

**Supply Chain Analytics**  
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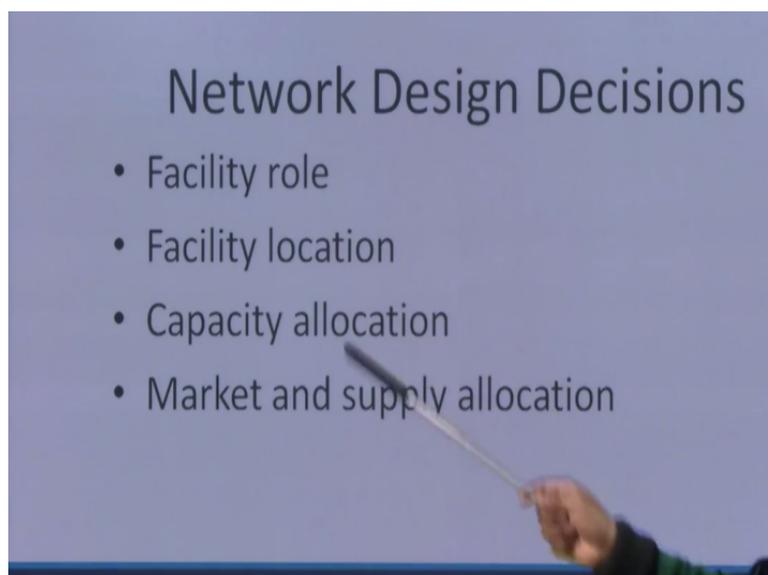
**Lecture-22**  
**Network Design in the Supply chain**

So welcome back, so far we have discussed two important things with respect to decision making, one was related to forecasting and another was related to inventory management. Now we move to third important issue of decision making in the supply chain and that is with respect to network design. If you recall in the beginning of this course we have discussed about one of the very important driver of supply chain that is facilities.

Now where to locate facility?, what will be the size of the facility?, what will be the role of that facility?. All these are some of the important questions, which we like to answer in the network design. Now as we are moving from a local market to globalise market this particular issue has become even more important and we will see that what are the important issues we need to keep in mind when we take decisions with respect to network design.

In this particular station and few more sessions after this we will also discuss some of the mathematical techniques, some of the analysis processes which we will use for taking a decision with respect to location of our facilities in the network.

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Now these are some of the important points which we are going to discuss in this particular session. Now as I mentioned that we are going to discuss about the facility, the facility role that is first important thing that what will be the role of the facility? our facility can be a retail facility, our facility can be a wholesale facility, our facility can be a manufacturing facilities. So these are the different types of roles facilities play in a supply chain.

So whenever I am going to have a new facility so whether it is a manufacturing, whether it is a retail, whether it is a whole sale or what type of facility it is, that rule I need to be very clear. So I take decision with respect to roll of the facility, that is one decision. You have thought of whenever Indian Oil, whenever Bharat Petroleum, whenever Hindustan Petroleum, they take 2, 3 types of facilities, one facility is the refinery.

That is one type of facility in the network, that other facility is depo where you have seen if you travel on Railways or some Highways, so close to those Highways and Railways you will find some big depose of these oil companies where you see large tanks and petroleum products are stored there and then you have retail outlets through where you get your scooters, cars, motorcycles fuel and these are the retail facility.

So in the network of in the complete system of a petroleum company you have refineries, you have oil depose and you have retail outlets. Similarly you can think of any other company there will be different types of facilities you can think of Army, you can think of public distribution system. In Public Distribution system which is very popular in our country for providing the food grain to below poverty line people right now.

You see there are local ration shops where you have seen queues of poor people those who are looking for food grains, sugar or kerosene oil. Then you have depose local depose, local depose are normally governed by district food authorities and then you have the central depose which are part of FCI Food Corporation of India, so there are big bear houses of Food Corporation of India then a smaller warehouses of district food corporations.

And then you have local ration shops where normally the customers go and take the Russians so these are the different types of facilities which are there so you need to take a decision about the role of facilities in your network decisions, then the location where should I locate my facility, that is another important decision are we take decisions with respect to network

design. When I want to locate a facility the role of a facility is the customer interaction, the retail facilities.

