Urban Transportation Systems Planning
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Lecture - 04
Transport Planning Morphology

Welcome to Module A lecture 4 in this lecture we will talk about the transport planning morphology.

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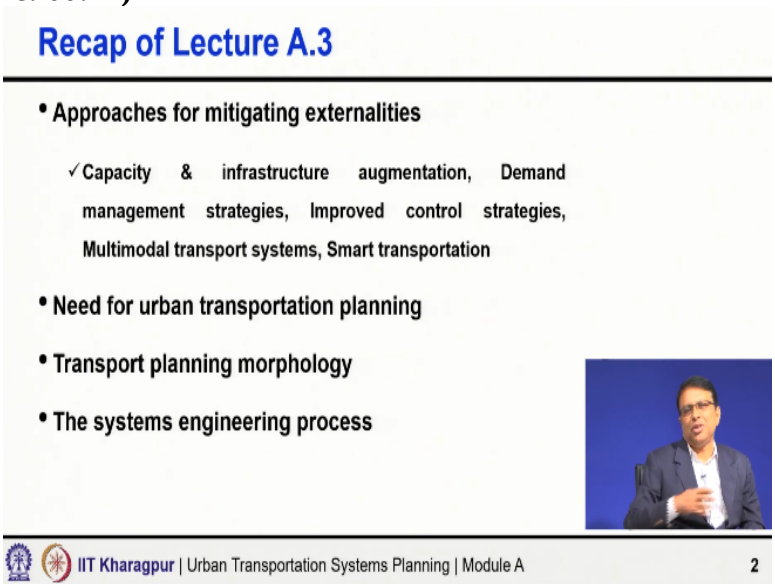

In lecture 3 we discussed about various approaches for mitigating the externalities then we discussed why we need or transportation planning and transportation planning or what is really the motivation for advanced transportation planning. Then just started the discussion with transportation planning morphology and showed you the system engineering process for the transport planning morphology.

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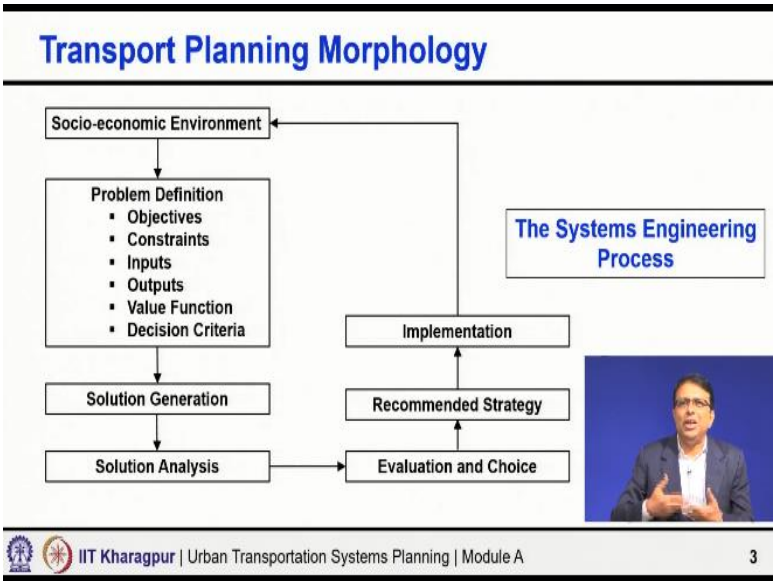

So, let us go back to that last slide where we stopped in lecture 3. There is a socio-economic environment where that shows the current scenario the current situation and the you know the problems what we are facing and once we try to solve or try to improve something. Then the very first thing is to do the problem definition of problem definition is actually everything to me. If we can do the problem definition properly remaining steps are very easy.

I mean most problems so occur because we are not able to define the problem correctly so we will come back to that. Then once we have done it then we have to generate solutions array of solutions, we will analyse each of those solutions then evaluate them to pick up the best one and then that gets implemented and what I said in the last lecture that this feedback arrow shows that it is a continuous process.

Because whatever you think is a problem today accordingly you developed some strategy and implement it improve it the after 1 year after 2 year after 3 year or after certain time again with increase in population, increase in travel demand, increase in the choice of mode and preference and everything again the problem is going to normal. So, it is always dynamic. You have to do something today it will improve the situation immediately tomorrow.

But then again after some time the problem will come back probably in some form or other because of the natural growth. So, you have to continuously keep on updating and upgrading the system so that is what it shows that it is a cyclic process.

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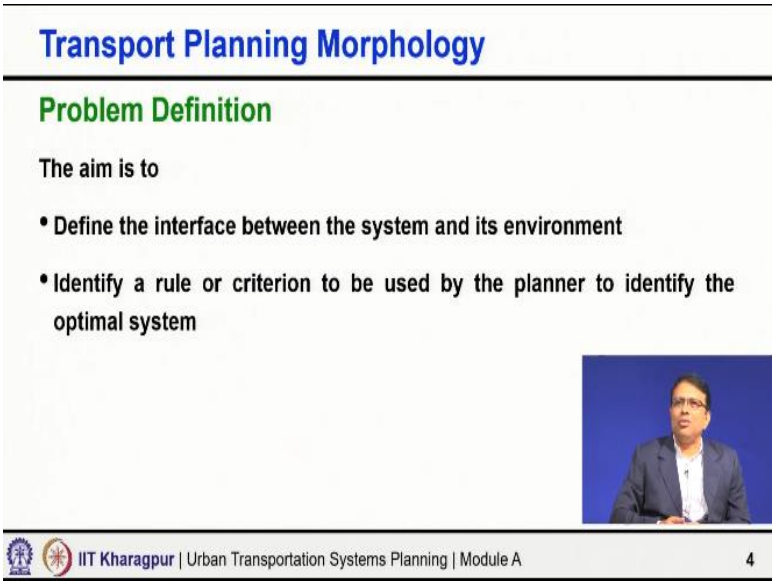

Coming to problem definition the basic aim here is to define the interface between the system and the environment and also to identify rule or criteria that may be used by the planner for identifying the optimal solution.

