Operations Management
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Lecture - 29
Capacity Planning: Introduction

[FL] friends welcome to session 29 in our course on operations management. So, we are discussing in week six the basic aspects related to production planning and control and as I have discussed in our last session also, that production planning and control is a very exhaustive topic, and it is not possible to discuss all aspects of production planning and control in short duration of two and a half hours.

But still we are trying to focus on the broad overview of production planning and control and trying to understand that what exactly is expected out of a engineer or out of a production manager, who is undertaking the production planning and control activity in an organization. And in this series we are today into the session four of week six in which we are discussing production planning and control, just to have a brief review of what we have covered till date.

We have already discussed the basic aspects of our course that is operations management in week one, in week two we have discussed product design and development, in week three we have discussed sales forecasting or demand forecasting, in week four we have discussed plant location, in week five we have discussed plant layout, and in week six we are discussing production planning and control.

And in production planning and control we have already discussed the basic aspects, objectives functions of production planning and control we have discussed process planning, then we have discussed in the last session if you remember we have discussed the aggregate production planning.

Today we are going to discuss capacity planning. So, this is the overview of the course that we are undertaking, now in aggregate production planning we have discussed that we have to allocate the demand to the production alternative. So, we have different types of production alternatives available with us, and we have to allocate this demand as we have seen that aggregate production planning is an intermediate time horizon planning

activity. So, intermediate time horizon means that it is one year to two year of planning activity.

So, we are going to plan, we are going to prepare ourselves for the next one or two years. So, for that we need to have the demand data for the next one or two years. So, once we have the demand we have to allocate this demand to the available production alternatives, production alternatives can be like regular time production, over time production, hiring of workforce, firing sometimes of workforce, subcontracting, back ordering inventory. So, we have different types of alternatives available with us and we have the demand data available with us.

So, we have to map the two things together the demand may be available on quarterly basis the demand data may be available on monthly basis that is the forecasted demand for the next year. So, we need to understand this all depends upon the capacity, if you remember in the last class we have seen that a problem we have tried to solve in which there was a capacity constraint of 100 men available in the beginning of the production year.

So, we have 100 people available, then we have also seen that there can be constraints in terms of time, we can we have also seen that the machine also has got a capacity that we cannot produce more than this many number of products on that machine. So, there are capacity constraints, and these capacity constraints which we have to overcome we have to plan in such a way that we are able to satisfy the demand, in terms of quality, in terms of quantity, in terms of time as well as in terms of cost.

So, here we are trying to understand that always for any facility there will be some capacity for example, maybe if there is a hospital. So, the capacity may be the number of beds the hospital has for the patients, if it is an example of a hotel it can be the number of rooms which the hotel has for the guests.

So, every maybe object or every machine or every facility or every production facility has got a capacity, and we have to plan our production based on this capacity and we have to do the capacity planning. So, that we are able to find out the best operating level at which we must operate and how much capacity we must utilize in order to satisfy the demand.

So, this is the topic for today, today we are just going to have an introductory discussion in capacity planning, and we will have one more session dedicated to capacity planning and try to understand the concept of capacity planning in a much better manner. So, let us quickly start our discussion now first let us see, what is capacity.

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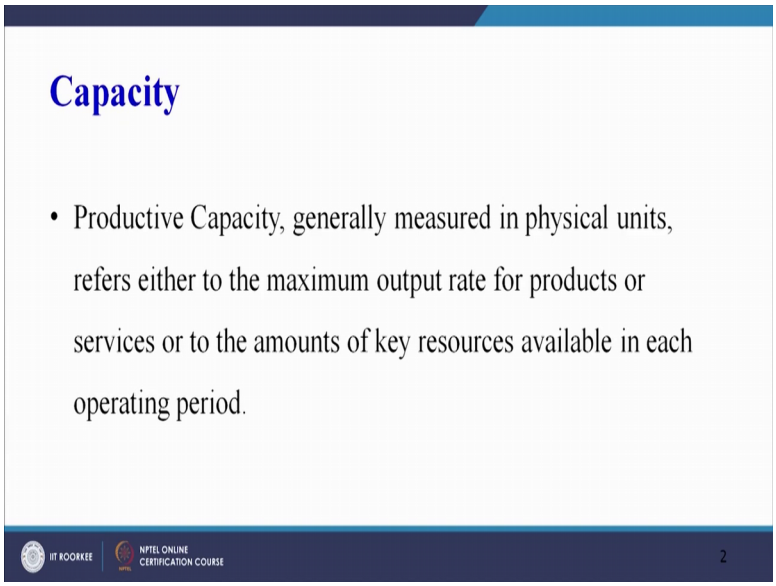

Because there are two words capacity and planning. So, first we must understand the meaning of the two words, planning we have already discussed in the previous sessions that where we can have a strategic planning, we can have a corporate planning, we can have a operational planning at different levels of management.

