Introduction to Multimodal Urban Transportation System
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Module No # 02
Lecture No # 08
Public Transportation: Basic operating elements of public transportation (contd.)

Hello friends. Welcome back to the next lecture session. Here we will continue from the previous lecture session where we were talking about the basic operating elements of public transportation. In the previous lecture we look at several operating elements such as capacity, utilization, stops lines, etc.

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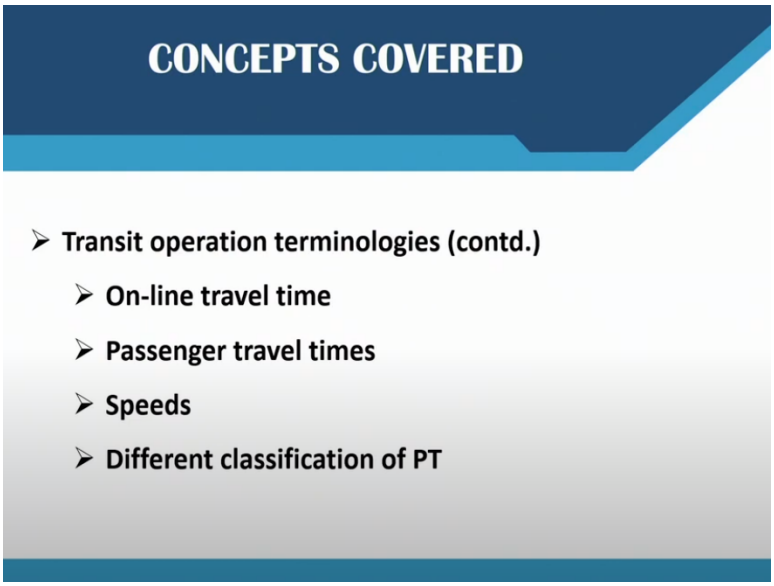

Whereas in this session we will continue and move forward and look at 3 distinct topics. One is, what is on-line travel time, what is passenger travel time, what are the different types of speeds involved in public transportation. And then we will end with classifying different types of public transportation and give you an idea of how they are classified.

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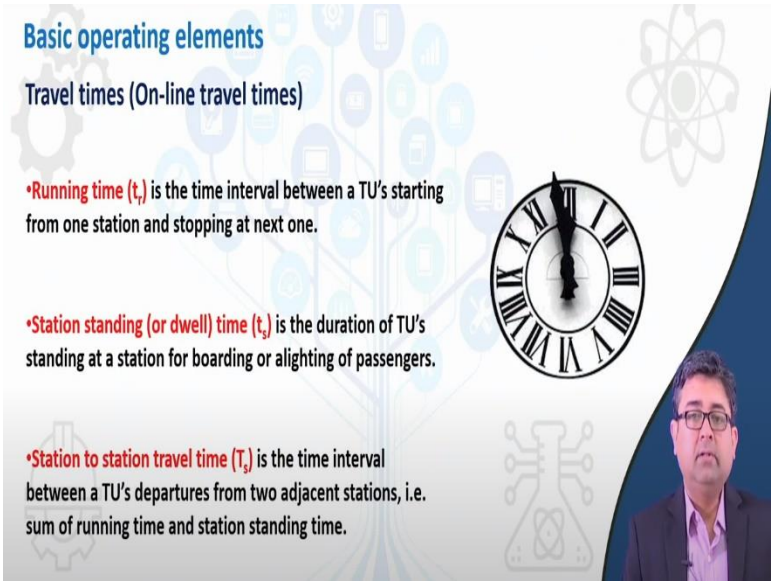

So we are always worried about travel times on public transportation. We always want to be fast, we always want to be on time, on schedule. Otherwise what happens is we shy away from public transportation and we will say that we will use our own private mode of transportation because that is more reliable. So these travel times have various elements associated with it. Let us look at them one by one.

So the first travel time involved in public transportation is what is called "running time". So running time is the time interval between a transit unit starting from one station and stopping at the next one. So simple enough, it is the time interval between a transit unit starting from one station and stopping at the next one. Next when we look at station standing time, or which is also popularly called as a dwell time, that is the duration of a transit unit's standing at a station for boarding or alighting of passengers.

So as we move forward in the lectures of public transportation system you will see that dwell time is a very major factor in determining what is your overall travel time on a public transportation line? So just to clarify, station standing time or dwell time is the time duration when the transit units are standing at a station for boarding or alighting of passengers. Next when we talk about station to station travel time it is the time interval between a TU's departures from two adjacent stations.