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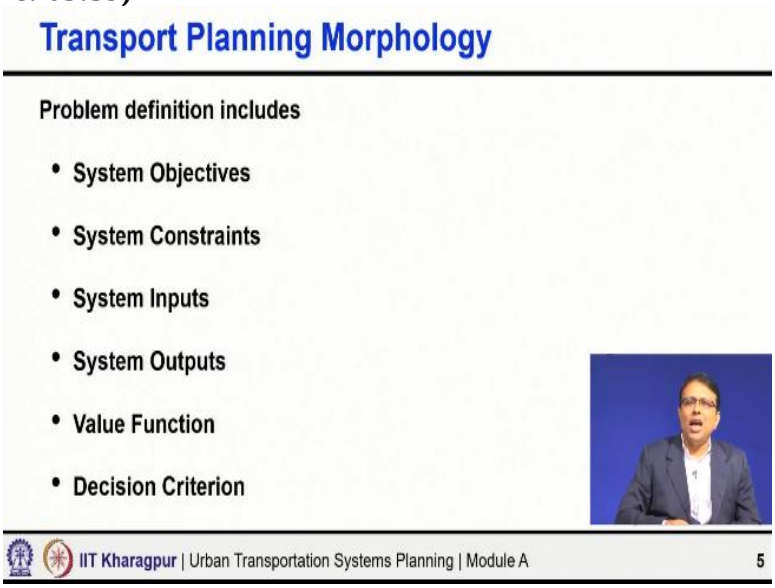

So, what we mean by the problem definition that is described in this slide so problem definition includes 6 major components first system objectives that means we should clearly say or identify what are our objectives we must understand what are our constraints because constraints limit the boundary of meaningful solutions. Then we should clearly identify if I want to do that what kind of inputs, I need what will be my outputs? Then how I will map the outputs with my objectives using the value function and then how I am going to evaluate my alternative solutions so what would be my decision criteria?

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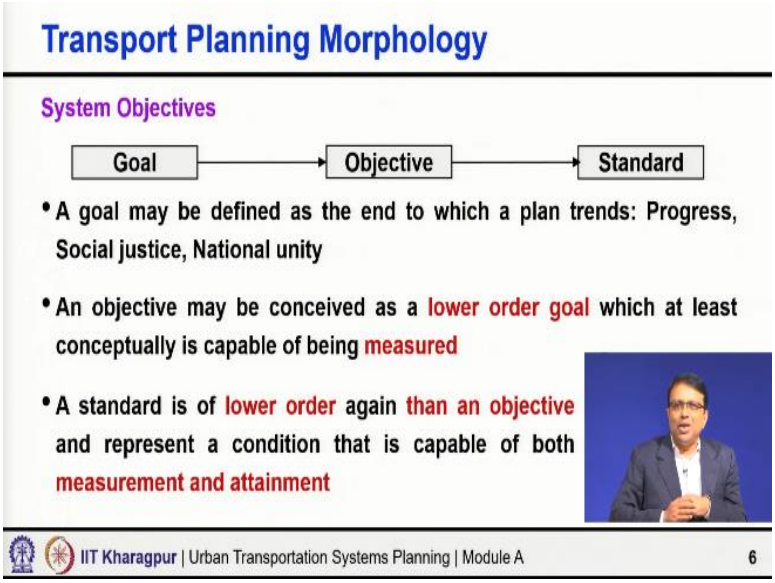

Let us try to understand a little bit more about the objectives now when we say the objectives it is important to probably understand 3 different terminologies one is goal another is objective another is standard. Sometimes we use them interchangeably but actually they mean different things so what we say a goal is basically as a state what we you know try to get at the end of the plan. It is something which convinces you meaning you can understand.

But you know it does not give exact quantification measures or anything for example if you say social justice out of transport I am saying or said national unity. We mean something we understand what they are meant is the current you know end of the goal what we are trying to get what kind of state we are trying to get. But the objective is the lower order goal which is at least conceptually is capable of being measured.

So, goal we cannot measure. Our goal tells that what is the state finally we want that is the kind of state we are going to achieve. We are trying to achieve objective is this a lower order goal something at least conceptually I can measure something. A standard the next one is a further lower order then the then an objective and represent a condition that is capable of both measurement and attainment. So I am sure still probably it is not clear to you and it would be good to taken transport example let us take that.

