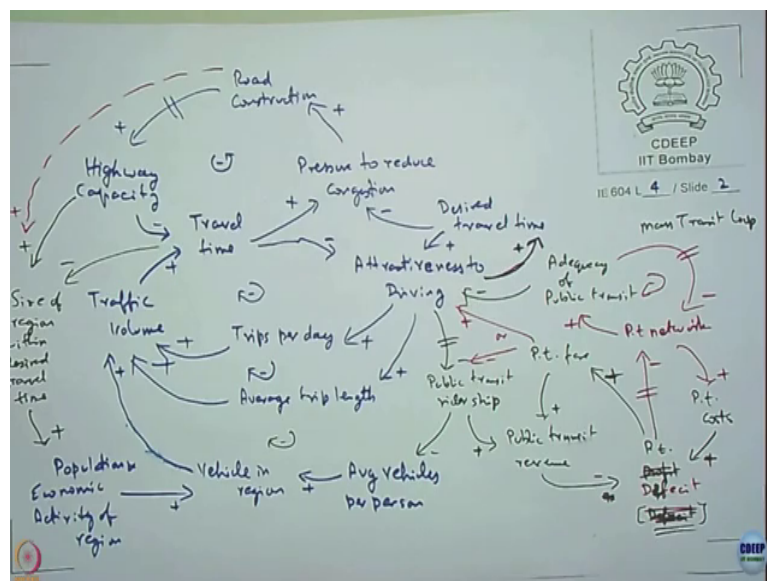


Introduction to System Dynamics Modeling
Prof. Jayendran Venkateswaran
Department of Industrial Engineering and Operations Research
Indian Institute of Technology, Bombay

Casual loop diagram Part-3
Lecture – 4.2
Study traffic congestion using CLD-II

(Refer Slide Time: 00:19)



So, we can actually explain further. So, if you think about what kind of things can happen what we call as, but as we construct highways, what happens? Two things happen, now rather the suburbs develop right. So, as travel time decreases, you would want to communicate from further distances; that means, you prefer expanding the region within which the work circle is there right, you start commuting from far that is one. That is reactive after the capacity is there based on travel time and travel further.

But as soon as highway capacity itself is bigger that region starts to develop right. Just imagine all the what can I say construction and township advertisement is for saying that highway is going to come here, airport is going to come here, metro is going to come here.

There is the mere news about highway capacity and capacity expansion itself is already result in development of the region and then your capacity follows right is that mere fact of addition or just the mere fact announcement of road construction itself results in the size and region within your desired travel distance I had to go up.

So, he can bring that aspect also inside the system. Let us just call it as simple variable called as size of region within desired travel time. Let us say size of region is at travel time becomes larger than overall population used in the road network also increases ah.

As travel time comes down, the size of region within the desired travel time is going to increase as highway capacity becomes larger the size of region that is going to be within the desired travel time is also going to increase or our own example within India where even just the announcement of this road network expansion can result in the size of region within desired travel to increase.

In Panvel airport is going to come or a bigger highway is coming, metro is coming. The price of land and building is already quadrupled in anticipation of all these things and by the time your road construction has finished, you are already under capacity.

So, now our simple idea of there is congestion, let us do the road expansion is not enough. We need to look at how ok, when there is road construction is highway expansion, how are people affecting or purchasing the vehicles, how many trips they are making, how can what else affects the attractiveness of driving as well as. So, all these things now as to go together.

It is not enough for a government or policymaker as ourselves to only worry about just let us look at road construction need leave everything else to market economics. No, you cannot; you need to if you want to control this travel time, then all other we need to look at other

places also like for example, Singapore is considering as then that you need to get a permit before you can add vehicles in the region.

So, this is one loop it is that stifling by using policy. What is the average vehicles per person when they have introduced delays? You need to stay there, you need to apply and after some time you get permission for doing that and that will effectively control vehicle in the region that controls your traffic volume, but then still people has to travel, but that people has to be happy. So, if people takes long time to travel either in public transport or other ways, travel does not need not be only in one transport. There will be always pressure to reduced at congestion.

Delhi metro before metro; however, people traveling? But now also there is a huge traffic. How will how were they commuting before metro? That is because there are so many other dynamics that is happening into play other than simple road construction. As soon as it was there people started, buying more vehicles, average trip length increased, trips per day increased. It is again results and comes back to your travel time to satisfy whatever you are doing to similar levels as it was previously.

And as I told you in desired time, you need not be exogenous; we assumed exogenous initially, but then you would like to also bring it endogenous to see where all we can have points of leverage to control it like to to make a driving less attractive, we can introduce more public transit. Is it possible? How will it get affected?

So, that is also thing that we can try because many times when you are looking at cars and vehicles it looks so nice, but what we also need to do worry about is public transit and they are different on and they are also sharing the same space. It is not only for cars and private vehicles, we also have public transit.