At the top level we have strategic planning, at the intermediate or corporate level we have a corporate planning activity, and at the lowest level we have a operational planning activity which only focuses on three or four months period. So, capacity basically when we are talking about production planning and control, the productive capacity is generally measured in physical units, refers either to the maximum output rate for products or services or to the amounts of key resources available in each operating period I am sorry, it should be to the amount of key resources available in each operating period.

So, this is a productive capacity in terms of products we can say it can be the output rate, for products maybe we can say 5000 nut bolts per day nut and bolt assemblies per day.

So, it is the product over a period of time day is representing the time domain and number maybe 5000 is representing the output.

So, the output rate for products or services it may be the capacity of a machine, the machine can produce a nut bolt combinations or combination of machines for nut bolt type of manufacturing two machines can produce nut bolt assemblies 5000 in a day. So, that is the capacity that is an example of a output rate for product or services.

Similarly, we can say a booking or a clerk, clerical staff in a banking sector can service maybe 100 clients in a day. So, all transactions maybe withdrawals or it is we can say deposits or issuance of cheques issuance of drafts. So, one clerical staff can render his services his or her services to 100 clients in a day. So, that is also maybe the output rate for a service.

So, basically for any capacity we can we can have a output rate in terms of number of products per hour, per day, per week or it can be the number of services rendered per week or per month or per year. So, that is one thing or the amount of key resources available in each operating period. So, capacity can be in terms of number of machines available or it can be number of manpower or the people or workers available with an organization.

So, that is the basic meaning of capacity, so we know now that the number of machines are available with us, we have a capacity of 100 machines for example, planning means that how to use this capacity of 100 machines, in order to achieve our targets that is our targets are basically coming from the demand that we have forecasted for the organization. So, based on the demand data we will see that how we can optimize or optimally utilize our capacity. So, that we are able to meet the demand.

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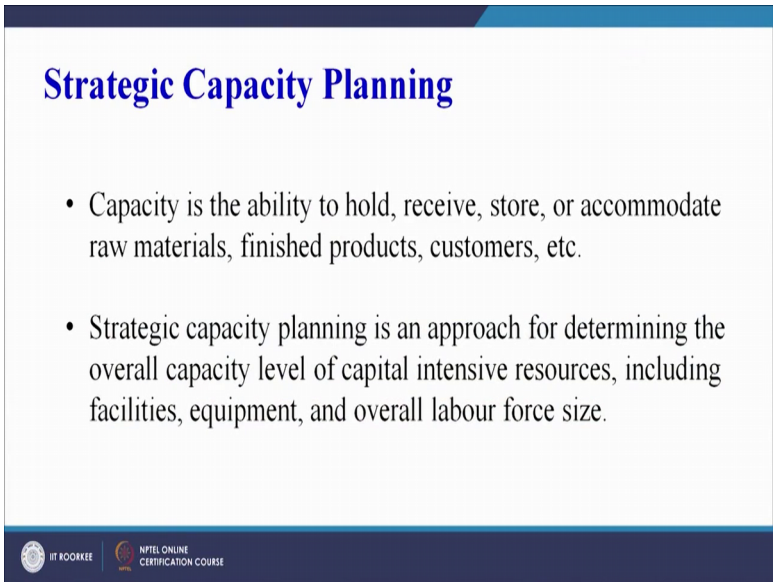

So, strategic capacity planning maybe the top level of capacity planning, the capacity word again we are trying to define it here again capacity is literally dictionary meaning can be is the ability to hold, receive, store or accommodate raw materials, finished products, or the customers, in case of services now strategic capacity planning is an approach for determining the overall capacity level often capital intensive resources, including facilities, equipment, and overall labour force size.

So, we can see here that the, we have two capacity planning basically refers to determining the overall capacity level of capital intensive resources. So, capital intensive word means that which are a involving lot of money. So, capital intensive resources and these resources are facilities equipment and overall labours.

So, if you remember in the previous session we have taken an example, towards the end of the session where we have tried to calculate the number of machines available that is I think in process planning, we have covered that in session two of this week. Where we have calculated the number of machines and there one slide we have focused on this roi word that is return on investment, and we have emphasized that manufacturing involves use of machines and equipment which are costly and therefore, we have to be very judicious in spending money related to the purchase of these machines and equipment until and unless the roi justifies the purchase, we must not involve or we must not commit too much of resources into the organization.