So it is the summation of the running time and the station standing time. So station to station travel time not only includes the running time but also the station standing time. So it is the time interval between TU's departure from to adjacent stations. So these are 2 adjacent stations that we are using to calculate this station to station travel time.

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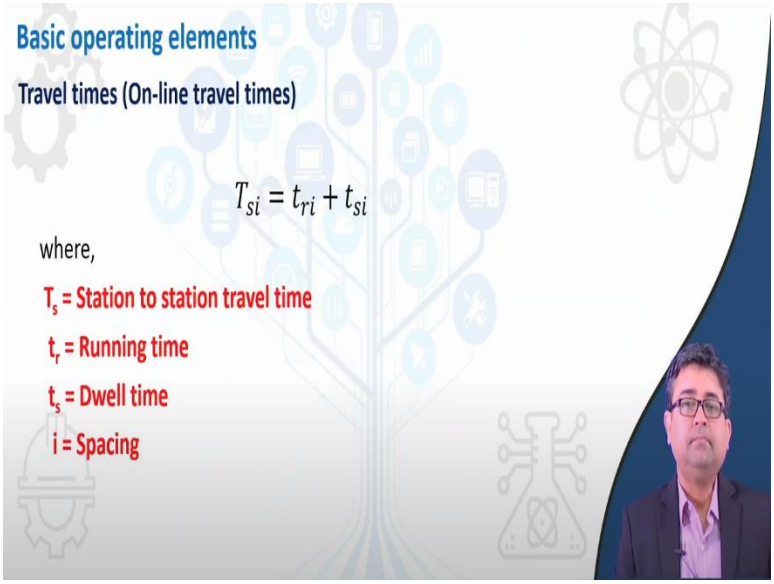

So very simplistically it is just the summation of the running time and the dwell time; it gives you the station to station travel time. So 'i' represents the spacing of the stations; where the spacing are not always uniformed throughout the line. They may differ from the area which is densely populated that may have very close station space to each other.

Whereas the area that has a less population density, the station spacing may be different. Depending upon the spacing of the station the running time or a travel time differs.

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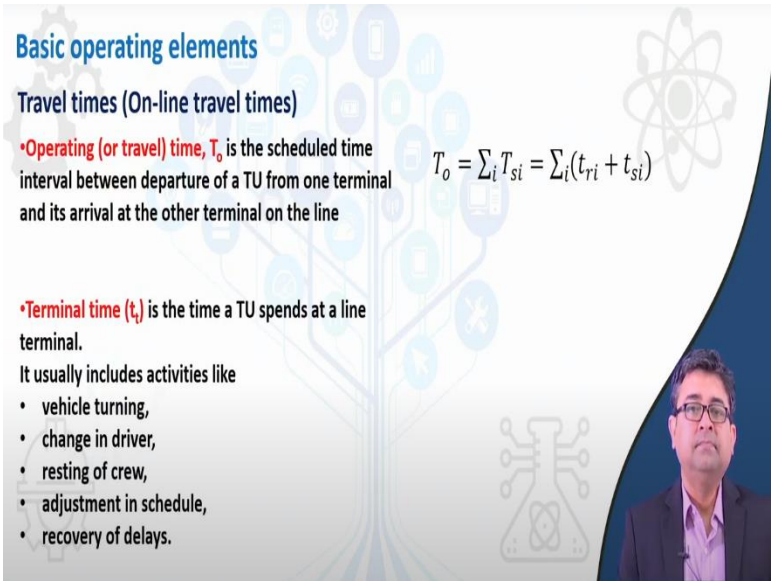

Next is what is called the operating time or the travel time. It is the scheduled time interval between the departure of a TU from one terminal and its arrival at the other terminal on the line. So now you remember what are the terminal stations? So terminal stations are the 2 end stations. So when we talk about operating time, we are looking at the time when the vehicle or TU leaves one terminal and when it arrives at the other terminal on the same line.

So far, we have looked at travel times between adjacent stations and now if you sum up all those travel times for each adjacent station pair, then you would arrive at what is called the operating time or the travel time. So that is what the equation also shows. Now there is another element called terminal time itself. So terminal time is the time a TU spends at a line terminal.

Once the vehicle gets to the terminal point there are various activities that happens at that point. So it is not that vehicle arrives at its end terminal and it immediately reverts back and starts it reverse journey along the line. Usually the terminal time includes the vehicle turning time or how much time it takes to turn around for the new for the next trip; change in driver, so may be the scheduled line has a different driver; change in resting of the crew, there is some time in public transportation. We have to remember that labors laws apply.

