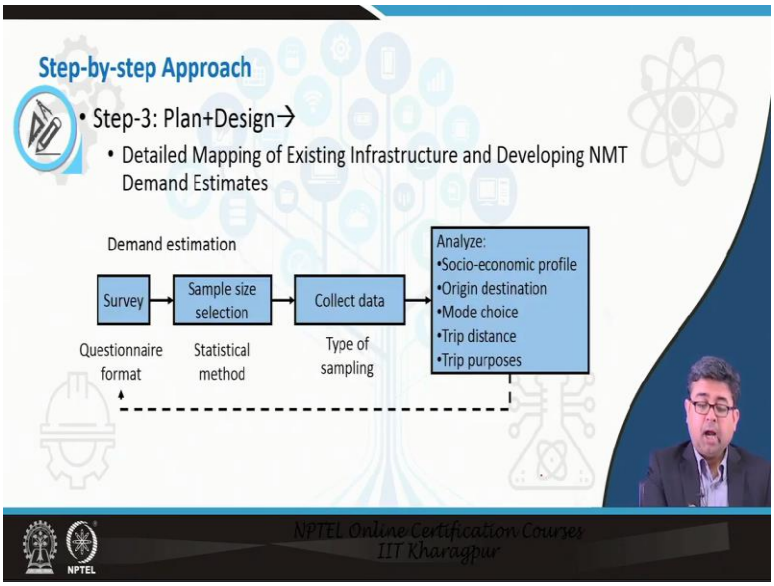

Next in order to understand how to develop demand estimation for non motorised transport, usually 4 steps are carried out. You have to conduct a survey. This is a primary questionnaire based survey that people usually conduct on a sample of your population that is in the city. You cannot go and ask every person in your city about an opinion that will take a long time and would be unnecessary also. How to determine the sampling? What are the different sampling techniques? We will be letting you know shortly, and using that data that you collect in the survey, you then have to develop answers to these questions as to what are the basic origins and destinations between which people are likely to use non motorised modes of transport, which non motorised mode of transport are they likely to use? Are they likely to walk or are they likely to use bicycles? What are the trip distances that can be obtained from the origin destination maps and for what different trip purposes, are they going to use it? Are they going to use it to go to work? Are they going to use it for leisure purposes? Are they going to use it for exercise? What the daily chores are? What the different purposes are? So, a questionnaire survey usually is used on a sample population of your city. So remember there are different scales of having non-motorised transportation projects. So if the scale of the project is a city, then you have to develop a sample for the entire city. If the scale of the project is just a street, then all you have to find out is how many people live alongside that street and you have to sample only a few people along that street.

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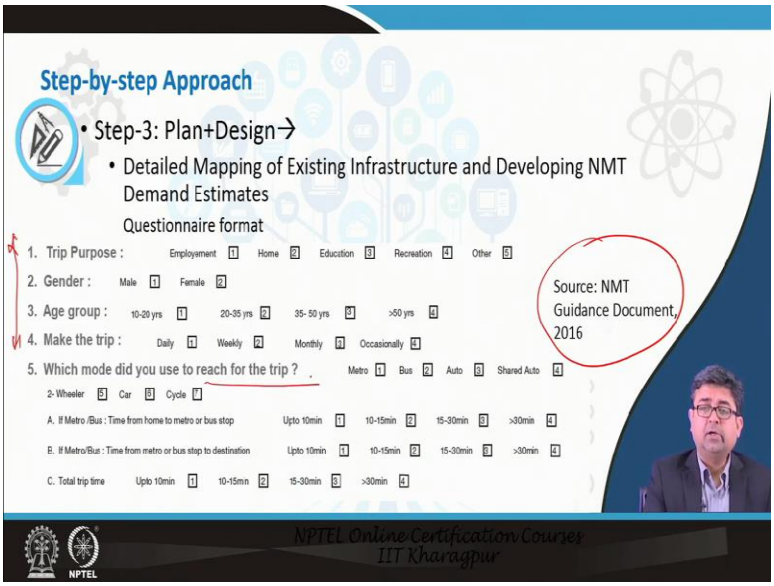

So, here is an example of a survey questionnaire that is usually used. Again all of this is available in the guidance document from which all of the material has been taken. The survey questionnaire has different types of questions. Questions about the demographics of the area, questions about which mode did you use different particular trips? When do you if you use particular mode? What is the travel time that it took on that mode? So, these are various quantitative levels that are asked. At the same time, there are different qualitative questions that are asked such as what is the quality of walking facilities?