So, here also our capacity planning means we have to judge that what is the capacity required for running a particular or for meeting a particular demand, and then only based on this decision, we must commit ourselves to adding the facility or for reducing out capacity, depending upon the demand in the market. Now strategic capacity planning we can see that capacity utilization rate can help us to identify that how we are utilizing our capacity and this will help us to take further decisions related to capacity that whether we must increase our capacity, whether we must reduce our capacity.

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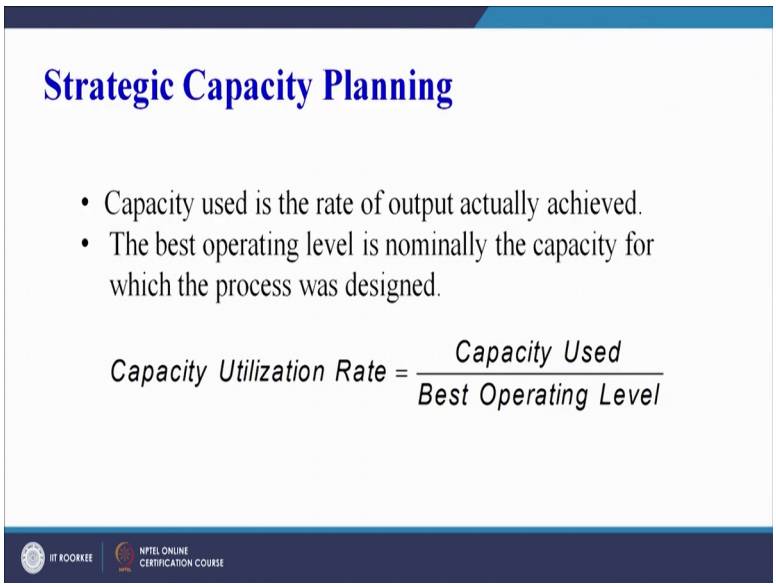

Now, capacity used is the rate of output, actually achieved and how it is calculated we will see that capacity utilization rate is equal to capacity used divided by the best operating level. Now what is best operating level is also given on the slide you can see the best operating level is nominally, the capacity for which the process was designed. So, usually we see that any product may be designed for a particular load carrying capacity, it may be designed to carry a maximum load of 100 kgs, but we are using it only for 70 load kg carrying only.

So, we can say the capacity utilization rate can be 70 kgs divided by the best operating or the best load that it can carry is 100 kg. So, 70 by 100 just a vague example based on their utilization rate, we will see that with the certain examples that how we can calculate the capacity utilization rate.

So, the load example may not be truly representing the way the capacity utilization rate must be used for example, another example is just coming to my mind that is related to the capacity utilization rate of in a hotel industry or of a particular hotel, suppose the hotel has 100 rooms, available with it for offering to the guest, but the average utilization for the month is only maybe 70 rooms, average utilization is there on per day basis. So, maybe on per day 100 rooms are available with the, for the hotel only 70 are being used.

So, we can see what is the capacity utilization rate that is 70 by 100? So, we can very easily calculate the utilization rate, and think that how to optimize our unutilized facility or cap capacity that is available with us. Now what are the decisions that can be taken we can very easily find out what is the capacity utilization rate, now what are the decision based on this capacity utilization rate.

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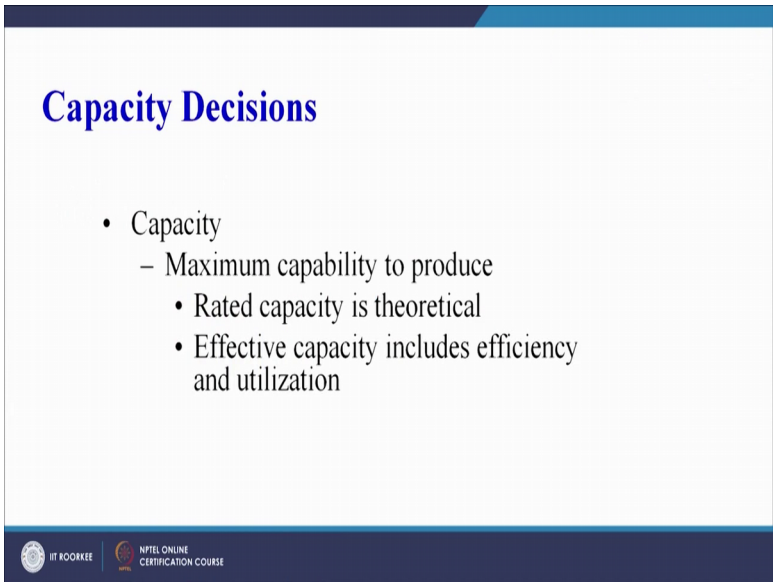

So, we can in terms of capacity maximum capacity to produce we have rated capacity is theoretical, effective capacity includes efficiency and utilization.