We have to give resting time to all the crew, the drivers, and the conductors on the line. So there is some resting time involved; adjustment in schedule, so it may be that the vehicle has arrived ahead of schedule or it is late and schedule. So how do you adjust all those schedules for the next

run to begin? That is all taken in the terminal time and recovery for delays. So, terminal time is the time that a transit unit spends at the line terminal at the two terminals at the end.

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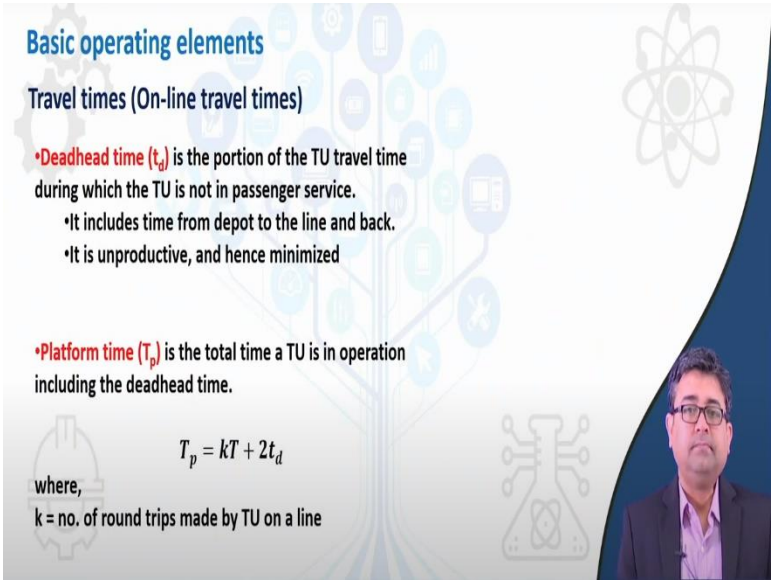

The next terminology to remember is what is called a dead head time. Now that is the proportion of the TU travel time during which the TU is not in passenger service. So deadhead meaning it is either headed from its terminal to its depot or back, or if it suddenly breaks down on the road and it has to be taken to a maintenance shop, so that time which it is not serving any passengers, is called the deadhead time.

Since it is not serving the passengers it is usually unproductive and hence all transit operators want to minimize the deadhead time. Then is a platform time. Now this is the total time a TU is in operation including the deadhead time. So when somebody says the platform time of TU is this we have to remember that the platform time includes the deadhead time along with the operational time.

So the operational time when it is actually functioning and serving the passengers plus the deadhead times. So the deadhead times may be there on each side of the 2 terminals, there may be 2 deadhead times. So if there are k number of round trips made by TU on the line, so k times T plus these 2 deadhead times add up to what is called the platform time.

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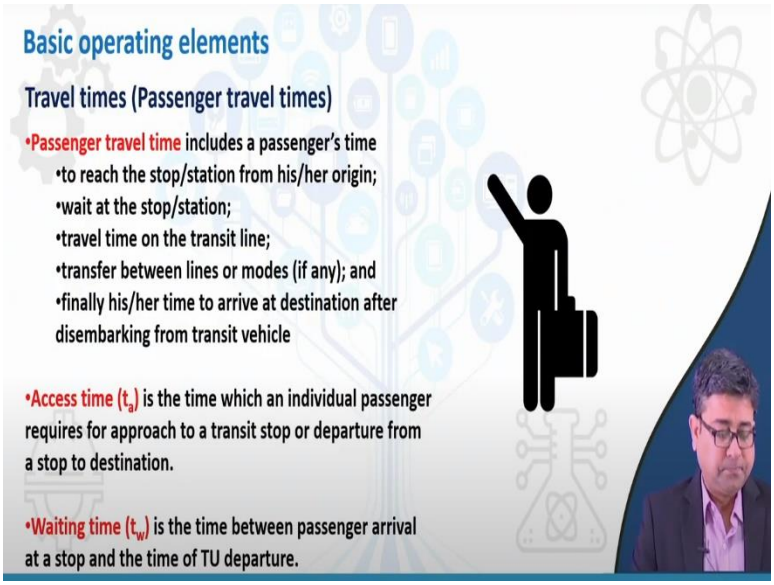

Now those were all the travel times when we look at it from the point of view of the operators. Now if you look at the travel times the point of view of the passengers we see that the passengers travel time on a transit line has 5 different sub classification. So, first element in a passenger travel time is the time that a passenger takes to reach the station from his or her origin.

