Industrial Engineering
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Lecture - 12
Module - 4
Facility Design Part – III

A very warm welcome to all of you in this lecture on facility design, if you remember we have started the discussion on facility design. We have seen in the first lecture that if we have to place a facility at a particular geographical location, we have to consider a lot many factors. On the basis of those factors we make a judicious decision that our facility or our plant would be located in this particular geographical area. We have also seen that once a particular area has been identified; we have to make a decision that what should be the location of the various plant facilities within the plant.

For example, the location of the machines that where we are going to place our machines? In which pattern we are going to place our machines? In which we saw 3 important types of layouts. For example: the product layout the process layout and the fixed position layout. In today's lecture, we would like to focus on certain details related to the selection of opposition or a selection of a locality for establishing our unit. Or we can say establishing our plant facility or establishing our service facility. We have to see that the major aim of any organization is the maximization of the profit.

So, for profit maximization we have to take into account the money that we are investing into the facility or the plant. So, if the returns that we get from that plant or facility or more than the money that we have invested in that we say that, yes we have made some profit from this investment. Similarly, this problem of choosing a proper location of establishing a plant facility or establishing a service facility in a particular geographical area is also same type of our problem. So, let us see that what are the various types of costs involved in setting up a facility or in transforming a raw material, to the final product?

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Now, on the very first slide we will see this problem of minimization of the costs or we can say maximization of the profit. On your screen you can see these are the costs affecting the location choice. Now, what are the costs? Initially, let us see that there are certain inputs those goes to the processing unit or the plant or the factory. And then we have a certain products that are produced as a output of this process technology which are then put into the market. So, the market is the geographical distribution of potential customers. So, geographically people are distributed in; we can say in different zones in a country or different states in a country.

So, the geographical distribution of the probable customers is there, that we can say that this is the market that we are tapping or the products have to be supplied in this particular market to the specific customers or the consumers. So, there is a input. Now, what is the input? So, the input basically is the human resource, people would be required to carry forward this transformation process from raw material to the final product. Natural resources may be required may be it may be in terms of materials it may be in terms of energy may we sometimes, we generate electricity using coal.

So, coal may be one of the natural resources that is available from the mines, then certain kinds of energy is required that is also input parameter. Now, energy can be in terms of hydel energy. It can be in terms of electrical energy; so different types of energy requirements are there. So, all these are the input parameters then there may be other input parameters such as the consultancy that is the expertise in a particular field available and then the sub-contractors. Sometimes it is so happening or it may happen

that whatever we are doing our process is dependent upon a number of other small industries are small scale industry.

So, we have to sub-contract some of our work to these people. So that they are helpful to us in making our final product for example, ours is a assembly line in which we are assembling 50 different subassemblies to make a final product. And out of these 50 subassemblies, we are manufacturing 25 subassemblies ourselves and 25 subassemblies we have given to sub-contractors or to our vendors who are manufacturing them for us. So, we have to whenever we are selecting a particular location for setting up our plant facility, we have to see these subcontractors also. So, this would also be a kind of a input to our process technology.

So, process technology basically means the transformation process; it can be any process in which we are transforming the raw material that is the natural resources into the final product which is being then sent into the market. So, this is basically a bigger problem which has to be solved for maximization of profit and minimization of costs involved. So, some input supply cost will be involved all these things that you are seeing on your screen: human resources, natural resources, consultancy, subcontractors all this would be the input cost or this would be the input supply cost.

So, some cost would be involved at this level of the transformation process or this would add up to a particular cost. Then we have the process technology or we have certain set of machines which are transforming the raw or the input into the final product. So, certain money would also be required at this particular point. So, what is the money that is required? That is the processing cost. So, some cost is involved in transforming the raw material from here to the final product for the distribution or for the customer. So, there would be some processing cost also involved.

Similarly, when we come to the market; geographical distribution of potential customers that we can call in as in a single word as the market. Then we would have a distribution cost like the product is ready at this stage or at the output of the process technology stage. The raw material has been converted by this process into the final product which is now ready to be used by the customers or the consumers. Now, this has to be distributed to different geographical locations. Then we have to take a decision that this cost should be minimum or the distribution cost should be minimum.

So, whenever we have to take a decision regarding placing of our plant or facility at a particular location, we have to minimize all these costs. How these can be minimized that different types of techniques can be used for that particular purpose. What is the

purpose? The minimization of the total cost or the maximization of the profit, so we have to select a particular location for setting up this process technology. So that the input supply cost is minimized because what is going to happen whenever a process technology or a factory is there; it is buying some raw material from the vendors. Now, these vendors would be supplying the raw raw material to the factory at a particular rate.

So, that rate would be dependent upon the type of transportation that is required. So, all those things will play a very important role in minimizing the total cost. There may be so many different vendors available for the raw material. So, a decision has to be made that which raw which vendor to be chosen so that the input supply cost is minimized. So, this is 1 problem, then the second problem is the distribution; that is the distribution cost. Now, we have different geographical locations at which we have to supply our raw material; the final product through the distributors.

So, the final product is going from going to one geographical location second geographical location third geographical location. And we have number of distributors for these geographical locations may be for north we have a distributor for south we have a distributor for east, we have a distributor for west, we may have a different distributors. So, there are different distributors and then they have the retailers who are selling the final product. So, this distribution cost has to be minimized we have to judicially judiciously place our distribution centers, so that the cost is minimized. Which cost is minimized? The distribution cost is minimized.

