

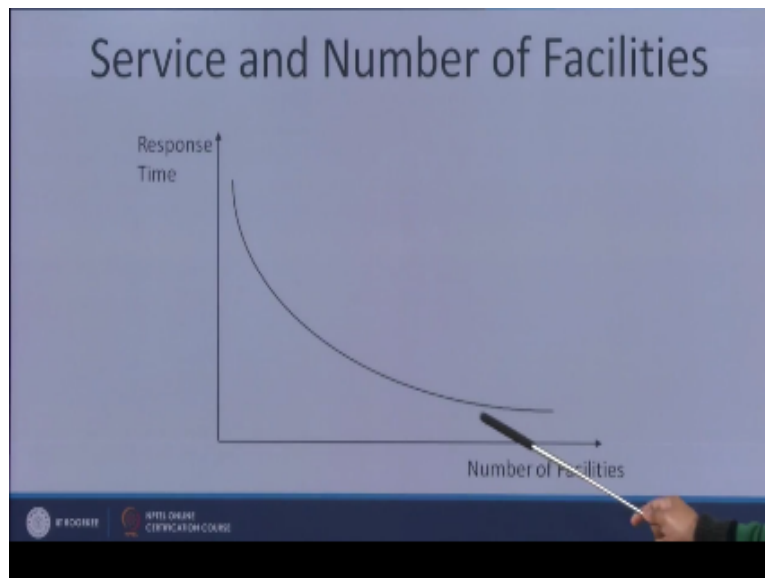
Supply Chain Analytics
Prof. Dr. Rajat Agrawal
Department of Management Studies
Indian Institute of Technology-Roorkee

Lecture-23
Network Design of Global Supply Chain

So welcome back in our last session we were discussing about network decisions we discussed about 4 important type of decisions which we take. We take decision with respect to role of the facilities, we take decision with respect to location of the facilities, we take decisions with respect to their sizes and then we take decisions with respect to market and supplier locations.

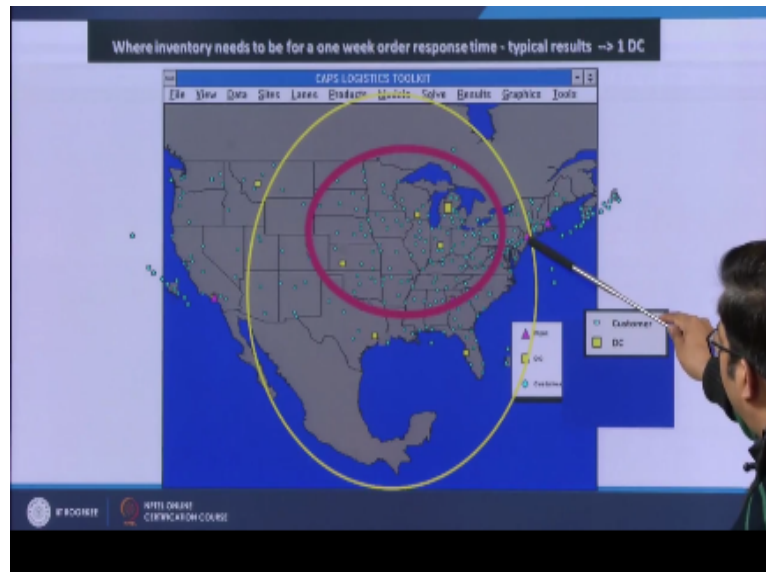
We discussed about various factors which are responsible for taking decisions for network decisions and then in our last session we also discuss that how response time and number of facilities are related.

(Refer Slide Time: 01:31)



We discuss that if we have more number of facilities the response time will decrease, as we are coming from left to right on the x-axis we are increasing the number of facilities, so our response time is also start decreasing.

(Refer Slide Time: 01:30)