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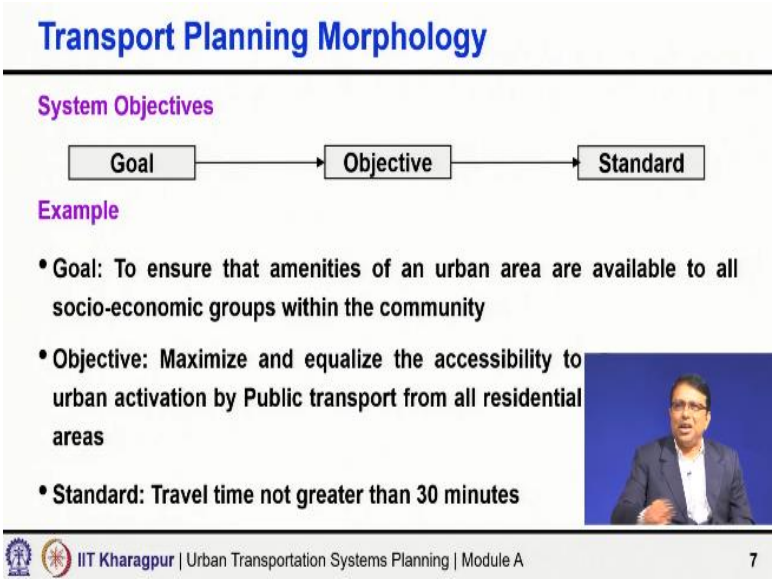

Let us say in the context of transport we can say the goal is to ensure that amenities of an urban area are available to all socio-economic groups within the community. So, we are trying to say our goal is to ensure that amenities of an urban area are available to all economic or socio-economic groups within the community. So, it can tell us it tells you, but it does not tell you then what you will do.

It tells you about the end state that you would like to achieve but it does not tell you that what you need to do immediately does not give any sense of quantification. So, the objective in this context with this corresponding goal could be to maximize and equalize the accessibility to urban activation by public transport from all residential areas. I want to say that if I have good public transport system from all residential area to all parts of the society.

You know parts of the city then any economic segment people being it poor being it you know rich anybody can travel from one end to another end and can access all the amenities and facilities which are available within that urban area. You will certainly agree that this tells you something I can at least conceptually I can measure that I know that what I have to do.

So, I need to develop my public transport network covering each and every parts of the city and then I can make sure that the amenities are available to all socio-economic groups within the community. Standard is further a lower order goal then the objective so I can say the travel time not greater than 30 minutes. Perfectly you have a measurement now so you know

that from any point to any point in the city, I should be able to travel by public transport system in not more than 30 minutes.

So that is the goal corresponding objective corresponding standard so the problem of absurd objective defining the objective clearly for any kind of transport problems what we are trying to solve is very important. You know we think that it is almost obvious but believe me you know that is the most a challenging task.

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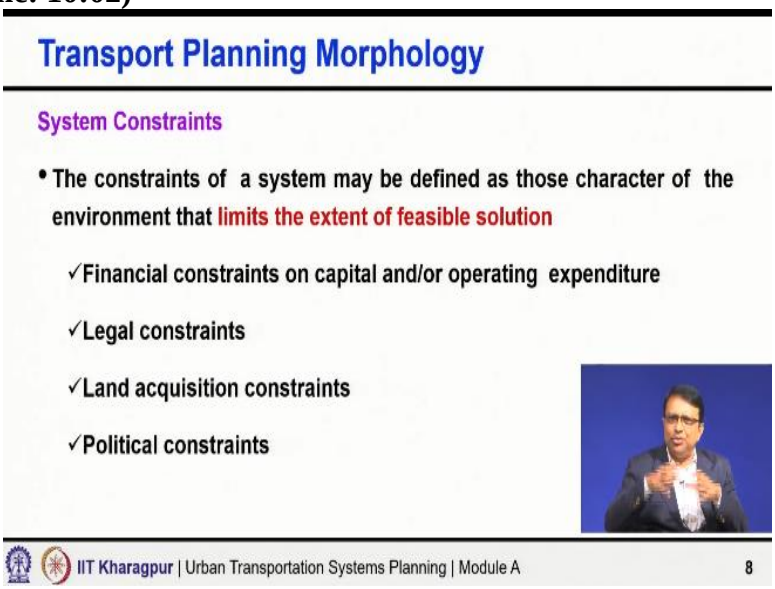

Next is we must understand what are our constraints even though I have seen in several locations people came out with some solution of a problem which can never be implemented. Because you know that probably there is a religious place which you cannot you knows relocate or you need to widen road which you cannot do. Because you cannot acquire the land and so on so forth or came out with something which will require so much amount of money that the government does not have that much amount of money to spend.

So, we want to avoid such kind of things. So before if he knew think of moving further once you have identified the objective you must know what are your constraints that tells you that what I cannot do. So, then I know that what is my domain and within the feasible domain I have to find out a solution which can be implemented I do not want to come out with a solution which cannot be implemented if the government does not have that much fun.

I must know a priori that you know what kind of fund is available so that I come out with a solution which can match with the available funds because obviously you know that you can

you know solution in not just one solution there are short term, long term that are capital intensive. Shall I send them management oriented solution or policy oriented solution. So, we must know so it is very important to understand the financial constraints or capital or operating expenditures that.

I can get one time money but do not ask me money after that or I then after that I only have a limited money or they can say that I my operating expenses fine, but I do not have really so much capital investment, okay capital to spend money initially. Similarly, we must know the legal constraints, there are many issues related to transport what is you know how much legally is permitted.