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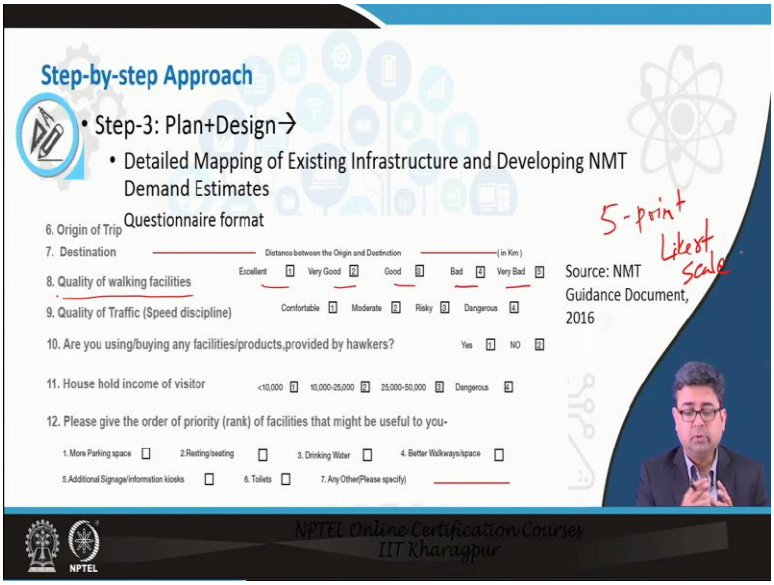

Do you think it is excellent, very good, good, bad or very bad? This is a 5-point scale, it is usually called a 5-point Likert scale. So, these are the type of questions that are asked usually in a questionnaire that is used to determine the demand for non motorised transportation modes. They are both qualitative and quantitative in nature, which is an essential part to remember. If it is highly qualitative in nature, then it is difficult to infer what type of facility and where those facilities would be needed. And if it is purely quantitative in nature, then you do not understand the perception of the people as well who are going to use it. So, it is very important to merge both qualitative and quantitative questions.

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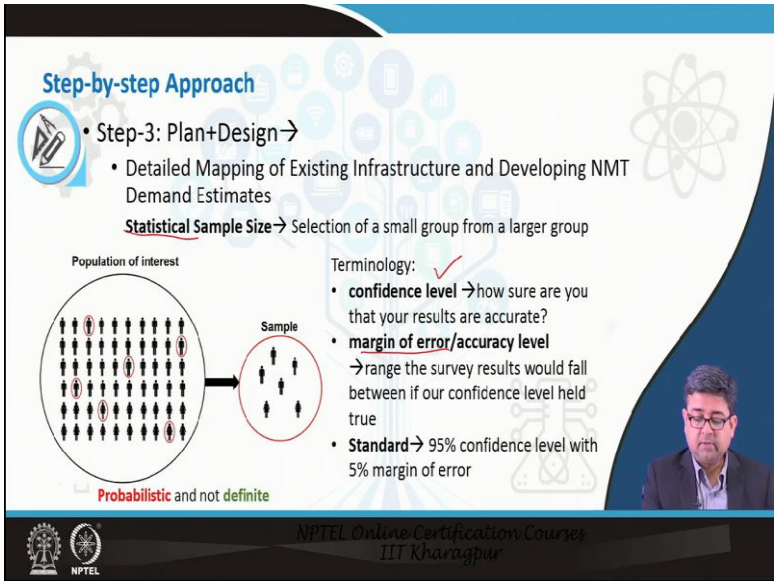

How do you determine the sample size? What do we mean when we say sampling? These are a sample from a population which always has a statistically significant sample size. So, if you use statistical formulas that will tell you that if your population sizes is ‘n’ you may have to only collect 0.01% of ‘n’ in order to be having a sample size that is representative of your entire population. So, the idea is to sample or ask ‘n’ number of people in your city or in your area who are representative of your entire city or area. If your city’s population is 1 million, you cannot go ahead and ask all the 1 million people about what type of transportation do you want to use? Do you like the quality of the NMT infrastructure available? So, you would only ask a few selected samples and that is what we are telling to we are trying to explain how to develop a sample from a population.

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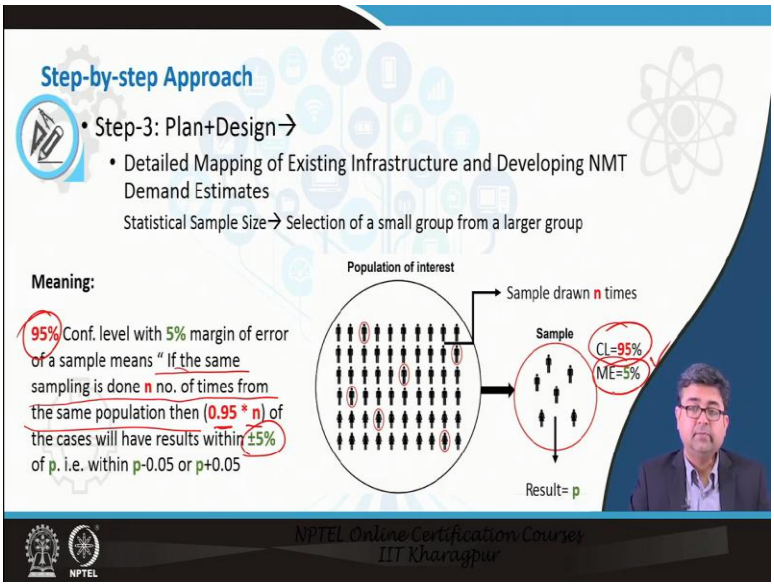

So, usually the confidence levels used is 95% and the margin of error is 5%. So, what that essentially means is that, if the same sampling is done "n" number of times from the same population, then 0.95 times "n" of the cases will have result which is within plus or minus 5% of your answer.