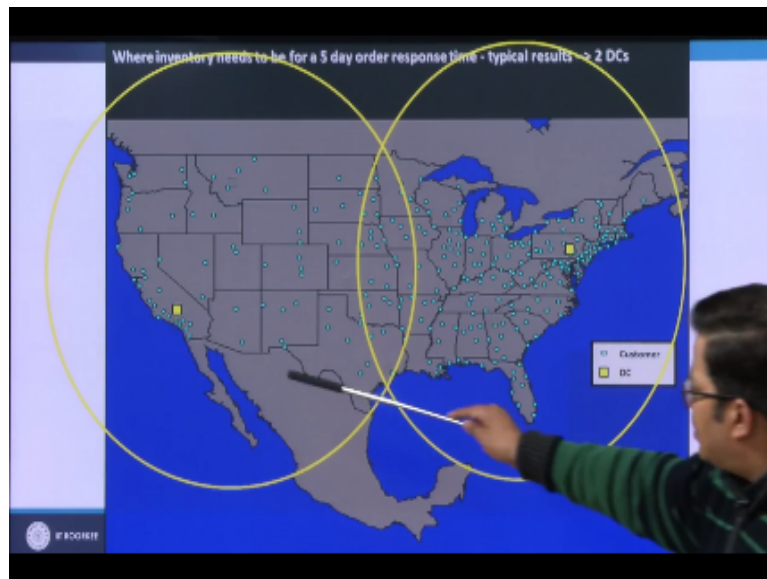


So we already discussed this in our last session. No going further if you see this type of figure that where you have this particular market which is plant, then here you have distribution centres, these yellow points. These are representing the distribution center and then all these dots are representing the customer. So you have these points representing the plant these yellow point representing the distribution center.

And then marks small dots are representing the customer, so this is a type of situation where you have so many customers, so many distribution centres and few plants. Now where you see we can say that we require one week order response time, in this particular case because you have only 3 plants 1, 2, 3, 4 plants and you have very limited number of suppliers with respect to distribution centre.

So here I talk like if I talk with this type of a distribution centre or this type of distribution centre here your required at least one week response time, so in this particular case the response time is very high because of limited availability of the distribution centres in this overall global market.

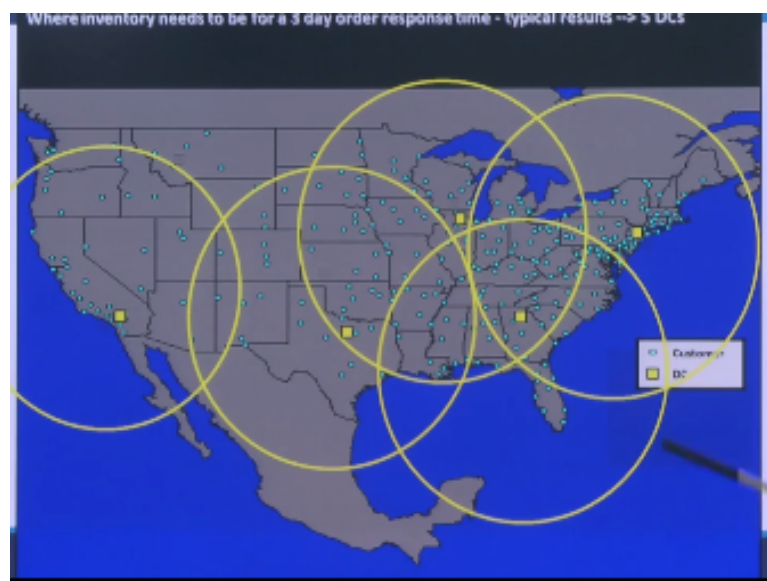
(Refer Slide Time: 03:19)



Now let us go to this type of situation, here you have this distribution centre this distribution centre. Now within this market you have 2 distribution center and here in this particular case because 2 cycles are intersecting, 2 yellow cycles are intersecting. Now you see here in this particular case for these people those customers which are coming in the intersecting cycle, here we have to distribution centre.

This distribution center can also fulfil the requirement of customers coming in this intersection cycle and this distribution center can also fulfill the requirement and as a result of that the response time has reduced from 1 week to 5 days. So that is the result of 2 distribution centres for the customers which are in the intersecting cycles.

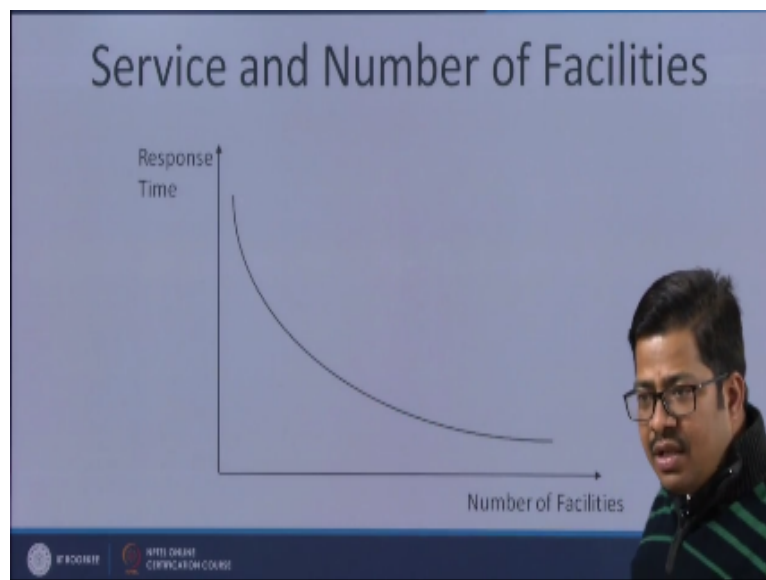
(Refer Slide Time: 04:26)



