Modeling and Analytics for Supply Chain Management
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Lecture 38
Fixing Fares for Public Transportation Systems

Hello and welcome to Modeling and Analytics for Supply Chain Management. We are into week eight and lecture 38. Now, as you know that this entire week we had devoted to public systems management and the way we do costing for public systems management. As I prelude to this, we had basically looked into the ways we do transport costing. We are also looked into the transportation systems that we have in the world and we gave you a brief orientation about the public transportation systems.

Today, we will deal with how to Fix Fares for Public Transportation System. If you recall in the previous week, we had told you that fixing fare for a public transportation system is very challenging, it is very debatable issue, it is very challenging issue. Now, today we will deal with how to fix fares and we will show you two approaches on how to fix fares in a public transportation system.

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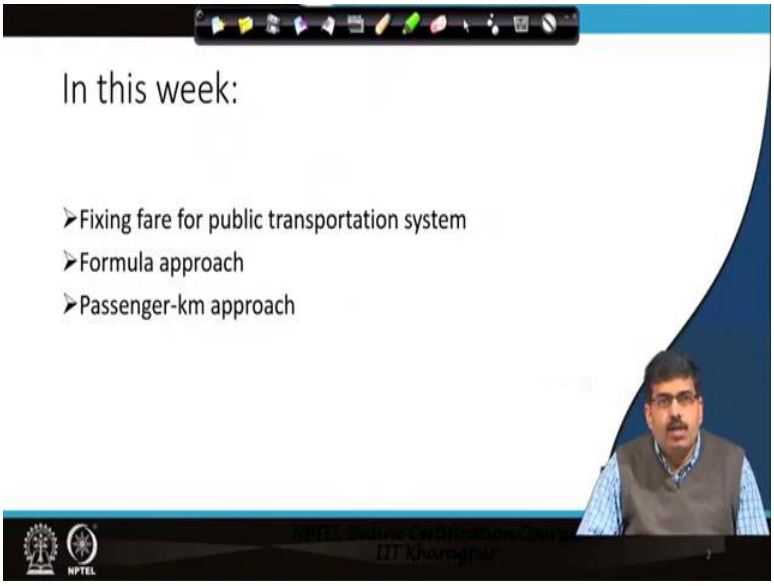

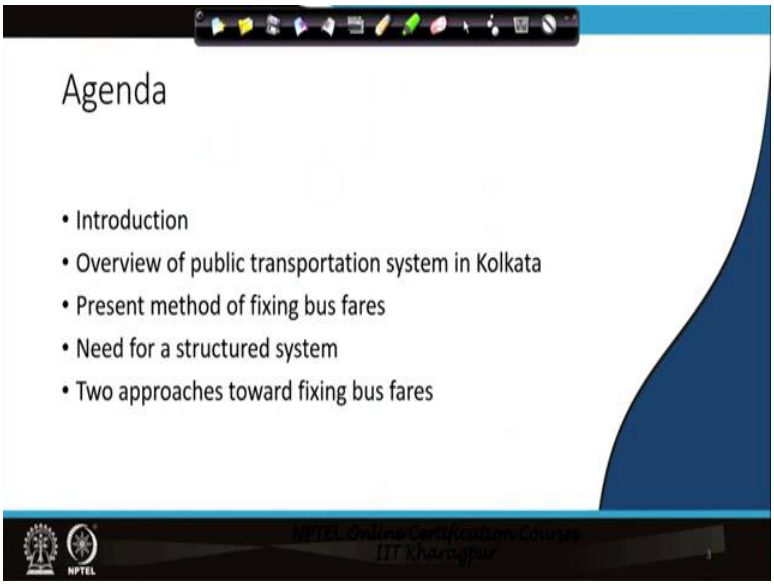

So, the two approaches that we will show you is a Formula approach and the other is the Passenger Kilometer approach. Now, see, we will take the example of Kolkata city in India, the metropolitan city and the capital of erstwhile British India for up to 1912. Now, see we will tell you what the background of this how to fix fares of public transportation system, what is the background.

See Calcutta or Kolkata as we know it till, know the city as of now. Calcutta is a city where the population density is very, very high and every day the suburbs of Calcutta bring in not hundreds, not thousands, but hundreds of thousands of people to the city who come to the city for work and once the day's work is over, they go back to their hometown, which in some cases, maybe 30-40 kilometers away.

Now, when you are traveling this 30-40 kilometers every day. Either by train or by bus, when you are traveling, you are paying money and you are earning a fixed quantity of income. But if your expenses become too high, your transportation expenses become too high. Then there is a problem, then people will not come to the city for work, people will stay back in their localities and earn less. But yet save money, save the huge amount of transportation costs that they would incur if the transportation cost is high.

That is why public transportation in a democracy, costing public transportation is always a very, very challenging debatable and is always incurred in a social mode as public

welfare or a social mode. So, that is why this agenda today that is how to fix fares for public transportation system.

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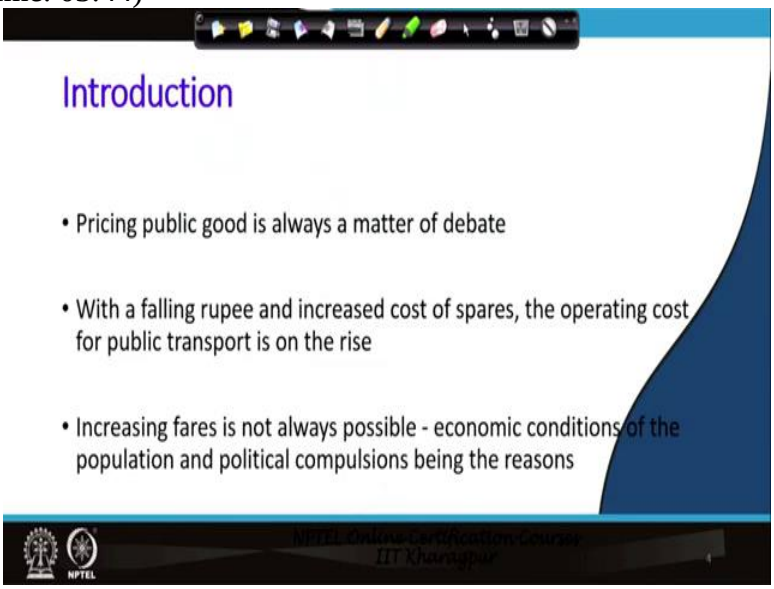