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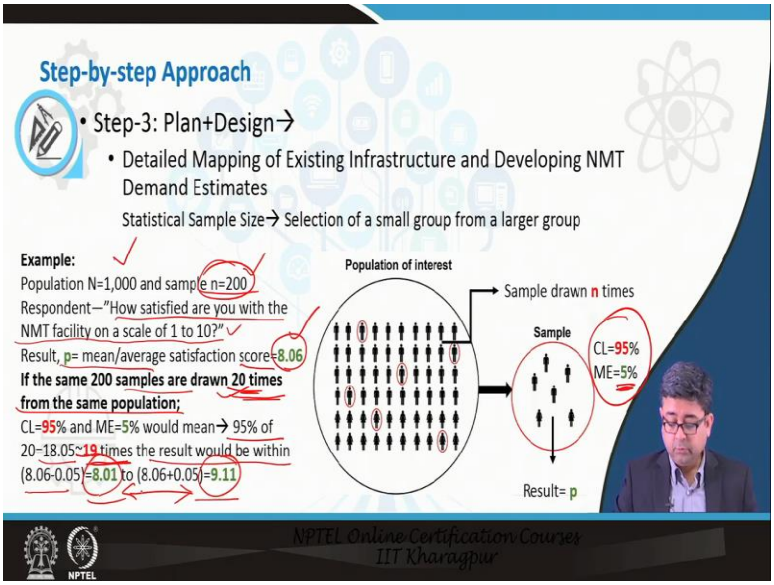

So, for example, if the population size is 1000 and if you want to know whether if you have collected data for 200 samples only, how satisfied are you? And the question asked was how satisfied are you with the NMT facility on a scale of 1 to 10? So, you asked this question to 200 people, however, your total population was 1000. And the answer, the mean satisfaction score

came out to be 8.06 on a scale of 1 to 10. Now, if the 200 samples were drawn 20 times from the same population, maybe there are different, maybe they are same, but they are drawn 20 times then what this 95% and 5% says that, it means that 95% of 20 which is 18.05 or say approximately 19 out of 20 times the result would be within plus or minus 5 of your mean value. So, the answer will be between 8.01 and 8.11 *(correction: 8.11 instead of 9.11 on slide).* You are confident that the answer is 19 out of the 20 times lies between these two values. So, since we are using probabilistic ways, whenever we are saying that you develop an estimate, it means the probability, it is not deterministic. Deterministic means we are determining exact number, who will use non motorised transportation. Exact numbers are difficult to determine because of the population size and the variability in the population. Hence, we develop estimates and it is imperative that the estimates are close enough to reality. So, they have to be calibrated and validated such that they can then be used to develop or implement these NMT systems.

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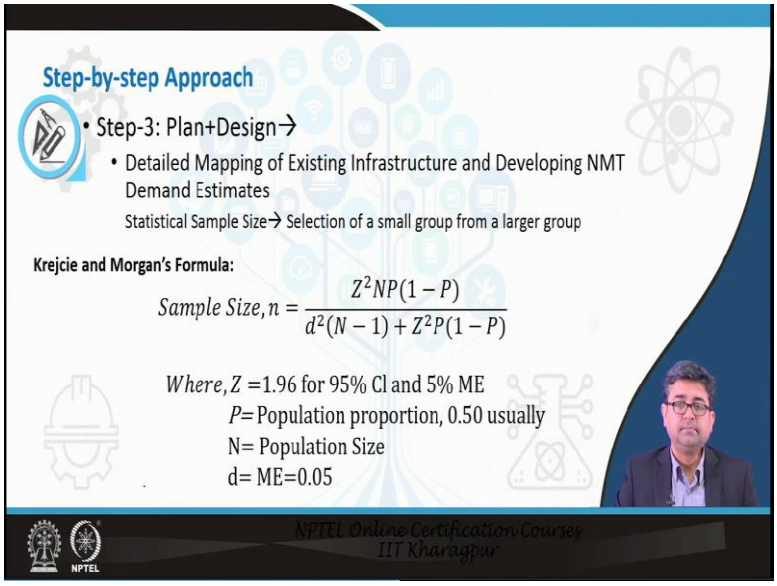

There are statistical formulas that will tell you how to develop the sample sizes. So, if you go back to this example, in order to know how we arrive at 200 for a population of 1000. This is a formula that can be used. You can easily follow the formula,

$$\frac{Z^2NP(1-P)}{d^2(N-1)+Z^2P(1-P)}$$

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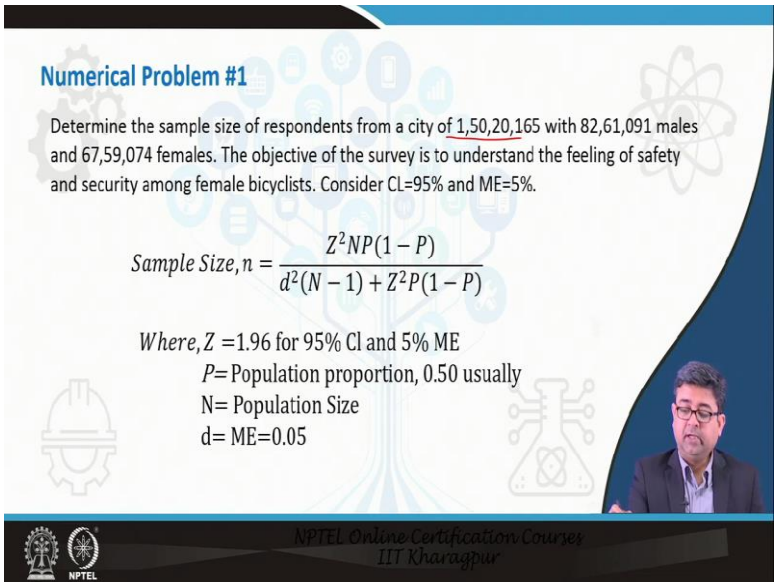