Now, let us briefly look at this public transit aspect. So, let us just go with revenue. So, let us say public transit, there is a ridership false revenue is going to fall. Revenue is depends on your public transit people plus just for short I am going to write pt public transit fares. So, I

am going to have fare as well as I am going to have. So, the revenue is nothing, but fare is whatever ticket price. Ticket price in number of people, it can be result in revenue falling.

Student: (Refer Time: 06:35)

Yes, correct ok. Public oh sorry yeah public ridership increases revenue increases yeah, sorry positive. But public transit also has costs to run the facility ok. So, now, costs and revenue, it is going to affect my profit as revenue decreases, my profit increases as cost increases, my profit falls down. Yes, higher the profit I may be able to about do discounts or reduce the price of the facts right or if revenue starts falling down when I end up increasing the fares or profit falls down or I go into loss when I increase the fares right.

So, that becomes negative feedback or I do two things if as profit falls down so, it is kind of counterintuitive, but I told let us give direction positive, but I want you to urge to think in terms of deficit. I think in terms of deficit in sense because all public transport transits are running in loss. So, it is easier to think it deficit.

So, as more the loss happens a public transit is already in negative, you are not making any money it is in loss, then they can either increase the fare right. So, let me just change the direction of that loop. Well I just call it deficit and I am just going to change the direction of it as the revenue falls down, deficit increases. I just made this thing and a deficit is deficit is more, then I increase the fares. So, that is to increase the revenue.

But I do other thing also, why? Changed my public transit netted network itself. I stop some buses, I had to cut costs, I had to lay off people, I had to stop buses; it may not go somewhere right. So, which after some delay public transit network itself because deficit deficit is large, the network falls down; as networks falls down, costs also falls down right.

The network is big then cost is big, I need more buses; I need more transport etcetera. So, this is your cost cutting. This loop here is your cost cutting loop. this here is your fare revision loop. So, I am going to revise in a swap ah. As my network is big, my adequacy of public transport is big and this is your interesting loop. But as while public transport network is

good, then the adequacy is good, but other way let us take a look at this ridership is falling so, revenue is falling; my deficit is increasing. So, I am reducing the network.

So, an adequacy of public transit is going down, then what does government do? After a delay after some time it invests in mass transit, your metro is coming. This is your let me just call it as mass transit loop, no its adequacy falls down then they do mass transit which increases the network size. As network size increases, it becomes adequate right. This is when the government decides on mass transit.

We have cost cutting loop and that I can do it if you want one more connection, it is public transit fare also affects a driving. As fare is more driving comes down, I can complete the loop there. (Refer Time: 11:24) Fare affects your ridership. I am putting it indirectly through attractiveness driving or you can do it here.

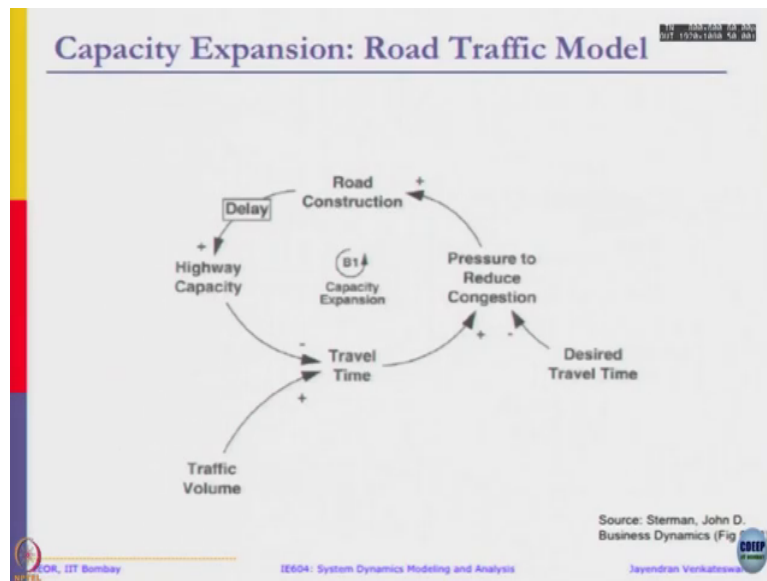
Student: (Refer Time: 11:33)

Here that is why public transit if fare increases, attractiveness driving falls down or fare comes down, attractiveness drive increases.

Student: (Refer Time: 11:40).

