Modelling and Analytics for Supply Chain Management
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Lecture 37
Public transport System Costing

Hello and welcome to modeling and analysis for supply chain management. Now, this week we had concentrated on the various nuances of transportation system. We had taken a separate module, separate week for transportation modeling. But this week our focus was on discussing the various nuances of transportation system. Because if you do not understand that, you cannot design a proper supply chain and some of these nuances will not be mathematical. But unless you know it, we cannot program these constraints in the mathematical model, these are constraints.

What did we do in the first lecture of this week, we presented to you the various transportation systems available in India and the world. What is the relevance of this? When you are designing the models you know what to do. For example, some states will run 20 metric ton trucks, some states will run bit lesser size trucks. If you are sending a goods by 20 metric ton truck, what will happen somewhere down the line you have to break it up, break-bulk. Moment you have break-bulk means time and cost have you put that in the model?

If you have not put it, then your model goes wrong, wrong means it is not optimized. If you have put it, then it is fine. So, this that was your first lecture of this week that you need to know the different nuances of public transportation systems and general commercial transportation systems.

What did you do in the previous week that is lecture 36, we had calculated, we had tried to find out the cost of operating a vehicle and that includes your fixed costs and variable cost and from there we came down to in number ton per kilometer number. What does that mean ton per kilometer number? We have calculated that rupees 1.5 is the ton per kilometer cost.

Have you ever been to a courier company or transport and not using a computer? Moment you go you say, I want to send goods to Bombay, without even blinking that person will say 5000 rupees. How did that number come? That number has come from nowhere. That number has come from that per unit transportation costs, cost of transport per ton per kilometer. That means if you are shift moving a product from, of one ton for one kilometer you are paying 1 rupee 36 paisa.

Now the transport agents you are sitting there booking cargo, they do not know where is Nashik, they do not know where is Pune, they do not know anything. What they only know is that rupees 1.36 or rupees 1.5 and what happens when you go as I want to send to Bombay, there is some numbers because your products move every day to same similar destination. So, they know Bombay is how many kilometers, Nasik is how many kilometers, Pune is how many kilometers?

So, they just multiply that 1.36 or 1.5 whatever answer you have got, multiplied by that distance of the cities from your boarding point from your booking point. So, we are booking from Calcutta, if you are booking from Kolkata to Mumbai, they only know the distance from Kolkata to Mumbai and then multiplied by 1.3 by or 36. So, they only know the distance that is what the in a nutshell, our previous week's issue was that if you know the distance you only need to know one number just keep on multiplying with that number and your job is done.

So, that was our previous exercise you need to know that one number, we will just shift now. We will shift to public transport systems costing. Why is it relevant for supply chain? Yes supply chain is not devoid of this aspect also. Public transport is not a part of supply chain we cannot say that today. It is definitely a part of supply chain because why because your products are moving in the base of buses and other vehicles aircrafts.

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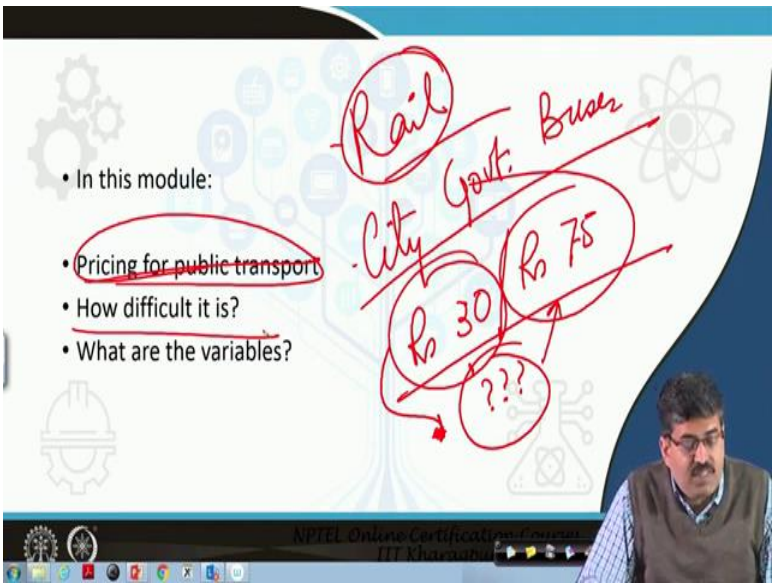

So, today we will deal with public transport systems costing. Now, what do we mean by public transport? See anything which is not owned by a private operator is a public transport. So, what are examples of public transport? Rail, City Government Buses these are examples

of public transport. Now how do you charge? You are traveling from let us say Howrah to Kharagpur. What is your local train fare? Rupees 30, What is your express train fare? Rupees 75.

How did you come up to these numbers with these numbers? How did you come up with these numbers? So, this is the essence of this is what we mean by pricing for public transport. How did you come up with this figure of 30 and 75? It is not exactly the costing method that we are taught number one.

Number two, how difficult it is? what are the problems faced? Your existing fare is rupees 30, train fare assume we are moving within the city of Kolkata, you are paying a bus fare of rupees 7 or rupees 8 minimum, some cases AC buses rupees 20-25. So, that is a minimum bus fare that we are paying.

Two issues, question number one, how did you arrive at the 7 or rupees 8? Number two, how did you come up rather rephrase it, how did you come up with that figure of 7 or rupees 8, what basis? what is the cost? And second thing is with fuel cost constantly increasing. How do you adjust the bus fare regularly on a regular basis, so that your people do not get angry? Your citizens do not get angry.

So, this is what we how difficult it is why difficult etc, etc, that this is why it is becoming very, very difficult. How difficult it is? that if you really go by calculations, somebody might ask you why, so frequently fares are increasing? Nobody will understand that fuel prices are also increasing or used to increase after a certain point of time and during certain halves of the day. What are the variables? This is what is public. So, this is what we intend to cover today.