Now, what is happening now is with increase in fuel prices and increased cost of spare parts, the operating costs for public transport is on the rise. Now, when operating costs for public transport is on the rise and your revenue is this much your, the price of a bus ticket or a train ticket or whatever the price of a bus ticket that is fixed and your cost are rising.

So, what is happening, the margins are coming down and when your margins are coming down the bus operators there, it is now hitting them. So, that is why they want an increase in the bus fare, so that the margin can be maintained. So, but then there is a problem that is point number three.

If you want to increase the bus fare, just now we mentioned there is an issue, people who are coming from faraway distances and not only by one bus, you are taking multiple connections in between. So, your transport costs become so high, your fare the amount that you pay from your pocket becomes so high that you do not want to come to the city.

Rather you stay back in your hometown and work from there. So, what happens, in the long run the income per head or the per capita income of these people also come down,

when a per capita income comes down that hits the savings and that hits the growth rate of the economy. So, increasing fares is very, very much related to so many other aspects. Now, this is one thing what you will have, which as an analyst, one has to be very careful about.

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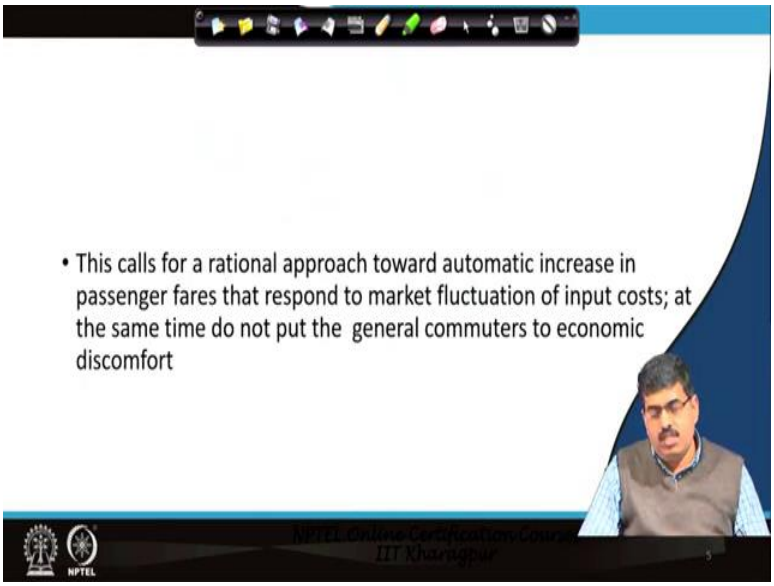

So, that is why we say that this calls for a rational approach towards automatic increase in passenger fare that respond to market fluctuations of input costs and the same time do not put the general commuters to economic discomfort. So, somewhere you have to make a balance if you do not increase the fares the transportation system which comprises of n number of small, small private operators or buses.

What are you doing? Let me give you give you a broad overview. I think I should give you that otherwise you will not appreciate the situation. See the buses are owned and operated by private payers.

They are owned by private payers, operated by private payers. But just to prevent them from charging anything, from the commuters charging anything at any point in the day that is morning you will charge some amount, afternoon you will charge some amount, evening you will charge some amount and late night when there are very few buses on

the road you want to extract money and so, you charge much more money, much more as bus fare.

So, to prevent this right from the beginning, right from the history of transportation system in Calcutta either vehicle may be privately owned and operated. But the bus fare is fixed by the government and the bus fare is fixed in slabs, where up to 8 kilometers you pay this much of money, up till 10 kilometers you pay this much of money.

So, the fares are controlled by the government but the vehicles are operated by the private sector. So, whenever the fuel price increases, the cost of operation increases and so, these private payers come back to the government and say that you increased the bus fares. The increase in the bus fare as is problems as we just mentioned.

So, now the private operators want, that let there be a mechanism, where every increase in the cost components of bus operation, I am repeating, the private operators are saying that for every increase in the costs of the cost components of bus operation, every increase up to a certain amount, you increase the bus fares by 1 rupee or increase of certain amount you increase the bus fare by 5 rupees.

So, they want a rational approach, that if costs increased by this much, is cost increased by this much, my bus fare increases by this much. So, the margin is maintained, original margin is maintained. But there lies the problem as a government said, that every day the oil prices are increasing which we will do not have that much of control over and every three to four days you have to increase your bus fare by 1 rupee or every 10 days and then if the bus if the fuel prices come down, then the bus fares also logically should come down.

So, such a wide fluctuation every five days, six days, seven days and the people will be confused, commuters will be confused and everybody will want to make the system, everybody will create a, everybody will want to make a problem, everybody will face a problem. So, this is something that the agenda is all about.