So a public transportation line does not come to your home or your college or your restaurant or your hotel; you have to reach to that point. So there is some amount of time that is involved in reaching to a bus stop or metro station. So, this is the first element in a passenger's travel time in to a public transportation line. The second is the wait at the station or at the stop. You have to wait as maybe the bus or the metro does not arrive immediately.

So the third is the actual travel time on the transit time. We usually always think that this travel time on the line is the total passenger travel time. That may be significant portion of the total passenger travel time and that is what we want it to wanted to be. But many a times, accessing and egressing the transit station, and waiting at the transit stops also take up a lot of time. And sometimes the next element may not always be present.

Sometime if you are transferring between two station or two transit line then there is some time that is involved in transfer. So that also has to be added or taken into account when we are calculating passenger travel time. And the last element is once you get off of the transit line you

have to then again go to your final destination, you have to access your final destination. So that maybe very close to the stop, or that maybe a little further away, and it may take some time.

So that time has to be included. So you see when we talk about the passenger travel time it is not only the travel time on the transit line, but there are other elements associated with it as well. So now let us break it down and look at each of those elements. Now, the first element is the access time. The access time is the time which is an individual passenger requires for approach to a transit stop or departure from a stop to a destination.

So at both ends of the trip where the passenger is accessing the station from his or her origin and is then accessing his final destination from the stop where he or she disembarks from the transit time. So, both of those are called access time so you have to take both of those in to consideration. The next is what is called the waiting time. Now this is the time between passenger arrival at the stop and the time of the TU departing that stop.

So usually we want to minimize these weighting times and passengers also look at minimizing these waiting time. So when we looked at the headways in the previous class we said that if the headways are greater than 6 minutes we usually want a clock headway, which are divisible by 60. So usually if you, i.e. if the passenger, knows that the next bus arrives 10 minutes past the hour,

he or she calculates the time it needs for him or her to travel from the origin to the bus stop and then optimizes that, so that he or she has to wait there for the least amount of time. So this waiting time, we always subconsciously try to optimize it, so that we do not wait at the bus stop for a long period of time. If the headways, i.e. the transit headways, are very small then we do not usually have to calculate that because we know that you will be waiting there for 1 or 2 minutes only because the frequency of service is very good.

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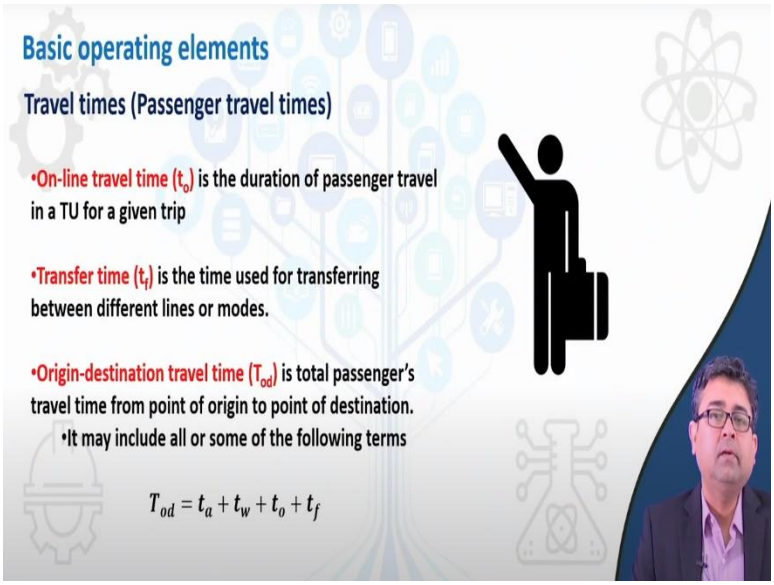

Now the on-line travel time is easy to understand – it is the duration of passenger travel in a TU for a given trip. So it is actually the time when the passenger is on board a transit line. Transfer time is the time used for transferring between the different lines or modes. So what happens is now you have different types of modes or different types of public transportation modes that you can take to complete your trip.

So you may be traveling from point A to point B. But point A to point C first you go using say for example bus and then point C to point B the larger line you go on a metro. So now you are dependent on 2 different schedule or 2 different headways. So there is a bus schedule then there is a metro schedule. So when you are transferring from bus schedule to metro schedule you see there is a this transfer time involved.

Now if your bus schedule and your metro schedules where aligned with each other, i.e. were integrated with each other, then this transfer time could have been minimized or would be minimized. But in many or most of the cities in the world, such coordinated systems are very few. So if there is a delay in the bus, suddenly you see that your transfer time is increasing because now you have missed the metro and you have to wait little bit longer to get to the next metro.