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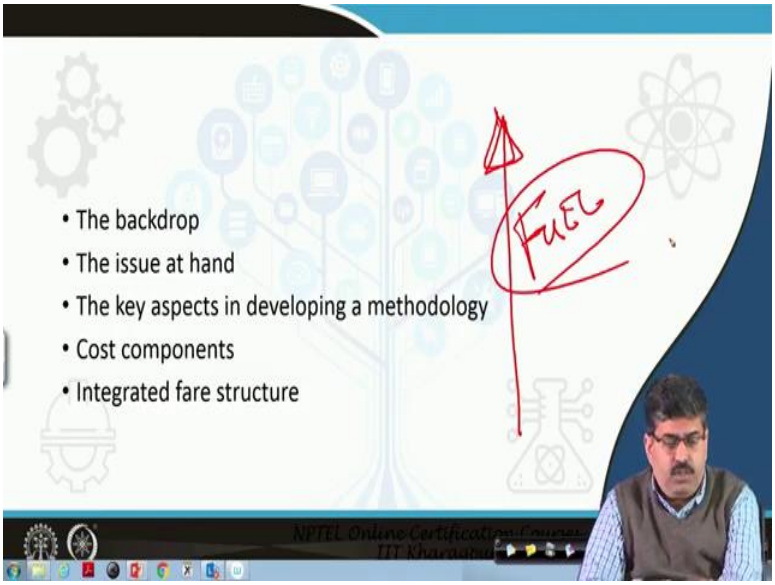

We will give you a small real-life example for this, this happened to a with a particular state and we will camouflage it and take the example of Kolkata. Every day millions of people are coming into Kolkata from suburbs working and going back what are the modes of transport rail road, water because air travel you will not take to come from suburb to Kolkata and definitely will not flow by pipeline.

So, road, rail and water, now what happens both these road rail and water leave out rail because that is government own. But water and road are privately owned operated buses. So, what happens these two vehicles are very much. So, these two vehicles are very much dependent on these two vehicles are very much depended on something called fuel. There was a time till some, about two years back when the fuel price was constantly increasing in a very creeping manner, in a very creeping manner the fuel price was constantly increasing.

So, there was tremendous pressure by the transport operators to increase the bus fare. Now, that bus fare is something which is associated with public sentiment, ability to pay, willingness to pay, so many other things. So, there was a bit reluctance or I would say a bit cautious approach by the government that whenever we increase bus fare that should be based on some sound justification some logic.

So, government now wanted a formula that takes care of whenever the oil prices increase, your bus fare will increase. So, the government wanted a formula that takes care of this increase in price. The second thing that the government wanted was whatever formula you gave fine, but give us a number. Give us a number, what is that number say? The number

says that okay when your prices when your price today your price is based 0 rupees 50 whenever the price is the price is creeping the best is creeping up whenever the price is creeping up and when it reaches rupees 7 increase, you increase the bus fare by rupees 1.

So, whenever the price keeps on increasing and moves up to a particular point it moves up to a particular point you increase the bus fare up to rupees 1. So, what is that point and how do you calculate that point. So, this was the agenda, so one is that you come up with a particular number, what rupees is the fuel price has increased since the last fare revision rupees 7, rupees 8, rupees 9, rupees 10, we will increase the bus fare by rupees 1.

Or the second option is what is the formula if we apply that as and when bus fare increases your fuel increases the bus fare can also increase. So, this is the backdrop with which we will start working. The issues at hand the key aspects in developing a methodology cost components integrated fare structure right.

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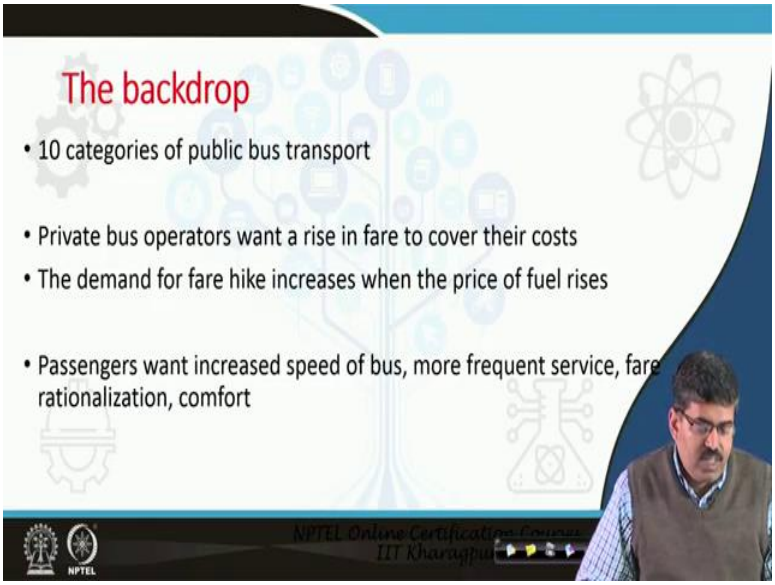

We have 10 categories of public bus transport in Kolkata right from AC two different types of private buses, different types of government buses, etc, etc. Now, the private buses as you mentioned wants a rise in fare to cover their costs and the demand increases when the price of fuel rises. The passengers want to increase speed of bus more frequent service fare rationalization. So, there is always a clash between both these groups.