Similarly, if we come on to the process technology which is transforming the raw material into the final product, there also cost is involved. What is that cost? That cost is the processing cost we want to minimize that cost. Let us take an example, suppose, the process technology requires are temperature of 10 degree to be maintained in each and every shop. If we place our plant at such a position or such a geographical location, where the temperature range is from 8 degree to 12 degree only, it would be easier for us to maintain the level of 10 degree centigrade temperature. But, if we place our manufacturing facility at a location where the temperature varies from 4 degree the 45 degrees, then we have to have a facility to maintain the temperature at 10 degree centigrade which would add to the cost of the plant.

So, judicious selection of a plant taking into account the requirements of the processing would also minimize the processing cost. So, all these 3 costs may be the cost for buying the material from the, he cost of distributing the final product into the market and the cost of processing the raw material into the final product. When these 3 costs can be

minimized in that case, we would be able to save a huge amount of money which would result into the profit. So, with this simple diagram we have seen that how we can make profit if we are able to minimize these 3 different costs. But, it is not as simple as depicted in this diagram.

There are so many different factors that have to be considered. So, those different factors when we consider them judiciously, when we give adequate weightage to those factors would lead us into profit maximization. Some of them are there on your screen if you have given attention; there are other constraints as well which can be social legal political. So, all this we have discussed in detail in our lecture one on facility design. So, we can conclude from this diagram that we have to maximize the profit and minimize the cost and thereby, we have to select a location judiciously which would minimize the total cost.

Now, let us see that what is the procedure for selecting a location? In the previous slide we have seen that the judicious selection of location is very, very important in minimizing the total cost and maximizing the profit. So, the procedure for selecting a location is divided into different phases its starts from: phase 1, phase 2 and phase 3; may be: stage 1, stage 2 and stage 3. Phase 1 and phase 2 are the different phases of stage 1 itself. So, let me a again repeat this procedure of selecting a location is in different stages: stage 1, stage 2 and stage 3.

Similarly, now we are going to see that what are the different phases in each and every stage. Now, we will take a decision that initially if you remember in the very first lecture I have told that whenever we have to make a house we have to first make a judicious selection that in which zone I am going to settle. The zone may be north zone, south zone, east zone, west zone of a particular country. So, when the zone has been selected then we will select a particular geographical area or a particular state. And when the state has been selected we will select a particular town or a city. When city has been selected within the city we have to go down to a particular area where we can afford to buy a house or by a piece of land on which we can construct our house.

So, all these decisions have to be taken one after the other. So, there are certain set guidelines which help us to make these decisions judiciously. So, let us now see that what is a procedure I have illustrated a very simple; I have given a very simple procedure for finalizing the housing problem. But here, whenever we have to decide setting up of a plant or setting up of a factory we have to take a procedure, we have to follow a procedure which would help us to judiciously select the most optimal location.

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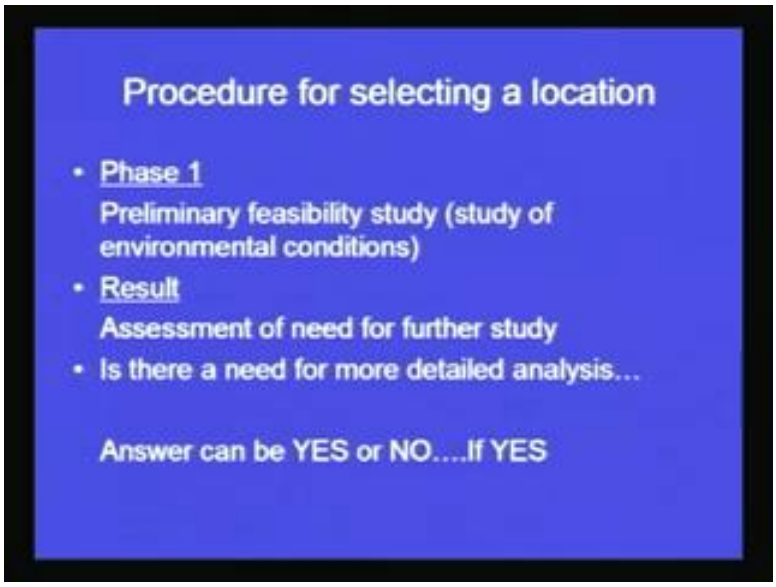

Now, let us see what is a phase 1? Phase one of the procedure for selecting a location is the preliminary feasibility study or the study of the environmental conditions. If you remember, in the previous slide also I have told that the environmental conditions play a very important role. So, that we have to take into account. So, whenever we take into account the environmental conditions, we would be able to generate a substantial amount of profit for our company. And what will this result into? This will result into the assessment of need for further study.

So, we will do a very preliminary study or a feasibility study that yes according to environmental conditions this geographical area is fine for us. We can set out plant in such and such location and then this would help us in doing the assessment need for further study. If we feel that geographically this area is not suitable for setting up our plant facility. In that case, we will say yes assessment is poor we are not going to set up a plant in such and such location. Let us find out some other locations for setting up of a plant.