So, based on the capacity utilization rate, we can see that what theoretically is the best capacity available with us and how much of that we are utilizing or what is our efficiency.

So, we can try to improve our efficiency and effectiveness by making some or taking some major decisions or making some major modifications in our thought process in our

procedures. So, that we are able to improve the capacity utilization rate for the equipment or the services or whatever the organization is involved in.

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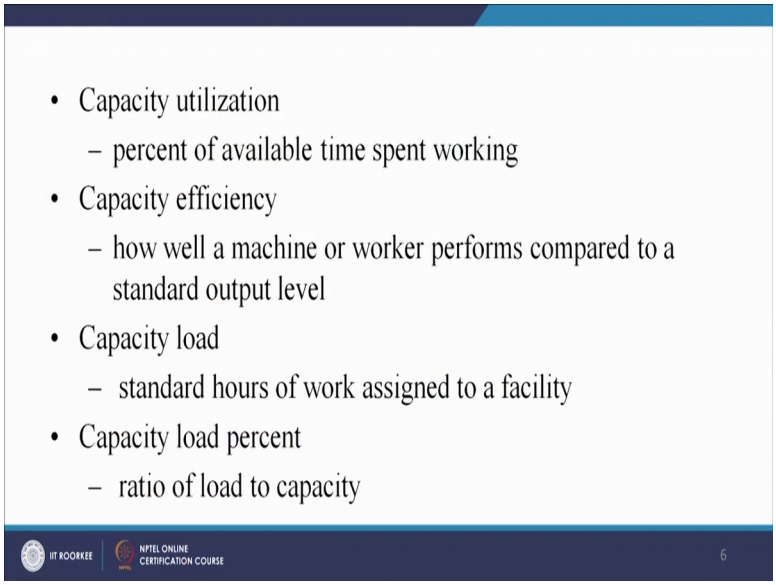

Now, capacity utilization is these are just some brief definitions because these words you may find in different books. So, I thought that we must just have a overview of all these words capacity utilization is the percentage available time spent working. So, this is the percentage of available time spent working in context of the total time, available capacity efficiency is how well machine or a worker performs compared to a standard output level.

So, we have a standard output level, which is a base or the denominator in the numerator we will have a value that is how well a machine or worker performs. So, in the divided by that we will get the capacity efficiency for example, how well a machine or worker performs compared to the standard output level, since machine is mentioned here. So, if you take an example of machine.

So, the machine has a rated standard output level of 100 components per hour, but it is producing only 70 components per hour. So, very easily we can calculate the capacity efficiency that 70 components per hour it is producing 100 is the rated output which is standard output level for that machine. So, seventy by 100 is the capacity efficiency.

Similarly, in terms of load, the capacity load can be calculated standard hours of work assigned to a facility, similarly capacity load percentage can be calculated that is ratio of the load to the capacity, so or the standard capacity. So, you will use you may find different words, but the basic a sense of doing the capacity planning is to make the most optimal utilization of the capacity, of a particular person, of a particular machine, of a particular equipment, of a particular facility. So, maximum possible utilization of the capacity is what capacity planning is all about.

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Dimension of Demand	Effect on capacity requirements
Quantity	How much capacity is needed?
Timing	When should capacity be available?
Quality	What kind of capacity is needed?
Location	Where should capacity be installed?

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Now, effects on capacity requirements we will try to see. So, you have different dimensions of demand. So, demand can be in terms of quantity, demand can be in terms of timing, demand can be in terms of quality, desired or quality specifications of the product, demand can be in terms of location. So, I think in the sales forecasting in the very first section or in the very first or second session, we have seen that demand is not only related to the number of products demands has varied dimensions.

The varied dimensions mean demand can be in terms of time, demand can be in terms of the location that where the particular product is required or where a particular facility must be created for example, there can be number of villages in a particular country where the electricity or the power has not been delivered till today.

So, the location is important the demand of electricity is specific to a particular location. So, the demand has a locational dimension also demand has a quality dimension also

demand has a timing dimension also. So, seeing the dimension of demand the effect of effect on capacity requirements is given now quantity wise we can say how much capacity is needed.

So, based on the number of products that we have to produce because in the previous session, if you remember in aggregate production planning we have seen that based on the demand and we have seen two examples also one was level production for aggregate production planning, and other one was chasing the demand for aggregate production planning. So, in both cases we have seen that the quarterly demand data was available to us.