Because otherwise you will do something you will try to recommend something do something and tomorrow people will go to the court and get a stay order finished. You cannot do anything then because the cook case will you know continue to have right to go for legal baton. So, you must understand the legal construct. You must understand can you get the land in busy area of you know Bombay or Calcutta or some other city you are trying to come out with the solution.

You can tell many things, but you know that maybe a given context, it is not possible to do land acquisition. So, it is meaning less to come out with a solution which will require land acquisition. Similarly, the political constraints because all of us we live in a in a system where there could be political constraints, but we have to work within all those constraints. So as far as possible, if we must try to identify our constraints and know them clearly.

So, that we know the limits the extent of we know what are the limits for the feasible solution so I said here that the constraints of a system may be defined as those characters of the environment that limits the extent of feasible solution and we must try to come out with the solution which is within this feasible domain.

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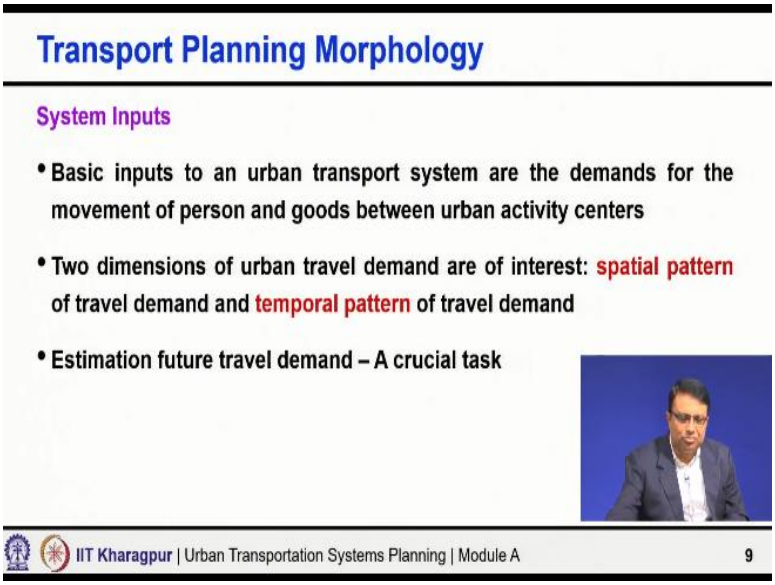

Third we must be able to identify the inputs very clearly. I mean not that you just go to the field and start collecting data no you clearly identify what are the requirements of your input. So before going to the field I must know that if I am going to do this work what are my inputs? So basic inputs for a transportation planning process basically are the demands for the movement of persons and goods between urban activity sentences.

Because most cases it is within the urban area and of course they are travel also to happen and happen you know a reasonable share may happen from outside the urban area to inside the urban area. So, or from external to external simply the road is passing through the urban area. So, what are the inputs whatever may be the demand so, demand is basically the primary input and I would again like to remind you here that please keep in mind that demand is spatial and temporal.

So, we need to understand the spatial pattern and the temporal pattern of the travel demand because often the total demand during 24 hour may not be a problem. The problem is that demand on 1 or 2 hours during 1 or 2 hours during the morning peak or in the evening peak. So, the temporal pattern we cannot miss sieving the spatial pattern we cannot miss because maybe people are traveling towards likely IT hub or the CBD area where most of the government offices are located.

So, estimation of future demand is absolutely an extremely important in the context of urban transportation planning. In fact, everything what we do in that transportation planning you can say that is all demand forecasting everything by mode by road by length you know or

activity everywhere you can say it is all about demand forecasting. So, estimation of future travel demand is an important and crucial task, but it is often challenging also to estimate that.

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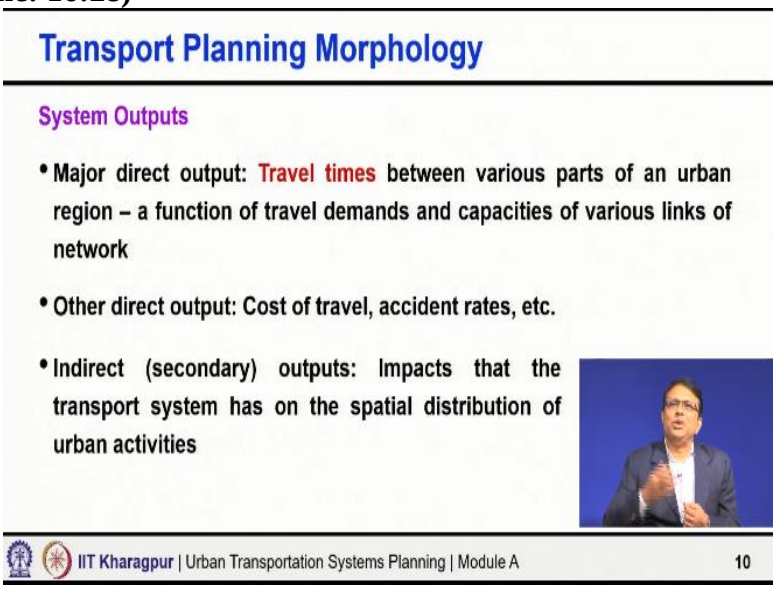

Then we must know a priori what will be my outputs? From the work what output I am going to get from all this work. Obviously, there is some major output or direct output and some are indirect, we are interested in both but more interested in that direct output. So, most cases the direct output in the transportation context is what is the travel time. Travel time between various parts of an urban area from one place to another place.