So, this would help u; the preliminary investigation would help us to take a decision that is there a need for more detailed analysis. If there is a need for more detailed analysis then we will go to the subsequent steps. If there is no need for subsequent analysis, then there is we will stop there, and then we will start searching for other geographical locations or other communities; where we can set the plant.

So, phase 1 may be we will repeat because these are the different phases that we need to understand. Phase 1 tells us the preliminary feasibility study; whether the location or the area that we are trying to focus is feasible according to the environment conditions or

not. Then we do the assessment that further assessment is required or not. Is there a need for more detailed analysis? We have to take a decision answer can be either yes or no if it is no, I have already told no need to go for further analysis.

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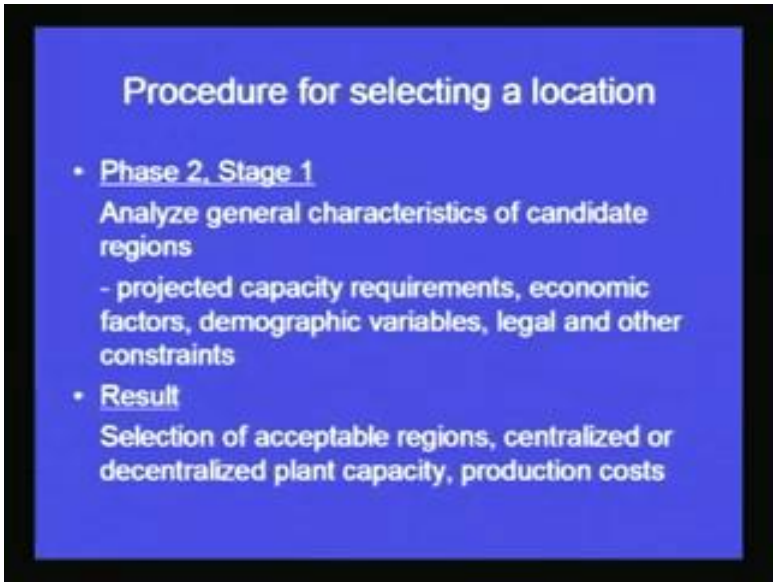

If it is yes, then what we have to do? Let us see that. Procedure for selecting a location phase 2 stage 1 now, this is now phase 2 of stage 1. Initially, we have seen phase one of stage 1: analyze general characteristics of candidate regions. Now, with initial from environmental point of view a feasibility study has been carried out, in which we have identified that yes this area can be used for setting up of the plant facility. or area means a very big geographical location has been identified. In which there may be different candidate regions in which we can set up the plant facility.

So, from a very bigger domain now we have come on to a specific domain. Now, within that domain also we have certain candidate locations which we have to finalize, that which would be giving us the minimum cost and the maximum profit. Then how we are going to make this decision? These decisions will be made on the basis of projected capacity requirements. Now, we have to take a decision that what are the projected capacity requirements if you remember the lecture on capacity planning.

We have seen that there is economies of scale there are diseconomies of scale. We have to see that whether we need to have a single plant manufacturing a huge volume. Or we have to have a distributed capacity or distributed centers or distributed factories may be 4 factories or 5 factories producing a certain amount of products and distributing to their specific market segments. So, we have to take a decision regarding the projected capacity requirements. Now, what would be the advantage if we have only a single factory; a very

big manufacturing facility or a very big factory which is catering to the need of a huge amount of geographical area.

The major advantage if you could remember is economies of scale. Because, the overall money that we have invested that in that particular facility or setting up of that very big factory would be divided into the number of products or the volume of products that we are producing. So, the cost of product may come down, but on the other hand on the contrary if we have a 5 different factories producing the same product and distributing it to the consumers in their neighborhood. Then we have to see that how much money we have to invest in setting up of 5 different factories.

And how much money we are saving by putting the factories close to the consumer. In the first case, when only one big factory is there the distribution costs would be higher, because the factory is located at one position and then from here we are distributing to all the consumers on in all the different locations. But, when we have 5 different factories the distribution costs may be reduced. But we have to make a trade off that in which particular scenario we are making more profit. So, this is also a decision that has to be taken when we adopt the procedure for selecting a location.

So, projected capacity requirements is one important thing, second thing is the economic factors that is the profit and loss factors that we have to take into account. How much would be distribution cost? How much would be the variable cost? How much would be the fixed cost? All those factors have to be taken into account then the demographic variables the distribution of population which type of population is staying in which type of areas. What is the kind of demand being generated and the different demographic zones? So, all those things have to be taken into account.

Then legal and other constraints also have to be taken into account. So, in phase 1 we have seen that we are only doing the preliminary investigation from the environmental conditions point of view and we have just justified that we are going to further go ahead with this particular area. In within that area also we have number of candidate regions which on which we have to make a decision that which would give us the best results. So, for different candidate regions we are analyzing certain general characteristics; which are there on your screen.

First general characteristic that we have analyzed is the projected capacity requirements then the economic factors we have seen, demographic variables we have seen and legal another constraints also we have seen. So, when we have to make a selection stage 1 there are 2 phases: phase 1 and phase 2 after this, what would be the results that we have

got. The results are selection of acceptable regions no within the candidate regions there would be some regions which would be acceptable to us on the basis of those factors which we have already considered.