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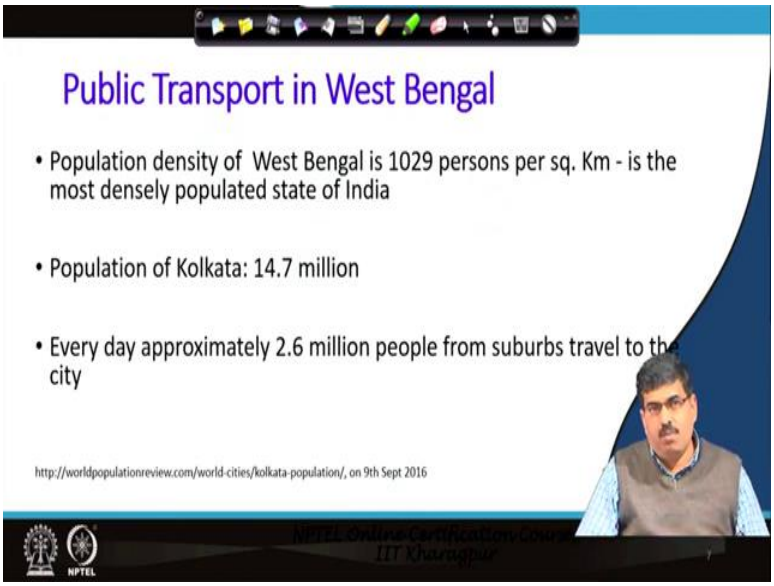

So, the public transportation system in West Bengal. The population density of West Bengal is 1029 persons per square kilometer and it is the most densely populated state in India. The population of Kolkata itself is 14.7 million and every day approximately 2.7 million people from suburbs traveled to the city. So, you can see what magnitude we are talking about. Every day 2.6 million people traveled from suburbs to the city.

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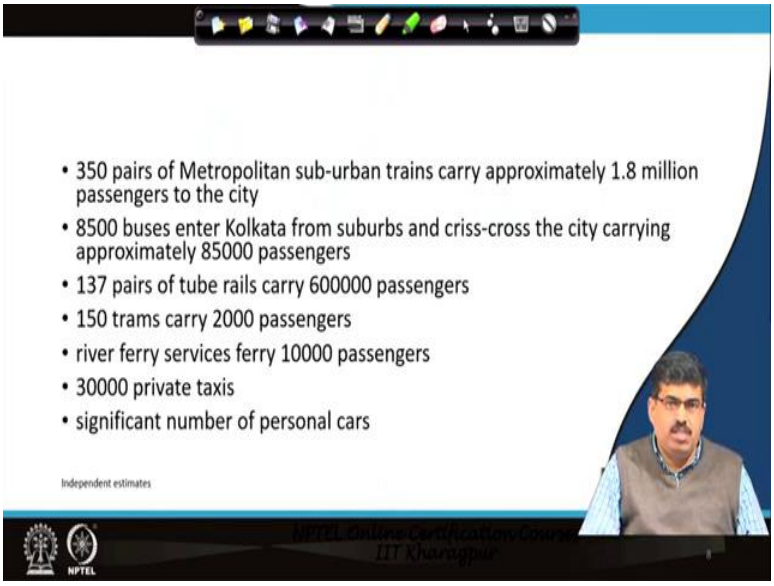

What is there in store for them? We have 350 pairs of metropolitan suburban trains, carrying approximately 1.8 million passengers to the city. 8500 buses enter Kolkata from suburbs and crisscross the city carrying 85,000 passengers.

137 pair of tube rails, tube rail? underground railway system carry six lakh passengers, 150 trams carry 2000 passengers, rivers ferry 10,000 passengers and there are 30,000 private taxis, in addition to a significant number of personal cars, much, much definitely much, much, much more than a 30,000 private taxis. This is the magnitude of a problem that you are looking at. This is the magnitude which we will have to solve.

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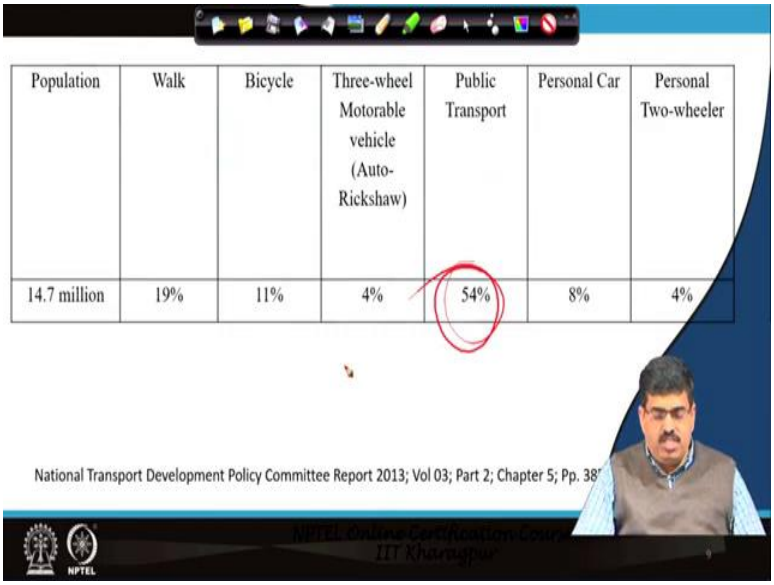

How did this 14.7 million population move when they are inside the city? 19 percent walk, 11 percent has a bicycle. Now, here bicycle will mean any other paddle mechanism transport system, three wheel motorable vehicle, which is auto-rickshaw we call it 4 percent, public transport 54 percent. Now you understand the problem.

54 percent of the people once they are inside Calcutta, they move by buses and they move by trams, they move by the river ferry service. So basically, they use public transportation systems, 8 percent have personal cars and 4 percent have two wheelers.

You may be a bit surprised why because two wheelers is something which people might have, yes, people might have but then the reason why this data is 4 percent only have two

wheelers is that not too many people drive two wheelers when they are inside the city. Because the roads are so much congested. So, much of heavy vehicles moving around speedy vehicles. So, motorcycles that is the two wheelers is not that much common in Calcutta. There has been lot of cases where people just slipped over the tram tracks and they fell and all these problems are there.