Now you have more such distribution centre and now you are reducing the cycles of distribution center and therefore you find that in some of the cases you have more than one

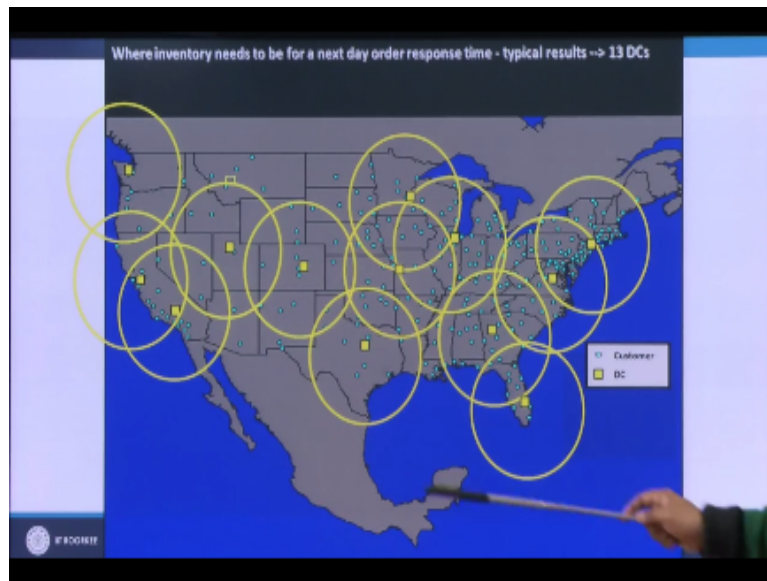
cycle which are able to fulfill the requirement, because you have 5 distribution centre for this market and talking of only this market right now, so for this market this US market you have 1, 2, 3, 4, 5 distribution center and there are at many places customers can be served by more than one distribution center. And what is happening that we have reduced the response time from 5 days to 3 days.

(Refer Slide Time: 05:19)



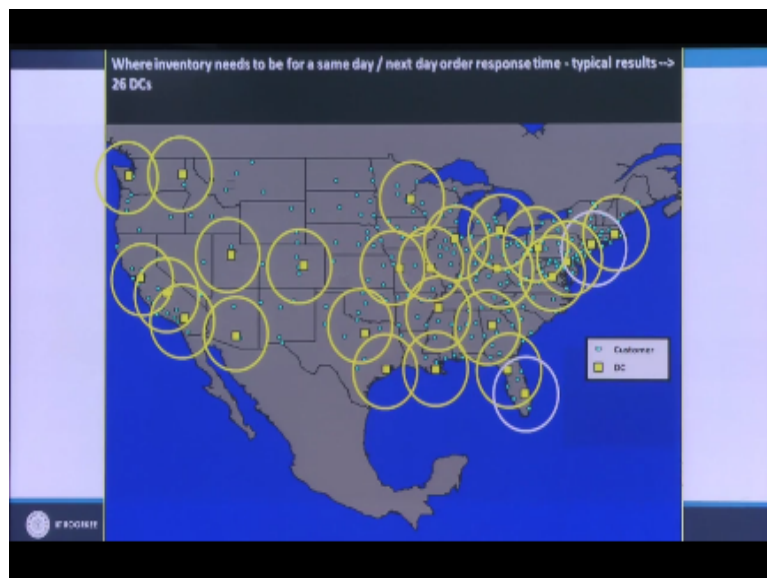
So as we decide that as other facilities if you go back to this light so as our number of facilities are increasing we have one facility so at that time 7 days was the response time we had 2 facilities, 2 distribution centre, so response time decreases to 5 days. Now we have 5 distribution Center to response time decreases to three days. So that is how we are moving for more number of distribution centre, less response time response time we are able to fulfill the requirement of the customer in a faster manner more with less time.

(Refer Slide Time: 05:56)



And now you see you have how many 13 distribution centre, you can see the 13 yellow here and these 13 new circles will further reduce your response time and here we see that the response time is the next day, you order today next day you get the supplies. So because in many cases here you will see large number of intersecting circles and as a result of that customers can get benefited by reduced response time. So more circles, more distribution centres and your response time for that decreases.

