Introduction to System Dynamics Modeling
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Causal Loop Diagram Part-2
Lecture - 3.2
Examples of CLD

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So, here is the example I want you to read it and start modelling in a fresh neat page, please go over it and try to come up with a causal loop diagram for this one. I get a neat page so that I can it works I can show it in this.

Student: (Refer Time: 00:40).

Go ahead, as employment opportunities increase in the city people are attracted into the urban area. Our in-migration does not immediately react to opportunity since migrants react the perceived opportunities that may 5 to 10 year lag in response.

Population growth from the influx of migrants tends to encourage business expansion in the growing urban area. This business expansion creates demand for additional labour which increases employment opportunity. So, try to identify some of these noun phrases, you may begin with the second point and then move on to the first point. It is not written in very sequential nice manner, it goes back and forth the narration. Some of the variables you can look at our employment opportunity, population in migration, there are couple of more you can think on that.

What are the names of the variables? Employment opportunities one what else; anyone else?

Student: (Refer Time: 01:53).

In-migration, this population no growth only population yeah, growth is an action yeah business expansion, right. Anything else, demand for labour. So, we have employment opportunities, business expansion, in-migration population our overall population. We can have a perceived condition also, we can have it will not change.

What loop will it be? All links are, is there any negative links here; anybody got negative link, in-migration to. There is nothing in description about that part it is an assumption you have made with a 5 to 10 year lag in response. There is negative thing it reacts in the positive direction the same direction, but there is a delay there that is all your perception delay.

Student: (Refer Time: 03:09).

It can, this is it not captured here, but that will all be short term. So, we do not need that link, this description link that is a previous example once we got that, ok.

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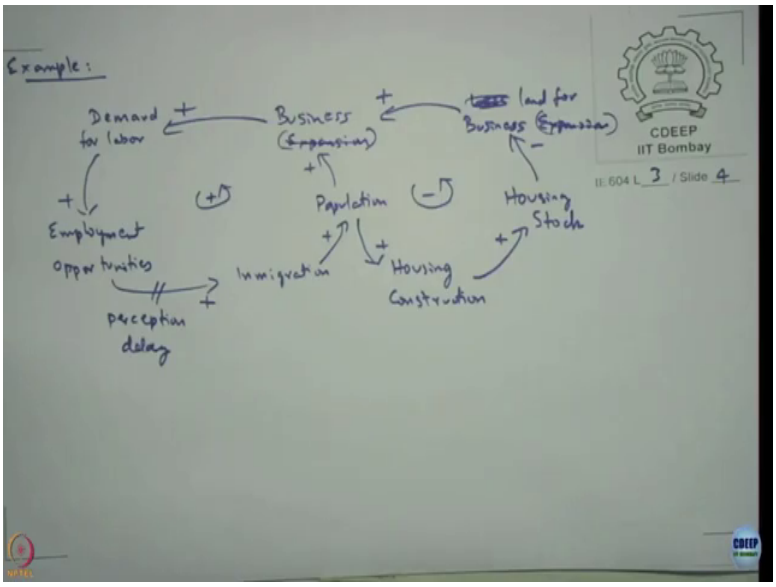

You can check your answers what do you have is a by a positive feedback system, all variables are mutually enhancing. So, as employment opportunities increase, the in-migration also increases, but it happens after a lag it is indicated by this delay.

So, can we what can I say perception delay, after a perception delay in migration increases. As in-migration increases the population of that region itself increases. As population increases more business opportunities and business expansion takes place; where it is small shops or big factories whatever it is an expansion happen as business expansion happen more demand for labour gets created. And more demand for labour gets created more employment opportunities come about and it keeps enhancing itself.

So, this is a kind of a work in is an ideal perceptions of how businesses can grow. But, we know that typically does not happen during the growth phase of any new place like 70's 80's

Bombay was the place to go. I guess there are many many industrial towns which has boomed because of this, where initially set up facilities and then people start to you see that enormous amount of employment opportunities there. And, people start migrate in to that place and that is going to increase the population there, more businesses will start booming it will create additional demand for labour.

So, it is will be really nice and smooth for quite some time 10 years, 15, 20, 30 years. But then eventually, problem will start kicking in because there will be some limitations in the resource, many many such resources going to take a hit. So, one common resource which is you know non negotiable is for example, you can consider land. Like in Mumbai city, it is an Island, where it was made up of 7 Island it is all makes into one single big island, right.

So, land is fixed, there is nothing to negotiate from so that is a total amount of plan that we have. So, you can keep expanding until you are going to hit that particular resource, which you can expect will start to influence this positive growth will act as a limiting factor for that positive growth.

So, let us consider one such scenario for land. So, we say there is couple of ways to write or we can employment opportunities, then have perceived employment opportunities, which then leads to in migration. And the delay will we become employable opportunities and the perceived employment opportunities. Meaning even if today the employment opportunity stops, people who start will still come to the city because they have perception that if I come there I will get a job, even if there is no opportunities people still come.