So obviously a retail facility has to be located close to the customer, but even in that case you have an example like Walmart, the retail facility, but it is not very close to customer it is not in the crowded market of a city, because of the model of Walmart where they want to fulfill the requirement of the customer at the minimum possible cost, so they look at their facilities on the outskirts of the cities or maybe some semi urban areas.

So that the cost of land, cost of facility is lower and therefore they can transfer that benefit to their customers, but on the other side we have discussed in our earlier sessions about 7, 11 also where they locate their facility in one of the most crowded areas of their cities, so that customer can go and have the convenience of buying things with minimum effects, so location is one important things that if you want to have a manufacturing location.

So it depends whether you want to have manufacturing location close to customer. For example if I talk of PET bottles which are used for containing water etc. in your refrigerator or dustbins made of plastic buckets, made of plastic. For all these type of facilities you will have lot of manufacturing facilities which are closer to your customers, because the transportation of these products is a very compressive activity.

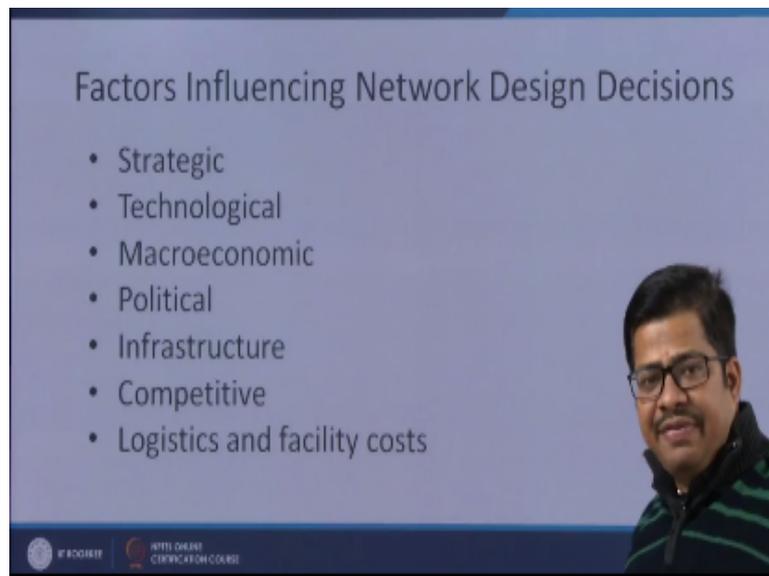
On the other side if I talk of automobiles, cars, scooters, motorcycles you will have limited number of facilities for manufacturing these products and these maybe centralised throughout the country. So depending upon the type of product you can have the location of your facility, so that is another important area in the case of network decisions. Then the third is capacity allocation, what should be the size of that facility? that is also very important.

I cannot have arbitrarily any size of the facility, I take a very logical rational decisions when I want to decide about the capacity the size of this facility, what should be my size of the retail outlet?, what should be the size of my depo?, what should be the size of my plant? Etc. So all these are the decisions we take with respect to capacity or with respect to size of the facility. And then market and supply allocations, which facility will supply to which market? or which supplier will supply products to which facility?.

So both these decisions are also very important. So that you may have heard that in a particular city there are 2 retailers of a product, 3 retailers of a product and then they will eat the market share of each other and there will be a kind of local competition between 2, 3 retailers of the same product. Now to some extent this is not a very good network design from the supply chain point of you.

You need to give sufficient market share to your individual facility, you need to allocate a particular size of market to a particular facility, so that it is lucrative enough for that facility owner to serve that product. Otherwise it will be difficult for the facility to survive in the market, so we will take these four types of decisions when we are talking of facility in case of our network design.

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Now what are the factors, now let us see what are the factors which are influencing the decisions of our network design, the first is strategic factors. The strategic factors are very important in selection of a particular size, location etc. You have examples of India now because of the very stable and strategic location we have so many multinational companies coming to this country and making their manufacturing business.

Now you go to some other countries because India is a very stable country because it offers every huge market, so it is quite understandable that companies are interested in coming to this country, but there are certain countries because of the strategic advantage like the development of lot of warehouses, development of business in countries like Turkey is a

result of strategic factor. Because Turkey's location is very much strategic, it can take care of Europe, it can take care of Asia.