This is an example problem. That we have shown in a city that has a population of 15 million, over 8 million are males and over 6 and a half million females. The objective there was a survey conducted to understand the feeling of safety and security among female bicyclists. So the objective was to find safety and security amongst female bicyclists. So if you 6 and a half million or more females, then you want to know what is the sample size, or how many females should be contacted for the survey so that we have a result that is representative of the entire population, or in this case the population is 6 and a half million.

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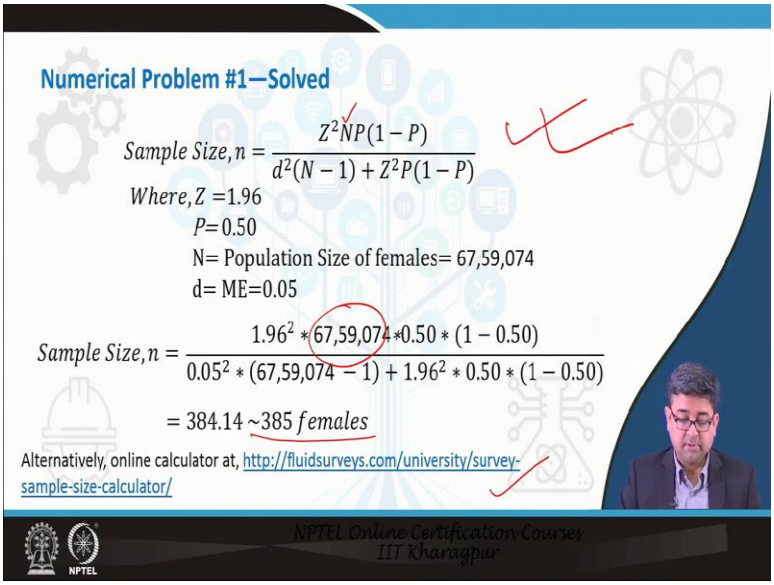

So if you go ahead and use this formula, here is the population size N. And if you use the formula, you would get that the answer is 385 females. So you see out of a population of more than 6 and a half million females if you just sample (randomly) 385 females, you would get a fair representation of what all the females in your city or area want or feel about the safety of bicycling. So, that is an example of how you find out a sample size. There are different calculators that are available that you can just put in the population size and they will give you the sample size. They usually use this formula or any variant of this formula to determine the sample size.

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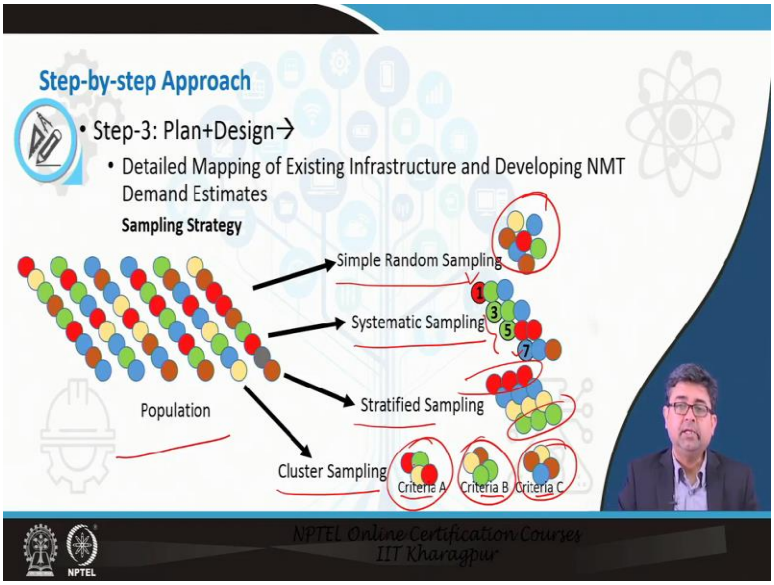

Now, what should be your sampling strategy? We found out in this previous example that we wanted to know about female bicyclist safety and security. So your sampling strategy should also be dependent upon who you are trying to ask the question to. There are different types of sampling strategies. So if this is your entire population, you can either do a simple random sampling, you can just pick any number of marbles from there that is simply random sampling, or you can do some systematic sampling. You can also do 1 red, 2 green, 1 blue, some kind of a systematic sampling. You can do different stratified sampling. In that case, I will take 3 red, 3 green, so on and so forth. And then you can do some cluster sampling. So, the cluster samplings are, if you have certain criteria by which you can break up this population and 2 different clusters. So, there are 3 different criteria used here and that will tell you how many samples you need from each cluster.