And then there is also the actual transfer time. So it is not only the transfer, wait time but now maybe the bus stop is 5 minute walk to the metro station. So you have to actually walk from the

bus station to the metro station then wait to the metro. So, all of that includes the transfer time between 2 modes or 2 different lines of public transportation. And then comes the final origin-destination travel time, that is the total passengers travel time from point of origin to point of destination.

So that is the summation of the access time, wait time, the on-line travel time and if there is any transfer time involved. So all of those summation is what is called as origin-destination travel time.

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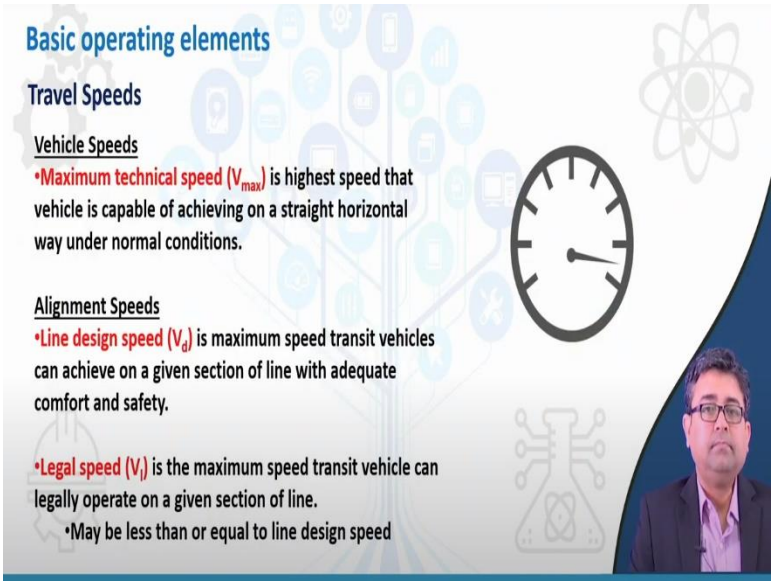

Now that we have looked at the travel times, similar phenomena is to look at is the travel speeds or vehicle speeds or travel speeds. This travel speeds have 4 different type of speeds that we will looking at. First one is called vehicle speed. So, maximum technical vehicle speed is the highest speed that the vehicle is capable of achieving on a straight horizontal way under normal conditions.

So every vehicle has their limitations. So every vehicle on a transit line can only achieve a certain maximum technical speed. And it also depending upon the straight horizontal way. So if there are lots of curve on the road, or on the transit line, the maximum technical speed may not be achieved. And in a normal condition, meaning it is a bright sunny day, when there is no rain or there is no fog or such thing so that is what is called maximum technical speed which is the vehicle speed.

Now there are different types of speed that are associated with the actual alignment of the transit line. The line design speed is the first. The line design speed is the maximum speed transit vehicles can achieve on a given section of line with adequate comfort and safety. There may be different sections in a same line, on a section in the line, design speed depends upon the safety and comfort of the passengers travel.

So usually we do not want to achieve the maximum speed if comfort and safety is compromised. So the line design speed and a maximum technical speed have some relationship with each other. We want to keep the line design speed as per the alignment, or as per different sections in a transit line. Then there is a legal speed, which is the maximum speed transit vehicle can legally operate in a given section of line.

It may be less than or equal to design speed. Just like on the roads we have speed limit signs which are legally enforced or that can be legally enforced. Similarly there is some legal speed on which the transit vehicle can operate.

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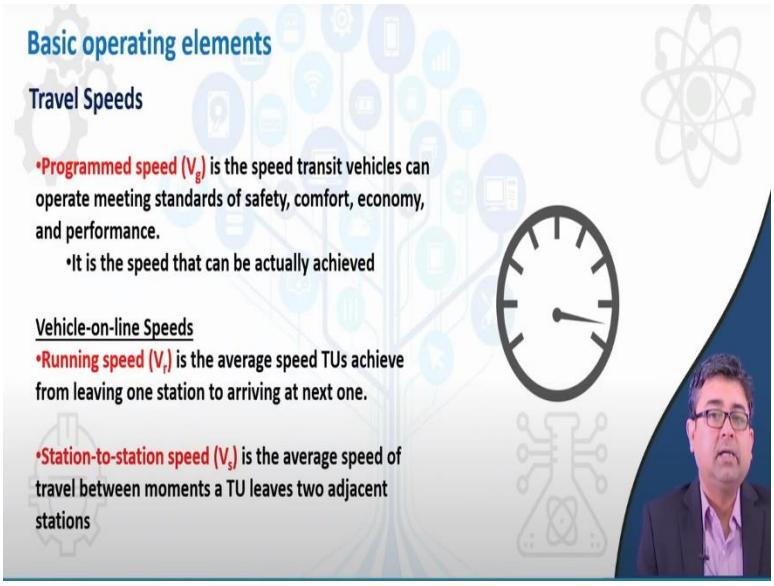