So, the number in terms of the number of products required, so quantity is the number of products required. So, how it will affect the capacity we need to answer how much capacity is needed to meet that demand in terms of volume of production. Then from timing when must the capacity be available with us, then from quality point of view what kind of capacity is needed, because once we have to deliver a quality product the type of machines that are available with us may not be able to achieve the quality standards set up in the design specifications of the product. So, then we need to take a decision that what kind of capacity we need to add to get this desired quality product.

Similarly, from location we can say where must the quality be installed. So, you can see that from the demand point of view, we have different dimensions to the decisions related to capacity that how much capacity we must have, when we must have that capacity, what kind of capacity is required? Where the capacity must be installed? So, there are so many decisions related to capacity that we have take, and all these decisions come under the capacity planning purview.

So, when we are doing the capacity planning we must ensure that in order to get or in order to produce the product which has been designed, we must have the requisite capacity to produce that product and if you do not have the capacity the we need to add the capacity in order to meet the demand, now capacity planning already I think it is clear.

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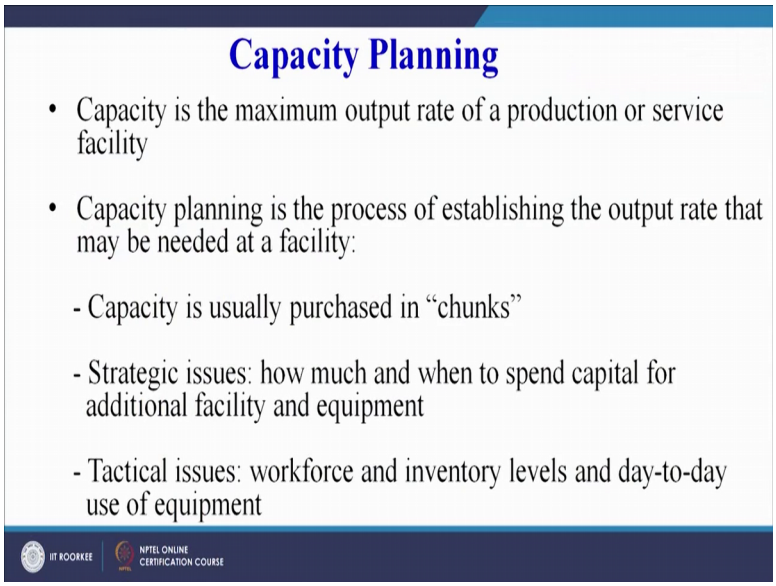

So, quickly I will rush through the slide, capacity is the maximum output rate or production or of a production service facility, capacity planning is the process of establishing the output rate that may be needed of a facility. And how you will identify or how you will find out what is the output rate which is needed at the facility this is based on the demand for which we are doing the production capacity is usually purchased in chunks.

So, you will keep on adding the capacity as per the requirement. So, the what are strategic issues related to this how much and when to spend capital for the additional facility and equipment as I have already told based on the capacity utilization rate we will decide, whether we require to add capacity in terms of machines or equipment or not or we can even think of reducing the capacity, because the demand is less we may try to sell off some of the machines or equipment's.

In order to add additional design additional types of machines which can help us to improve or increase the demand of our product in the market tactical issues are also involved such as work force and inventory levels and day to day use of equipment. So, tactical issues may be as written there that workforce level and inventory levels and day to day use of equipment also are important when we are doing the capacity planning.

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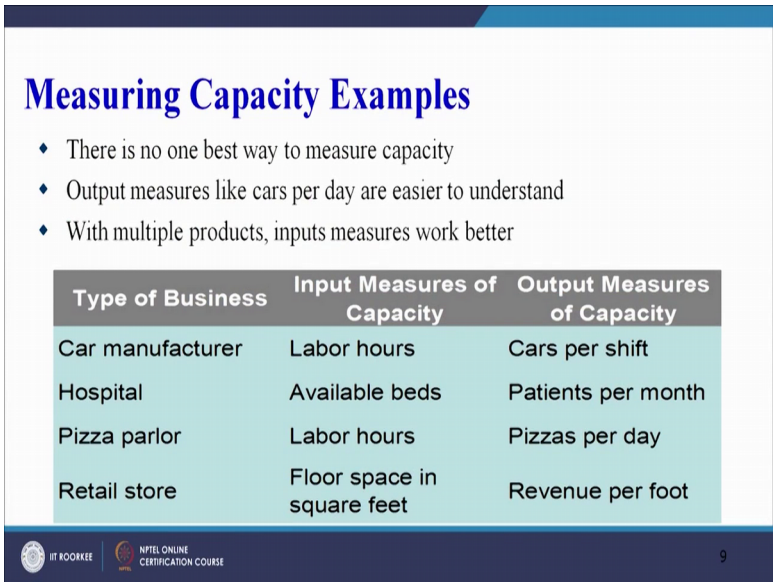

Now measuring capacity examples, it is maybe capacity word I am using maybe again and again I think maybe 100 times I may have used the word capacity we have tried to define capacity in two-three different ways, but I think still there may be some doubts. So, we have included this table which give us a exact maybe example of how capacity can be defined for different sectors or different segments.