There would be some regions which would be out rightly rejected that economically, it is not justifiable to place a plant in such and such location or demographic variables do not insist or do not persist on setting up of a plant in that this particular location. So, some locations would be rejected some locations would be accepted. So, selection of acceptable regions would be done after the phase 2 of stage 1. Then we would also be able to justify whether we have to go for a centralized or a decentralized plant capacity. That means, that whether we are going to place our plant at 1 particular location or it is going to be a very big plant facility or it is going to be a distributed facility spread over 5 different locations. May be decentralized in which we have 5 different factories catering to the need of the local customers.

So, this would also help us to take a decision judiciously should we go for a centralized facility or should we go for a distributed facility. So, 2 points 2 answers we have got. What are those two answers? First 1 is a selection of the acceptable regions and second 1 is the centralized or decentralized plant capacity. And third one is the production cost. So, after doing the phase 2 of stage 1, we are we have got 3 different answers. We also know that what are going to be the production cost involved. So, we know that what is going to be the acceptable region whether it is going to be a distributed or a single plant capacity or what are going to be the production costs.

So, why production costs are important, because we want to minimize these costs in order to maximize the profit. So, after doing a judicious analysis of all these factors which are there on your screen, we would be able to identify that this is going to be the minimum production cost, if we choose such and such location. Now, we will see that it is very easy to say that we will consider all these factors and we would be able to achieve these results. But, there is a substantial amount of information that would be required in order to carry out this type of a analysis. So, what would be the information or data which that is required in order to make such type of an analysis that we are going to see in the subsequent slides.

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Now, this is the data needed to select a suitable region. So, there are different candidate regions we have to select a suitable region. Now, what is the data? What is the information that is required? Let us see that information. Future increase in demand by region translated into productive capacity requirements. So, future increase in demand means that we have to have a sales forecast data; that this is going to be the sales forecast for another 5 years for another 10 years. And then we have to see that what is the product produced productive capacity requirements? What do we in, how much we need to be produced?

How much is the requirement in the market? What is the demand in the market? All that has to be taken care of or this data has to available with us when we have to take a decision regarding the location of a suitable region or regarding the location of a particular plant facility. We have to select a suitable region we have to set up a plant facility. So, we need to have a sales forecast data available with us that is that is going indicate a future increase in demand. So, this would be translated into the productive capacity requirements.

So, what are the capacity requirements required to meet that demand which is there in the market? Then cost relationships for production and distribution. We have already seen in the very first slide today that there are certain inputs which are transformed by the process technology into the final products and these products are then finally, distributed in the market. So, we have to minimize the distribution cost, we have to minimize the input cost as well as the producing cost. So, when these 3 costs are minimized our overall location of the plant is justified. Then cost relationships for

production and distribution have to be studied or we need to have information regarding these things or these 2 important points.

The third point is identification of sources of needed production inputs. Now, for production we require a certain amount of input also. Now, what is that input we need to have information regarding the raw materials. What is the quality that is required? What is the quantity that is required? What is the cost of raw materials? What is the reliability? How this is going to influence our decisions, we can just take a simple example that for a raw material the cost may be different in different states of the country.

Same raw material may be costing less in 1 particular state and it may be costing more in some other state or some other particular state. Then we have to take a judicious decision that the raw material is cheaper in such and such state, why not to do the feasibility analysis of setting up of our plant in that particular state. So, raw materials we have to see that what is the quality of raw material available? May be the quality may be different in different areas of the country.

So, we have to see that what is the quality available? What is the quantity available and the costs already I have told quantity also is very, very important and then finally, the reliability. Somewhere, doing the risk analysis we find out that the vendors are very, very reliable. All the time you place an order you are bound to get the raw materials at a specific date on a specific time. But there may be a region in which the reliability is very, very poor or the transportation is not available or the transportation is very, very risky.

So, all these information should be available with us when we have to make a decision that this is the area in which we are going to place our facility. So, within the candidate regions whenever we have to select a particular candidate or a particular location we have to have information regarding all these points. So, we have seen that sales forecasts are important identification of sources of sources of needed production inputs; that is raw materials we have already seen. Then the labour market also very, very important whether, we have the available skills in that particular region.

Suppose, we want to setup a software company we are not going to setup a software company in a region where there are no software engineers available with us. And if no software engineers are available we have to get our software engineers from some other location and then all their habitation cost have to be borne by the company. They would come you have to bear for their housing, for their boarding, lodging all that has to be taken care by the company; which would add to the cost to the company.

So, we would like to setup our software company in such an area where there is a plenty of skilled manpower available in terms of software. So, available skills are one of the most important points. Then the wages already if you remember we have seen in of the lectures that if we want to setup a facility we would always like to setup the facility in such an area. Where, the prevailing wages are not very high, because the wages or the money that we pay to our workers is going to add up into the cost of the product.

So, we want to minimize the cost of the product to be competitive in the market. So, we have to take into account the prevailing wages. So, may choose an area where the wages are less or we have to pay less wages to get the similar kind of work done. And then the supply level also is very, very important. So, skills the money we have to pay and the adequacy or the supply of the labour, that is very important.