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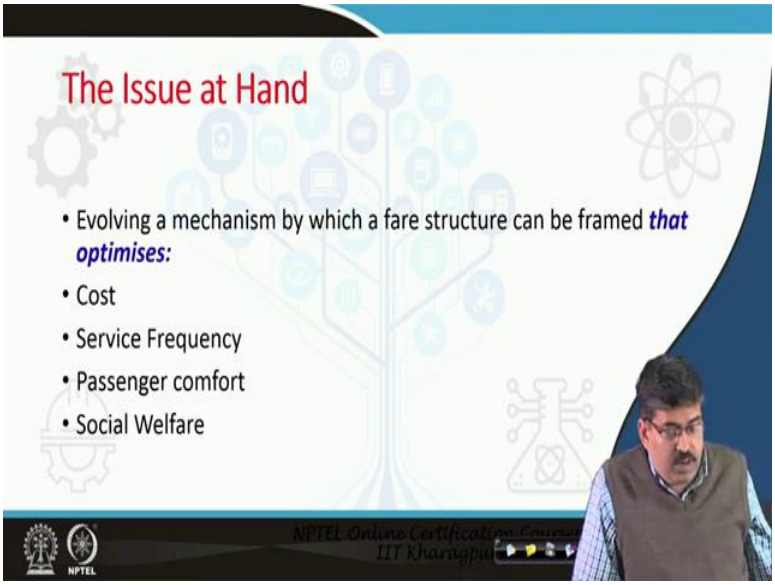

What is the issue at hand we have to evolve a mechanism by which a fare structure can be framed that optimizes the cost, the service frequency, the passenger can comfort and of course social welfare. So, cost is all, not only the single criteria.

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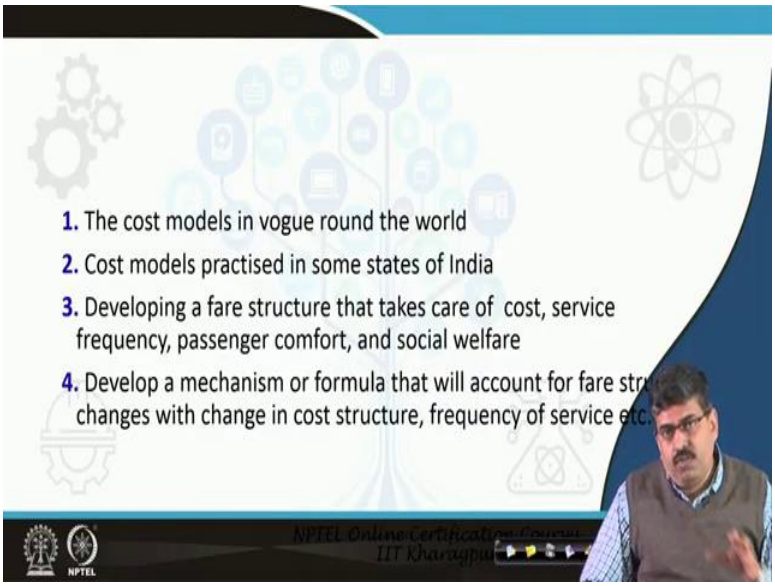

What are the key aspects in developing a methodology? First we have to see, what are the cost? See what why I am doing this exercise again as an analyst you need to understand. Like what you need to do when a situation is given to you. This is a situation that has been given to you and you looking at the cost models. So, what we will do first look at what is existing cost models.

World, what are the existing cost models in India? Based on these two, you develops the fare structure that takes care of cost service frequency. Because the moment we increase fare passengers start shouting that buses never come. Buses are always crowded buses are very, very slow and then why are you allowing them to increase the fares and the bus owners say this is the only source of income otherwise we will go to sleep and we have developed mechanism that will account for fare structure changes with change in cost structure frequency and service as the cost change, the fares will also automatically change.

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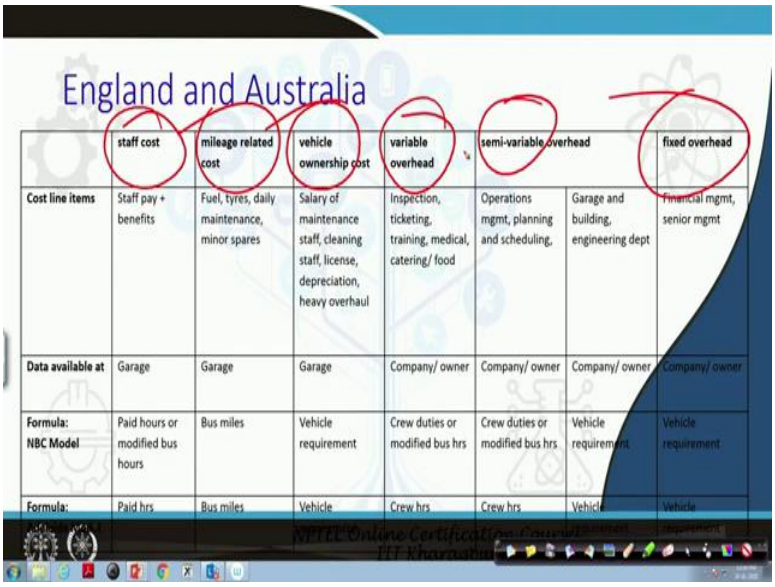

So, the starting since this is a job of you, as an analyst, so starting how will you do there is a cost models will practice first of all, let us look about the cost models in practice. These are different (())(14:39) cost models that are there in practice England and Australia. We will outline some of them for you, put it under the broad heads staff cost, mileage, vehicle ownership that is the fixed cost variables, semi variable, fixed. So, basically if you see your costs have been broken down into fixed costs and variable costs, cost have been broken down in fixed cost and variable cost and fuel cost.