So, we can see there is no one best way to measure the capacity output measures like car per day are easier to understand, with multiple products input measures work better. So, with multiple products means if a company is producing different types of products, so the input may be constant, so based on the input we can measure the work better.

So, let us try to see the type of business for example, a car manufacturer the input measures of capacity can be how many labour hours are input for making the cars per shift. So, output measure of the capacity is how many cars are being produced per shift. So, you can see per shift is in terms of time and number of cars is a number.

So, what are we trying to do here, we are trying to see that how many number of cars are produced per unit time. Similarly, hospital what are the available number of beds and the output measure can be patients per month. So, our available number of beds can be 100, but patients per month can be or per day basis can be only 60 or 70, similarly pizza parlour labour hours can again be the input output can be how many pizzas are served per day.

Similarly, for a retail store usually we see that this is the biggest shopping mall in the city this much of square feet area for shopping. So, floor spacing square feet can be the input measure and the revenue per foot that the shopping mall or the retail store is generating can be the measure of the output. So, we can have input measures of capacity we can have output measures of capacity as given by the examples, now another thing which is very important is the best operating level I think.

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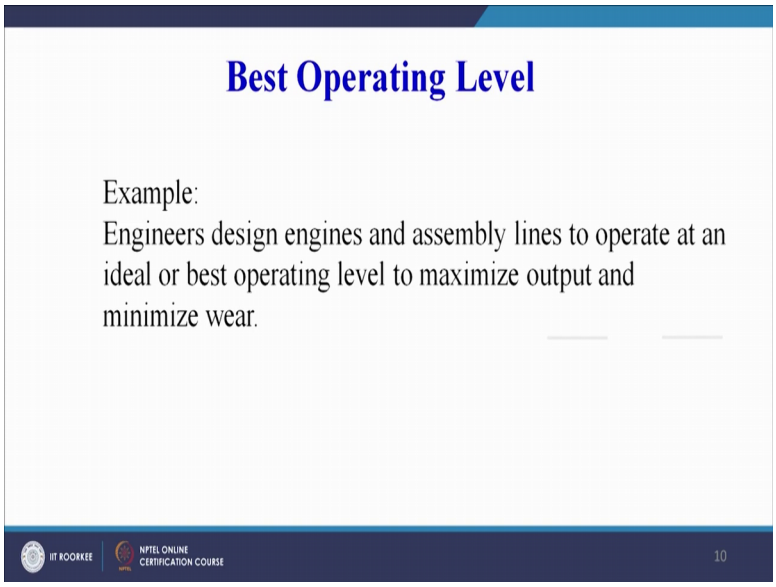

The first part of our discussion was related to the understanding the words what is capacity and what is planning. Now, for we know that how the capacity can be defined as in terms of number of patients served in a hospital per day per month or number of cars produced per shift or the revenue generated per square foot of the retail store. So, we have understood that how we can define or understand the capacity.

Now, from planning point of view we have to see that how much of our capacity we must utilize in order to achieve the economies of scale or in order to achieve the lowest overall operating cost. So, we will try to understand this with the help of an example here. So, the best operating level is defined here the example engineers design, engines and assembly lines to operate at an ideal or best operating level to maximize output and minimize wear just one vague example is coming to mind.

Whenever we are driving a motorcycle or a car usually the speedo meter will show from 0, we can go to 200 kilo meters per hour, but there will be one limit in between which

will be shown as the optimum range for driving. So, if we are driving below that range we may be our fuel efficiency may not be that good, but when we go beyond that range also our fuel efficiency may not be good.

So, that optimal range basically is helping us to identify that if we drive continuously in that range our fuel efficiency will be best. So, we can say that is the best operating level for that engine, so here again it has been tried to explain.