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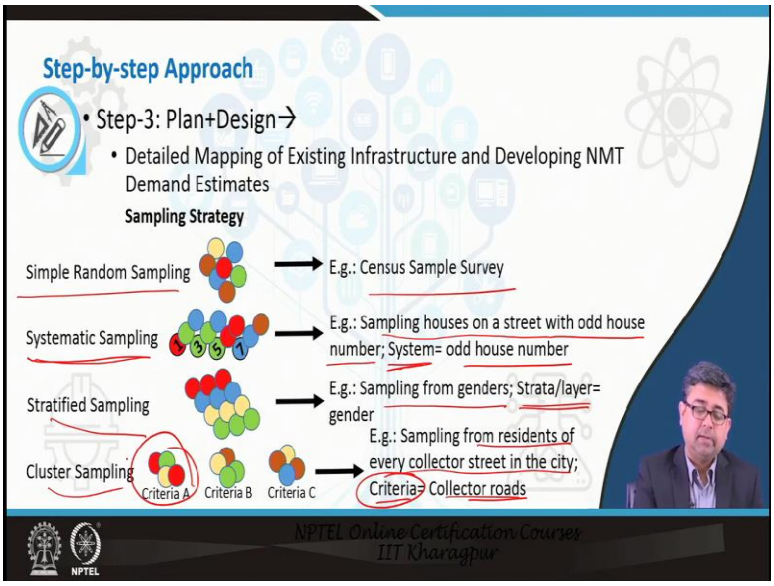

So, for example, census sample surveys. If you ask this question in a census, census is a simple random sampling. When we do a census every 10 years, it is a simple random sampling. Whereas, say if you want to do a systematic sampling, what is systematic sampling here? You want to sample houses on a street with odd house number. Every house has a number, so you only want to sample on the in the houses that have odd house numbers. So that is the system, with odd house number, if you are doing a systematic sampling. Stratified sampling again, sampling for genders. So if you want only want to do female, so that that is a strata or a layer. Then cluster sampling, sampling from residents of every collector street in the city. So that is a criterion. The criterion is collector roads. So if you want to know all the residents who live along collector roads, that is the type of road, so that becomes a criteria and you use different clusters. So, that is an example of different types of sampling strategies.

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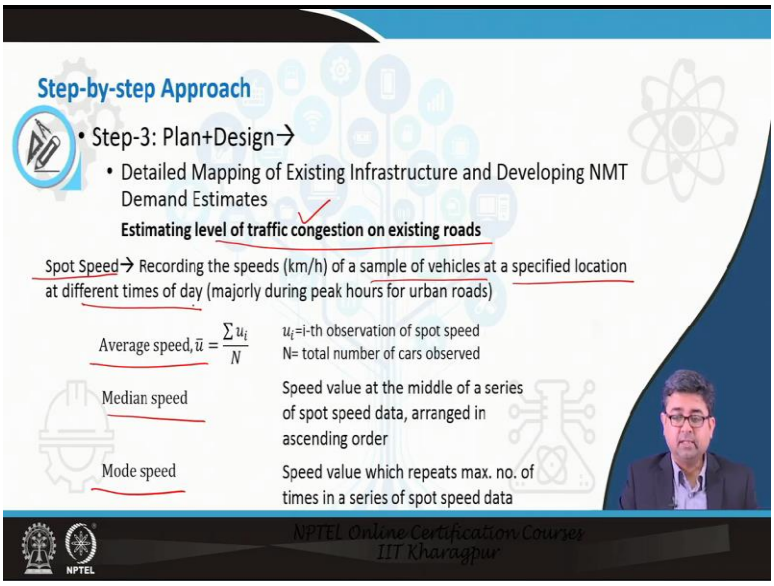

Now, remember, in the second step we wanted to know what is the level of traffic congestion on the existing roads? Unless you know the level of traffic congestion, meaning motorized traffic congestion, you would not understand the need for non motorised transport, and only then you can understand the demand for non motorised transport. So, traffic congestion usually is measured by different types of speeds on your roads. If you say the speeds are low, that means, it is usually an indication that the there is a lot of congestion, travel time is large, speed is low. So, here we are telling about speed, so usually what we do is something called spot speed studies. We record the speeds of a sample of vehicles at a specified location at different times of day, if you do that, then you would know different times of day what is the congestion level by measuring the average speeds and that will give you an idea of how congested that road is. And that will in turn tell you maybe there is a need for decongesting or having more non motorised facilities on that road.