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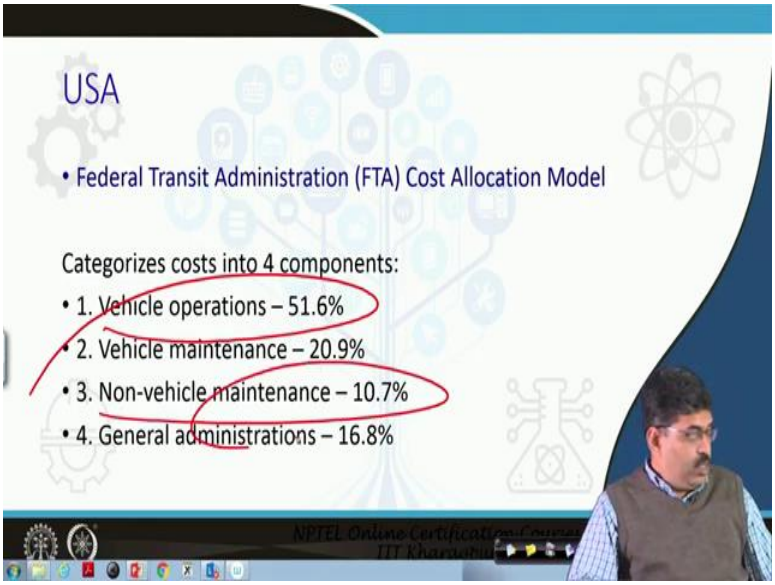

Now let us look at what are the cost components that different countries are using. USA, now there are, these have been collected from different sources, we fully acknowledge them. But for the purpose of simplicity I just picked up the numbers from the sources. Now, USA Federal Transit Administration, they categorize their cost components into four, vehicle operation, vehicle maintenance, non vehicle maintenance and General Administration. So, you see operations maintenance are taking (())(16:07) of.

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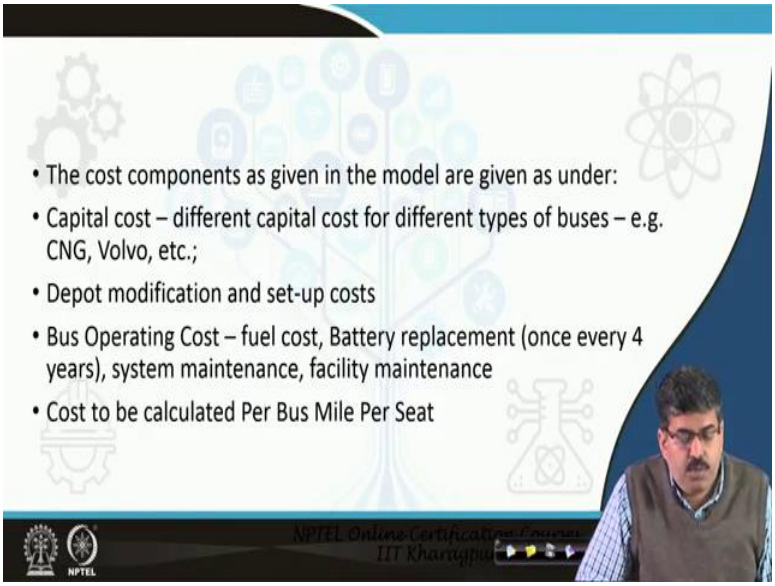

Is cost components capital cost, depot modification, bus operating costs, cost to be calculated per bus mile per seat etc, etc.

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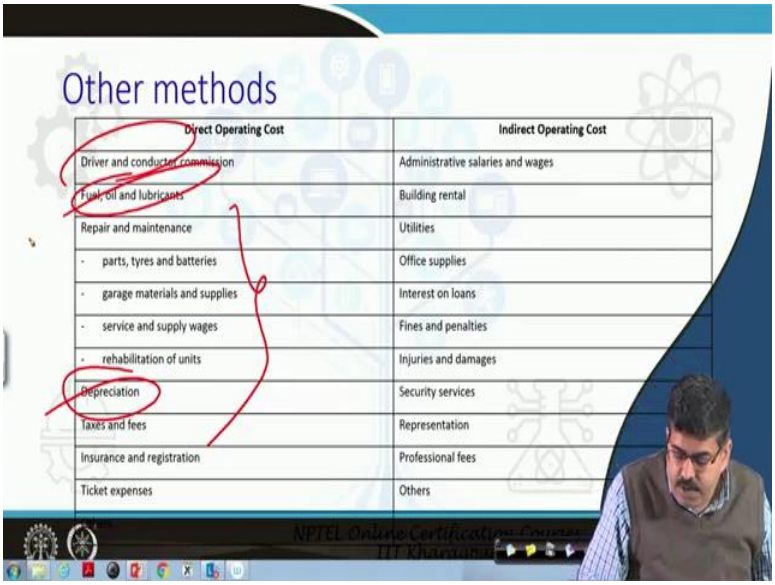

What are the other methods that are possible, direct operating costs and indirect operating costs. So, everywhere we are looking at these things, if you see again, if you see again what has happened here is repairs and maintenance you know depreciation is your capital costs. So, we see these as we mentioned and your driver cost fuel cost as we have mentioned that the most important component is the capital cost and fuel cost. So, these are taken care of here. Now, this this the one that we have mentioned is sometimes followed in some countries in Asia.

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What is India doing? Cost models practice in some states in India. Now in India till some years back we did not have that many formulas, we did not have that many formulas. Now,

over time most of the states have started developing their own formulas. Gujarat is one of them, Maharashtra is another, Bhubaneshwar that is Versa is another one. So, most of these places they are introducing the formulas for such a mechanism, the cost and but that is one but before doing that you have to come up with costs.

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So, this is the cost models that are in practice, 2013 the comprehensive costs model was developed and Naya Raipur has developed this model which is very, very presentable and pretty much as per the methodologies.

