Sustainable Transportation Systems
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Lecture 54
Case Study-V: Non – Motorized Transport

Hi friends, so, in this series of case studies this is the last case study in the sense of different kinds of modes of transportation. Initially we studied BRTS that is Bus Rapid Transit System then MRTS Mass Rapid Transit System. And then airports and last time we were discussing about the water transport systems and this is the fifth one related to non-motorized transport.

That means, which are not based on some motor or some engine kind of s and the advantage is that it is not based on some fuel burning activity. So, there are no direct emissions at such. So, we will see the non- motorized transportation system how does it really help us in our daily life as well as how can we integrate it into larger scheme of the transportation systems.

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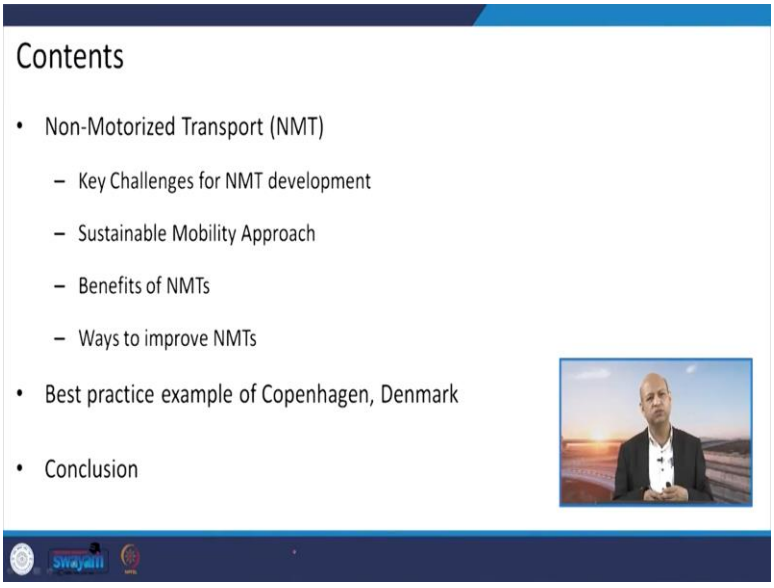

So, the contents of this lecture is like what are the key challenges for development or promotion of NMT and NMT is nothing but Non-Motorized Transport. And different approaches basically the sustainable mobility approach how it is interlinked with the NMT that is Non-Motorized Transport and what are the benefits of Non-Motorized transportation system. And how can we improve means through policies through land use land planning at the city level at the regional level can we really take into integration of different multimodal transportation system. And that

last we will discuss about the Copenhagen of the Denmark which is the kind of Non-Motorized Transportation systems wonderful example so, that we will see as a best practice example or best practice case study and lastly, we will conclude what do we learn out of this particular lecture.

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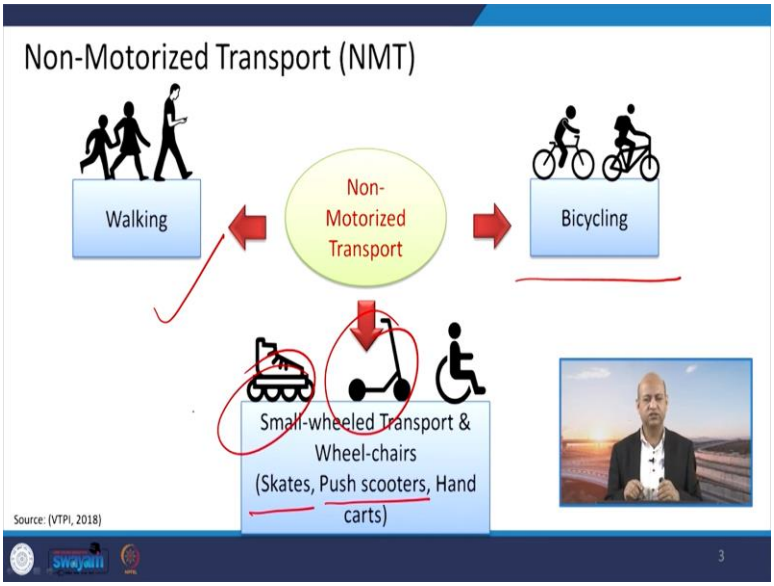

So, as you can recall when we discussed the evolution of transportation systems so, there was a little cartoon if you could recall that walking was the first view of mobility in human civilization. We used to walk from one point to another and this is still we are using it of course, there are different kinds of inventions and we are using them as transportation modes, but walking is still one predominant way of transportation or mobility. So, mobility through walking is one part of non-motorized transportation system other one is bicycling.

So, if you have these bikes paddled once or some small wheeled kind of like some mistakes or skates or push scooters or hand cards those kinds of things can also be included as mean small carts if you can see we can push it or pull. And then some trolley system-attached to a cycle bicycle and those kinds of systems, even wheelchairs or these kind of scooters or skates all these things are part of Non-Motorized transportation system because it does not use any kind of engine like IC engine or some other technology is not used by Non-Motorized transportation system.

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Well, there are challenges because you see, this pictorial representation, pedestrian infrastructure is not adequate. So, for pedestrian if we do not have good infrastructure, then people do not feel encouraged to use, those footpaths which are not in the proper shape and rather, there are problem or, if there are imbalances, there are some parts so, even injury can occur.

So, if transportation to be improved, that is NMT Non-Motorized Transportation is to be promoted or improved, we need to have good infrastructure for that other one like lighting is part of the infrastructure again So, pedestrians if they do not feel safe to walk at a particular location, then they will avoid it.

So, if there are like, these kind of underpasses if sufficient light is not there, so, we feel no endangered or have something bad may happen or some antisocial elements can approach us to do whatever. So that space must be properly lit. Again then there are no sidewalks at all in that case we have to walk on the main road where lot of traffic is there of every kind, whether it is car or scooter or three wheelers and we have to walk through these, within the mixed traffic. So, that is challenging in the sense because you are kind of at the risk of hitting some vehicle, if somebody is not able to, apply the brakes, they may hit you. So, these kinds of challenges are there.

So, we need to have separate footpaths or walks also like if you want to use bicycle but if you do not, you do not have separate tracks for bicycles and you have the mixed traffic on the same road. Again, you will feel kind of at the risk of that other vehicle which are having higher spirits they can hit you or something like that. So, that is why the adequate infrastructure for walking or cycling is essential for promoting NMT or Non-Motorized Transportation.

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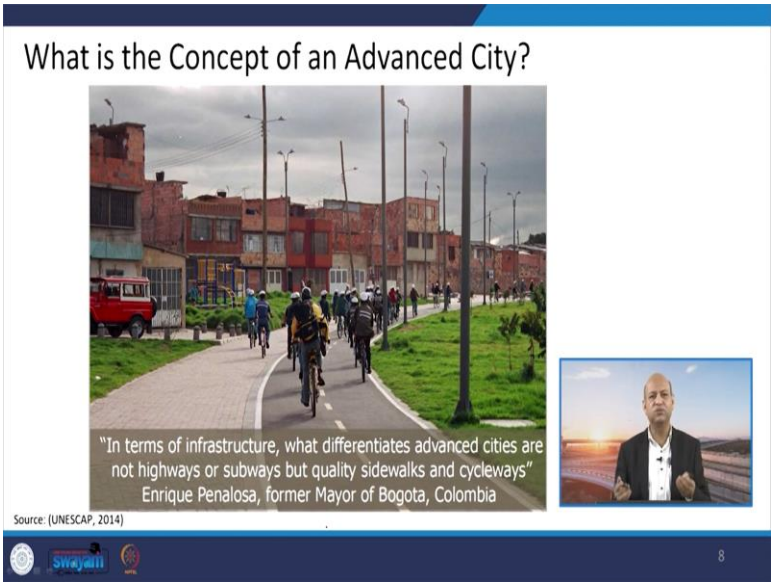

Then, what do we how do we define advanced city means some people may argue that it should have big skyscrapers and metros and all those kinds of transportation systems. But one very interesting definition given by, former mayor of Bogota, Colombia, he speaks that in terms of infrastructure, what differentiates advanced cities are not highways or subways. But quality sidewalks, and cycle ways that is that is one wonderful definition in the sense to promote the

healthy way of living or quality of daily life because it promotes us to work to cycle. And it also helps in calming down the environment because when we are using IC engines they are making some noise. So, again noise problem is also there besides air pollutants and greenhouse gas emissions.

So, if you promote these, sidewalks or cycle ways, so, people may feel incentive to walk through different streets to do their daily work and this is also healthy. So that way the advanced city in his region, which is very interesting and I would say I would like to support it that advanced does not mean having very hi-fi technologies and, a particular segment of the population is using them and the large segment of the population it just, struggling to move from one point to another, that is not the advanced city. The city which really applies to those facilities which are accessible to all the population or majority of the population only then we can see that it is really planned and advanced city.