So, these factors why we are seeing these factors because these are the factors which would help us which would guide us in making a judicious selection of a particular region in a big geographical domain. So, these are the first 2 parameters that we have to take into account.

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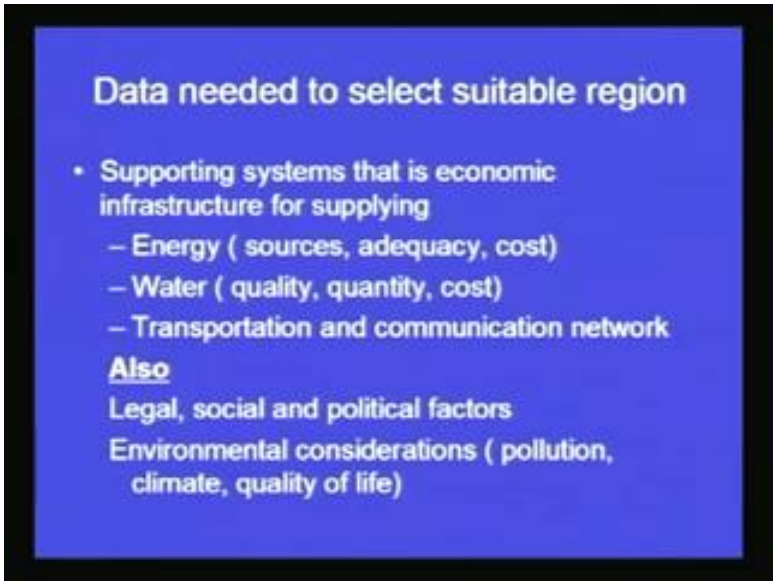

Then there are other parameters such as supporting systems that is economic infrastructure for supplying. Now, 2 things already we have seen raw material it is quality quantity cost reliability. We have seen labour adequate skills are required, proper supply levels of labor are required the wages should be less. So, those 2 parameters we can say: raw material and the skills required of the manpower or the labour. Third parameter is the supporting systems. Now suppose we have the raw material very cheap

we have labour also we have adequate skills also; but, if we do not have the energy water or transportation facilities available they are of no use.

So, supporting systems also have to be in place and these supporting systems have to be very efficient and effective. Now, on your screen you can see the third point supporting systems that is economic infrastructure for supplying energy. Now, energy should be available different sources of energy can be there adequacy and cost. Now, whenever we have to choose a location we can see that if we place our facility in a particular state, that cost of electricity may be less. But if we place the same facility in some other state the cost of electricity may be higher.

And this is the regular or a reoccurring in cost which would always be there if your are operating different number of machines, if you are operating the factory energy would always be required this would add up to the cost of the product So, sometime this would be a sole criteria for making a decision regarding the optimal location of the plant. So, energy should be available may be from different sources then it should be adequate also It should not be such that in 24 hours we are only getting the power supply for eight hour then for the remaining 16 hours our plant capacity would not be utilized. So, capacity would be wasted we can say.

So, we want that the power should always be available that is, adequacy of power then the sources of power should be there and the cost should be less. So, when the optimization of all these 3 factor that is cheap also, it is available for the large period of time and it is available from all different sources of energy. Then we can say yes this is an optimal location because this here we would have to spend less money for the same amount of power. The power is also available 24 hour a day as well as if 1 source of power is not available; there are other sources of energy which are available. So, this is a judicious location or judicious selection of a location for setting up of a plant facility.

Similarly, water quality, quantity and cost; we have adequate quantity of water available the quality of water is good as well as the cost is also justifiable. This is going to have a bearing on our on our decision regarding the selection of a location. Then the transportation and communication network would also play a very important role that is, we have to see that all the transportation modes are available. Let us air it can be railways it can be road. So, all different modes of transplantation should be available, then the communication network should be there telephone lines should be easily available.

So, if we have information regarding all these factors then we can very easily make a decision. But, if we do not have the relevant information related to all these factors we would not be able to take a decision that which particular location would be best for us and which particular location would gives us the maximum profit. Also we to consider some other factors till now, we have seen 3 important factors: the first factor was the materials or the raw materials, second factor was the labour third factor is the supporting systems.

There are other factors that have to be taken into account that you can see on your screen. So, we have to take into account the legal, social and political factors. So, this we have already discussed in detail in our previous lectures on facility design. So, we have to take into account legal, social and political factors as well. Also, we have to see the environmental considerations. So, in environmental considerations we have pollution, climate and quality of life. So, if we see in stage in this particular stage whenever when we have different candidate regions out of which we have to select the most optimal region. We require data of this particular type or these particular levels which is going to help us in making a judicious selection.