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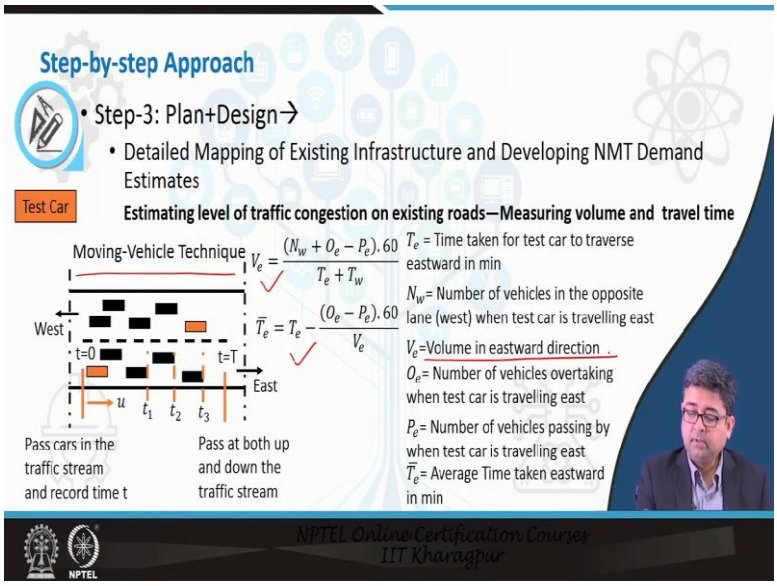

So, the technique used is called a moving vehicle technique. What is the average speed moving vehicle technique? It is nothing but you drive a vehicle, your test vehicle, in the direction and also in the opposite direction, going at a speed that is very representative of the traffic stream. So you do not drive very fast or not drive very slow. And how do you know whether you are driving too fast or too slow? While driving the car, you have to make sure that you overtake the same number of cars as are overtaking you. If two cars are overtaking you, you too have to overtake two cars. So, that means you are kind of driving at an average speed of that traffic stream. So, it is a very simple experiment you just take your vehicle, drive, make different number of runs between two origins and destination pair. In that you will be able to understand, "What is the average travel time or average travel time on that segment?" So, that is given here using these using these 2 formulas,

$$V_e = \frac{(N_w + O_e - P_e).60}{T_e + T_w} \quad \bar{T}_e = T_e - \frac{(O_e - P_e).60}{V_e}$$

You first have to understand what is the volume in the direction that is V_e and then you will know what is the average time taken in that direction to travel.

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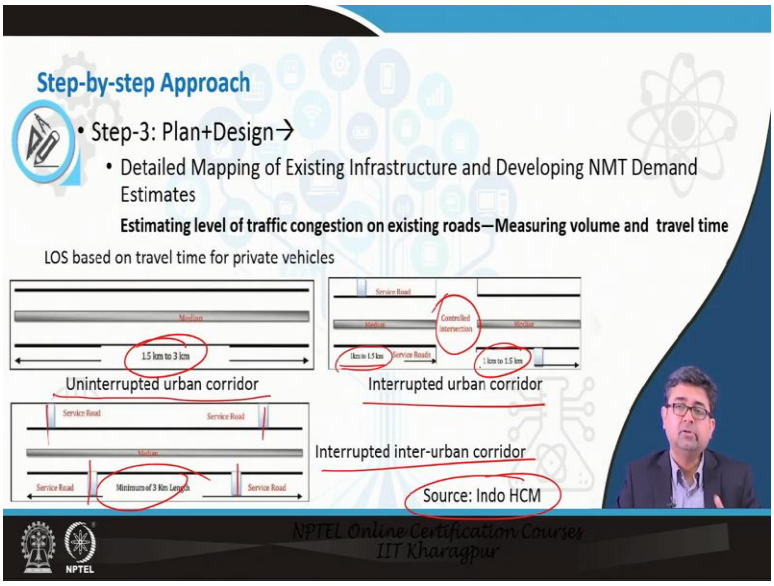

Then you can do this at different types of roads. Also you can do it at road which is usually called an uninterrupted urban corridor. Uninterrupted urban corridor meaning there are no intersections along that road for almost about 1.5 to 3 kilometers. Interrupted urban corridor meaning there is controlled intersection that means there is a signalized intersection for every 1 to 1.5 kilometers. Whereas, an interrupted interval corridor meaning along 3 kilometer stretch there are several number of service roads, access roads, so on and so forth. So, these all are available in the Indo HCM (Indo Highway Capacity Manual). These different classifications of roads are available and you could do a travel time or travel speed study. Remember, we are trying to get an estimate of the congestion along those streets and they should usually mean motorized congestion, and that in turn tells you the need for NMT.

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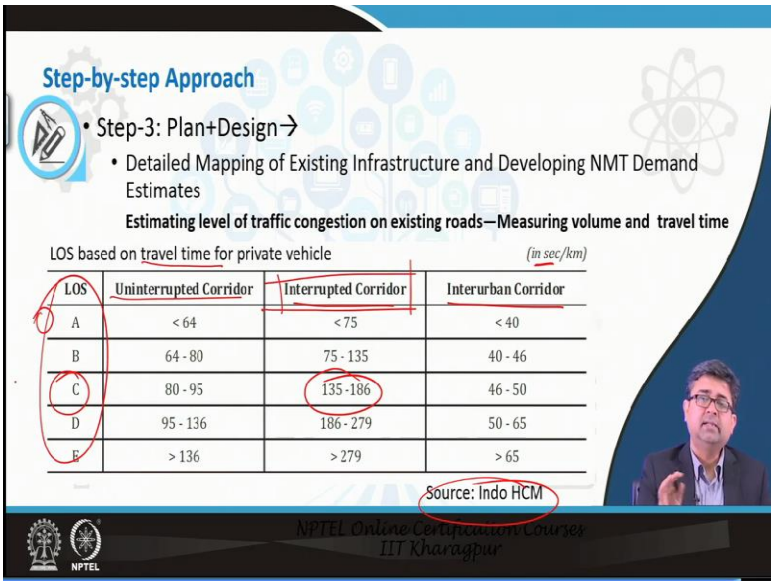

IndoHCM develops a scale for different types of travel time, essentially in seconds per kilometer. So, every kilometer, what is the travel time along these 3 different types of roads, and these are broken up into all these different scales. So, if your travel time along your particular type of street is anywhere between 135 to 186 seconds, every kilometer, then this type of road, then you have an interrupted corridor with a level of service C. What that level of service C means? The congestion is an average level. Level of service A meaning your travel speeds are pretty good. So there is nonexistent congestion or there is no congestion, whereas, level of service E would mean there is heavy condition on your streets.