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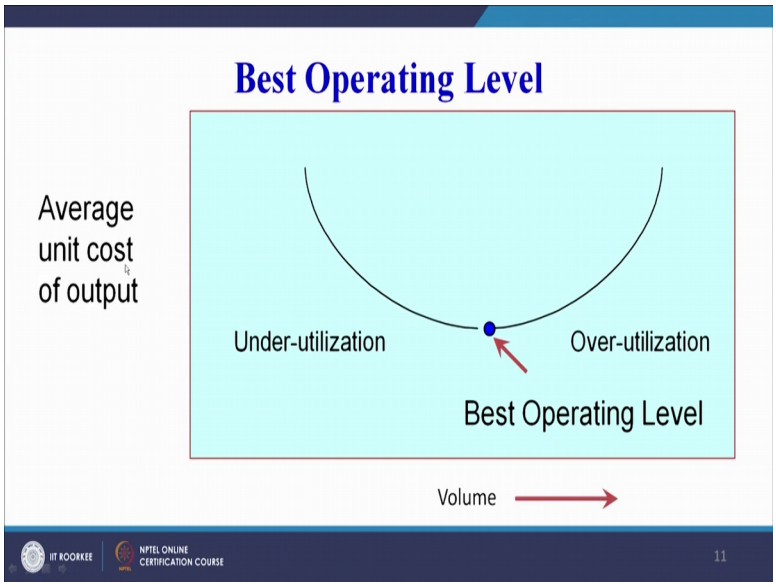

So, his is a average unit cost of output suppose we are producing a product, it can be soap cake, so it is average unit cost of product. So, if we are producing less number this is the volume of production that is increasing suppose we are producing only 100 soap cakes the average unit cost of output is more, but if we are producing 500 soap cakes we have that can be the best operating level, but if we are producing 5000 soap cakes.

Then maybe we are over utilizing our resources and the unit cost may further go up, now why the unit cost may go up because it may lead to wear and tear of the machines and then the maintenance cost of the machines will be added to the overall production cost, which may lead to the overall increase in the cost of the soap cake or the average unit cost of the output So, there has to be one best operating level at which we must operate and this graph sums up everything and this is another example.

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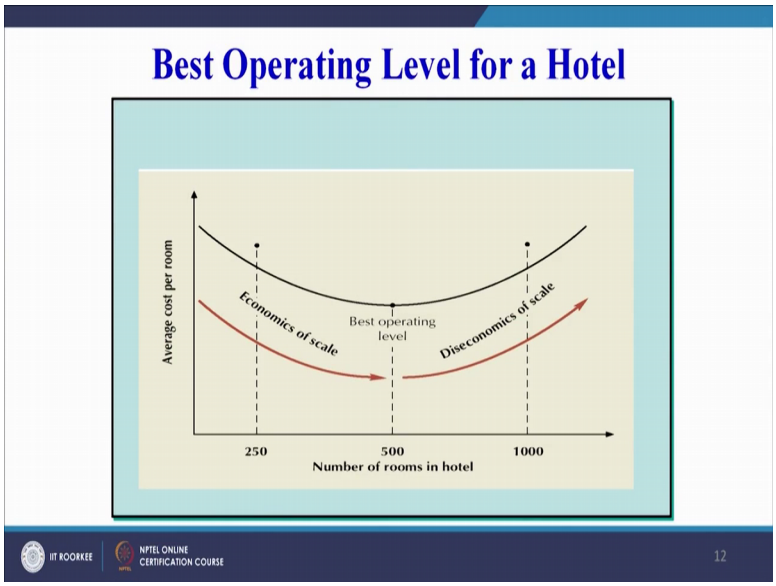

That was a general operating curve here we can see that the best operating level for a hotel. So, number of rooms in a hotel, so if you have 500 rooms in a hotel the average cost per room is lowest, but if you have more than 500 rooms the cost is increasing. So, that represents the diseconomies of scale, but if you have very less rooms you have 100 rooms only you have to spend more money for the up keep maintenance and there are few costs, which are maybe if they are spread over large number of rooms they will remain constant. So, where we can see the economies of scale we must take advantage of and we can find out the best operating level which in this example is a 500 rooms.

So, number of rooms in a hotel, suppose they are 500 it is not maybe representative it is just an example it we cannot say for every hotel that if we have 500 rooms, it will give us the best operating level this is just an example to understand that if we have less rooms our economies of scale are not helping us with the minimum cost per room, if we have more than 500 rooms there is diseconomies of scale.

So, we have to see that what is the best operating level in terms of number of rooms in a hotel which will give us the average cost per room to be minimum, now let us try to understand these two terms and then we will close the today's session economies of scale and diseconomies of scale.