So, this is whatever we are seeing is the breakup of how people travel and what is important is that 54 percent. What is important is that 54 percent of these people move by public transport. So, now, I think you understand the importance of fixing bus fares for public transportation systems.

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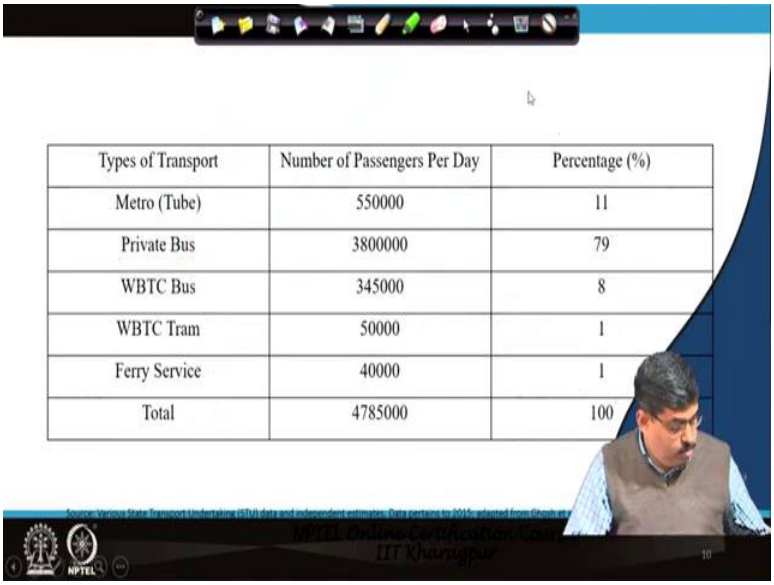

What is the breakup of the passengers that are moving? Metro the tube rail 5,50,000 passengers move per day. Private buses a whooping 38 lakh people move by private buses. You will be a bit surprised how come 38 lakh people move, it is to and fro counting the total number of buses total number of rounds they are taking, we get this number.

The West Bengal transport cooperation buses 3,45,000 people move, West Bengal Transport Corporation trams 50,000, ferry service 40,000 and total we have a 47,85,000

people moving around and the percentage, if you see 79 percent of them are moving by road transport. But you have to be very careful with this particular data.

But what I want to highlight 79 percent of the people move by private buses, private buses means I have a bus, I am running it on the routes. Somebody else has a bus he or she is running it on the routes that is private buses, WBTC buses and trams and ferry service are also these three are owned by the government.

So, roughly 10 percent of the people are traveling by this mode of transport. So, what we are saying is, that if these 79 percent of people are travelling by private buses, you have to monitor the bus fares that these private buses are charging. Otherwise what happens it is, if bus fares keep on increasing if it is like go as you like then it hampers the overall welfare of this population of the state.

So, that say the private buses are planning to increase the bus fares. They are pressurizing the government to increase the bus fares, that is the origin of developing a formula by which you can whenever the prices are increasing, you can increase the bus fare. But only up to a mathematically proven amount. So, this is the issue.

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What is the present method of fixing the bus fares? The present method of fixing the bus fares is, you keep on demanding for increase in bus fare and then after some time the government increases bus fares by 1 rupee depending on whether it is really, really necessary, that is the method. But as we say that should not be the rule, you should have a proper pricing mechanism.

So, prior to October 2015, the price of diesel was fixed by the Ministry of petroleum. Since then the oil companies are now charging their own prices. So, the price fluctuations every 15 days the price fluctuations happen.

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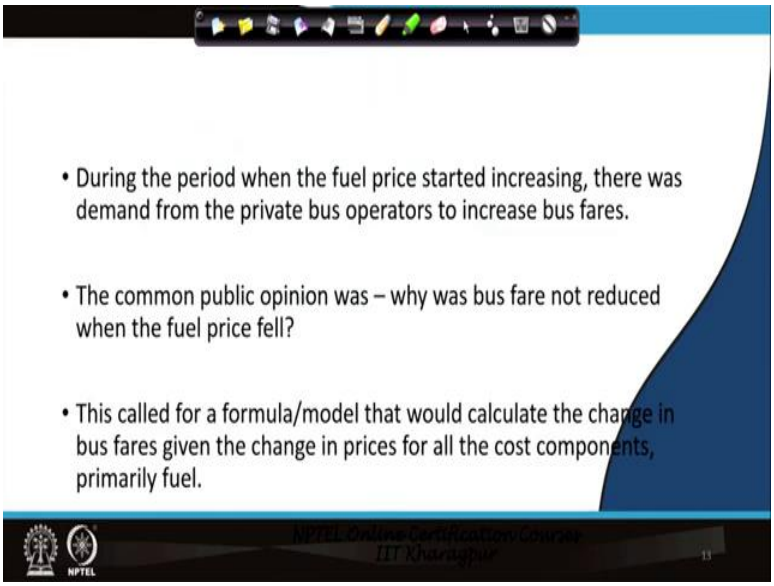

Now, during the period when the fuel prices started increasing, there was a demand for the private bus operators to increase bus fares. The common public opinion was why was bus fare not reduced when the fuel prices fall? So, bus fare rises you ask for increased bus fare, fuel price, fuel price rises, fuel price falls. But you never reduce the bus fare. So, this call for a formula that would calculate the change in bus fares given the change in fuel prices for all the cost components comma primarily fuel.