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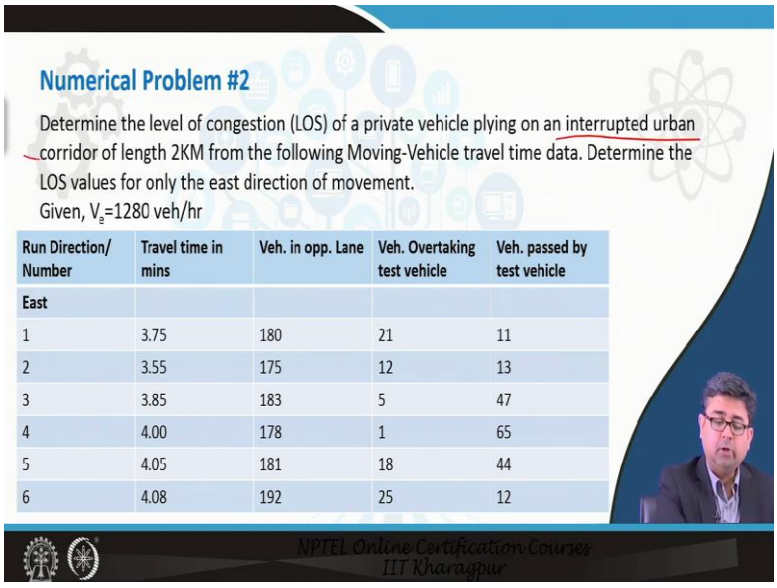

Here, is an example problem to determine the level of service of private vehicles plying on an interrupted urban corridor (that is the type corridor) of length 2 kilometers using the moving vehicle travel time data, determine the level of service only in the east direction of movement. And the volume is, in this case, we have made it simpler we have already given you the volume. So here is an example in the east direction, we have run our test car 6 different times. Thus we have had 6 different travel times on that corridor and every time we have identified the number of vehicles in the opposing lane, the vehicles overtaking the test vehicle and the vehicles passing the test vehicle. In this case, you would see that the driver may not have driven well whereas here, you might have driven very well, because 12 and 13 are very close to each other. So that kind of averages out how you drive your vehicle.

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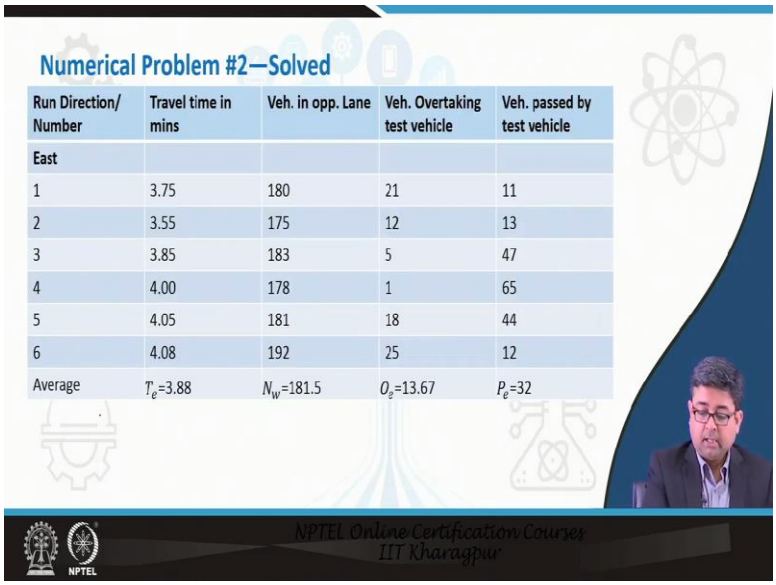

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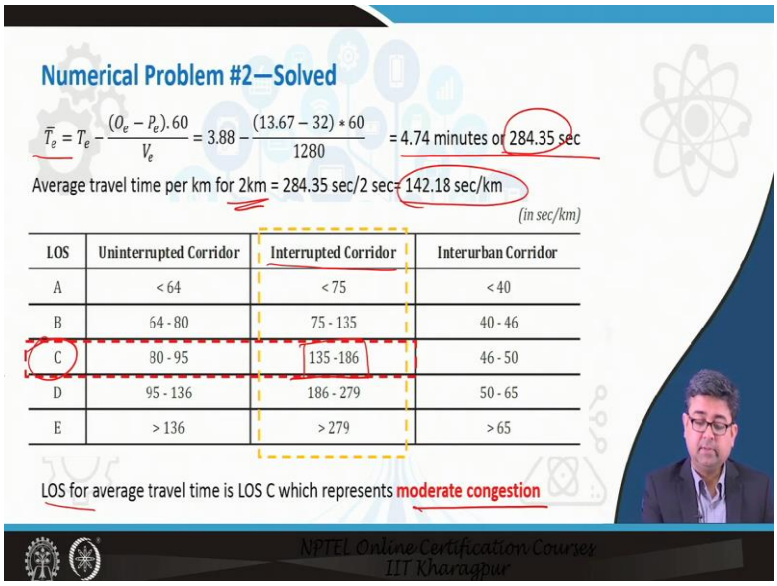