Only after a few years the message goes that it is very very difficult to get jobs here. So, then slowly in-migration will lesson if that all happen, with this narration it is not visible or fully note here. Let us take just one simple resource and we will try to model that.

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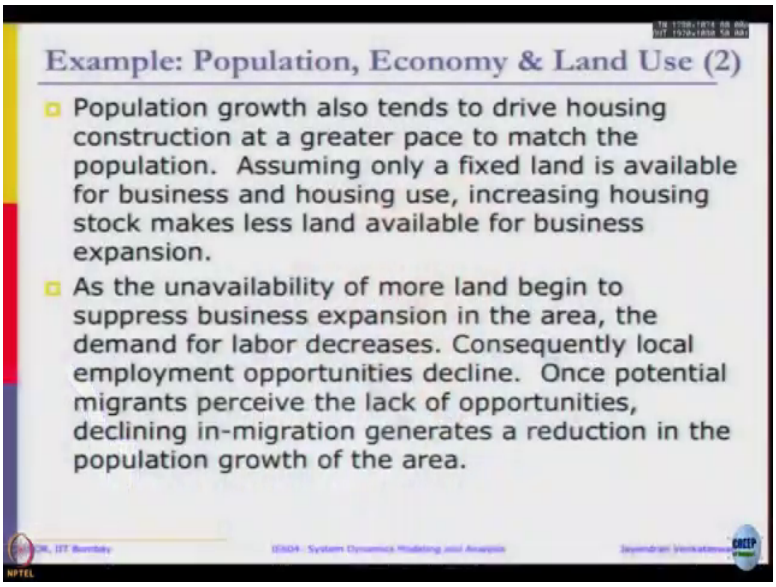

This is slide number 2. Now, let us let us look at one resource constrains how it affects population growth also tends to drive the housing construction say at a greater place to match the population. Assuming only a fixed land is available for business and housing I can only use it for two either I do houses or I do factory, there say businesses

And increasing housing stock makes less land available for business expansion as unavailability of more land bring in to surplus business expansion area, the demand for labour decreases. Consequently, local employment opportunity is declined; once potential migrants perceives a lack of opportunities declining in migration generates a reduction is a population growth of the area.

So, we can for the second part we do not actually into model the first one. For example, population growth tends to drive the housing construction. It means housing stock increases

as number of houses available increases, which reduces the land for business expansion which again affects the business expansion.

And let me is draw that and so both I do (Refer Time: 08:16) more population growth also tends to drive the housing construction at a greater place. Fixed land is available for business housing increasing housing stock. Certainly, this as more housing construction happened housing stock increases as housing stock increases less land is available for business this opposite directs. As less land is available for business, business expansion slows down again same direction. So, we are going to put a positive sign for the last one.

So, let us make this some this. So, population; increase in population drives housing construction housing construction increases housing stop, currently narration does not have delays, but we can imagine. Housing stock as they increase becomes less land for business expansion. Let us land for business say sorry, land for business expansion (Refer Time: 09:34), it should be less land for business may decreases, which will further decrease the business expansion.

So, when we read the loop; so, we have two loops one loop its goes from population goes around like this. And the second loop starts population goes like this like this, so that is the bigger loop. So, narrated as population increases, housing construction increases.

So, results in more number of housing stock which reduces the land for business expansion as less land for business expansion means less business expansion. As business expansion falls down, demand for labour falls down; as demand for labour falls down, employment opportunity is fall down. Let us employment opportunity is fall down, after the lag or after the perception of employment opportunity is falls down. And as a perceived employment opportunity is fall down, in-migration reducers which eventually saturates the population in the region to where we want. So, this outer bigger loop becomes your limiting factor for your resources.

So, this is a very simple model but can be used to elegantly to understand what is happening. For example, as population consider Mumbai, initially we had it expanded up to a point and

then as more population more housing there is less land for business, but we do not want this to slow down.

So, the government has to somehow create more land or create more opportunity; so, what do you do? You increase the FSI plus space index. So, then you are actually just increasing the land you said, you de notifier change the areas change the housing regulations, change the land use pattern from coastal to which is marked for parts and for as areas versus marshlands etcetera. All you are trying to do is play around with this loop, when you are just pushing the boundary at some point it has to become a constraint will has to have its limits.

So, these can help in understand where all we need to organize their target or interventions better by just mapping out all the variables in the clear a nice fashion. It is an addition of new businesses so, we wrote it yeah so, you can what you are saying this is not needed, yeah. You do not need business expansion; you can leave it fine questions on this. I have a slightly interesting example for 10 minutes (Refer Time: 12:27), yeah.

So, yeah ok, I mean I think we are kind of I need to couple do some couple of admin thing. There is a big kind of case study; we will go over the case study in the next class.