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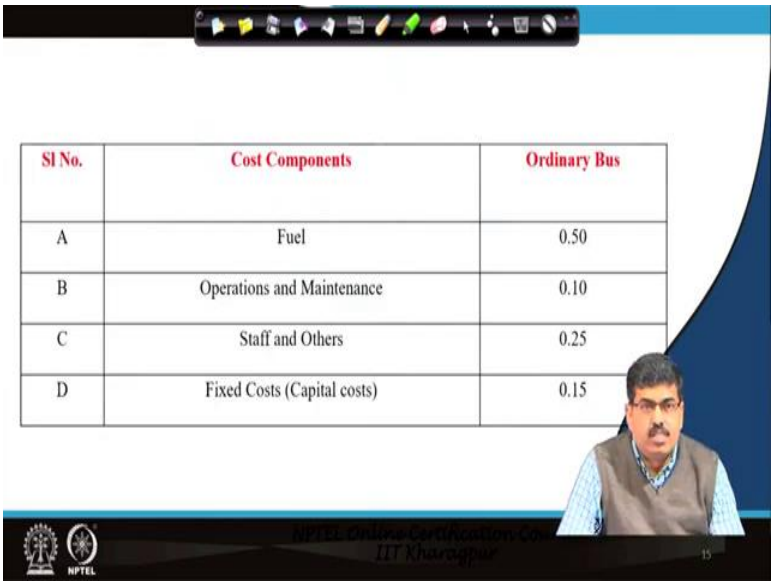

So, let us develop an empirical model for public transport. This is something you should understand cost components fuel 50 percent of the total cost of bus operation is your fuel cost, efficiency is fuel efficiencies 4 kilometer per liter. So, fuel cost is 50 percent, the cost of the bus that is the capital cost, it is the last column D 15 percent.

Staff cost is 25, operations and maintenance cost is a pretty low 10 percent. Why is there operation and maintenance costs pretty low? Because not too much of operations and maintenance costs are done. Because anyway after 15 years the vehicles are to be sold off.

So, not too much of maintenance is done, only after the 10th year when the vehicles really go into wear and tear then some maintenance is taken, a minor maintenance is always done but major maintenance is only after 10 to 12 years. So, that is why the operations and maintenance cost looks a bit less.

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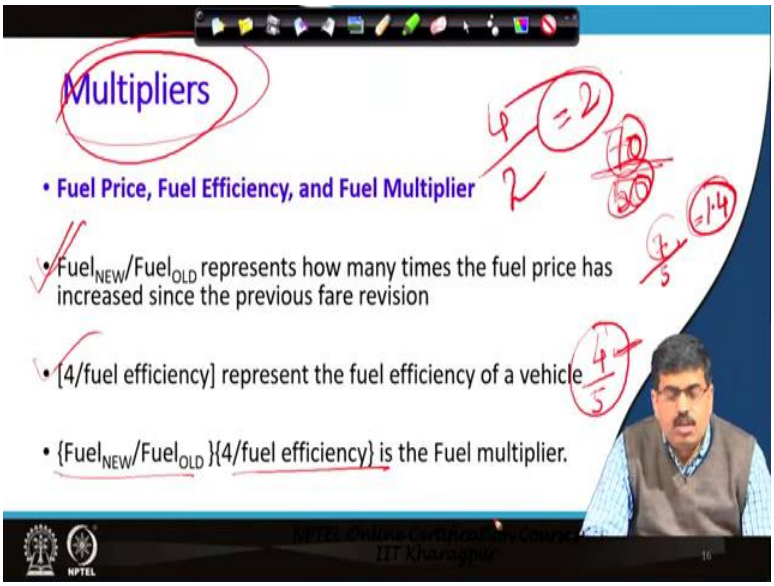

Now, we are developing this thing fuel price, fuel efficiency and fuel multiplier. What are these? See, fuel price new divided by fuel price old, represents how many times the fuel prices increase in the previous fare revision. You read this first bullet point very, very carefully. I am pausing for a second.

Fuel new by fuel old this point, represents how many times the fuel price has increased since the previous fare revision. So, your fuel price old means the price at the point of time of previous fare revision let us say a fuel price old was 50 what is the fuel price new 70.

So, it becomes 7 by 5, 1.4 times. So, this 1.4 what did we say? Fuel price, original fuel price when the last fare revision happened that time it was 50. Today the fuel price at the fuel filling stations is 70. So, how many times has the fuel price increased, fuel prices increased 1.5 times. This is what we call as the fuel multiplier.

No partly, fuel price has increase, but what is the fuel efficiency? 4 kilometer per liter is the standard by which your vehicles will consume oil in within the city. So, 4 kilometer by fuel efficiency that is the second point, 4 kilometers by fuel efficiency represents the fuel efficiency 4 by fuel efficiency represents the fuel efficiency of a vehicle. So, if your

efficiency is 5. So, 4 by 5, so this quotient comes down, which is good, not good for increasing fare but good for justification not to increase fare.

Now, if your fuel efficiency is only 2. So, 4 is the standard, 2 is your fuel efficiency. So, not living up to the standards. So, you have a multiplier effect of 2. So, the net multiplier effect is fuel price new this one, fuel price, fuel price new by fuel price old into 4 by fuel efficiency is the fuel multiplier. Fuel new by old into 4 by fuel efficient, 4 is the standard with which the vehicles move, the speed the fuel consumption per liter within the city of Kolkata.