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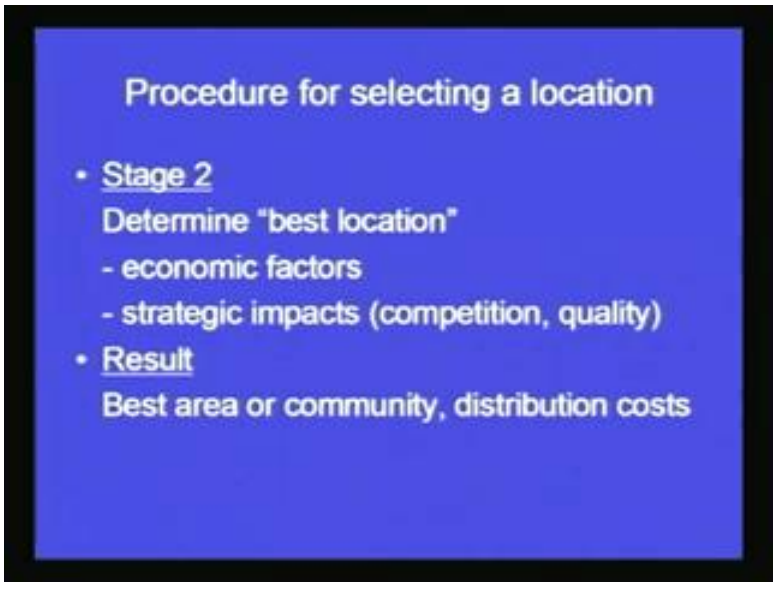

Now, continuing the procedure we have seen stage 1. In stage 1 we had 2 phases: phase 1 and phase 2 and for phase two we need to do we need to do analysis of the general characteristics of the different candidate locations. And for that we required the information or data regarding so many different factors. We have seen, what are those different factors 1 by 1. Now, let us come to stage 2. Now, stage 2 we have to determine the best location.

Now, how this best location would be decided this would be decided on the basis of economic factors and strategic impacts like competition and quality of the product. Now, in this particular case if you remember in our previous discussion we have already seen that there are different stages: stage 1, 2 and 3 .Within stage 1 we have phase 1 and phase 2 in which we do initially a feasibility study and then from among a number of candidate regions we have to select the best one. We have to see that what is going to be the capacity requirements? Where we how much capacity would be developed? How much capacity is required?

From those points we can say that already we have fixed up the processing costs that this is would be the cost which would be required for processing also we have fixed up that this is going to be the raw material or the input cost. Now, the last type of cost that is left to be determined is the distribution cost. Already we have taken a decision regarding a plant facility we know that this is going to be the input cost, this is going to be the production cost or the processing cost. Now, we have to optimized optimize in stage 2 the distribution cost. We have to see that where we have to locate the facility so that the distribution cost is also minimized.

So, from those candidate regions which from which we have to do the selection we are going to see that which particular location is instead of not only optimizing the input as well as the processing cost it also optimizes the distribution cost. Because, it has to be solved in totality; not in 1 particular taking 1 particular factor at a time. If in a particular case the distribution cost is minimum, but the input and the processing costs are exorbitantly high the location is of no use. Similarly, on the other hand the raw material is easily available, but the processing costs are very high.

Similarly, the distribution of the products is also very costly. There is no point in selecting that location. So, we have to make a judicious selection wherever the total cost is getting minimized there we have to setup our plant. So, in this particular stage our focus majorly is on the distribution cost. So, we determine the best locations or the best location on the basis of the economic factors focusing on the distribution cost. Similarly, we have to also take into account the strategic impact. So, strategic impact means the competition and the quality.

So, competition is also going to dictate our decision is also going to direct our decision in a particular focus area or in a particular location. We need to understand that what the competitors are doing? Where they are placed? What is their market segment? How they are doing? What is their market share? And then we have to take a decision that where

should we be placed in order to outdo our competitors. Similarly, the quality also is going to play a very important role although quality and raw material quality in the manpower quality in the supporting system, all though quality has to be incorporated at each and every step.

But here also are the strategic impacts we have to take into account the quality aspect as well the quality of the product that we are manufacturing. So, what will this result into? Here we are trying to do the strategic analysis we are trying to optimize the location on the basis of the economic factors. So, economic factors here we are trying to optimize the cost or the distribution cost and we are trying to find out the location from where we can distribute our final product in the most cost effective manner.

So, what this is going to lead us into this is going to lead us into the best area or community on the basis of the distribution cost. So, production costs already we have seen if we remember, in the previous stages here the focus is on distribution cost of we have to see that on the basis of distribution cost which is going to be the best location and best area or community has been identified.

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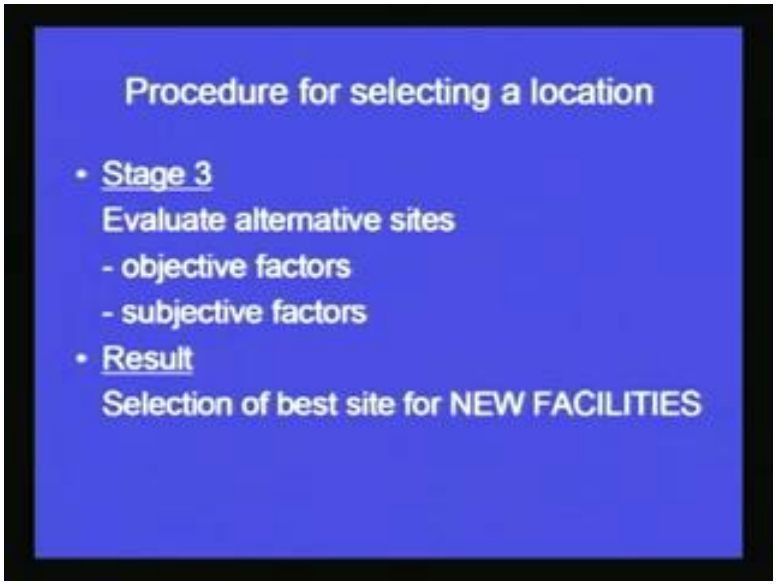

Now, let us go to the stage 3. Now in stage 3 we have to evaluate the alternative site. So, we have got the best site from the production cost or from the environment friendliness. We have got the best site from the distribution costs minimization. So, the location for which the distribution costs are minimum that also we have identified. Now, we have to evaluate the alternative sites. So, all these sites are available with us now. Now we have to make a final decision, now the final decision is made in stage 3.