Next is the program speed. Now this is the speed that can be actually achieved. So the program speed is the speed transit vehicle can operate meeting standards of safety, comfort, economy and performance. They are programmed to travel at that speed so you would see that sometimes

buses are traveling on the road but the road are empty then you will think that why the bus is not speeding up.

On this empty road we can go fast but they are programmed to go at the certain speed because they have to maintain the schedule at each stop. Because people at the next stops know that the bus comes at this point or at this time. So you cannot go fast and bypass that schedule time. So there is always a program speed associated with it. So that is what essentially programmed speed means.

The next category of speeds that we have to aware of are the vehicle on-line speeds. Now when the vehicle is running or when you are on a vehicle, or on a transit line, what the different speeds that can be defined are. First one is the running speed. When we say running, it is the average speed TUs can achieve from leaving one station to arriving at the next one. So similarly now you find a lot of similarities between the travel times that we have looked in the earlier definitions.

So this is the average speed TUs can achieve from leaving one station to arriving at next one. There may be different types of vehicle running on the same line. What is the average speed that all of these TUs have achieved. The next is the station to station speed. Now this is the average speed between the moment a TU leaves two adjacent stations. So what will be included in this would be the time taken to stop at the station.

So when the vehicle stops the speed is usually 0. So this will be taken into consideration in the station to station speed.

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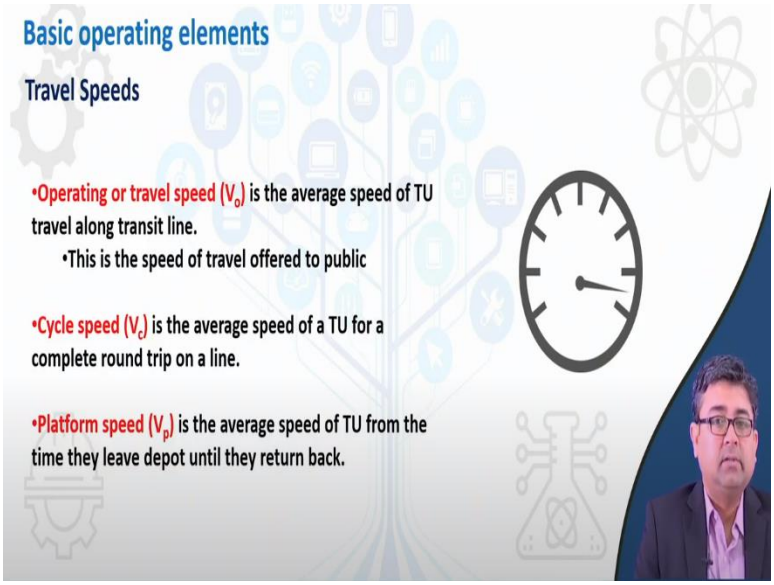

Now operating or travel speed is the speed that is offered to the public. So when we say that transit line operates at this operating speed or travel speed this is what we mean is the average speed of TU travel along the transit line. The average speed in some times on the day can be higher and sometimes in the day can be lower due to some congestion on the street. If it is metro kind of transit operating speed are pretty constant throughout the day depending upon the headways of course, but it usually pretty similar throughout the day.

So that is the speed that is given to the public. So the public then can calculate to travel 10 kilometers, based on this average speed that the transit vehicle is operating. So I can reach my destination or the destination stop or station by this time. So this is the element that is taken into consideration. The next thing is the cycle speed this is the average speed of the TU for a complete round trip on one line.

So, once the transit unit completes a round trip, so back and forth. So what is the average speed during the entire run is known as the cycle speed. And lastly platform speed is the average speed the TU from the time they leave the depot until they return back. So remember there is platform travel time as well. So this is similar to a platform speed where the depot travel time are the speeds from which the travel from the depot to the transit line and back are calculated.

So it is not only the operation travel speed but also the speed with which they operate when they are going back and forth from the depot as well.