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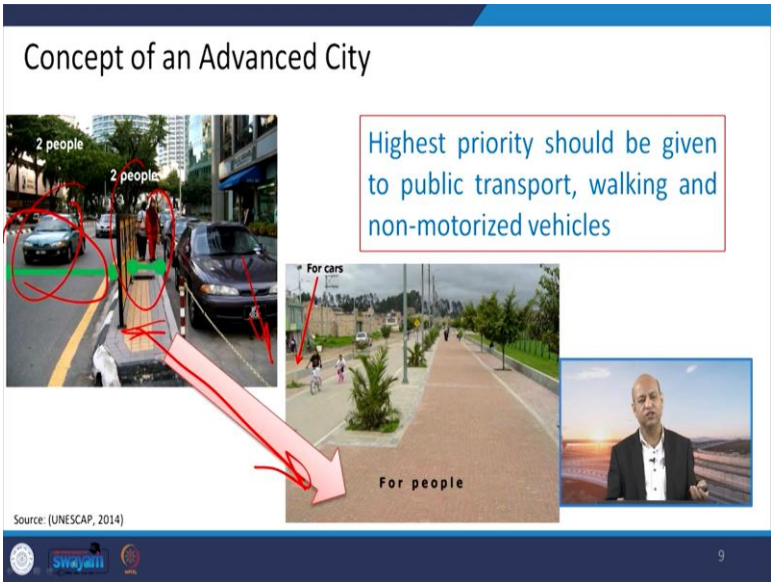

So, you see the concept of advanced city here, this is car which is using this road, and here also this car using the road and so, two people which are in the car they are using this much wide road width. And these people who are working so again to people but very narrow lane left over for the those people who want to walk so that means this infrastructure particularly discourages people to walk . So, concept of advanced city, it should go towards this way a lot of spaces

therefore, people means we give importance to people to walk. And, let me share my experience with you.

In Germany, we saw first time that pedestrians and cyclists are given the first priority to cross the road. So, if you put your, feet on the road, all traffic just they apply brakes and they allow you to walk through. So, initially we were quite hesitant because we are not accustomed to this kind of facility or priority. And later on we were quite confident to walk through zebra crossing and those points where people are given preferences that yes, those people who are walking they are the first priority to cross the road. So, this kind of concept should be inculcated and it should be applied or integrated into the public transportation system as well as the complete transportation system of urban environment.

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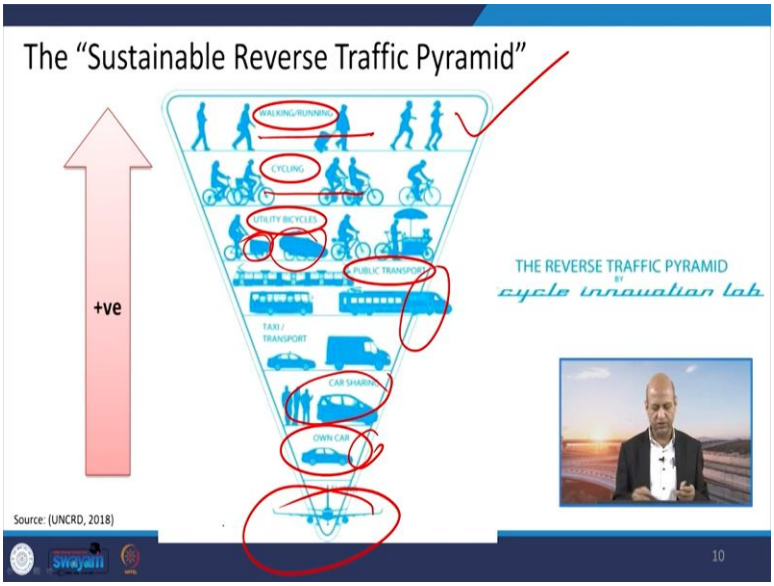

So, you can see here positive sustainable reverse traffic permit means right now, what happens in all cities, if you see in our case of Indian cities, a lot of space is occupied by private vehicles of cars or two wheelers, three wheelers or all those and very narrow spaces there for people who are walking or using bicycle etc.

So, if we reverse this trend and if we apply this reverse traffic pyramid that means we give the first priority to people who are walking or jogging and they are using these walking lanes or they are using cycles bicycles or utility bicycles like some kind of cart is there are some trolleys there

those kinds of things can be used by bicycling also. And then after they are the public transportation system right and then the commercial one taxi or transportation those drugs etc.

After that, the car sharing pooling. So, the last one is the privately owned cars and then this of course, air traffic that is mostly isolated and at the corner of the city. So, it is always at the last So, you can see if we design the urban environment of the transportation system in such a way that we give the first priority to those who are walking or running and bicyclists though the clean environment can easily be achieved. So, this is the positive way of the sustainable transportation through Non-Motorized Transportation system to be encouraged.

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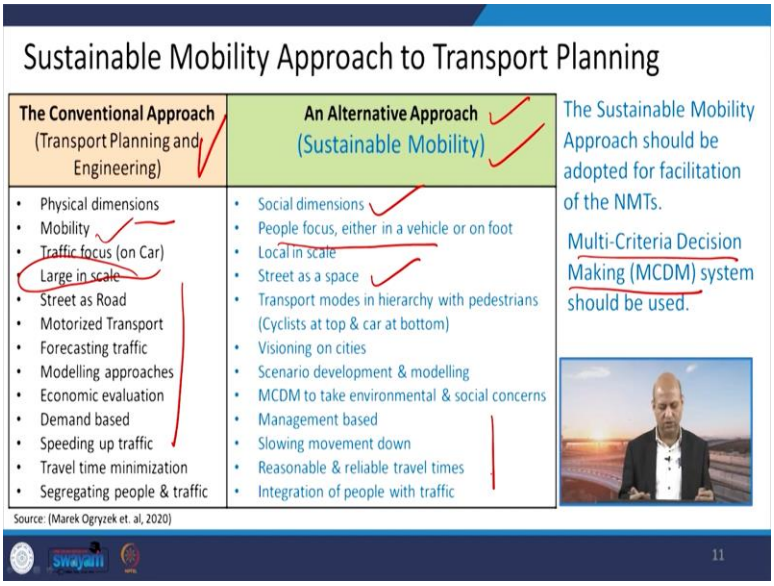

So, to achieve that what we should do for sustainable mobility approach we have to apply that means from this particular engineering approach which is quite mathematical approach or dry or robotic approach you can say like we see under physical dimensions this much of road we have to develop. So, we will develop we do not, see the implications or in a larger picture, but if social dimensions are to be addressed for alternative approach or sustainable mobility so, beyond physical dimensions, we have to see the social dimensions. So, what kind of public we are addressing in our city, which income group people are off in which proportion are they comfortable to use, the paths or infrastructure which we are providing all these things we have to see.

So, the socio-economic dimensions we have to look into properly. Then mobility is the focus of those engineering our old his practices, but when we talk about sustainable approach, we have to focus on people and those who do not want to use vehicles or they want to use walking and these NMT's and in larger scale, traffic cars etc., and they see the larger picture that so, many cars are registered. So, we need that motto of roads and, these our petrol pumps or those kind of infrastructure facilities, but in case of this sustainable mobility. We focus on a street as a space means how to connect a street by street that means most focus is that can we do our daily work through walking through these kinds of mobility's which are addressed by NMT.

Then visioning of the cities based on scenario development, here it is forecasting traffic. So, engineering approach that this must population with lead that much of cars or two-wheeler so, we should have that much wider and longer road network, but in this vision that this much population we have to address so, they have to be kind of healthy population. So, for that what can we do in terms of alternative approach.

So, you can see multi criteria decision making system has to be there for environmental and social concepts integration. And then this is speeding traffic all those, we have traffic lights, because then there are chances of accidents etc., is speeding traffic we have to keep in mind. But in this particular alternative approach, our traffic is, calm cool slow and people still can do their daily work. So, those kinds of things we have to see in this particular sustainable mobility concept.

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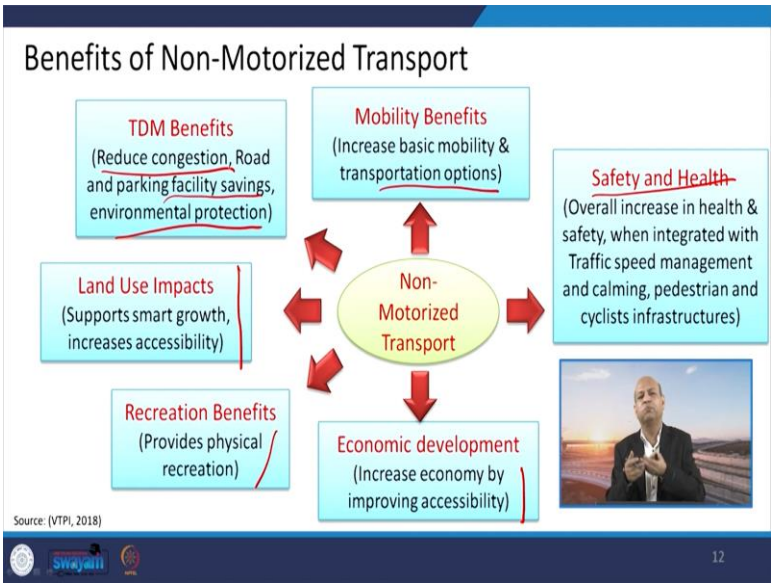

And then, there are benefits means, these are the benefits of Non-Motorized transport because it like co benefits you can see direct and indirect benefits. So, it can increase this transportation options, because, it is quite usable by every kind of person, anybody can walk into a facilities are quite nearer or even two three kilometers people can use bicycle also. So, those kinds of amenities if we put in that kind of distance is small distances, then people may feel incentive. Otherwise, if big malls are they are at a corner then of course, people will not like to walk there but they have to use car etc.