Now, this decision would be based on certain objective factors and certain subjective factors. So now, based on the objective and subjective factors we would be able to make a final decision that where to locate the facility. Now, this would result in the best site for new facilities. So, new facilities means that the procedure that we are following for choosing a appropriate location for setting up a facility; is in the case where we are setting up a new facility. It is not or revamping of the old facility it is the setting up of a new facility.

So, you can see we have seen different stages: stage 1, stage 2, stage 3 and different phases in that stages. In stage 1 there were 2 phases: phase 1 and phase 2 and now we have come to the last stage that is stage 3 and in which the final decision would be made based on certain objective and subjective factors. Now, what are these factors or what is the information that is required or what are the factors that we have to consider when we go for the final selection? Let us see, the factors to be consider in selection of a community and a site for a new location. So, mind you this is a new location all these factors are considered when we are going to select a site or a community for a new location.

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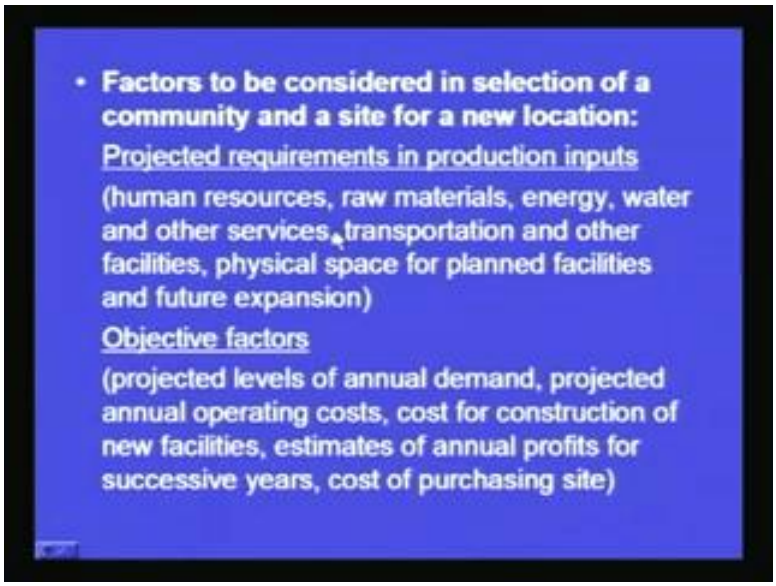

So, the first point I will divide this into 3 broad categories. Now, first is the projected requirement in production units. So, in this we will see human resources. What is the requirement of human resource? What is the type of human resource required? What are the skills required? What is the quantity required? How many in number they are required? So, first point is the projected requirements in production units or production inputs.

So, inputs already we know human resources we need to understand. Raw materials raw materials there we have already seen their quantity, quality; all these factors their cost, reliability is going to dictate our final decision. So, the human resource is the raw materials, energy, water and other services transportation and other facilities, physical space for planned facility and future expansion. So, these factors we have to take into account for the final selection. Initially, the selections we have done those were for minimizing the costs; may be production cost should be less we have considered economic factors, we have considered strategic factors.

Now, we have identified we have close down the domain now is very, very limited. Now, within that selected domain we have to locate we have reached to a particular area or a community. Now, within the community we have to see that in which particular location we have to set our plan. Now, within that closed domain now, we are going to consider all these factors. Now, what are these factors we these factors just again. Let us see, human resources, raw materials, energy, water and other services transportation and other facilities, physical space for planned facility and future expansion.

So, now we have to see that this is the requirement, this is what we are going to produce and we need so much of area for this particular plan. May be, that may run into acres of land that may run into hectors of land. So, we have to identify that area that this is the area that would be required. Now, when we identify that area we have to keep into mind that may be after 5 years the future demand may expand and when the demand would expand we have to expand our capacity also. So, when we have to expand our capacity we should have the facility or we should have that kind of space available with us to increase our facility or to increase our capacities of future expansion also has to be taken into account.

Whenever, we decide on a particular point or a location to place our facility. It should not be such that we have decided on a position or a area within the city in which, we do not have any control over our neighborhood. We cannot buy our sub adjacent land because already, there is existing certain infrastructure there. So, we have to take a judicious decision we have to setup a plant; keep some space for future expansion also. Similarly, we have to keep into account many objective factors also those are the projected levels of annual demand. We have to take into account another 5 years, 10 years down the line what is going to be the sales forecast or what is going to be demand.

We have to see projected annual operating cost. Now, operating cost may be in terms of the manpower or the wages that we pay. The materials that we buy the raw materials that

we buy for transforming them into the final product. What is the cost? What is the transportation cost for that? What is the production cost? So, what is this all these operating costs we have to take into account. Then we have to take into account the cost for construction of new facilities. So, whenever we think of setting up some new facilities within our plant, we have to see what would be the cost incurred in that particular area or that particular field.