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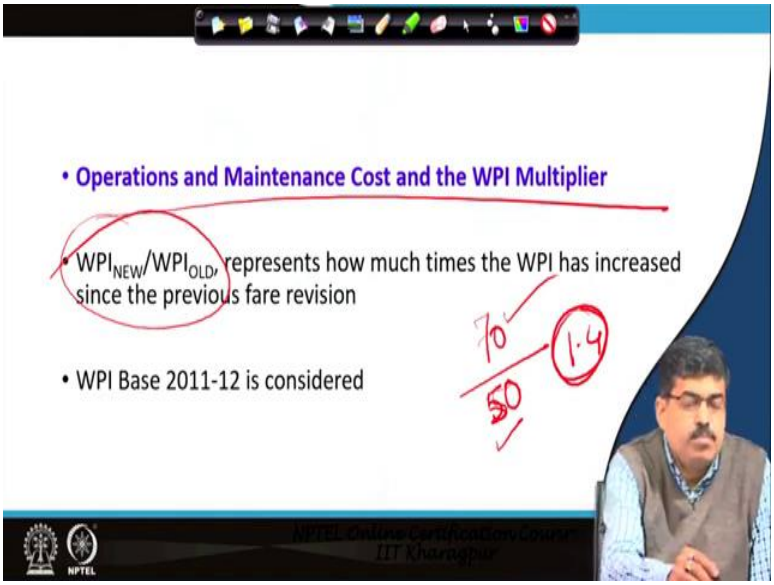

Now, similarly operations and maintenance cost and the WPI multiplier. What happens? See operations and maintenance cost is very difficult to trace how much the cost is increasing. Why? Because spare parts every day spare parts prices will fluctuate. Number one. Number two, how many spare parts do you need in a public transport system? Almost 6000 to 7000.

So, which one, how much price what is the, what is the wholesale price. So, all these are problems, plus how the price is vary from garage to garage, the prices vary from urban to rural. So, what is the multiplier that is in the previous one, fuel new buy fuel old, here

that item prices so much fluctuating. So, much varying across the villages and the cities, it is very difficult.

So, instead of that, instead of the prices of these and moreover how many components. So, dealing with 5000 to 6000 components. So, can you have a list by the time we finish completing the list already the prices are changed. So, we do not take this, we take the wholesale price index the WPI, we take the WPI new by WPI old we take the wholesale price index as a measure of increased price of spares.

If my WPI new is 70, just in the previous one and my WPI old was 50, is just for illustrative purpose. So, what has happened 1.4 times the operations and maintenance cost has increased, my earlier cost was rupees 50, present cost is rupees 70. So, the multiplier that is it has increased by 1.4 times.

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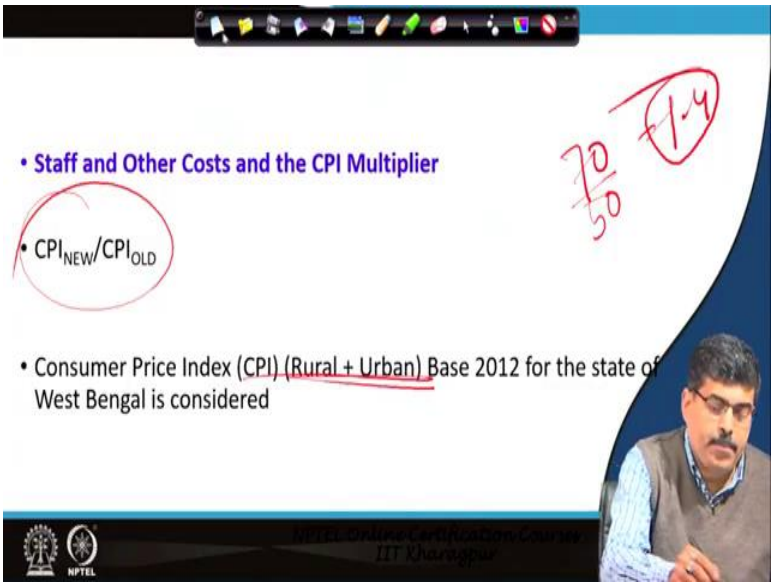

Staff and other costs same thing, you cannot measuring is because of it problem. So, we take consumer price index same CPI new by CPI old and definitely you will have to take the consumer price index for both rural and urban, why? Because a lot of people are coming into the semi urban and rural areas to work in the city. So, the staff cost again is consumer price index new by CPI old. Remember my old was 50, my new is 70. So, my multiplier effect is 1.4.

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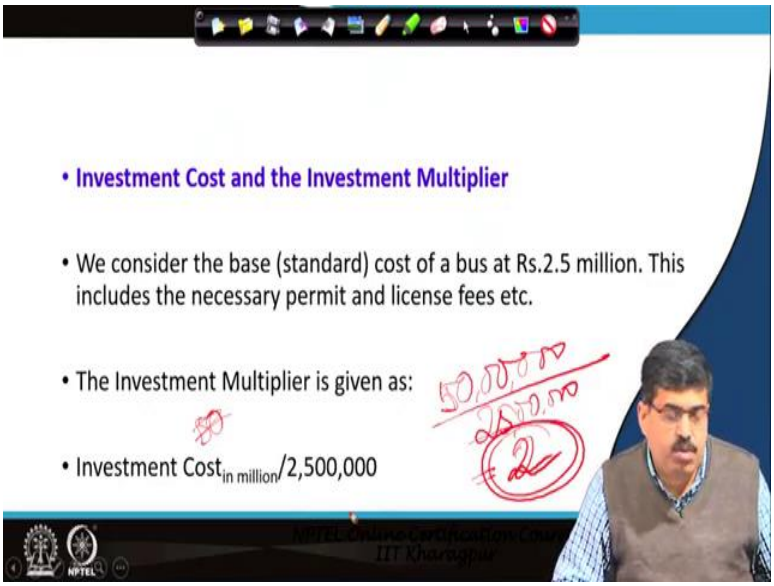

Investment cost, that is your capital costs. What will this the multiplier be, the investment multiplier is given by investment caused by 25 lakhs, why 25 lakhs? 25 lakhs is the standard price vehicle. If your prices double, so your multiplier becomes investment costs double.

So, your price is 50 lakhs, price is 50 lakhs, your price is 50 lakhs and this is 25 lakhs. So, 2, 2 is your investment multiplier. So, in this what have you got? We have got the fuel multiplier, operations and maintenance multiplier, staff cost multiplier and definitely your fuel investment cost multiplier.