So a lot of companies are interested in making their warehouses, in using the facilities of Turkey for transportation of their goods. So it is important that strategic factors affect some of your decisions with respect to location of the facility. Strategic factors primarily affect the location issue; they primarily affect the location issue. In our country also you will find there are certain state borders, the development of areas around Delhi particularly if I talk of Noida, Greater Noida, then Gurgaon, then Faridabad.

All these areas have some kind of strategic advantage, because you are not in Delhi, so that type of issues resolved and then you are close to Delhi. So you tell the strategic advantage of some type of benefits which you can get because of proximity of national capital. Then technical resources are also important in deciding the network decisions. Now development of a lot of engineering facilities in a particular country will obviously help you in deciding the manufacturing location in that country.

Particularly if I talk of countries like Japan, countries like Germany, where because of technological excellence most of the manufacturing activities were concentrated and most of the automobile companies, most of the electronics companies were interested to take the advantage of those technological factors and this again affects the kind of location. But at the same time technological factors affect the capacity allocation to a facility.

Because some technologies cannot be adopted, cannot be applied on a particular scale, you need either higher scale or lower scale and this constraint of technology can also become a particular reason for particular capacity allocation to a facility. So if I want to operate on a particular economy of scale so I need to have a particular size, so technological factors are also important. Macroeconomic factors are other important factors in the queue which are affecting my decision for network design.

I need to have a stable economic market, economic condition of that area, that country particularly if I talk. Now if economic activities are not stable then probably I will not like to establish my facilities in that area. If you recall all in last year's time in 2016 November

government of India decided to withdraw the legal status of notes of 500 rupees and 1000 rupees and all of the sudden the Indian macroeconomic market becomes volatile.

And as a result of that lot of uncertainty was there in this macroeconomics situation of Indian market and at that time it is difficult for a company to locate its facilities particularly manufacturing facilities in the Indian area. So therefore we look for stable macroeconomic conditions, predictable macroeconomic conditions for deciding the location of a facility. Then political situation we want stable political situation, arrear we used to have favourable political situation.

But now slowly and slowly we are moving from favourable political situation to stable political situation. Because more and more focus is there on industrialisation throughout the globe. So there is no question that Political situation is not favourable, but unfortunately because of so many reasons you can say in most of the countries political environment many a times remain volatile.

And as a result of that the effect of this political uncertainty makeup on business and therefore we want stability in the political environment. If stability is there it will help business because business will have a predictable line of action. If a political uncertainty is there you will not have a predictable line of action and therefore you will not like to establish a facility, a bigger facility in that area.

You see India is very fortunate that we have lot of political certainty, political stability in this country and this is one very important major factor in attracting the global investment to this country and most of the Global Giants they look for establishing their facilities in Indian market in Indian subcontinent because of political stability. On the other hand you see our neighbours and different types of other markets where political serenity is not there.

So investors are not looking to establish their facilities in those markets. Then infrastructure, infrastructure also plays very important role in deciding the facility and particularly facility at the manufacturing level at the warehouse label, these two facilities are very closely related with the availability of the infrastructure. If appropriate infrastructure is not available these facilities are difficult to establish.

You can see the example of some of the states of India, Uttarakhand, Jharkhand, Chhattisgarh. These are slightly new states and what is most recently we got Telangana in this list. Now the states like Uttarakhand develop the infrastructure for Industrial Development right from Devon and as a result of that lot of new industries, lot of new facilities by industries were developed in these areas because of the availability of good infrastructure.

This includes good network of rail and road. These include good air connectivity, this includes good power availability, this includes good water availability. So these are the things which are required for surviving business and if you can provide a decent kind of infrastructure, so business will come or the facilities can be located into those areas. But if infrastructure is not there, if it is not there you require that products will come to you using rail as a mode of transportation.

But if there is no rail network available in that area, so how will you locate a facility in that area. So it is very important that whatever type of infrastructure requirements you want to have for your business, these requirements must be met by the local people, local authorities and then the business can be located in that area. Then competitiveness, competitiveness can be related with two aspects. The one aspect of competitiveness is that what competitiveness area of a studio?

The facility where you are locating, the local can offer some kind of competitiveness. So when I say the area or the local offers competitiveness, it is very much similar to strategic type of thing. So we locate certain facilities because of its offering to the competitiveness and the second is the competition available in the area, what type of competition is available in a particular location?, that is also a very important factor in deciding the location of the facility.