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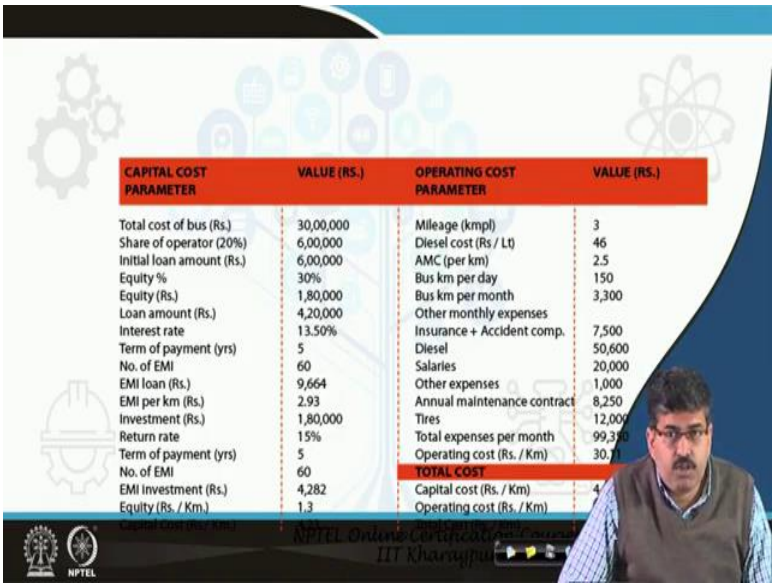

This is the rough cost, this has been taken from a report. Cost of the bus roughly 30 lakh rupees etc, etc.

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What is more important is this one. That is my fuel cost is 15 percent maintenance cost 8 percent and capital cost is 12 percent. So, capital cost is 12 percent, fuel cost is 45 percent, 45 percent is fuel cost. So, we will write it, we will write it here. We will have to use white. So, fuel cost is most operations cost and followed by your capital cost. So, your fuel operations maintenance and capital costs.

Now, the fuel cost operations and maintenance costs capital costs. So, let us come back to it, if it is just drawn you the diagram put in the person that is a etc, etc. In India, we see that metropolitan cities always there will be very high fuel cost percentage why you know, because metropolitan cities buses cannot move very fast. So, every time you are pressing the clutch and the brake every time there is consumption of fuel.

Now, one more thing that the vehicles cannot pickup speed, the vehicles cannot pick up speed you have to press the brakes. So, the fuel efficiency as such is not generated as remove. So, fuel cost is very, very high. Now, followed by as we have already mentioned your operations costs after some time operations cost also keep on increasing and plus the band date that 15 your 15 years of service of vehicles.

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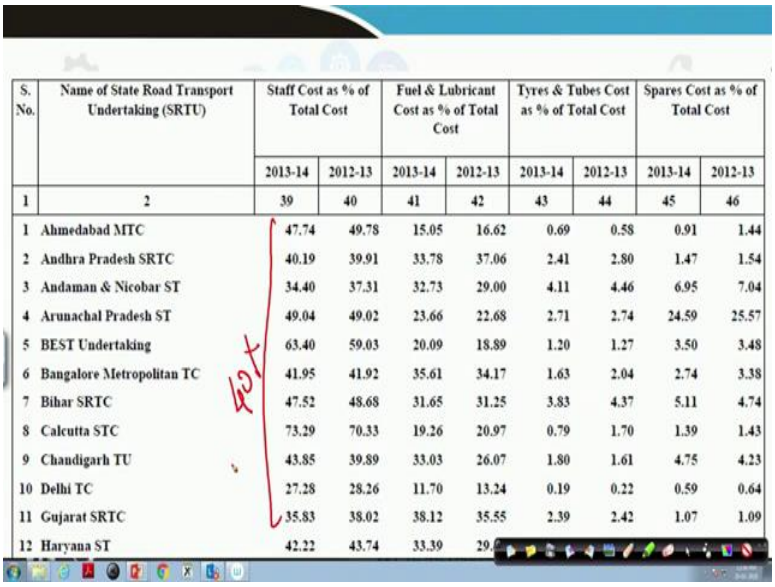

S. No.	Name of State Road Transport Undertaking (SRTU)	Staff Cost as % of Total Cost		Fuel & Lubricant Cost as % of Total Cost		Tyres & Tubes Cost as % of Total Cost		Spares Cost as % of Total Cost	
		2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13
1	2	39	40	41	42	43	44	45	46
1	Ahmedabad MTC	47.74	49.78	15.05	16.62	0.69	0.58	0.91	1.44
2	Andhra Pradesh SRTC	40.19	39.91	33.78	37.06	2.41	2.80	1.47	1.54
3	Andaman & Nicobar ST	34.40	37.31	32.73	29.00	4.11	4.46	6.95	7.04
4	Arunachal Pradesh ST	49.04	49.02	23.66	22.68	2.71	2.74	24.59	25.57
5	BEST Undertaking	63.40	59.03	20.09	18.89	1.20	1.27	3.50	3.48
6	Bangalore Metropolitan TC	41.95	41.92	35.61	34.17	1.63	2.04	2.74	3.38
7	Bihar SRTC	47.52	48.68	31.65	31.25	3.83	4.37	5.11	4.74
8	Calcutta STC	73.29	70.33	19.26	20.97	0.79	1.70	1.39	1.43
9	Chandigarh TU	43.85	39.89	33.03	26.07	1.80	1.61	4.75	4.23
10	Delhi TC	27.28	28.26	11.70	13.24	0.19	0.22	0.59	0.64
11	Gujarat SRTC	35.83	38.02	38.12	35.55	2.39	2.42	1.07	1.09
12	Haryana ST	42.22	43.74	33.39	29.				

Now, what a different state transport undertakings doing, this is the data of state transport undertakings, data the percentage will not be that much different. You see most of the state transport undertakings is a very high roughly about 50 percent, that 45 percent of their cost is employee cost, roughly about 40 percent to 45 percent is employee cost.