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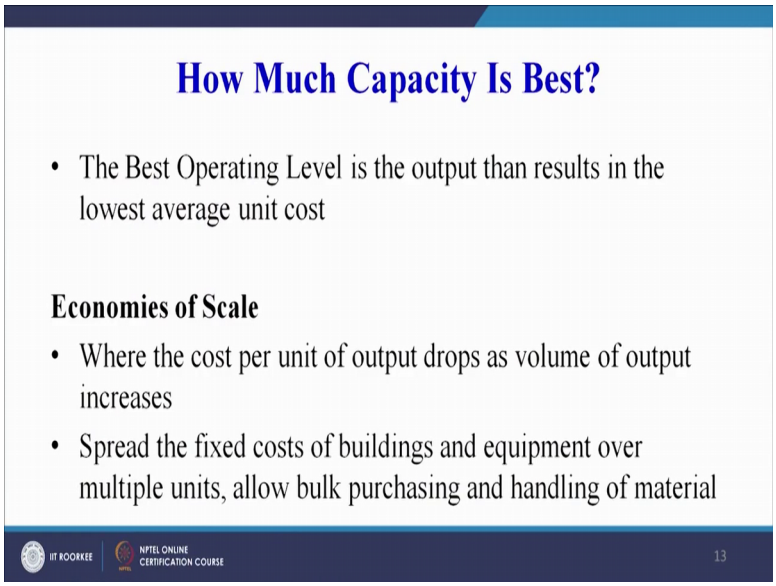

Now, much capacity is best we have seen the best operating level. So, the best operating level is the output that results in the lowest average unit cost, I think all of you must have understood with the help of the example of an hotel. Now why this is possible because we are taking advantage of the economies of scale, now economies of scale are achieved where the cost per unit of output drops as volume of output increases.

So, we have seen when the number of rooms are increasing the cost per room is decreasing, why it happens because it spread the fixed cost of buildings and equipment over multiple units also sometimes it allow bulk purchasing and handling of material.

So, there can be depending upon the segment of industry we are focusing on there can be different reasons that may lead to economies of scale, but yes there will be a best operating level at which our overall cost will be optimized, and that will lead to the lowest operating cost, but there is opposite to the economies of scale also if we are not taking advantage of this bulk purchasing or handling of material.

We are maybe going on adding capacity and going beyond the best operating level, there can be diseconomies of scale also. So, what are the diseconomies of economies of scale where the cost per unit rises as volume increases?

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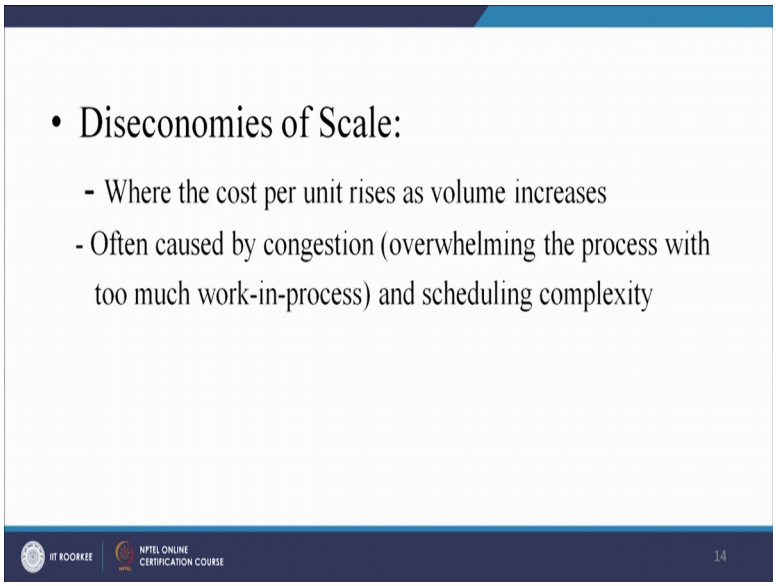

Now, economies of scale represent where the cost per unit decreases as there the volume increases and here the diseconomies means the average cost per unit increases as the volume increases. So, why it happens, it happens because of congestion overwhelming the process with too much work in process and scheduling complexity, wear and tear of machines, then the skills available with the people are not matching up to the we can say the rate at which we want them to work.

So, there are there can be number of reasons when you have large number of products we being manufactured in a small unit or in a small manufacturing facility, there can be scheduling problems, which may lead to failure defects and there can be number of reasons or in general I can say there will be lot of chaos in the manufacturing facility, because of increased number of different types of products that we are producing.

So, there can be diseconomies of scale there can be economies of scale. So, based on our capacity we must be able to find out the best operating level, at which the average cost per unit is minimum and that should be our operating level at which we must operate or utilize our capacity.

So, with this we conclude today's session in our last session on production planning and control we will again focus on the other aspects related to capacity planning.

Thank you.