If and in competition also there can be a case of positive competition or negative competition, like we almost have seen that in all cities of our country India we have a particular Jewellers market, now in that Jewellers market you have all the shops of jewellery, adjacent to each other, you have this market where everyone is competitor of each other, but still a new shop which is opened in an isolated location not in that Jewellers market.

It is very difficult for that shop to survive, it is not that competition is not there and because of that the shop must go the fact is just reverse of that, while because this market offers a

positive competition, because all the customers will come to this market only and therefore there is a positive relation, there is a positive relation and with that positive relation the growth of all the facility owners take place.

And as a result of that any a new incomer, any new comer in that Jewellers market will get the benefit of that positive competition, but you always cannot have, you know there are certain clusters in our country and ministry of micro small and medium enterprises is working on that cluster mechanism, that you have a market of locks, manufacturing of locks in a particular city known as Aligarh in UP.

You have a particular sarees known as Banarasi sarees in Banaras, you have a particular product which is famous for a particular location. So these things offer you positive competition, so if you want to have the similar kind of product, if you want to have a factory of making the auto components. So Faridabad which is close to NCR is one of the most prominent place for that, because you find thousands of auto component manufacturers in that place.

So the local ecosystem will help you in developing in using those various facilities which are customised for auto component manufacturers. So is the example of Pune, so is the example of Rudrapur in Uttarakhand that and so is the example of Ludhiana in Punjab. That these are some of the places where we have developed the clusters of auto component manufacturers and similarly you will find many places, you have in Himachal Pradesh.

The industrial area known as Baddi where you will find lot of pharmaceutical companies are coming up and there is a ecosystem local ecosystem of Pharma products manufacturers. So positive competition is also an essential element for developing your infrastructure, developing your facility related decisions and then we already discussed under the infrastructure head, logistics and facility cost.

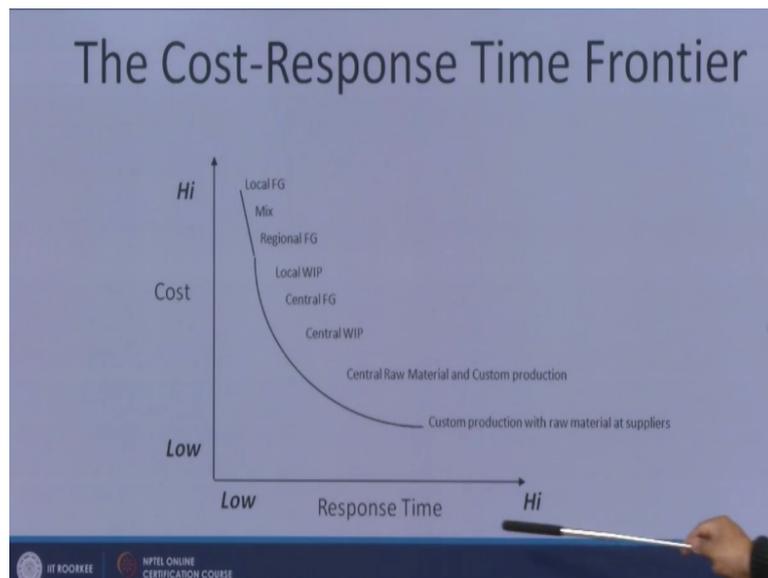
Though in place like NCR, Gurgaon, Faridabad, Noida we have highly developed infrastructure. So I really if I want to start a new business I want to start a new facility for manufacturing something, these are the places in my first choice, but because of excessive logistics and facility cause. These areas the cost is very high, already they have achieved a

very high level of success and as a result of that it is very difficult for me to meet the challenges of very high cost.

So that also becomes a very prominent issue in my decisions of facility location that what is the cost of facility, what is the cost of logistics in that particular place. If I want to open a retail in a place like Chandni Chowk in New Delhi or in Connaught place in New Delhi the cost is so high that it is almost impossible to think of a bigger showroom in these places.

So what I do I will shift to some low cost areas where the cost of logistics and facilities are relatively much less than these places. So these are some of the factors and I will take decision on the combined consideration of all these factor. I take all the factors into my combined consideration and then I take a decision that where to locate the facility?, what will be the size of the facility? and what will be the role of the facility.