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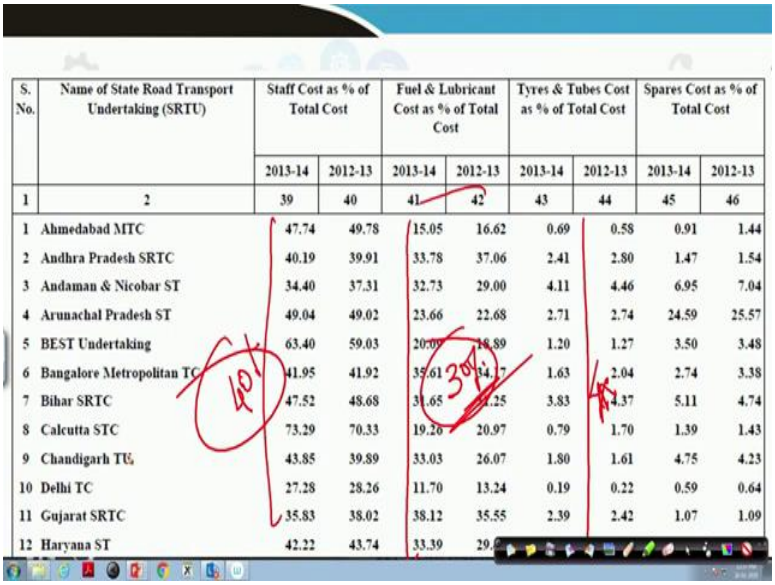

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1	2	39	40	41	42	43	44	45	46
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2	Andhra Pradesh SRTC	40.19	39.91	33.78	37.06	2.41	2.80	1.47	1.54
3	Andaman & Nicobar ST	34.40	37.31	32.73	29.00	4.11	4.46	6.95	7.04
4	Arunachal Pradesh ST	49.04	49.02	23.66	22.68	2.71	2.74	24.59	25.57
5	BEST Undertaking	63.40	59.03	20.09	18.89	1.20	1.27	3.50	3.48
6	Bangalore Metropolitan TC	41.95	41.92	35.61	34.17	1.63	2.04	2.74	3.38
7	Bihar SRTC	47.52	48.68	31.65	31.25	3.83	4.37	5.11	4.74
8	Calcutta STC	73.29	70.33	19.26	20.97	0.79	1.70	1.39	1.43
9	Chandigarh TU	43.85	39.89	33.03	26.07	1.80	1.61	4.75	4.23
10	Delhi TC	27.28	28.26	11.70	13.24	0.19	0.22	0.59	0.64
11	Gujarat SRTC	35.83	38.02	38.12	35.55	2.39	2.42	1.07	1.09
12	Haryana ST	42.22	43.74	33.39	29.2				

Fuel 30 percent, tyres and tubes are very negligible 4 etc, etc. So, fuel cost and your staff cost is very high, if it was a private operator, it would have been the fuel cost and the capital cost, the capital costs would have taken place. Now, then you should ask as an analyst you should ask like where is the capital cost gone? Where is the capital cost gone?

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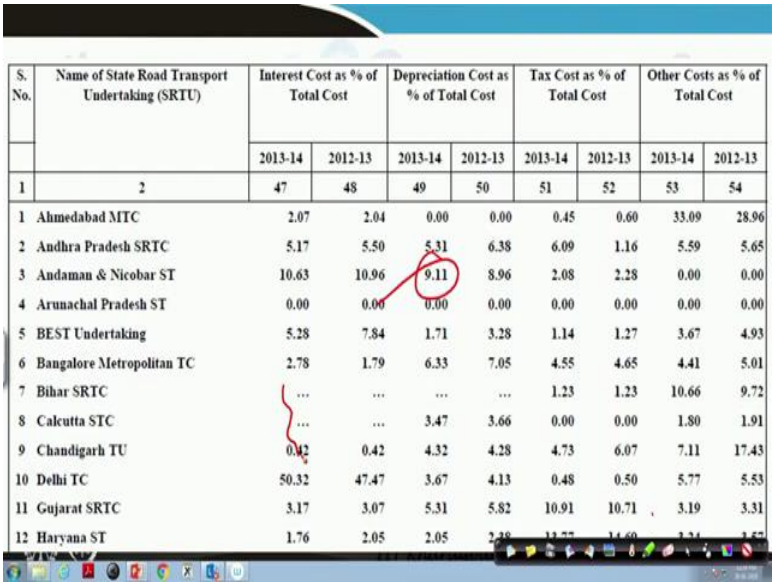

S. No.	Name of State Road Transport Undertaking (SRTU)	Interest Cost as % of Total Cost		Depreciation Cost as % of Total Cost		Tax Cost as % of Total Cost		Other Costs as % of Total Cost	
		2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13
1	2	47	48	49	50	51	52	53	54
1	Ahmedabad MTC	2.07	2.04	0.00	0.00	0.45	0.60	33.09	28.96
2	Andhra Pradesh SRTC	5.17	5.50	5.31	6.38	6.09	1.16	5.59	5.65
3	Andaman & Nicobar ST	10.63	10.96	9.11	8.96	2.08	2.28	0.00	0.00
4	Arunachal Pradesh ST	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	BEST Undertaking	5.28	7.84	1.71	3.28	1.14	1.27	3.67	4.93
6	Bangalore Metropolitan TC	2.78	1.79	6.33	7.05	4.55	4.65	4.41	5.01
7	Bihar SRTC	...	...	...	...	1.23	1.23	10.66	9.72
8	Calcutta STC	...	...	3.47	3.66	0.00	0.00	1.80	1.91
9	Chandigarh TU	0.42	0.42	4.32	4.28	4.73	6.07	7.11	17.43
10	Delhi TC	50.32	47.47	3.67	4.13	0.48	0.50	5.77	5.53
11	Gujarat SRTC	3.17	3.07	5.31	5.82	10.91	10.71	3.19	3.31
12	Haryana ST	1.76	2.05	2.05	2.28				

Here is a capital cost, depreciation costs in terms of percentage you say some the Andaman and Nicobar Islands have a 10 percent depreciation cost. Now for certain for certain state transports you will line dot, dot, dot, dot, this does not mean that they do not have any they do not have a 0. But basically, this means only that they have not provided data. So, this is your fuel so once, once you do this, you are pretty much on the job for finding out a formula

for fare fixation for public transport, same for other transport undertakings. So, in this way you have data, what you do is these are the data on average fleet held etc, etc.