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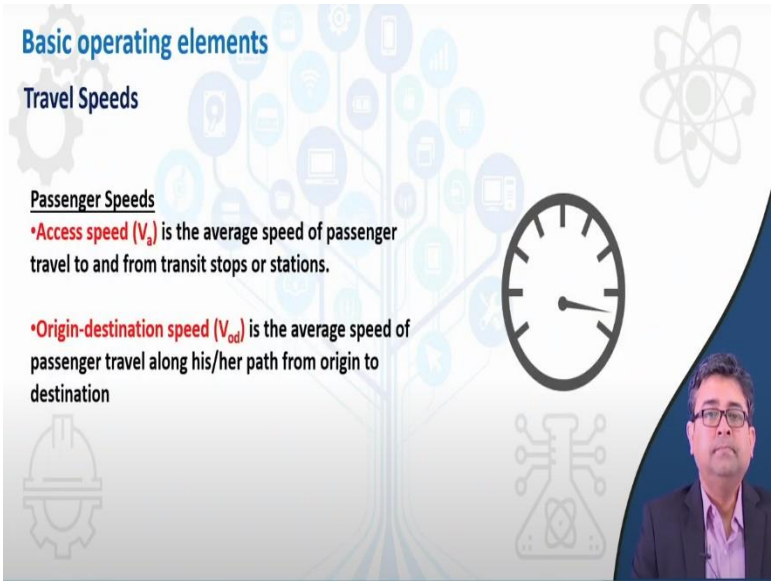

Lastly, the other type of the speed that has to be considered is the passenger speed. Now just as passenger travel time there are different aspects of passenger speed as well. So access speed; now access speed is the average speed of a passenger travel to and from transit stops or stations. So just as there is a travel time involved to access a transit stop, from say your home or your college to the transit station, similarly there is speed involved.

So that now you can walk to the transport stop or station or you can come on a bicycle or you can take you own vehicle and park there. So all this will have different types of speeds involved. So these speeds play a very important role when we are calculating the passenger travel times. So a passenger maybe in a hurry so he or she may take his motor vehicle, 2 wheeler or car, to the public transportation stop or station and park it there and then take the metro or bus.

But parking is not available then he or she may have to either walk or take some other intermediate public transportation mode such as rickshaws or cycle rickshaws whatever they may be and then access the public transportation line. So that speed is called the access speed. Then the origin-destination speed is the average speed of the passenger travel along his or her path from origin to destination.

Now this is the total origin to destination speed which will also have access speed, and speed on the transit line. You already looked at speed on the transit line if you add the access speed on

both ends of the trip now, that will give you the origin-destination speed, the average speed of passenger travel along his or her path from origin to destination.

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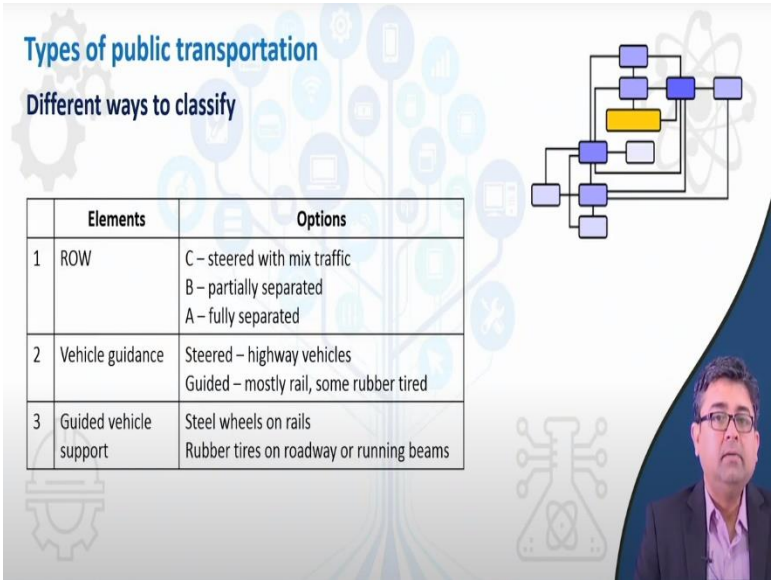

So those were all the different types of speed and travel times that we have; that we were able to show you; and that is something that you have to remember as we move forward and try to solve some problems. Finally let us look at how differently we can classify all these types of surface public transportation system.