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Now moving further if you see this particular graph it is some kind of representation of cost of location of a facility and the response time. Now on this y-axis we represent the cost, on the x-axis is the response time. Now where you see this curve, here you have local fast foods and then you are moving with these type of makes regional local work in process, central fast good, central work in process and then you are coming to custom production with raw material at suppliers.

Now here your response time is very very low, customers do not want to have very high response time and here the when the response time is very low obviously the cost becomes

high and custom products with raw materials at suppliers. Now when we are moving to this way that you can provide the custom products and customer is ready to wait for sometime and with this raw material is procured from the suppliers on the basis of your specification products are produced.

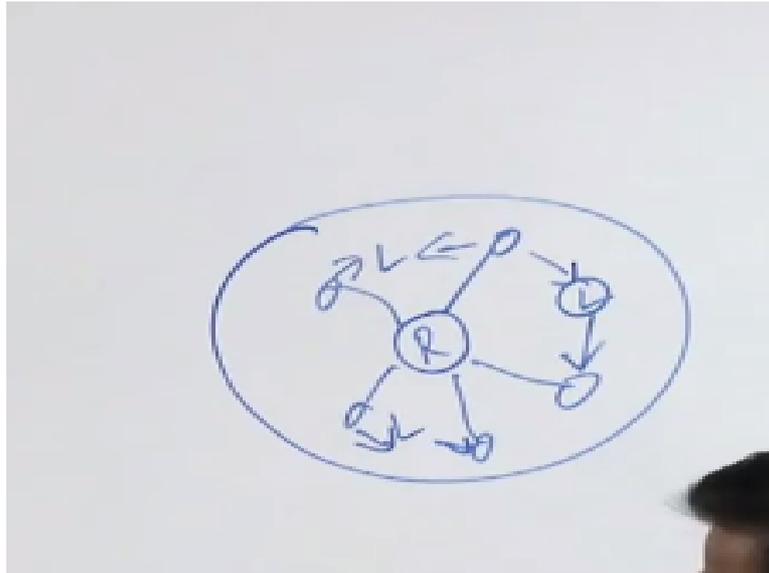
So here your response time is very high, you have a high response time means the time taken to supply the product is high and since time taken to supply the product is high you can expect the low cost, because customer is now ready to wait and when customer is not ready to wait customer immediately wants the finished good so in that case the cost will be high because you have to fulfill the response immediately.

And accordingly when you need to keep the finished goods at the local level the last point of delivery from where the customer is picking the product, customer is ready to pay extra premium on that, but when customer is ready to wait, it means you can take depending upon this particular curve you can see that what type of customers are there for you? and on the basis of that you can decide the location of your facilities.

If your customers or you are providing the finished goods to your customers immediately, you need to be close to your customer and therefore you will be in a crowded market where customers often visit and this type of curve will be there and if customer can wait, so there is no need to locate a facility close to customer, you can be far away from the customer, you can be far away from the costly places because customer is giving order.

And then you are procuring raw material from the supplier and providing products with the customer, so here because customer is ready to wait you are on the extreme side where though this is how you see a straight line is coming local finish goods that makes then some kind of regional finish good. So from a particular reason there is a type of local area from where you can provide, you have one situation where locally you are providing the product.

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And in some other case you have a region and from here you are providing the finish product to the customers, so this is reason, this is looking. So in this case when I am providing the product from the regional cases my cost slightly decreases because I can take the advantage of economy of scale but and in our further discussion also you will see that as my number of facilities will increase I am moving actually from regional facilities to local facilities.

When I will provide with the local facility to my different customers for these 5 customers I can conceive 3 local facilities like this and one here. So with these 3 local facilities I can fulfill the requirement of my customer in a much better way, so as my number of facilities will increase you see as I am increasing the number of facilities on this X access, the response time means my ability to fulfill the requirement of my customers also decrease.

I can fulfill my customer on a very fast bases, very fast basis so the response time also decreases with the increase the number of facilities, but there will be it cost associated with increased number for facility. So in our next session we will see the relation between the number of facilities the cause related to those facilities and then how to achieve and optimum number of facilities, so that you have a lower response time and the same time you have optimum level of total cost of facilities. Thank you very much.