Then safety and health issues are there because it has been seen that those people who are using most of the Non-Motorized Transportation systems like walking and bicycling etc. They are more healthy they are more healthy because it is a kind of exercise also when they are walking or using bicycle. Economic development because it improves the accessibility of each person the majority of the population can use these kinds of NMT's.

Then recreation because when you are cycling you are talking and it is not very high speed so, that kind of recreation is also there you are also using I mean enjoying our surrounding and that is one benefit. Then land use impacts like again the accessibility to one locality to another one is there and then the smart growth can be achieved by this kind of land use planning.

When you are using these bicycles etc., in the in the in the fashion of like public bicycling hiring facility all those kinds of smart growth is there. Then there are some other benefits for example

parking facilities or savings in the sense because if you have to use car then you have to use some parking space you have to pay some money for that. So, those kind of things are not there then reduction of condition because these cars etc., they need more space and a small number of people using those kinds of vehicles they are encouraging conditions so a lot of fuel burning etc., those kinds of things get away with an NMT's.

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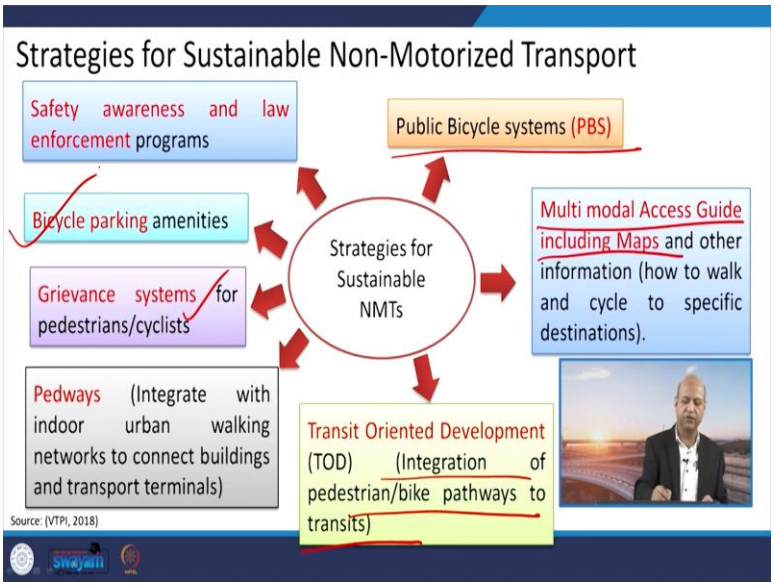

Then we have to do some strategic planning. So, what are those strategies to achieve these sustainable Non-Motorized Transport So, for that, this Public Bicycle System PBS that has to be promoted. Then multimodal access guide including maps etc., because when you are promoting this bicycling, so, there should be some track kind of guidelines that this first track will meet the another track there may be some transition zones also. So, those kinds of information should be there. And then integration of pedestrians pathways and transits in the sense for example, you want to travel let us say 20 kilometer and you do not want to use bicycle for hold 20 kilometer stretch through maybe you go 5 kilometer by bicycle.

Then use some public transportation system where the train or the low floor buses which provides you a lot of space for your cycle and you can use by this cycle when you get down on the different next station then again you use the bicycle so those kinds of integration has to be there. And then grievances system means if there are some issues then there must be some way

of addressing those issues like if some immunity is also parking amenities must be there proper otherwise where you will park your bicycle.

So, at certain locations there must be this dedicated parking system for bicycles. And then if something happens like some part is broken, then there must be some filter facility we will see next slide that there are like dedicated service points you can just telephone them they will come to you and they will provide some transportation mode for you to reach to the destination and then they will provide your bicycle after the pairing. And safety awareness campaigns and law enforcement programs all those have to be integrated only then we can achieve NMT promotion.

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So, this is again in this tabular form it has been like price incentive in the sense congestion pricing if you are using motorized vehicles. So, if you are increasing condition then condition pricing must be there so that you feel discouraged to use the car. One example I usually quote the London this city center they applied this tax congestion tax or city center tax and as a result people felt discouraged to use their private vehicles because that tax was quite high. And that way that space became condition free people used to walk and air quality was also improved. So those kinds of things should be there. So, all these insurance and parking management or these integrations has to be like earlier also we discussed about the strategies.

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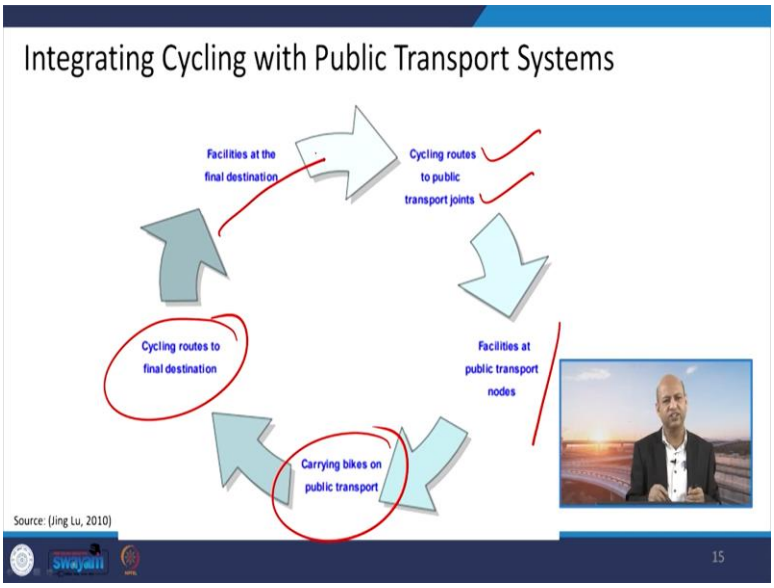

Well when we want to integrate so how to do that, like cycling routes to public transportation joints must be there otherwise, how will you reach to a particular point or joint then facilities or public transportation nodes. So, you want to go for example, you want to park your bicycle, you want to use them public transportation system after office work, you want to come back and use your bicycle again to reach your home like last mile connectivity kind of thing.

So those facilities must be there for parking. Then carrying bikes on public transportation if you want to take it means then other another option must be there that you want to take because after a station you have to walk 3 or 4 kilometers and you do not want to walk that much you want to use your bicycle. So, the public transportation system whether it is train or it is a bus that should have adequate space for your bicycle.

So those kinds of things can be done and there are cases we will discuss later on to show you that how it is achieved then cycling routes to final destination. So again, from the source to the destination those routes must be there otherwise again you will feel problem and you will not enjoy that bicycling to that destination and facilities at the final destination again. So, this kind of cycle which is virtuous circle or virtuous cycle rather than vicious cycle so virtuous circles must be there to connect from source to the later on our final destination.

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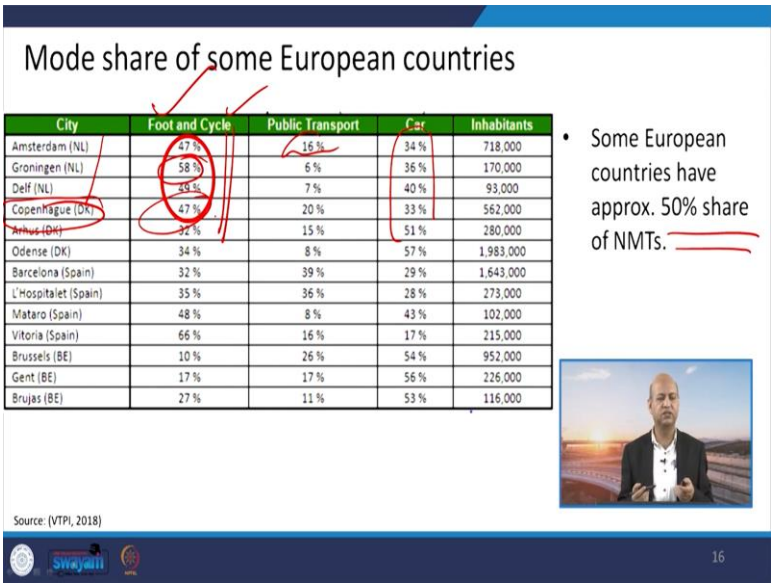

In European countries, lot of policy majors have been there to promote an NMT's and as a result you can see like Netherland those cities Amsterdam and Groningen, Delf all these cities of Netherlands. They are using by foot means walking or cycling around 50 % some 58 % even in in some cities and then Copenhagen which we will see 47 %. So, around 50 % car of NMT are there it is a big big share of an NMTs otherwise public transportation is also good, but then cars are also there 34 % or 35 % and according to the number of population. But this is wonderful share for an NMT's that that gives us an insight that they promote the real healthy life.