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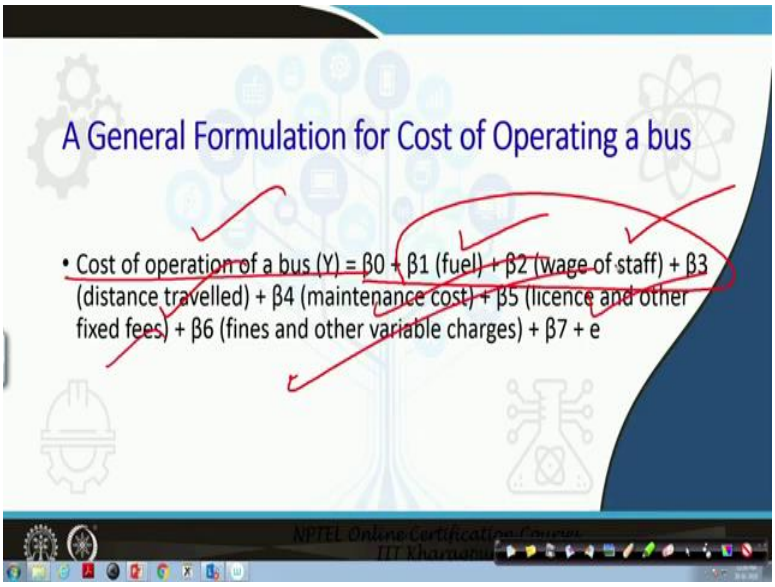

What do you do is that you should have develop a structure a formula now here, we have done we have framed a regression model we have framed the regression model cost of operation of a bus this is what we want, cost of operation of a bus is beta naught plus depends on the dependency function, cost of operation depends on fuel, wage, distance traveled, maintenance cost licensed and other fees, fines and other variables. So, these are all put in a regression model these are all put in a regression model.

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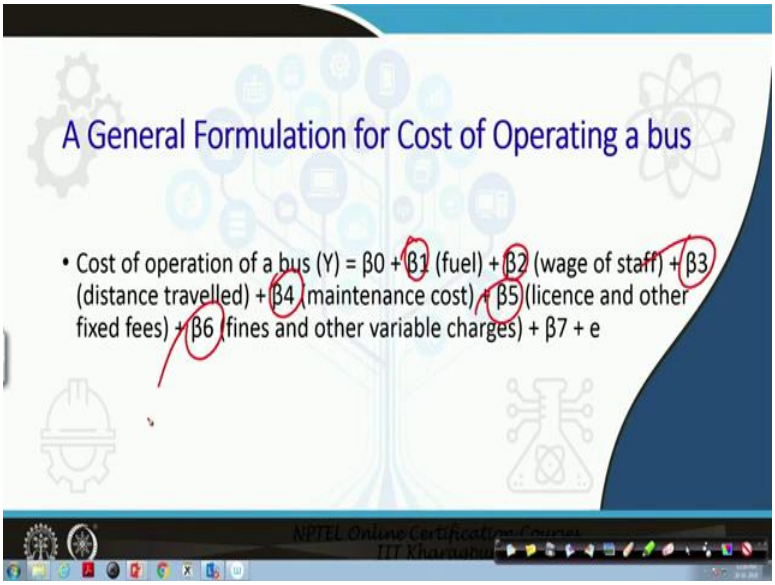

And we want to see the impact, we want to see the impact of these that is the, your beta you want to see an impact of these and then we get to know the price of the price that the bus the bus should charge. Now, what are the issues with this is it practicable? can we solve this problem like this? very, very difficult.

Different buses moving in different directions, fuel efficiency for a city bus is x, fuel efficiency of a bus which is coming from the suburbs to the city is more. So, somebody is getting benefit out of it somebody is not getting benefit out of it. So, as an analyst you should develop a formula that is applicable to the marginal bus owner. Marginal bus owner means he has only one bus. If he or she is satisfied with this formula, your work is done.

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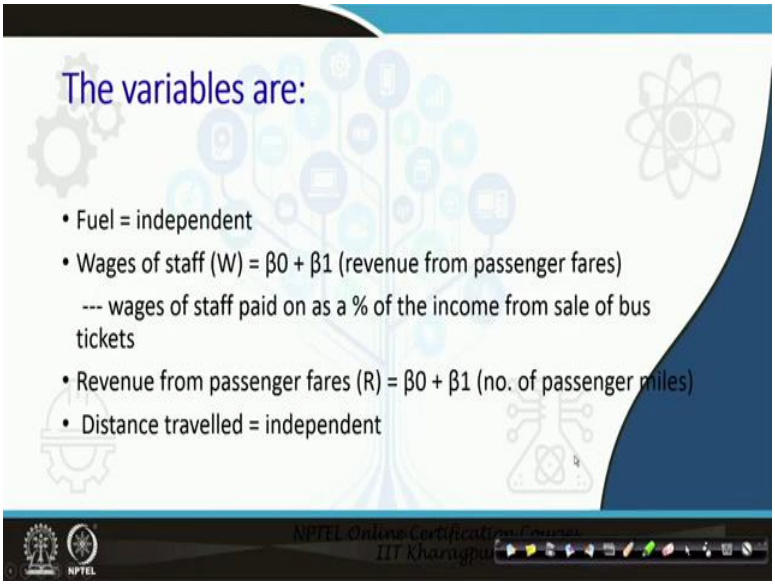

Look at the variables just we mentioned fuel, wage of staff, distance, maintenance, etc. Fuel is an independent variable wages of staff is now a composition of the revenue from passengers because the conductors get a commission. But the revenue from passengers depends the number of passenger miles and number of passenger miles depends on the frequency of the buses job transport, buses that are traveling and the distance traveled that is also an independent variable.