You know how much is the travel time and you know that travel time is a function of demand because when there is no traffic early in the morning you are traveling you may be covering that distance in 20 minutes whereas in the peak time that may take 40 minutes or even 1 hour, why because the more traffic is there. So, we are still travel time is also a function of the demand and the type of road or what is the road capacity.

There are other direct input maybe the cost of travel the accident if you can predict that and there are other secondary outputs, that is the impact of the transportation system had on spatial distribution of urban activities because as he said that land use and transport are interrelated. So, whatever is the transport system if 2 places connectivity is good and you can reach faster and you know less condition or so obviously that will influence the development of that idea? So, these are all various indirect inputs in the emission and all other things.

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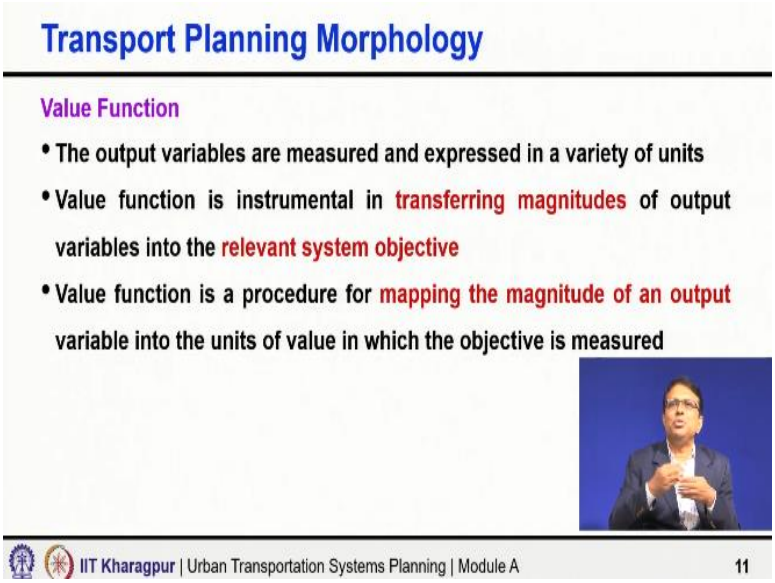

The next part is the value function, value function is that when you see the transport outputs the outputs maybe multiple outputs and they are not in same units maybe they are you know measured and expressed in variety of units. So, value function what we are trying to do different units can we convert them to 1 unit using certain multiplier so that is called the value function.

So, use certain multipliers to bring different outputs to a common unit and common unit which unit units of the objective because we want to map, map output with the objective. So, what I said here the output variables are measured and expressed in a variety of unit the value function is instrumental in transferring magnitudes of output variable into the relevant system objective. If everything is in rupees then rupee to rupee I can compare very well.

If everything is in terms of minutes, minute to minute I can compare I cannot compare minute to rupee to distance. So, value function helps us to bring all the outputs to a common unit so that you can map with the relevant system. So, value function is a procedure for mapping the magnitude of an output variable into the units of value in which the objective is measured.

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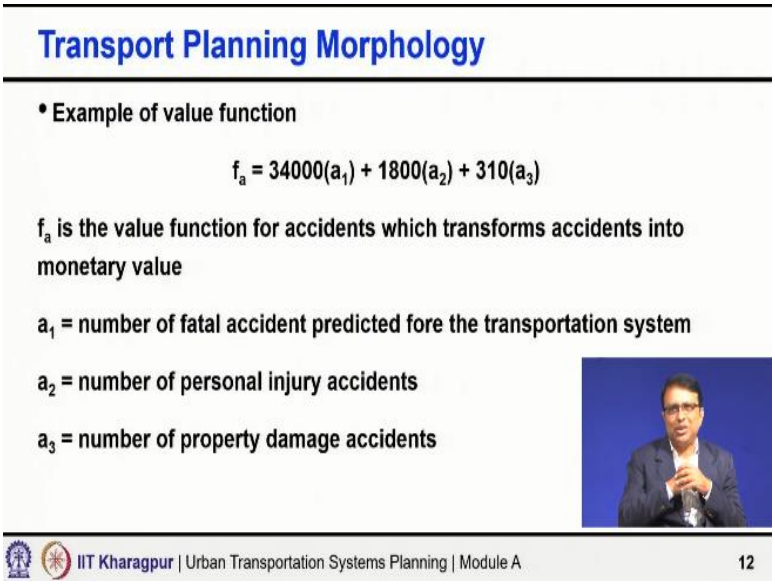

Let us give an example to further understand it this is an example you can say that accidents sometimes result to fatality you know people may die because of that road accident. Sometimes it may cause severe injury that people do not die but the injury is realistic maybe you lose some part of the hand, leg or some permanent damage that happened but one may not die or die one may not die.

Actually, that is another type of thing the other could be that nobody gets injured nobody is skilled but only the property gets damage the vehicle go and you know destroy roadside building so naturally. If I want to you know compare one road to another road. Now, 2 roads the number of fatal accidents the number of injuries severe injury the number of property damage accident all will be different. So, how do they compare?