(Refer Slide Time: 06:54)

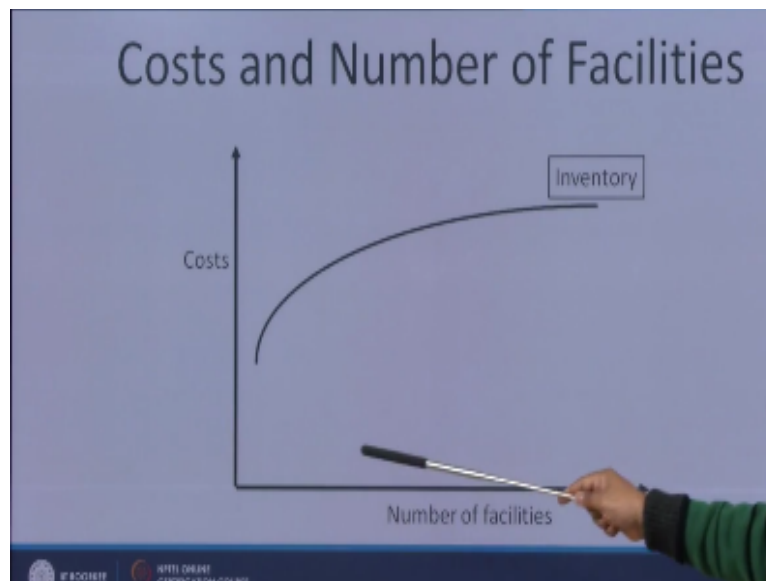


So again strength in the same thing that more facilities and response time will decrease. Now going further you have now how many you can count these yellow circles. You can count is yellow circles and the result is already displayed here that is these are 26 distribution centre. 26 distribution centres and your order can be received same day, the same day order or in some cases like in this case where you do not have any intersecting circles.

So probably in these cases if I talk of this customer, so probably because of the distance from this distribution Center to this customer order may be supplied next day in this case goes 3 customers are very close but there are two customers which are on the periphery of the circle for them order may be supplied next day. There are few customers which are not part of any of the circle for these customers order may come after one day only.

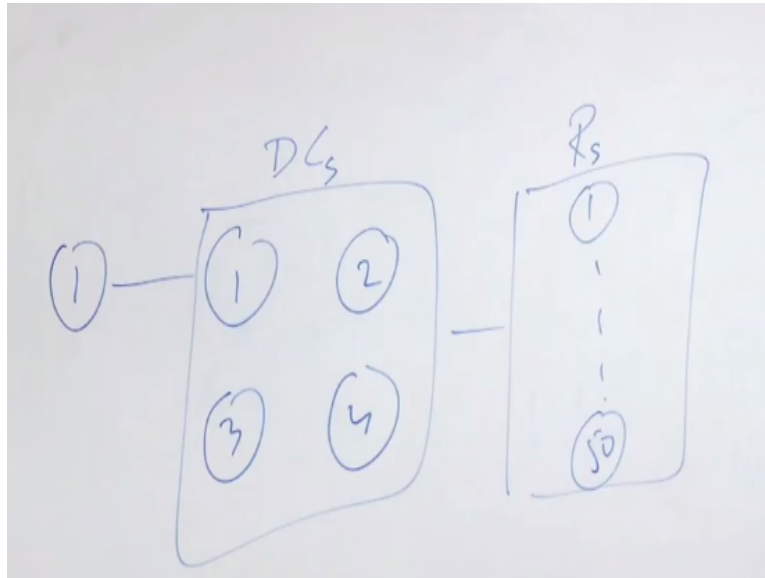
So as we are improving our number of facilities as we are increasing our number of facilities we can see in this diagram that the response time has for the reduced you are able to get the product in the same day, so from one distribution center when we were having only one single yellow circle at that time our response time was 7 days, one week and now we have 26 distribution centres and the response type is the same day or next day. So as we are increasing the number of facilities it is very simple to understand that the response time will keep on decreasing.

(Refer Slide Time: 08:31)