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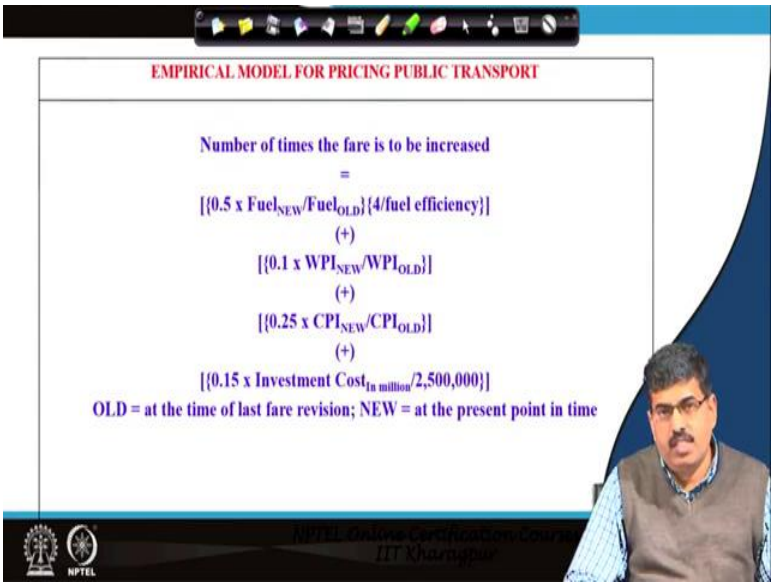

What is the formula? So, now just culminate it put it together 0.5 into fuel new by fuel old by 4 by fuel efficiency 0.1 old at the time of last revision etc, etc. So, old means last fare revision new is the new fare revision. Now, this formula has been developed by the MD of West Bengal Transport Corporation Mr. Narayan Swaroop Nigam IAS and myself. So, this is an acknowledgment that I am giving to my, to my co founder of this formula. The background work has been extensively done by us and this formula has come up.

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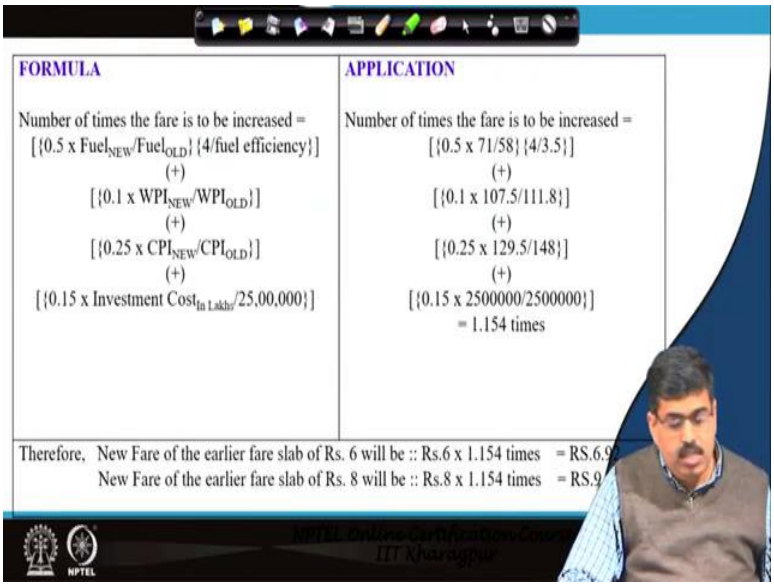

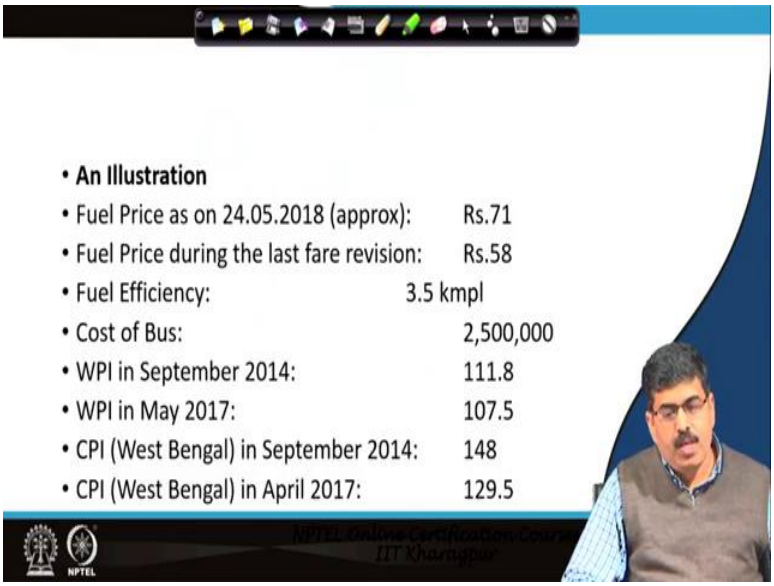

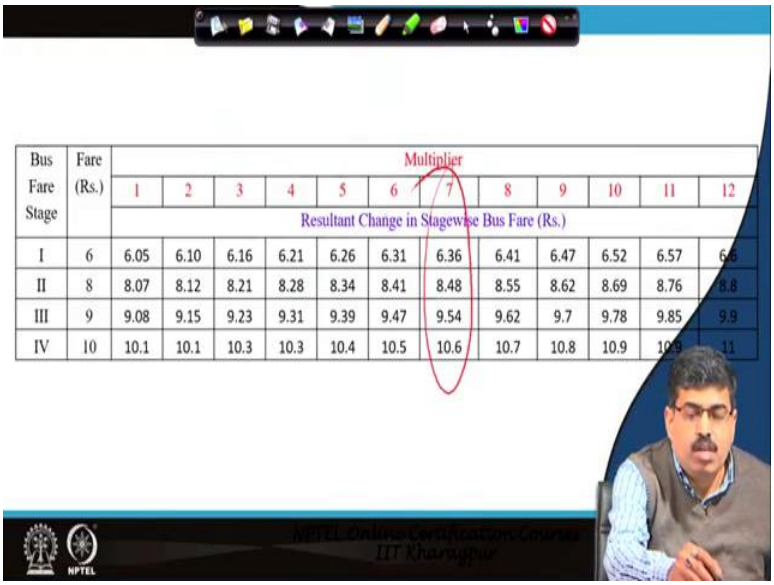

Now, we can easily compute some numbers are given. So, based on that, I have given the solutions here. You can easily compute and check how you are were faring and then if you do this table you have different multipliers, the bus fare stages and how the prices will change with the multipliers.