We have already looked at the right of way element and how they can classify C, B or A. They can also be classified as different types of vehicle guidance -- they can be a steered vehicle like buses, or they can be guided vehicles, which as rails or sometimes on rubber tired transport as well. But mostly rail transport metro rail or light rail or public transportation rail or region rail, all of these are usually guided systems, or guided public transportation systems.

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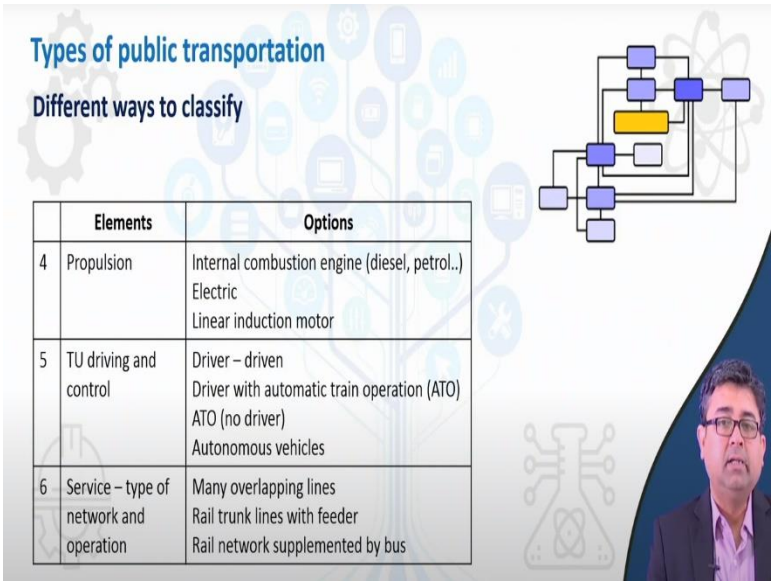

Next if you move on they can be also classified based on the propulsion -- either they are IC engine vehicle, the electric vehicles, or the induction motors. There are different types of technologies that these transit vehicles may be using and they can be classified separately as well. The main basis of classification is the operating cost and the headways; all can be calculated based on all these different elements of classification.

Transit unit in driving and control -- it may be driver driven, or you already know that there are lot of light rail or metros rails that have automatic train operations. So they do not have any driver, and they run automatically on the rails, and now of course there are autonomous vehicles that are also coming up. And then the other type of characterization that are done is based on service.

There may be many overlapping routes, there may be we look at how different types of public transportation network has setup. We have only looked at couple of maps that you saw that there were lot of overlapping routes, there were lot of interconnecting routes. But they all have their basic advantages and disadvantages. And based on the character of city these types of services are developed. So public transportation system can also be categorized based on what type of service they provide; the type of network; and operation that is available.

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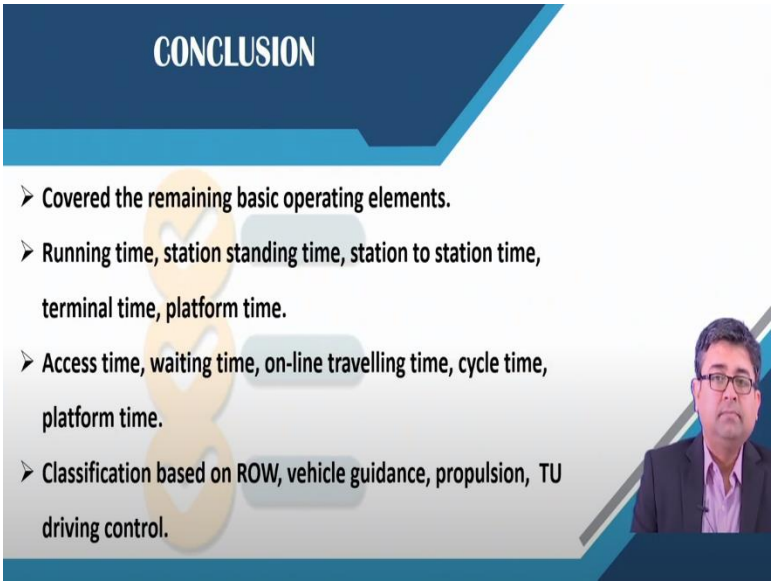

So now we come to the end of our basic operating public transportation module. We have covered in this lecture all the other elements such as the running times; the different types of times involved -- the station standing time, station to station time, etc. We also looked at access time, waiting time, and then we looked at different types of classification that are based on right of way, vehicle guidance, propulsion or driving control.

I hope you now got your basic foundations of public transportation and from the next class onward we look forward to giving you some examples; solving some examples based on all these terminology so that you understand how the basic transportation system works. Thank you.