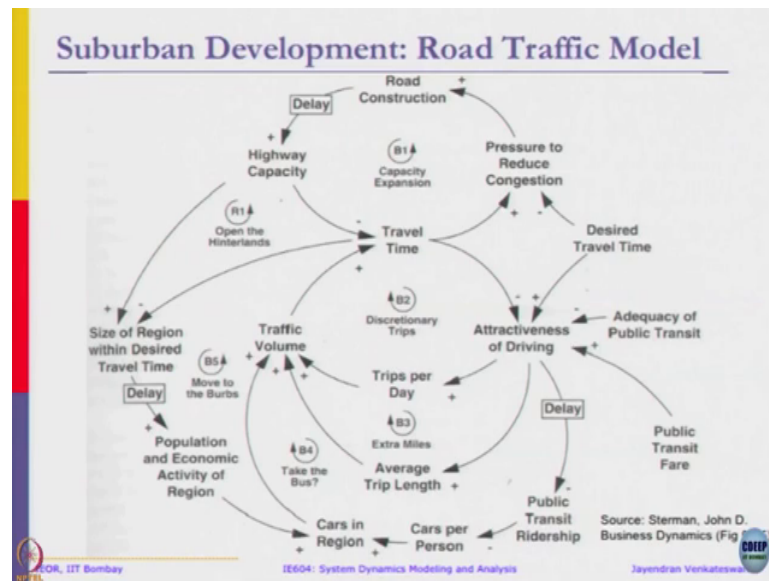
Fare increases oh sorry plus fare is higher attractive, driving is higher sorry plus. So, let me quickly come back here and wrap up.

(Refer Slide Time: 11:55)

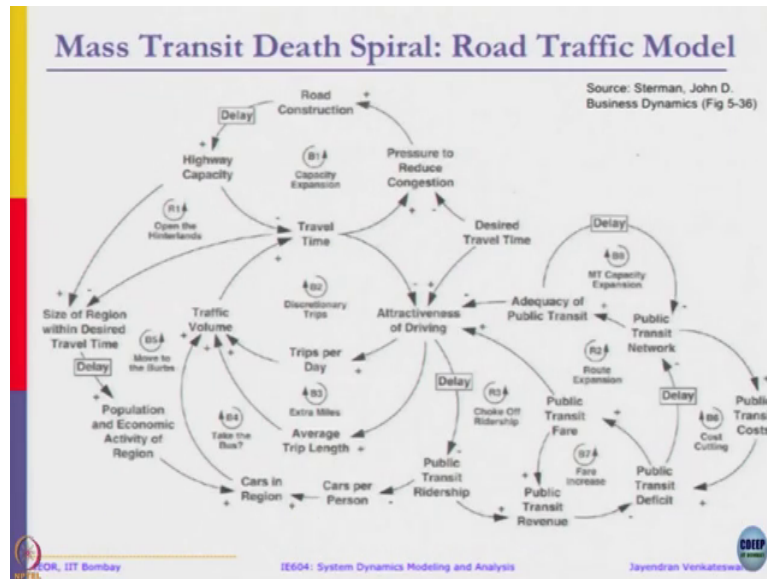


So, yeah that is taking that you know size of region we expect to go after the capacity is increased. But sometimes as the news of the capacity itself people, we discuss that it can increase the size of the region like people invest in property just because highway is going to come 10 years later. That is what I meant. I think it is just illustrate that there is no strong connection, but there is some link between these variables.

(Refer Slide Time: 12:23)



(Refer Slide Time: 12:27)



So, we did all this actually. It is a nice we did up to this loop based on the description is what we just gave. One way is to again go through this loop to figure out what is happening. Each of these loops are nicely marked choke off, relationship mass time. expansion fare increase, cost cutting and what happens when one increase and decrease it gives a nice feel.

There is one more link from this to the next one only new addition is this one size of region within travel time. As it increases, it reduces the adequacy of public transit. People have already started occupying and whatever doing something in do not believe, but there is no bus facility there. There is no public transit there, but already that has expanded. So, then that will force you to buying vehicles. So, that so that as soon as new region comes and bus as not even connected there; that means, it has already became inadequate, but that is that you cannot get there on the bus loop.

(Refer Slide Time: 13:29)

Model for Traffic Congestion

- Open Loop View
- Closed loop view
 - Travel Time
 - Pressure to build roads
- Dynamics of Traffic volume
- Growth of suburban regions
- Mass Transit Death Spiral
 - You can't get there on the bus!

IE604: System Dynamics Modeling and Analysis

IE604: System Dynamics Modeling and Analysis

Jayendran Venkateswarar

IE604: System Dynamics Modeling and Analysis

So, we had gone through all these things; started with open loop view, then closed loop, then dynamics of traffic volume, then growth of suburb mass transit death spiral. So, these kinds of models agent better decision making. So, it is not just a simple highway construction.

Now, you need to not only invest in one, you may need to invest in two three things in parallel. Let us do construction at the same time, let us see how we can invest more funding to improve public ridership, at the same time let us see how we can control the traffic volumes by providing better facilities.

If every region is going to have you know a small economic area where you can buy your provisions and movies and all those things amusement parks, gardens etcetera that can

incentivize people to make smaller distance trips right. So, you need to invest in multiple activities. So, these kind of narration helps that level of planning.