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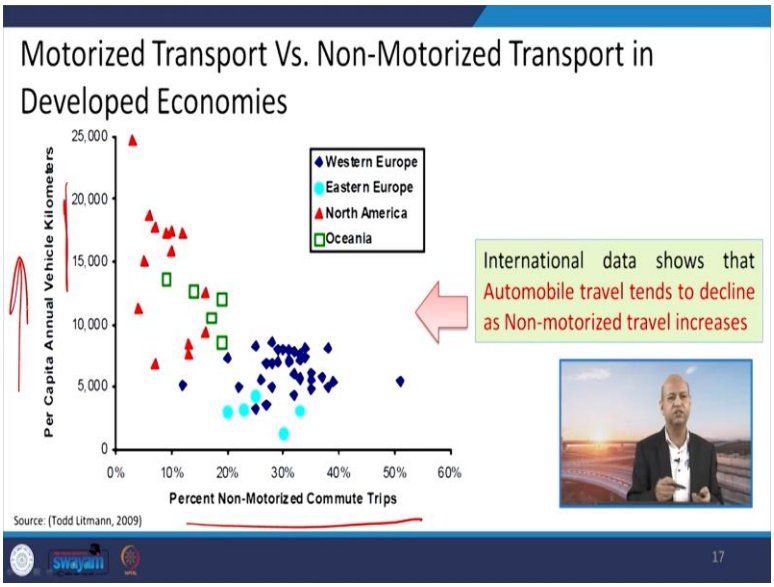

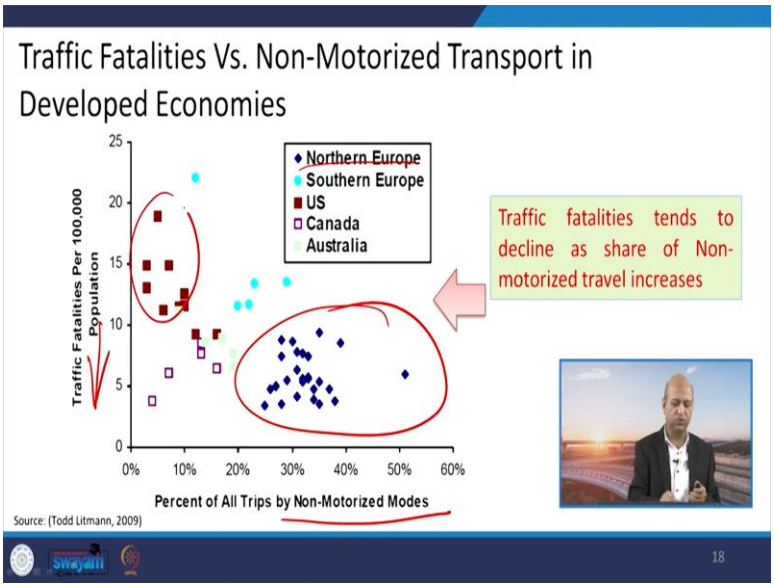

And there are relationships like per capita annual vehicle kilometer travel and the percent Non-Motorized commute trips. So, there is a relationship in this so, you can see those who are having less, Non-Motorized commuters, they use most of the vehicles as the percentage of people using the NMT is grow then these vehicle kilometers driven by automobiles they also get obviously reduced.

Similarly, the traffic related fatalities so, as you grow in number of Non-Motorized modes, these penalties come down very less so, Northern Europe where most of the people are using Non-Motorized Transportation modes. So, very less number of fatality, accident related or traffic

accidents related fatalities very less occur but US which is known for automobile industry, you can see the lot of fatalities in comparison to these European countries.

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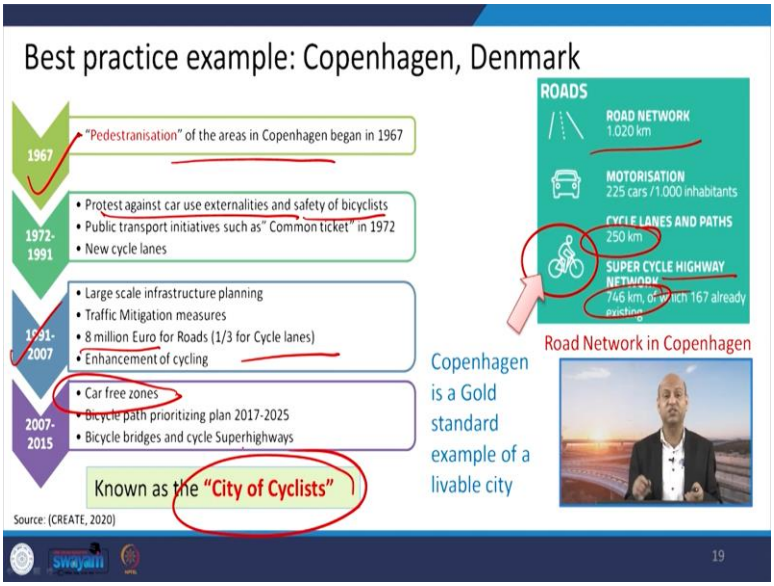

Now, we come to this best practice example, which is Copenhagen in Denmark. So, some figures can give you wonderful insight like road network around 1020 kilometer and out of this, 250-kilometer cycle lanes and around 746 kilometers super cycle highways means within cycle also they have different categories when you are just bicycling slowly so one track is there.

But as we have expressways for more motorized vehicle or automobiles, they also have some dedicated tracks where you can bicycle very with very high speed and there are now a modern bicycle with gear system etc., you can reach very good speed. So those kind of highways for, bicycle, super cycle highways are also made there.

So, you can see how much promotion or investment is there for those infrastructures which are dedicated to walking and cycling. Since 1967, they are promoting this Pedestrianization of the city and later on, there was some kind of protest against cars because pedestrians were not having comfortable journey. So, there were a lot of demand from the public side. And later on, the cycle lanes were constructed around one third in 1991 8 million euro for roads, and one third for cyclists. And slowly, car free zones were made completely no car there. So, that means you are promoting the walking and cycling. And this nowadays now it is known as city of cyclists, because of these kind of policy measures which they have used.

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Now, you see more than 47 % of the people prefer bicycle or working in that city so NMT is highly used. And new cyclists regions for like survey was there. So, they say it is faster means faster in the sense even if you are using some car etc., if you are stuck to the condition it is taking a lot of time. So, means if you are having dedicated lanes or cycle ways you can reach timely at your destination and of course in comparison to walking Cycling is faster and then more convenient and healthy, cheap, no emissions, feels good factor again because you are in control your health and you are enjoying the surrounding so, this is the survey result of 2010.

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This is the past Copenhagen picture you can see a lot of condition which in our cities we usually see So, these kind of these people are having mixed traffic and the cars and all those other transportation modes or site cycling all those were mixed and very less space was for walking etc.

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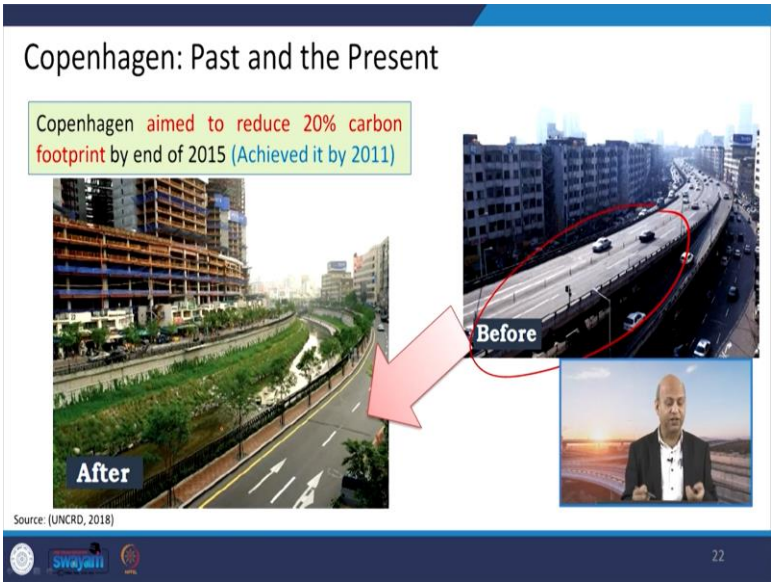

So, later on for example, this much of kind of road network was there for the traffic and later on some policies were given. So, it is empty and people are using for cycling and walking etc.

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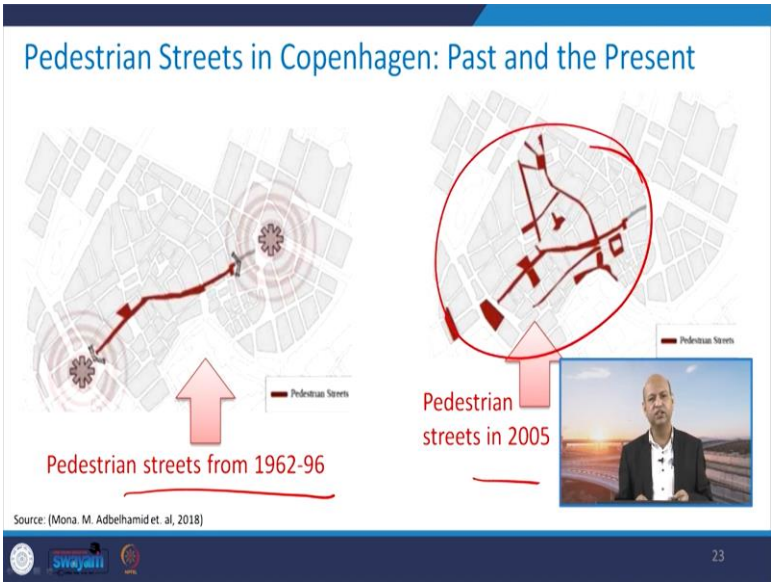

So, you can see these pedestrian streets for from 1960 to 96 so, that has increased and in 2005 this is much more integrated with other points from the past and present comparison you can see.