Then estimates of annual profits for successive years now, what is going to be the profit. We know that we are going to sell our product at such and such rate. We know that what is going to be the demand on the basis of that we can say that this would be the profit that would be generated. Cost of purchasing site that also has to be included. So, whenever we are finalizing the location we have to see that the projected requirements in production inputs.

So, what are the production inputs and then we have certain objective factors like: the projected levels of annual demand, projected annual operating cost, cost for construction of new facilities, estimates of annual profits, cost of purchasing the site. So, these all decisions would guide us in the right direction to hit the nail on it is head and to choose the best or the most optimal location. In spite of doing an analysis of these 2 important points, there are certain subjective factors also that we have to consider.

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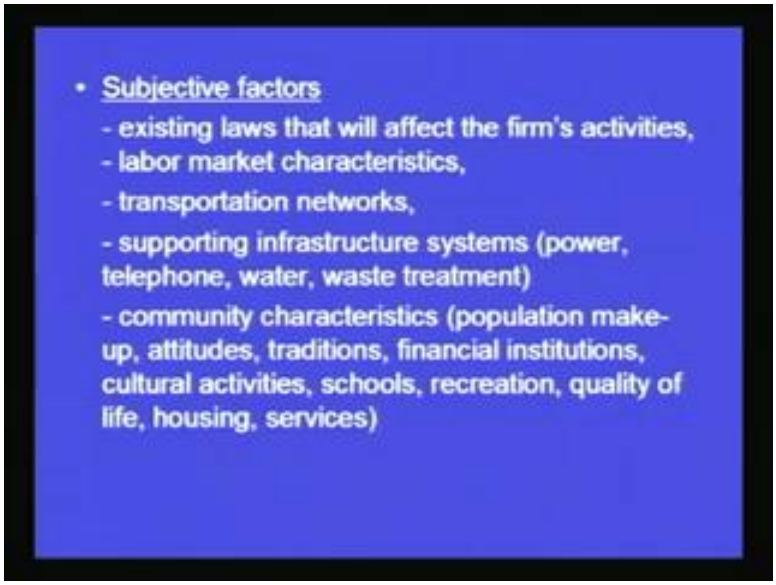

So, what are these subjective factors the those are there on your screen. So, the subjective factors are existing laws that will affect the firm's activities. So, there may be certain laws specific to that particular location that will be influencing the firm's activities. So, those laws have to be considered while selecting the plant or plant facility

or the location of the plant facility. Then the labour market characteristics have to be studied labour market characteristics means that the skills available, adequacy, the wages all those things have to be considered.

Then transportation networks also have to be considered what modes of transported transportation are available. What is the kind of connectivity adequate numbers of goods trains or the aeroplanes are available or road ways? What are the links? What are the highways that are available for dispatching the goods as well as for bringing the raw materials? So, transportation networks also have to be considered then supporting infrastructure systems like: power, telephone, water, waste treatment all these have to be considered. The waste treatment is very important in today's scenario.

We have to take into account that whatever waste is being produced out of the plant facility? What is the treatment is that is required? What are the norms that are there for waste treatment in that particular location? That have to be considered in a very strong way, because if we do not adhere to these waste treatment loss the company may set down or the location may be stopped to produce for that particular product. So, there are other infrastructural support systems also which we have to consider; already we have seen power, telephone, water, waste treatment etcetera.

Then the community characteristics also have to be taken into account. Now, the community characteristics means the population make-up whether it is a completely rural area or it completely urban area or there is a mix or it is a metropolitan city. It is a cosmopolitan city. So, the population make-up would also help us in making the selection or placing a facility at a particular point. May be suppose, if we want to place our service facility may be ATM in a particular city. We wll see that what is the population make-up in that particular region.

If all of the population is very well educated they can use the ATM facility very well then it is very appropriate to place that facility there. But if, the people are not going to use it then there is no point in setting up the facility, because it would not be used properly or adequately. So, the population make-up is also going to help us in making a judicious decision regarding the location of the facility. Then attitudes, traditions, financial institutions these are also going to help us in guiding help us or guide us in the making a decision

Then the cultural activities, schools, recreation facilities available, quality of life, housing and other services all these points are going to help us in making a judicious selection of the location; at which we are going to set up our plant or our facility or our

factory or our service center. So, in today's lecture we have seen that it is very important to minimize the total costs of transforming the raw material into the final product. We have to choose a location at which the input cost is minimized the cost of raw material, the transportation of raw material from the vendors to the factory.

Similarly, the processing cost should also be minimum that is the cost of transforming the raw material into the final product. And the third one the distribution cost that is the cost of distributing the final product to the consumers or distributing the finished product into the market to the customers that cost should also be minimum. So, whenever we are able to minimize the total cost we are able to maximize the profit. Now, we have also seen the procedure for selecting the appropriate location. So, in this procedure we have seen that there are different stages: stage 1, stage 2 and stage 3. In which, we take into account a large number of factors and these factors guide us in the right direction towards the judicious selection of the location. In the subsequent lecture, we will see that what are the methods for making such type of decisions?

Thank you.