So, if I can compare bring all these different types of you know accident to a common unit using some kinds of weightage appropriate weightage then I can compare the 2 roads in terms of that total number. So, here you can say 34000 into a 1 + 1800 into a 2 + 310 into a 3. So, we are saying that if you know property damage is 310. Then we are considering a major injury as 1800 and a fatal accident as 34000. I mean, these are all different weightages do not think that is the way we are you know considering the value of life.

But for you know for planning purpose and for understanding you know quantifying the benefits due to improvement you need to quantify such kind of things. So, now 2 roads having all different values of 3 types of you know impact or 3 types of accidents. I can say I can compare them very well using the value function.

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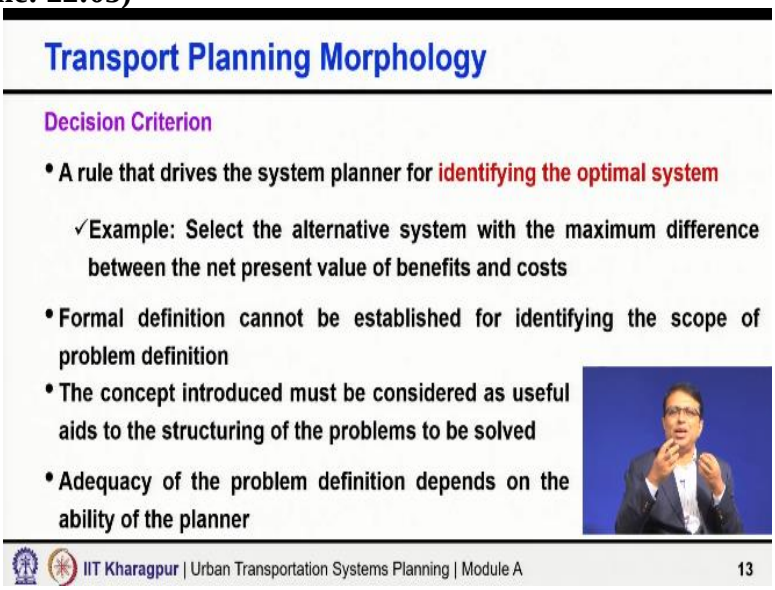

Now the decision criteria it tells you, you have alternative solutions now you want to pick up the best one so, I am saying or rather that is what it should be right? So, in the problem definition stage we are deciding that this decision criteria not that we will start doing something and once the solution comes. Then I will think how I am going to evaluate you cannot do that you have to decide the criteria a priori.

It is like if you are doing a tendering after getting the bids you cannot decide that how you are going to evaluate and you have to decide that well in advance. So, same way in the problem definition stage itself we have to see clearly and decide what would be our criterion for you know evolution. So, what we say that decision criterion? A rule that drives the system planner for identifying the optimal system, you have got many alternative solutions, which are available, what you are going to take which one you are going to select.

So, example you can say that select the alternative with the maximum difference between the net present value of benefit and cost you know that once you do something. There is capital investment, there are operational and maintenance costs, and all these happen over time the traffic benefit also you develop a road that traffic you know maybe for 15 years or 20 years the traffic witches, which are all going to use the road gets benefited so they come in different times.

So, you actually bring the all discounted benefit and all discounted cost and then you compare and do say whatever will give me maximum difference that means my gain is

maximum there. So, in general of course we will discuss this thing in details if possible but the net present value. So, you decide that the net present value or you can say what will be my benefit and what will be my costs and I will select the one where the benefit cost ratio is maximum.

That means, if I have got 3 solutions I will calculate in each case the BTC ratio benefit to cost ratio and I will select the one which is having the highest value or net present value. That is the net present benefit if it is positive and most cases it will be positive only. So other is we do not take that action if the benefit is not higher than the cost then we will not take that action, so most cases will be the positive value that is benefit net benefit.

So, we want to select the net benefit is maximum we want to select it now remember that whatever we say in the problem definition 6 components we discussed. Actually, formal definition cannot be established for identifying the scope of problem definition actually, anything you say is included as a part of the problem definition. So, whatever we tried to discuss here and tried to indicate.

You can consider them as a kind of concept which we tried to introduce and which we consider them as useful aid for the structuring of the problem. Now adequacy of problem definition depends on the ability of the plant.

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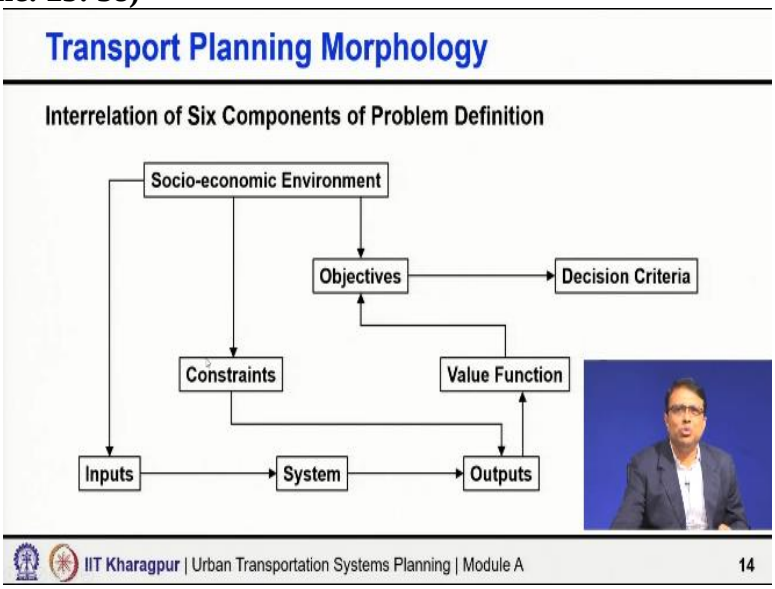