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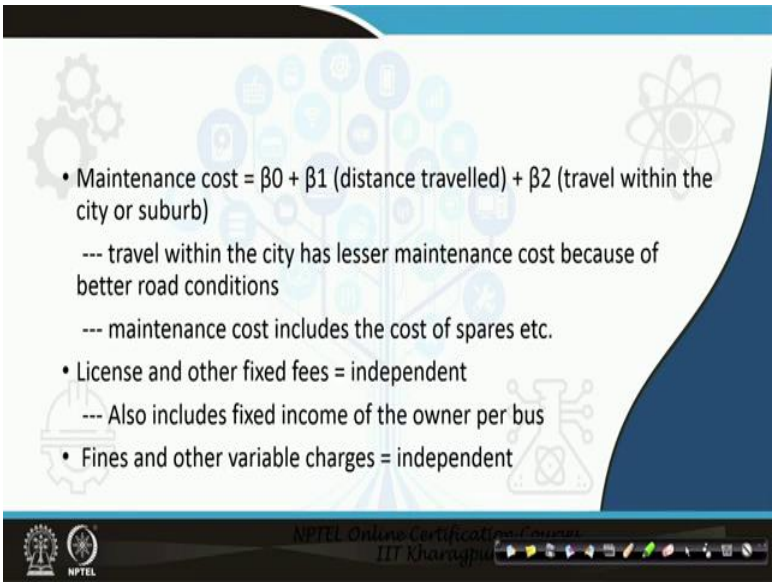

But then if you see maintenance cost is a function of distance travel, travel within the city as we mentioned, travel within the city lesser maintenance because of better road conditions.

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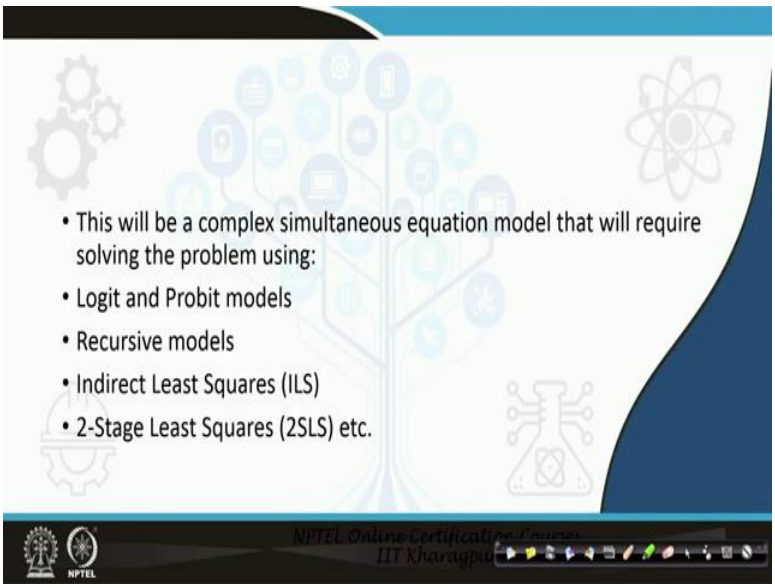

Now, so, what we want to say is, there are different methods that are possible you can use logit and probit, recursive models, in indirectly square, 2 stage least squares etc, etc. But then you have to find out a formula that is understandable.

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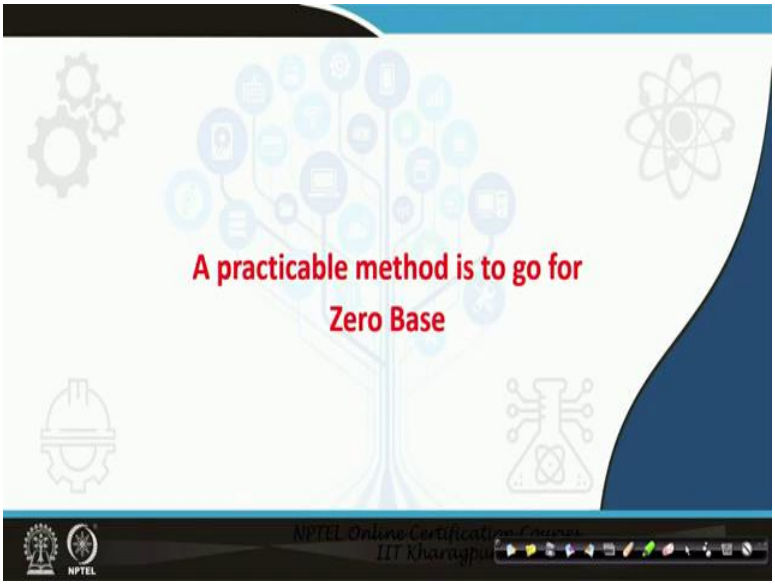

The practical method can be to go for 0 base. So, see now what we are doing, we are looking at numbers and are telling you what are the things that you can do.

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We require the following data:

- Stages or slabs of fare – on the basis of kilometres and Rupees (fare chart)
- Number of passengers travelling in each fare slab per day per bus – daywise (e.g. Monday, Tuesday, Wednesday etc.)
- Passenger-kilometre in each fare slab per day per bus – daywise (e.g. Monday, Tuesday, Wednesday etc.)
- Average number of days of bus operation per month per bus

- Number of trips (round trip and half trip)
  - Per day per bus
  - Per month per bus
- Total revenue from each fare slab
  - Per day per bus
  - Per month per bus
- Cost of bus operation per month segregated into:
  Individual cost components and % of the component cost in total cost
- Individual cost components segregated into broad categories of (a) Fuel costs, (b) Repairs and Maintenance costs, and (c) Other costs

- Fuel Efficiency of bus (number of kilometres travelled per litre of fuel)
- Earnings (Rs.) per km
  - Per day per bus
  - Per month per bus
- Cost (Rs.) per km
  - Per day per bus
  - Per month per bus

The determinants of cost and data that are required. These data's can, these data is required for it, number of trpis etc, etc earnings. So, with these we can calculate how or we can develop some formula on how to go about looking at bus fare fixation. This will do in the next module next lecture for the time being, thank you.