LOS	Uninterrupted Corridor	Interrupted Corridor	Interurban Corridor
A	< 64	< 75	< 40
B	64 - 80	75 - 135	40 - 46
C	80 - 95	135 -186	46 - 50
D	95 - 136	186 - 279	50 - 65
E	> 136	> 279	> 65

All you have to do is you develop an average of each of these, and then using the formula that was given to you earlier, you put it in the formula to determine the average travel time, each of this and you get the average travel time is 4.74 minutes or 284 seconds. Now that 284 seconds was for a 2-kilometer stretch, so for every kilometer, it is a 142 seconds. Now if you go back to your table, and you see where 142 falls, since it is an interrupted corridor and 142 falls here. So your level of service is of moderate congestion C, level of service is C. So, that is how you determine what is the level of congestion along different corridors in your road/ in your roadway network or in your city or area and that in turn tells you the need for non motorised transportation. If the level of service becomes very poor for motorized conditions, then you will have to develop non motorised transportation.

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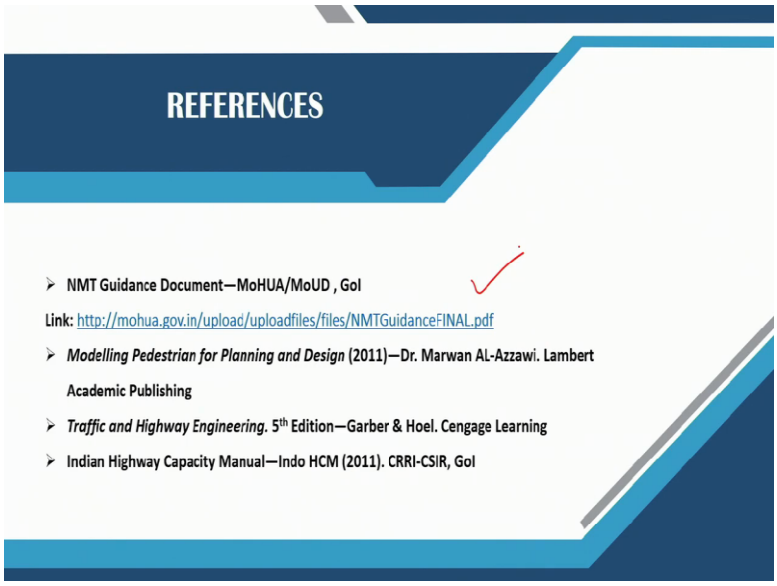

Again, these are the references that are available to you most of it was taken from, the NMT guidance document. But the example problems were also taken from Indo HCM as well as a textbook on traffic and highway engineering by Garber and Hoel.

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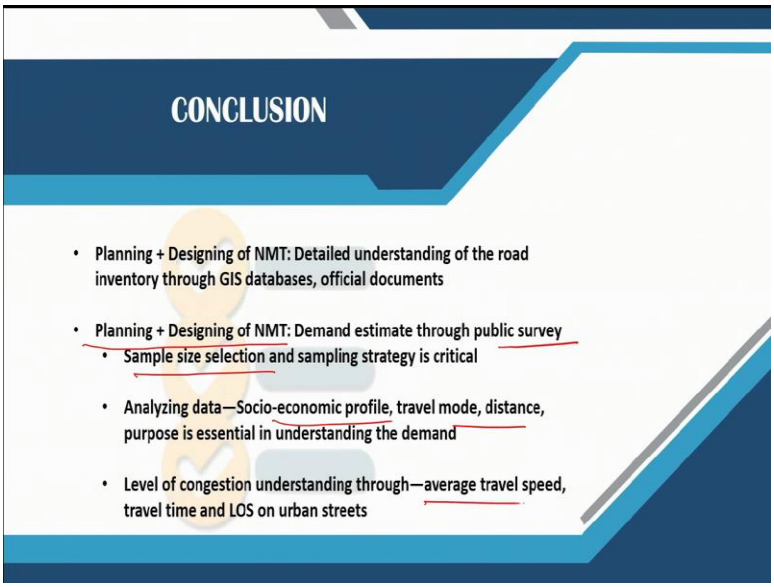

So, I hope you have followed through in this presentation where we have looked at the second stage or the second step in the 5-step planning process where we have looked at planning and design of NMT facilities. We have shown you how to determine the demand by conducting surveys, and in the surveys, how do you determine sample size? What is the sampling strategy that should be used? How do you analyze different types of data, socio economics, travel mode,

distance? And then how do you understand the level of congestion using average travel speed formulas and how do you conduct that study. Thank you.