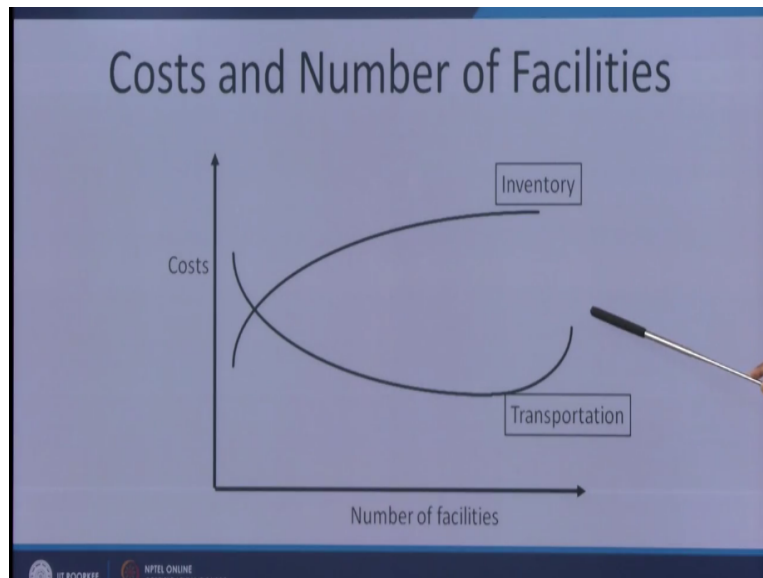
Now you see in this particular case what are the different types of cost which are associated with facilities. Now as we have this cost verses number of facility ground, so your with facility as you are increasing the number of facilities, your inventory cost increases.

(Refer Slide Time: 09:03)



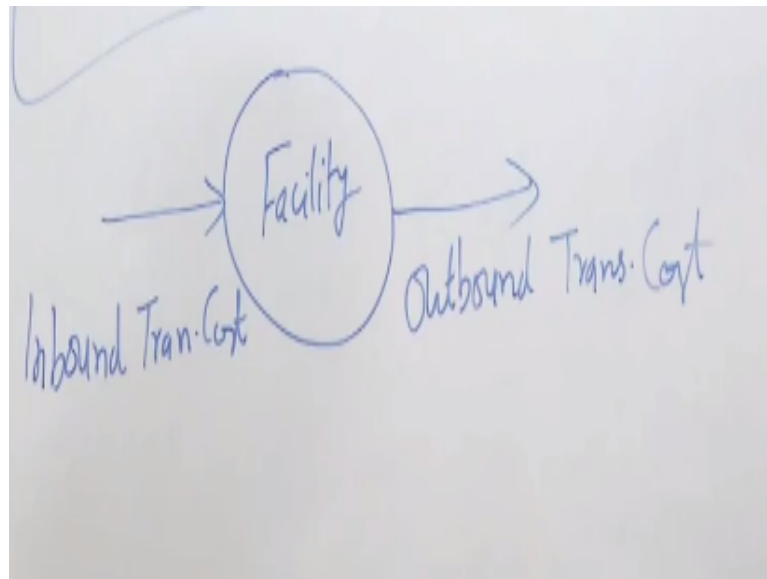
Because now if you see you have various distribution centres 1, 2, 3, 4, one manufacturer, all these are the DCs, then you have large number of retailers maybe 1 to 50 and as you are increasing these numbers from 4 to 6, from 50 to 60 you need id at each location at each facilities some amount of inventory, some amount of products to be kept at each of these locations. So when you are having more facilities in your network your inventory cost is bound to in case. You have higher inventory cost, so that is one simple lesson that more facilities more inventory cost.

(Refer Slide Time: 10:02)



The second is transportation, now the kinds of transportation you see the cost starts decreasing as we are increasing the number of facilities the cost starts decreasing to some point here and then all of a sudden it starts increasing, why it happens, why it happens that way that cost is decreasing to a point and then starts increasing.

(Refer Slide Time: 10:40)



The reason is that transportation cost can be divided into two parts if this is a facility in supply chain. So there are some materials which are coming to the facility and there are some materials which are leaving the facility in a supply chain. So materials which are coming to a facility the cost of transportation associated with the inbound material is known as inbound transportation cost.

This is inbound transportation cost and the cost associated with the materials leaving the facility that is known as outbound transportation cost, it is very simple to understand that normally the size of consignment which we receive at a particular facility is larger, is bigger than the size of consignment leaving the facility. The size of consignment leaving the facility is normally is smaller than the size of consignment coming to facility.

We know that if I am a manufacturer I receive raw material in large quantities and which is very homogeneous also and the finish product because these finished products will go to many dealers, many distribution centres, so the size of outbound transportation, outbound consignment will be smaller. The point which I am trying to say here you get inbound logistics, here you get sufficient economy of scale, but here that economy of scale will not be there.

Though we try to keep some amount of economy of scale even in the outbound transportation also. When we are making more and more facilities we are trying to go closer to the customer, so what will happen we may lose after a particular level of facilities after a

particular number of facilities we may lose all of a sudden economy of scale even in inbound transportation cost because more facilities so the size of inbound consignment will also reduce with the assumption that market is not growing.