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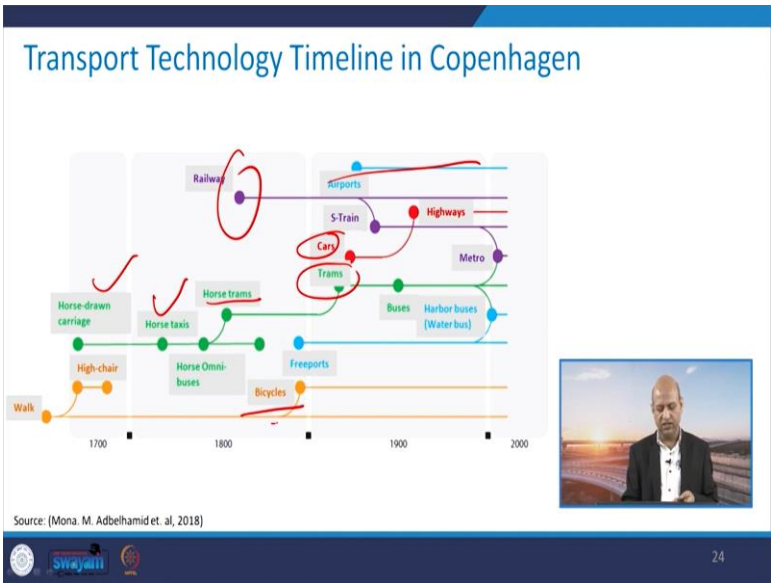

Similarly, this is one timeline for different kinds of transportation modes. So, earlier these horse drawn carriages were there and then horse drawn taxis or trams then railway came in 1800 or so and then bicycle started and then trams cars and then airport started so, all these missions happened. But bicycling usage increased and now it is increasing more and more because of these kinds of campaigns for healthy life and free from fumes and emissions and noise.

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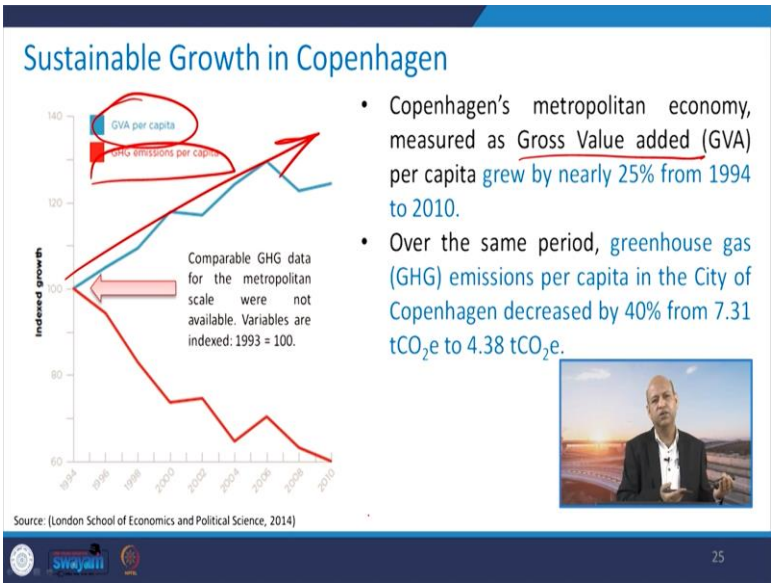

So, the sustainable growth if you see this one you might have heard about GDP this is the concept of GVA that is gross value added. So, that is basically how much GDP you are having and then how much of this GDP portion you are investing in these public transportation systems of Non-Motorized vehicle. So, in terms of GVA, this contribution has increased over the years and GHG emissions that is emissions of Greenhouse Gases it is decreasing, so that means NMT's are increasing. So, the automobiles are decreasing and as a result, greenhouse gas emissions are decreasing.

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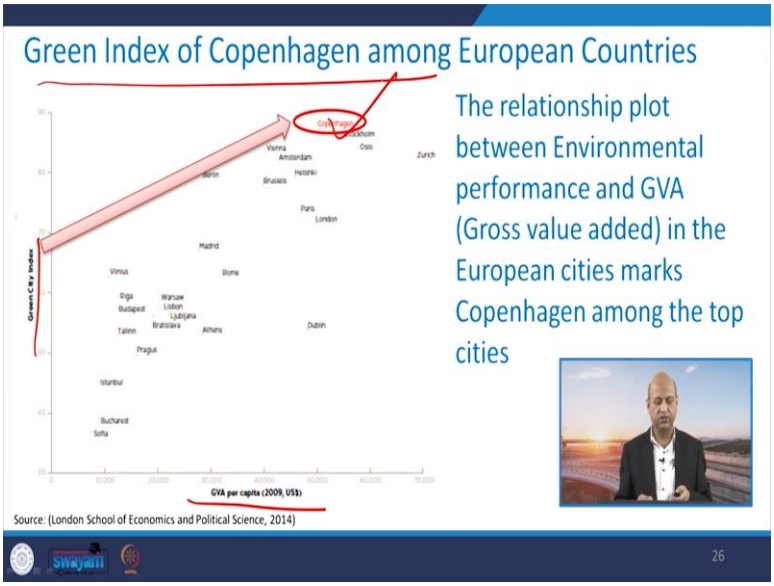

Similarly, the green index of Copenhagen among European countries. So, if you compare this green city index and GVA per capita, so, that is again indicator for seeing that how much and my mental performance and GVA they are interrelated. So, Copenhagen is at the top you can see in this particular indicator.

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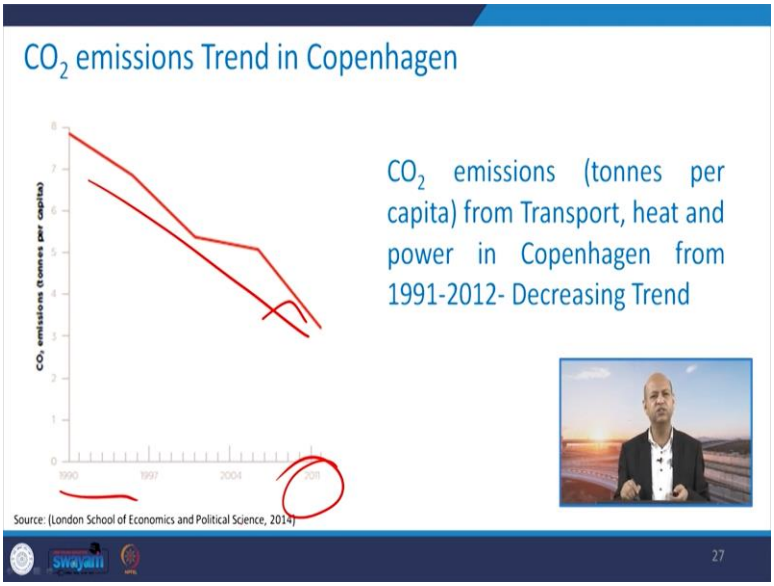

Similarly, the CO2 emissions that is the emissions of carbon dioxide were the predominant greenhouse gas that is also reducing from 1990 to 2011. So, again, this is continuously reducing decreasing trend.

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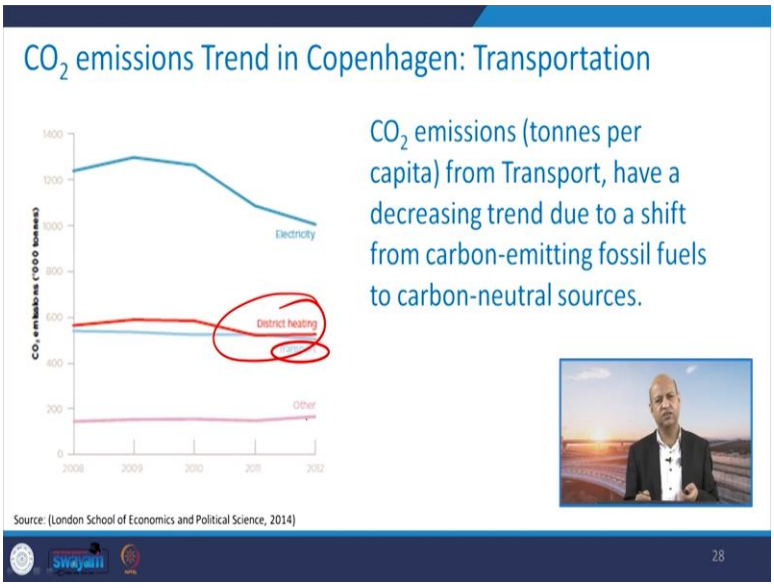

And in Copenhagen, if you see the district heating that is the, energy used for warming because cold countries use a lot of hot water. So, energy is used for, boiling the water or creating steam etc. So, the electricity related consumption all these things have decreased and other emissions related to because that means they are using more renewable resources in that sense.