So, these are the interrelation of the 6 components you can see that you have defined objectives you have identified the constraints you have identified the inputs. The inputs are

then fed to the system and then you are getting the output and now you are checking with the constraints and then only you know taking the probably. You know the meaningful outputs and then through value function, you are actually mapping it on the objective and you have decision criteria already there. So, based on that you are trying to select something so, all these are very clearly defined.

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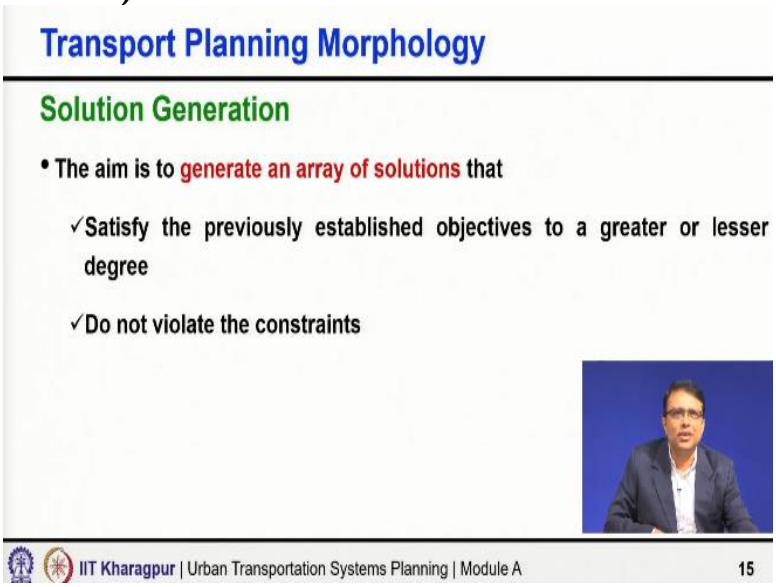

Then next steps are simple you simply generate an array of solution so what is an array of solution it satisfies the previously established objective to a greater or lesser extent and importantly do not violate any constraints. So, if it violates a constraint then it is not a solution. So, we are trying to generate solutions which to a greater or lesser extent try to you know satisfy the system objective and which do not follow the constraints.

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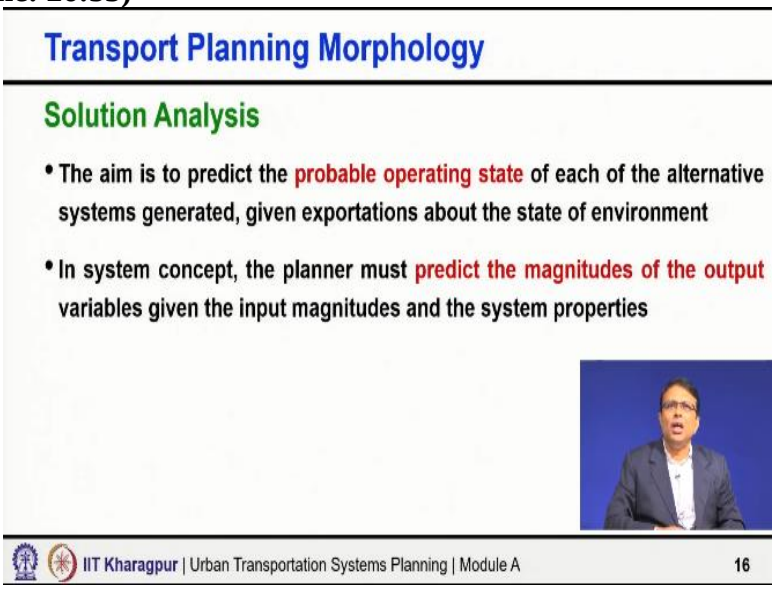

Then next you analysis the solution so here the aim is to predict the probable operating state of each of the alternative systems generated given exportation about the state of the environment. That and then in a system concept, we say the planner must predict the magnitude of the output variables given the input magnitudes and the system properties. So, we know what it is going to give analysis the solution completely.