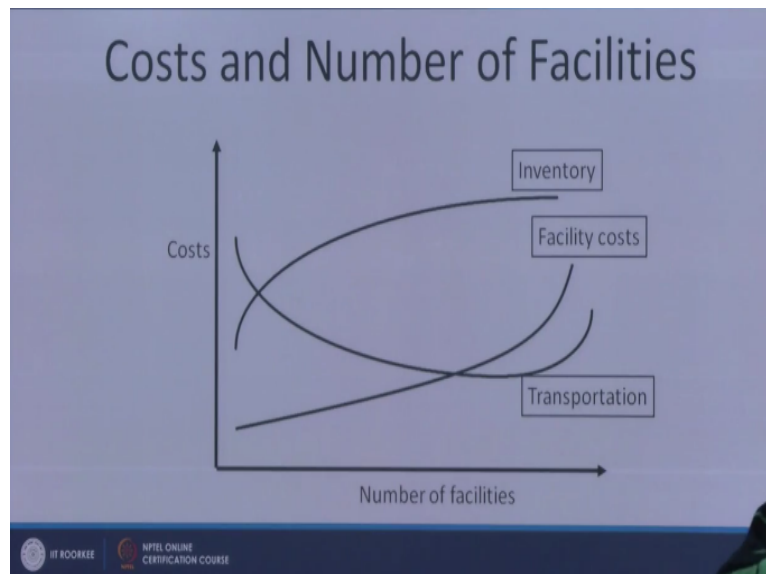
If market is constant and I am making more and more facilities so in that case it is quite possible that with increasing number of facilities my economy of scale my benefit of economics will not be there even in the involve transportation and if that happens because of more number of facilities, so transportation cost starts increasing after a particular number of facility.

Otherwise as long as I am coming to this site transportation cost will decrease because I will be going closer to my customer and I will continuously decreased my outbound transportation cost, I am going closer to the customer, so this out on transportation cost which is much higher than the inbound transportation cost. This cost is higher than this inbound transportation cost. So making more number of facilities will help me to reduce the outbound transportation.

As long as I am able to maintain economy of scale in the inbound transportation cost but what I said that after a particular number of facilities I will lose economy of scale in the inbound transportation cost also and at that time the benefits of reduced outbound transportation cost will be nullified or rather I need to pay more if that happens if I lose the economy is scale in my inbound transportation cost.

And therefore I can have this type of increase very sharp increase in the transportation cost of the product after a particular number of facility, so that is the discussion about the second important cost with respect to number of facilities.

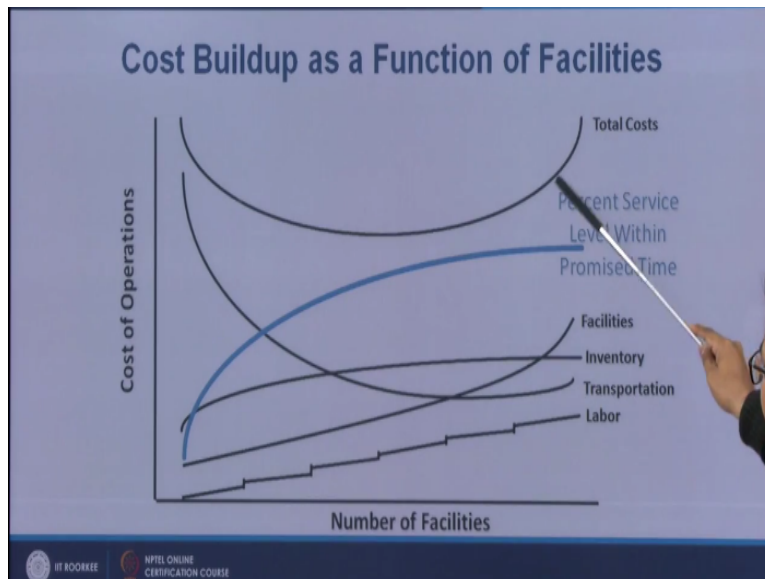
(Refer Slide Time: 15:20)



The third cost of the facility cost itself, this is the facility cost, so as I am making more number of facilities I need to develop the required infrastructure, I need to put my capital into that and as a result of that with more number of facilities I have increasing the cost of facility. Up to some level you see I am moving in a very linear fashion up to here, but beyond this point there will be a very sharp increase exponential increase in the facility cause.

I will ask my students to think on this aspect that why the cost of facility increases in this exponential manner, after a particular level. after a particular number of facilities. And probably in our next session I will like to around reply I will give you this question right now that why you have this straight line up to a particular point of number of facilities and beyond this the shape of the curve changes at it becomes more exponential in nature with respect to facility cost. And you please think through and in our next class we will like to discuss the answer of this every question.