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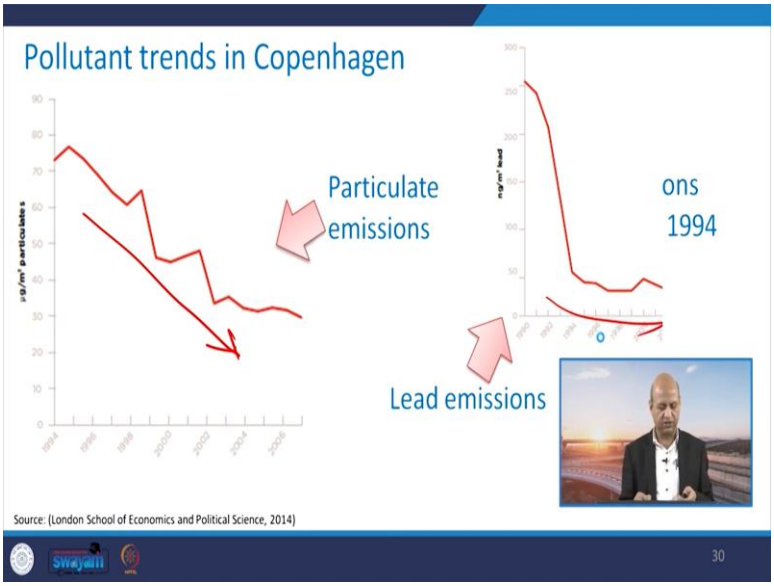

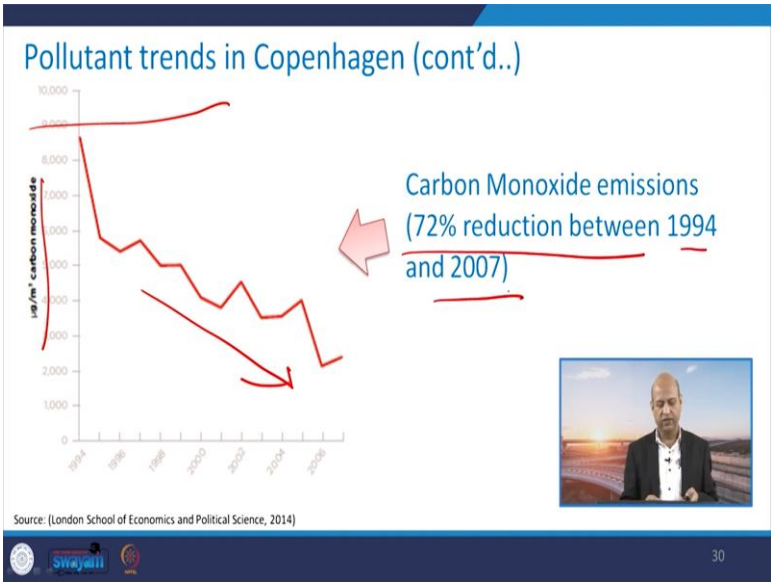

So, pollutants also like greenhouse gas as well as air pollutants emissions, they are also in decreasing trend over the years. And lead emissions like we also have used unleaded gasoline or petrol. So, similarly, there several, policy interventions have been there. So, lead reduction in emissions have been issued very significantly. You can see then if you see the pollutant trends

overall, like carbon monoxide which is one indicator of automobile emissions, carbon monoxide and NOx emissions, these are two big indicators of automobile fossil fuel waste means petrol diesel those kind of. So, they are again decreasing so, again it is proving that 72 % reduction between 94 to 2007. So, this is one big indicator that, these are transportation system is moving or shifting towards NMT Non-Motorized Transportation.

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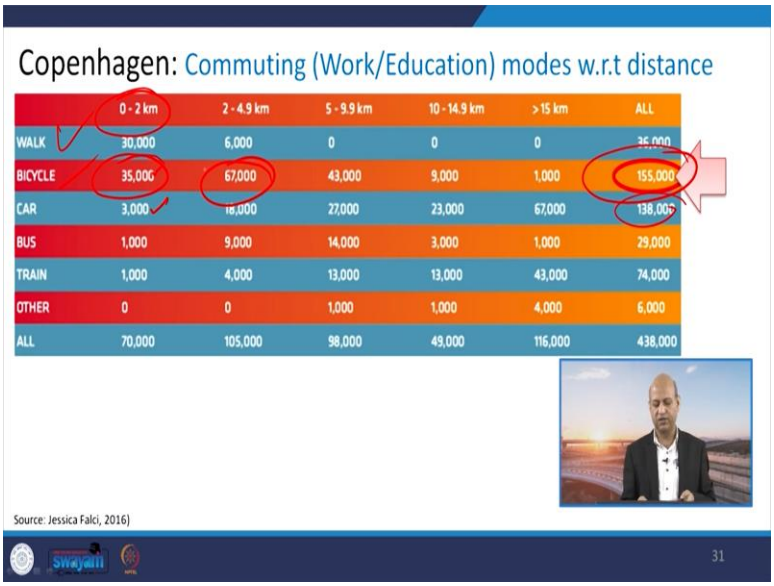

Then for work or education how much people are using or preferring walking or bicycle. So, you can see so, many people 155,000 people are preferring the bicycle So, this is one highest number using bicycles. And after their this car because at several distances some other dominant like a small distance is 0 to 2-kilometer bicycle is the predominant. And car is the one of the least like bus also people do not use so, this bicycle was dominating and 2 to 5 kilometer around again this bicycle was the preferred mode of traveling. So, that way you can see different distances and different modes of transport which people prefer.

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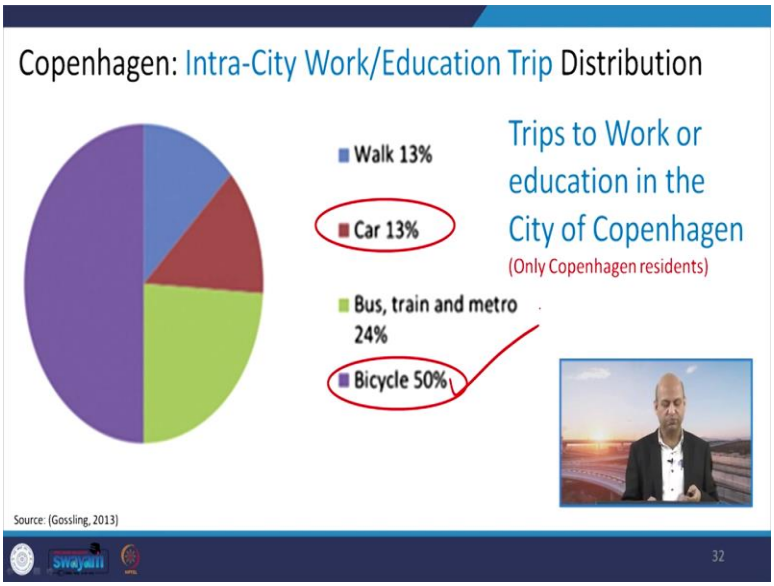

Well if you see trips to work for education again intra city within a spaces of the city some localities or communities. So, bicycle again 50 % big big portion of people are using for bicycle.

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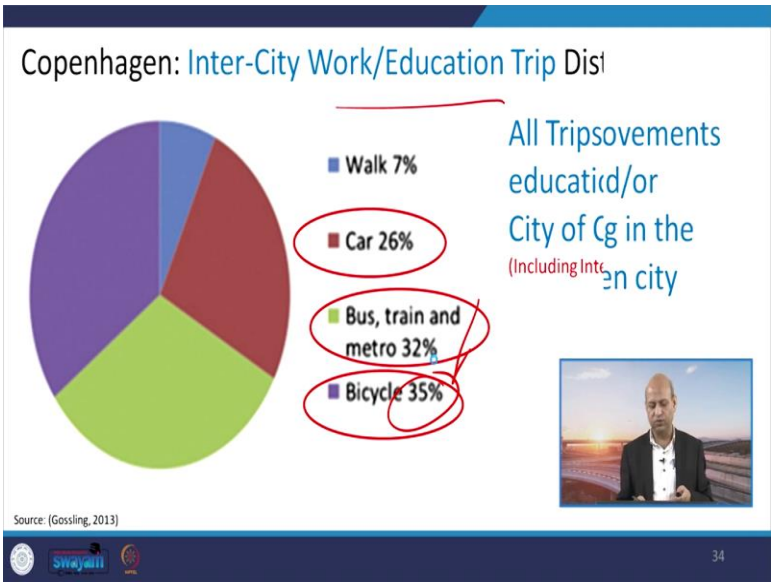

Intercity means big parts of the this city for these kinds of work or education again bicycle is 35 % and bus and train then public transportation system 32 % so, car is still like third or fourth option those kind of things.

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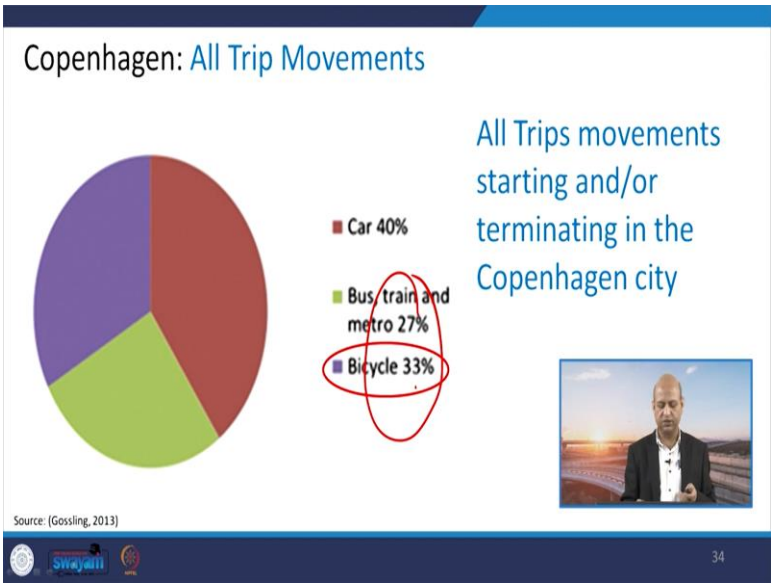

But all trips moment if you see so, bicycle and these train or public transportation system that is around 60 % and then car is the second preferred one.