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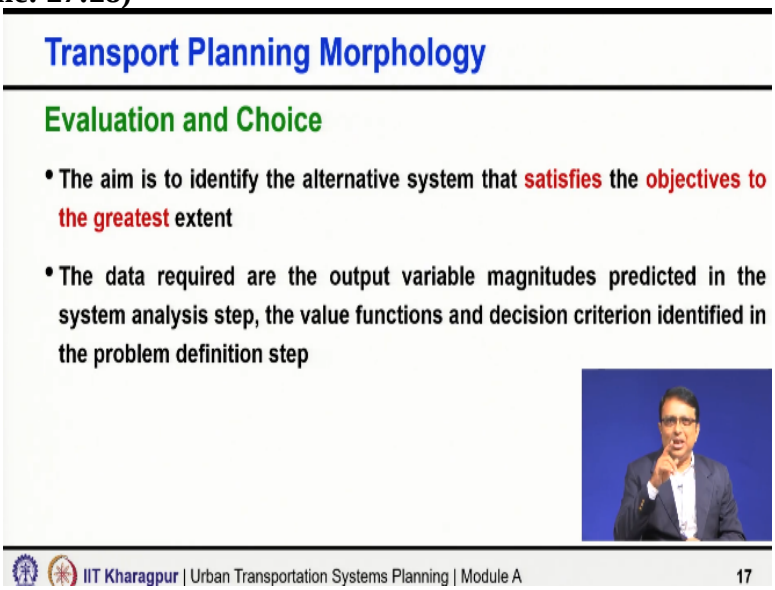

Once that is done then we need to evaluate the alternative solutions and what is our aim here we want to actually identify the alternative that satisfies the objective to the greatest extent and criterion we have already decided earlier. So, the data required are the output variable magnitudes predicted in the system analysis step and the value function and decision criteria identified in the problem definition step. So now that is what we evaluate and we choice that means we recommend the value.

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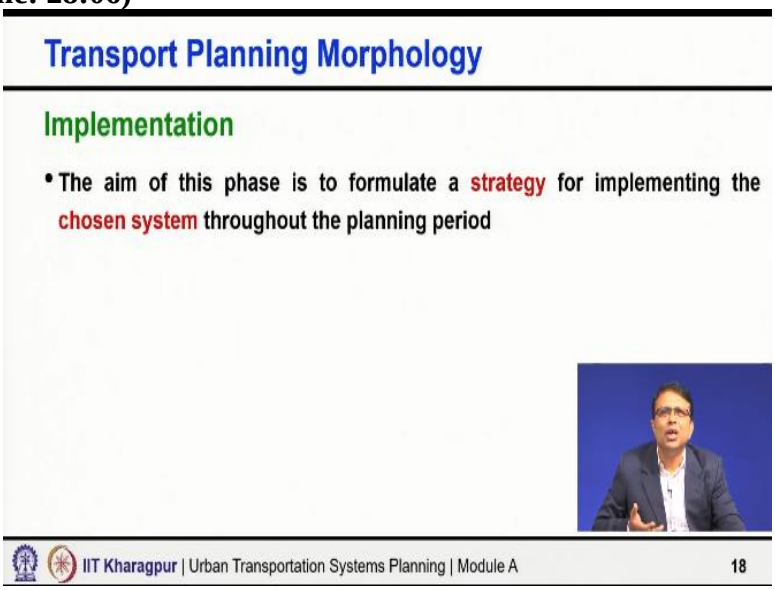

Then the recommended strategies implemented for the benefit of the society to address the concern to address the problems and you remember the feedback arrow it goes back it will go back to the system socio-economic environment. So, just remember that we are coming problem definition then solution generation, solution analysis, evaluation of choice identifying the recommended strategy. Then implementing it and the arrow going back to the socio-economic environment because over time again you will find you will require carrying out similar works.

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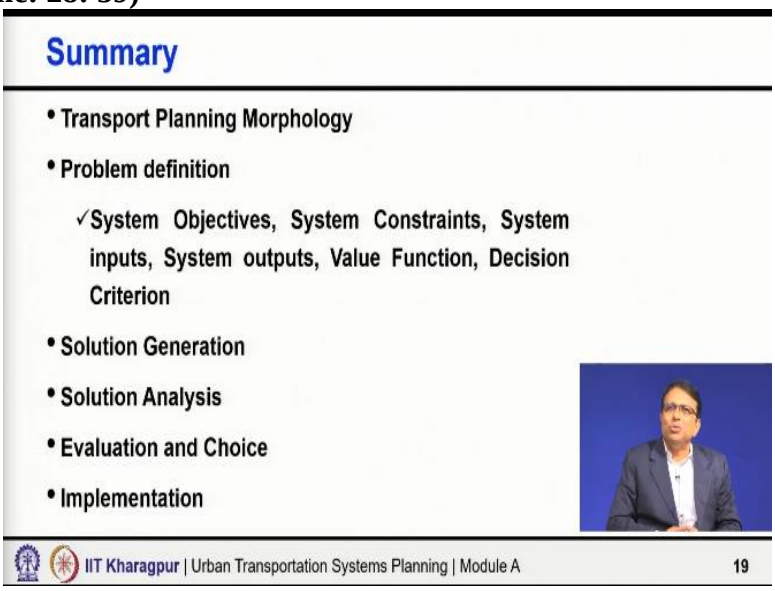

So that is what it is then to summarize, I would say we discussed about the transport planning morphology. I tried to tell you the importance of problem definition in the context of planning morphology. That is the most important component which required you to identify the objectives clearly, identifying knowing the constraints clearly identifying the inputs, identifying the outputs, identifying the value function to map the outputs to the unit of the objectives and also to identify the decision criteria.

And as I said, these are not that only these are the things you know anything else is required also to be done in the problem definition stage. So, that is your preparation in a way the remaining following that you now generate your solution. Analysis the solution eventually with them takes the optimal one which maximizes, satisfy the objective to the maximum possible extent as per the evaluation criteria and implement it. So that is what it is so that gives you an overview of the transport planning morphology. Thank you so much.