(Refer Slide Time: 16:54)



Then if I combined my various types of cost, so this type of curve merges where this curve at the top represents the total cost which is the sum of facilities, inventory, transportation and labour cost, more number of facilities so with increase in facilities you have a step increase in the labour cost also, you have transportation cost decreasing and then increasing, you have inventory cost which increases with number of facilities and the cost of facilities itself.

And as a result of that you have this total cost curve where the cost is decreasing up to a point and then it starts increasing because of increase in the transportation cost and then the role of services and facilities is also very important with your increased number of facilities why are you increasing the number of the facilities?. The question is why are you increasing the number of facilities?, we increase facilities because we want to serve our customer in a more satisfying manner.

Or you can say that we want to achieve higher level of services by providing more number of facilities, more number of facilities going closer to the customer and going closer to the customer will bring better service level so as you are seeing with this curve that your service level is increasing with number of facilities as you are increasing the number of facilities your service level is also improving. So this is a combined discussion of variety of cost and the service level which you get with the increase number of facilities.

Now with this discussion we cannot understand that what should be the ideal number of facilities. Now if you see the total cost curve, the lowest point of this total cost curve somewhere here around this point and here if I get this level of service and if this level of

service is within the my promise limits to my customer then I will like to keep this as the number of facilities, these number of facilities I will like to keep and you see this is the point of intersection of my facility cost and the transportation cost also.

So this is the point where I get the minimum cost of facilities and this is the level of service. Now if I want to improve my service level this is only possible when I will incur additional cost of facilities. Additional cost of facilities will be required for improved service level for higher response rates and in case of a product where we want very high level of responsiveness we can go with higher level of service and accordingly cost of offering that service will also increase.

So those products probably of emergency nature where we require very high level of service in that case cost many a times may not matter therefore you will provide high level of services by going to the higher level of caused by increasing the number of facilities like in the case of humanitarian supply chains, the disaster subtiles where you are providing the facilities for better rehabilitation for immediate relief of the victims.

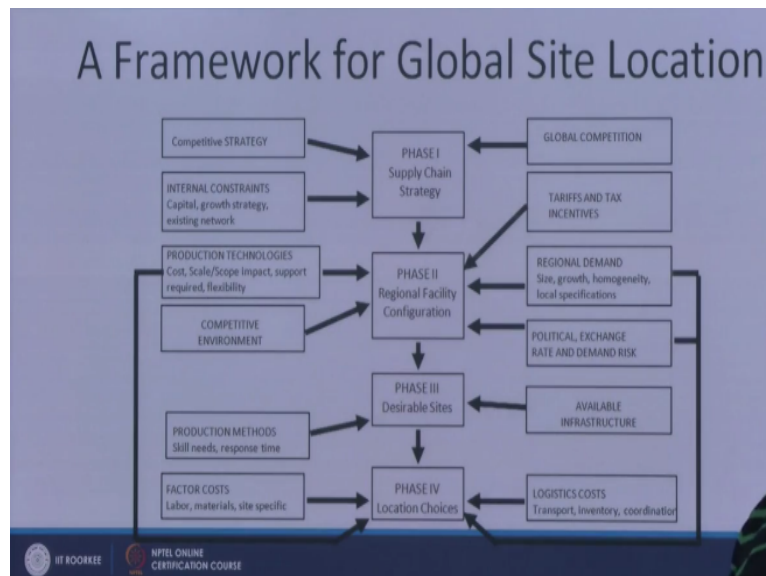
In those cases cost issues are secondary, the ability to provide relief immediately is more important and in such type of situations we will like to have more number of facilities in those disaster prone areas in those risky areas where you feel that disasters makeup and for that purpose to provide higher level of services you keep your ambulances, your nursing homes, your other dispensaries, your other facilities, always readily available.

And therefore your cost is also high but in those situations we require very high level of response and therefore it is well justified but in any other cases the higher level of response of service may not be required and therefore it is not essential to increase the cost of your offering by increasing the number of facilities. So therefore in most of the cases it is always advisable to understand this graph very carefully for the practitioners those were attending this class.

It is always advisable that please understand this break up and try to optimise the number of facilities. Otherwise you will increase the number of facility but you will not have proportionate increase in service level, because you see the service level curve becomes

almost is pregnant after a particular type and therefore understanding of this graph is very very important.

(Refer Slide Time: 23:11)



Now moving further let us quickly see that the PC that once we are deciding about the location of the facility, so how do we select the sight in a global environment, what are the different phases involved, you see this is a 4 phase process, phase 1, 2, 3, 4. The process starts with the supply chain strategy, this is the first stage of our site allocation, site selection that what is my supply chain strategy.