If a multiplier value is this, if you multiply values at this then what is the result in bus fare increase and then you will see that somewhere down the line, if you are here if you are somewhere here then that is the place where at every stage you can increase the bus fare by one rupee though the logic there decimal points are there.

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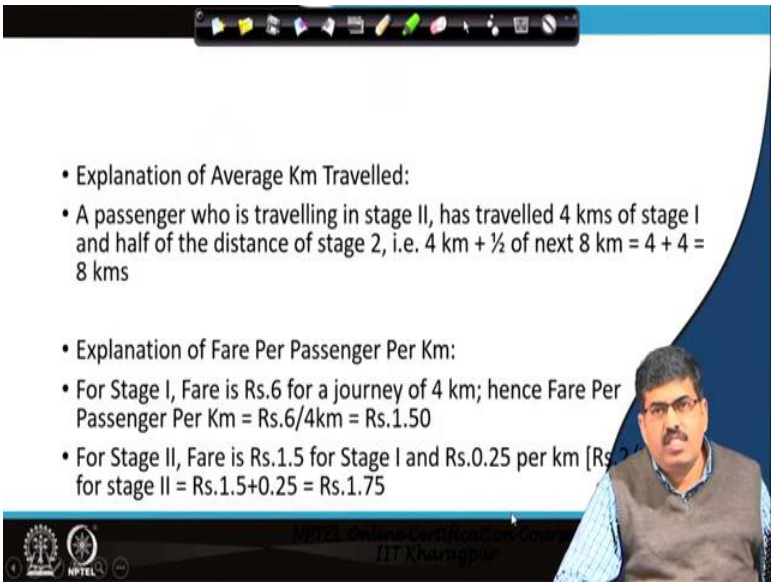

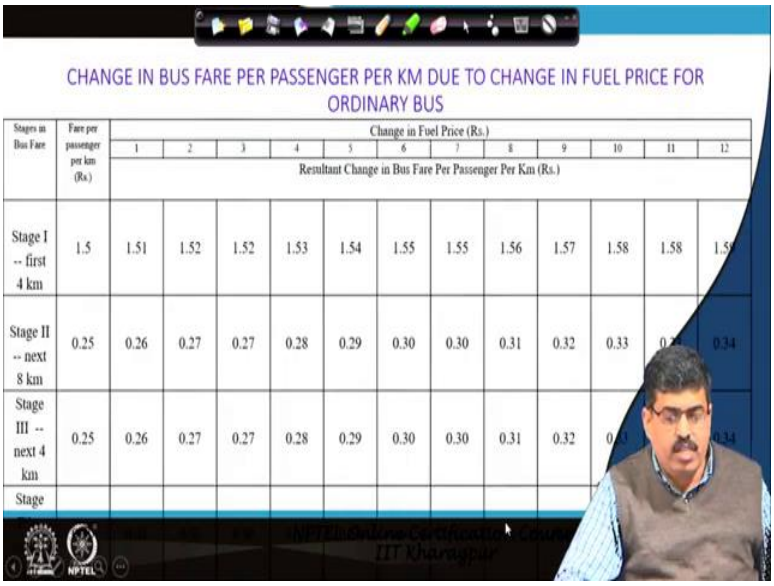

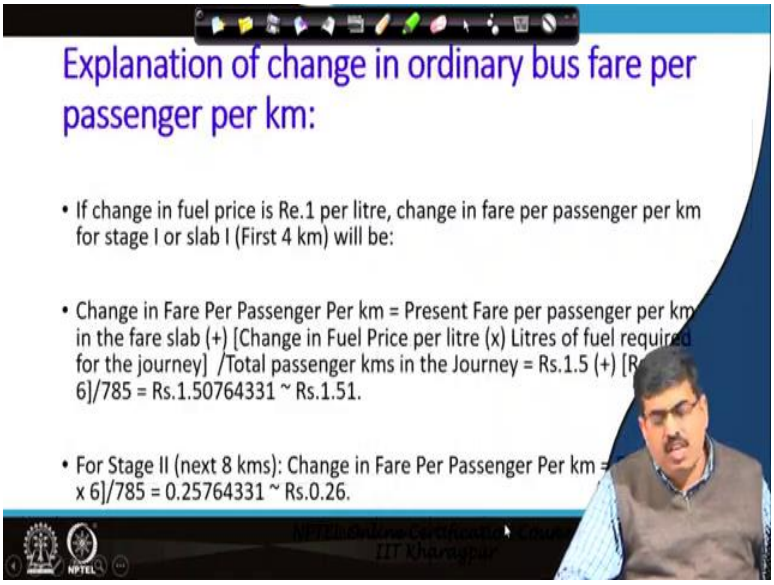

So, this is the passenger kilometer approach towards fixing of bus fare, every passenger traveling every kilometers we can calculate and get this same thing, same problem we solve it in a different manner. This is to show you how you fix public transport bus fares. Thank you so much, thank you.