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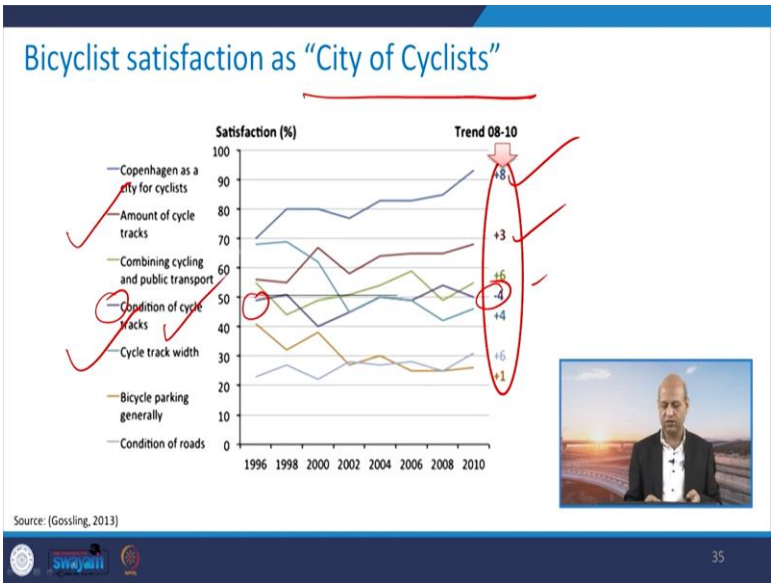

Then city of the cyclist how different indicators or like amount of cycle tracks and then cycle track with all these indicators if you see. So, most of those have growth plus plus plus sign only one indicator this is this one. So, that is condition of cycle tracks, this is minus means that means according to the standard that condition has not been improved so far because tracks are increasing lot of money is being invested in those.

And so, those campaigns are going on and other indicators they are very much in positive sign that they are promoting, but this will also be addressed but other indicators like tread width is increasing their track length is increasing, parking facilities are increasing all those things are increasing, right.

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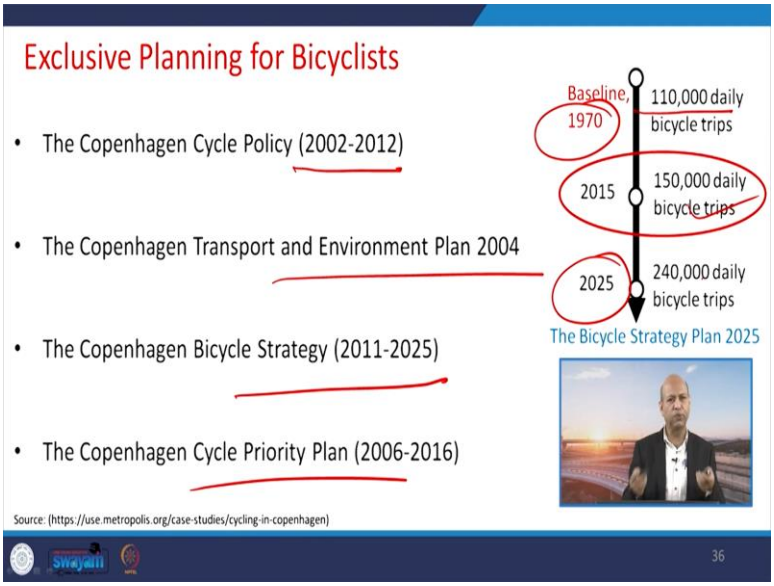

So, exclusive planning for bicycles from 2002 to 2012 so 10 years one decade and this environment plan all those things strategies and priority plans for these pedestrians bicycle strips, these have been improved. And that is why baseline or data of 1970 when around 110,000 daily bicycle trips were there. So in 2015 it was around 150,000 and in 2025 it is estimated that 240,000 daily bicycle trips will be there so that means this policy to promote NMT is going on.

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And the present day bicycle peak hours when we see in our cases peak hours means congestion of cars buses, etc. Here people are more in number on bicycles. So, it is quite comfortable I mean, it is not like you are standing in the place where a lot of fumes are coming and a lot of pollution is there nothing like that. Otherwise, it is quite clean and calm kind of situation.

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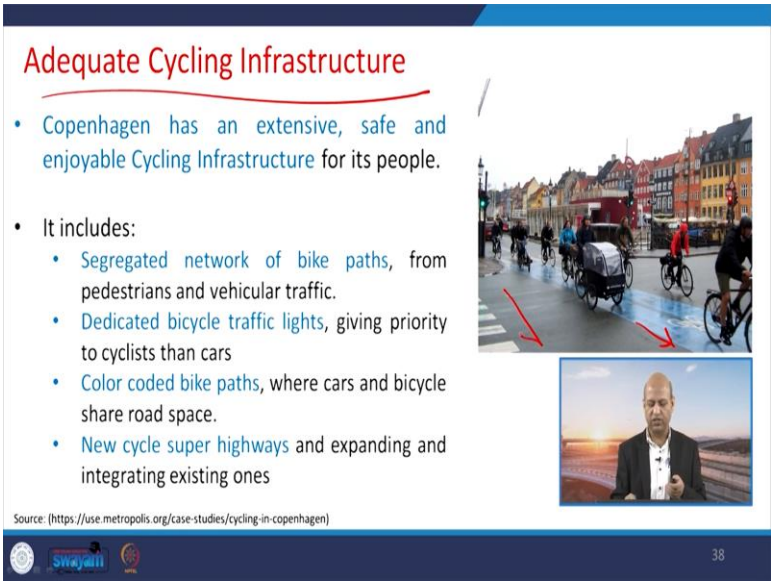

And then adequate cycling infrastructure means again as population grows, they also plan for additional ways of cycle and these footpaths. So, they are dedicated cycling lanes as well as for walking they have different and plus for car etc., they have different kinds of paths.

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Plus, these uninterrupted bike paths So, that means as I said these are dedicated ones means no scooter no car nothing will come here they have designed in such a way height and width. So, that other transportation modes will not be able to use it, it will be only for bicycling purpose right.

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And then parking lots properly planned and these infrastructure has to be provided which are exclusive.

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And these like searing parking have been common parking maybe they are where you can park we were on and if you have hired bicycle that also you can park.

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Similarly, then they are dedicated modern parking systems for bicycle docks. Where easily you can put your bicycle safely and nicely.

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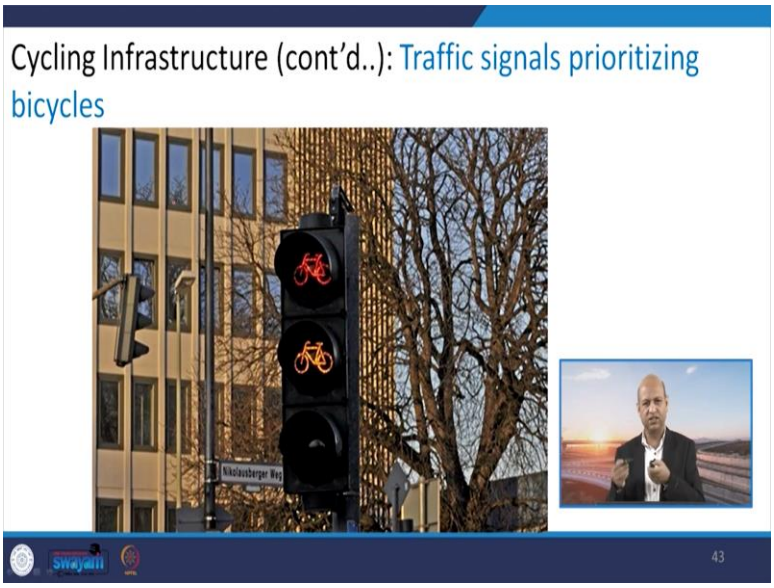

Then there are these signages also for rooting properly bicycle preferences that no bicycle will go and other modes are not proposed.

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And beautifully aesthetically appealing bicycles are there for Public Bicycling System through PBS. So, people can hire them and it also promotes the science means kids also get attracted towards this end when they are at the very tender age impressed impression occurs that this is good thing. So, later on also they will prefer to use bicycles rather than aspiring for cars etc. Like sometimes we make these cars having cars or owning cars as the sign of development or growth,

which is not the right way in fact, there are other parameters of life which really gives us the quality of life indications.

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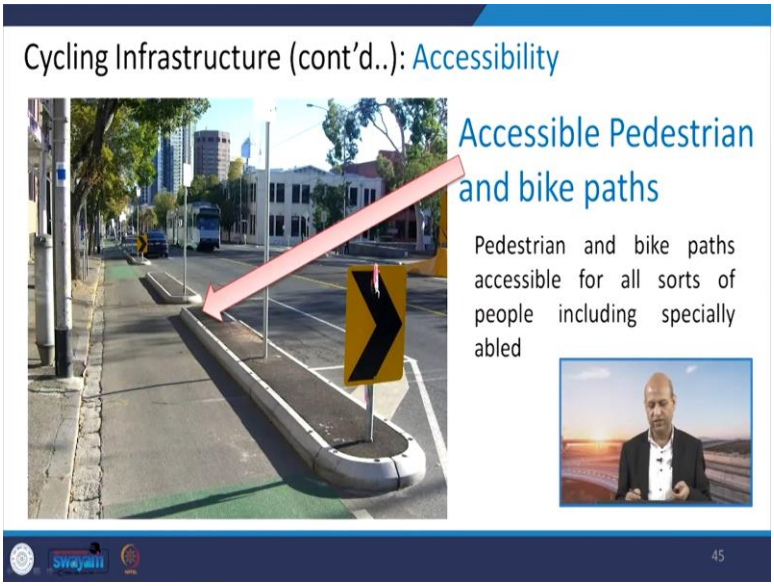

So, the accessible pedestrian and bike paths must be properly changing from pedestrian to cycle or cycle to pedestrian those kind of systems are there and continuous expansion means earlier these, bridges were used for cars etc. But later on, car free zones were made and a number of cyclists now outnumber the cars in Copenhagen.