Because all the facility location decisions must be in line with your supply chain strategy, so so understanding the strategy is very very important, I discussed in my last class about Walmart and 7-11. The Walmart strategy is to provide low cost product, the 7-11 strategy is to provide the very high level of responsiveness. If I am an emergency type of hospital, so my condition is different and if I am a hospital for routine medicines, so in that case my condition is slightly different.

So this depends upon my whether I am a routine type of hospital or I am there to handle the emergency cases. So as per that my first important thing is supply chain strategy. Now supply chain strategy is we have already discussed that for every quick brush up will like to discuss that it comes from the competitive strategy of the organisation, what is the competitive strategy of the organisation that derives your supply chain strategy.

And then the other factors which contribute in proper understanding of the supply chain strategy or proper you can say written framework of the supply chain strategy one is the internal constraints and the second is the Global competition. These are the two more factors which are very important in deciding the supply chain strategy. So totally there are three inputs. Three inputs for my supply chain strategy one is the competitive strategy of the organisation.

Second is the global competition what is going in the global level with respect to your industry and the third is the internet that concerns related to Capital, the growth strategy, the existing network etc. These things also play important role because if I am let say Tata Motors and I am launching Tata Nano a new vehicle in my portfolio, so I cannot have entirely new network of distribution for Tata Nano.

Because I already have a disc vision network for my other products and I will like to use I will like to have some kind of synergy with my existing network. On the other hand we have the example of recent example of Maruti Nexa, where Maruti to promote its exclusive type of product is not using the existing Network and Maruti has created a separate network of distributorship named as Nexa.

So it depends upon what type of truth exit strategy what type of existing network in case of Maruti do we all know Maruti is known for its largest network among the automobiles, but still for its exclusive products if they want to have some kind of different positioning of some of their products they gone for the Maruti Nexa. So it depends that what type of growth strategy?, what type of capital requirement you have and then on the basis of that use decided supply chain strategy.

The second phase is the regional facility configuration. Now on the basis of that you have certain regional consideration and regional considerations come from the tariffs and tax incentives like when new states of Uttarakhand, Chhattisgarh and Jharkhand came into existence in India. Uttarakhand government, so on Chhattisgarh, so on Jharkhand, so on Jargat gave of tax incentives to new organisations.

And as a result of that many new companies, many new MNCs they open their facilities in this new stage. So some type of tax incentives, what type of tax incentives are available in a

regional area?, what is the regional demand?, whether we have any regional demand or not, most of these states were not having any kind of regional demand. But because of very heavy tax incentives many facilities came in this areas.

Then certain political stability type of issues are also very important and because industry can only survive facilities can only service where you have political stability. Then another issues related to production technologies whether we have appropriate technologies available. This issue is more important when I look at the global level. So because in that case the regional issue is a particular country.

If I talk in case of India a regional issues related to a particular state, so in that case what type of technology support will be available in country like India or any other country where I am thinking to establish my facility and what is the competitive environment do we have a positive competitive environment in that regional area or not, so that is also very important and with these things I draw some conclusion about my regional configuration.

I divide the global market, global arena in certain regions and then I do this type of analysis for all those regions and on the basis of that I may consider one or more than reasons which are favourable for my decision making and once I have done that third issues related to side, within that region what are the possible sites where I can locate my facility like if I take regional issue related to Uttarakhand, Uttarakhand is one reason.

So desirable sites can be Udham Singh Nagar, desirable sites can be Sitarganj, desirable site can be Haridwar and out of that I will look that what is the available infrastructure in each of these sites. Now I will go to a very specific issue related to power availability related to manpower availability related to railroad infrastructure related to water availability etc. and the production methods is still needs.

And response times means what type of skills are available in that particular site and what will be the response time how I will manage the response time from this particular site. So depending upon my market and supplier location I will take the decision with respect to response time and on the basis of this finally I will like to decide I will come to a particular location where I will see the issues related to logistics costs, issues related to factor cost of labour material and some site specific issues.

So when these four stages are passed I can take decisions with respect to location of a particular facility in a particular region at a particular site. We will see, we are stopping our this session at this end but in our next station we will see that some of the mathematical model, some of the mathematical analysis which can help us in selecting the regional facility and desirable sites on the basis of various inputs which we are required and some mathematical models are there.

And we will request you that if you can practice some Excel solver kind of thing, if you can install Excel solver in your computer and we will do some questions here and with the help of those questions you can also practice at your end and then you can see that how in real-time the modelling related to networks can be done, because the decisions related to stage one of the supply chain where we are talking of manufacturing related decisions.

These are permanent type of decisions, but decisions related to next stages retailers, distribution centres or more dynamic in nature and where we require more real time analysis. So thank you very much we stop at this time and will look for your participation with Excel solver in our next session. Thank you very much.