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And you can see how these tracks for dedicated ones for bicycles they have been this network has been made properly in an entire city.

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And this is one very famous breeze, this iconic cycle bridge which is also known as the snake bridge of 235 meters long and that is only for, cyclists no other vehicle can go there. So, those kind of dedicated bridges are there.

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Similarly, this queer bridge here also 190-meter-long for pedestrians and cyclists. So again, it is free from traffic and you can enjoy the beautiful scenic beauty of river and free sky open sky all those things. So, these are incentives for promoting cycles.

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Then there are, some counters, bicycle counters, which monitor, number of cycle users etc. So, data collection is there and then those data are used for policymaking in future.

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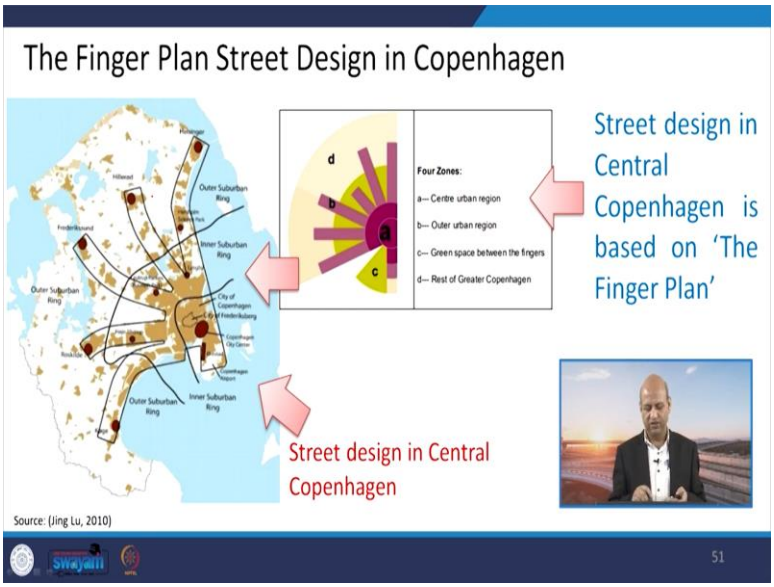

This is finger plan is to design in Copenhagen because of its landmass in such a way so that is for outer urban area central urban area those kind of and palm like planning is there for Chandigarh city also if you recall. So, this kind of planning has been they are in strict planning means for pedestrians and cyclists in Copenhagen.

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You can see the street design in Copenhagen again for bicycle dedicated one then public transportation system. So, they are separate lanes no mixed traffic and you can just move comfortably.

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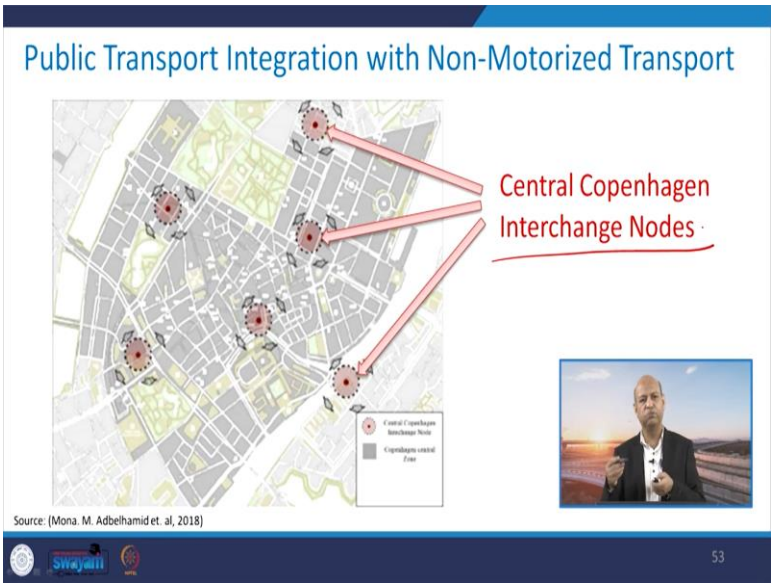

Similarly, interchange nodes means if you want to change if you want to go from one place to another and you want to use your bicycle and you take so, there are certain places where you can change over transportation mode or node.

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You see these trains and they have like spaces for bicycles even for parking them within the compartment. So, these kinds of public utility system and parking system within the carriages gives you incentive that you can take your bicycle and go from one place to another using train as well as buses they also provide.

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Plus, as I said earlier, that these kinds of things are their innovative ideas for promoting integration of cycling and public transportation like it reads problem with your bike call us anytime and we pay your Metro ride while we repair your bike. So, these kinds of facilities means this gives you confidence if there is something happens then it is not that you have to walk all the way you just call people will come and they will take your bicycle in a bicycle and they will repair it meanwhile you can use the metro they will make arrangement for your Metro ride to reach your destination.

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These beautiful pictures are again to promote the pedestrian streets. So, traffic free where you can walk and enjoy the amenities all those surroundings these restaurants or places where you can sit down and have good time have coffee etc.

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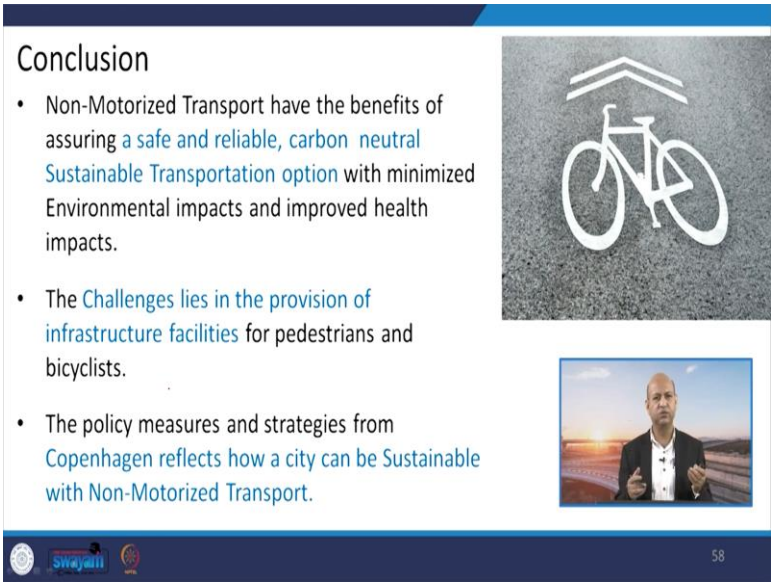

So, in conclusion, we can say that Non-Motorized Transportation benefits are there and it has to be in such a way that it is safe, it is reliable and carbon neutral because it does not emit any greenhouse gases or so. But there are certain challenges in terms of infrastructure facilities which we have to provide as per the quality only then people will shift from motorized transportation system to Non-Motorized Transportation systems.

So, the bigger planning is needed, that the facilities must be near one where people can walk or can use bicycle rather than using the cars or scooters etc. So, that whole holistic system has to be in mind when we plan a city to promote or for cyclists and for pedestrians that is very important as a policy aspect and vision for the Smart City, Healthy City and quality city so that is all for today.

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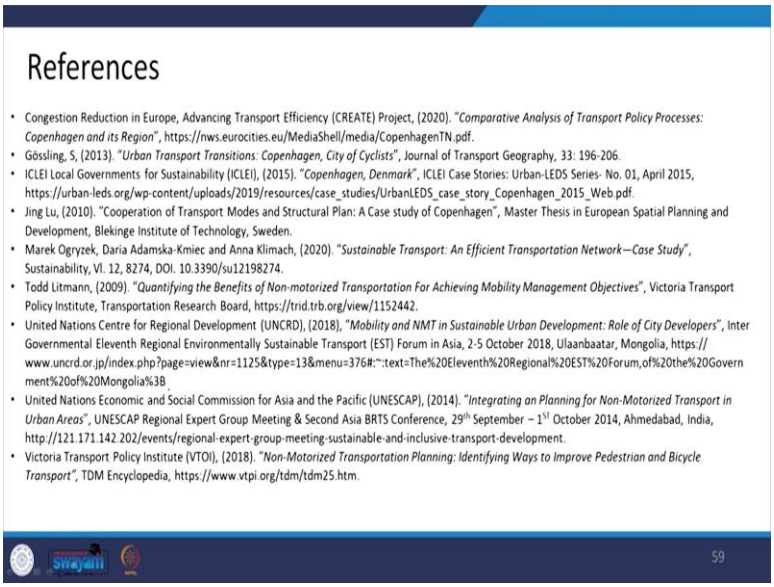

These are the references, if you want to know more about how NMT is are promoted and how these motorized vehicles, population need to be shifted towards an NMT's. So additional references are there. So thank you again for this your time and attention in this particular lecture and see you again. Thank you.