Modelling and Analytics for Supply Chain Management
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Lecture-22
Space calculation - II

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Hello and welcome. Today we are into week 8 of this module, so Modelling and Analytics for Supply Chain Management, now our job today is to look at warehouse space calculation most specifically calculation of the space for storing area that is for the racks. In the previous week, we had calculated the space required for the loading unloading zone that is called as the staging area. Then in continuation we will learnt the space calculation or formula for a module that is module length, module width and module height.

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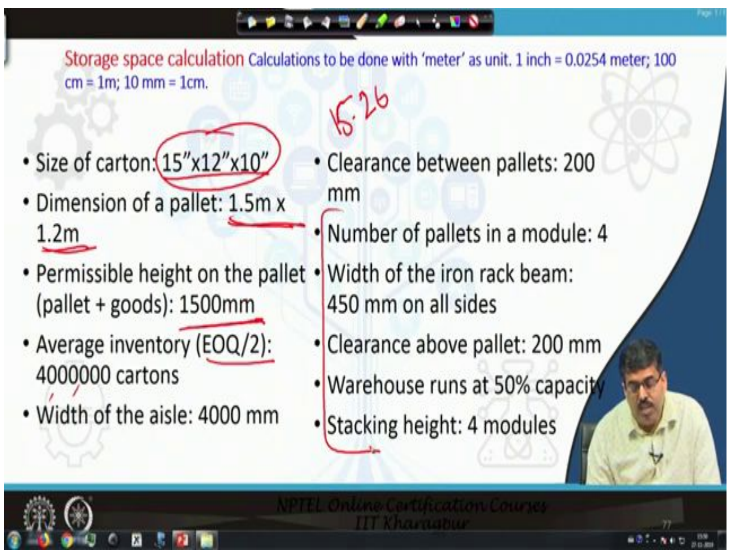

Today we will learn how to calculate space for a particular warehouse that is storage space calculation. Now, this is a simple mathematical problem, calculations had to be done with meter as a unit and I have given you the nomenclature also 1 inch is equal to 0.0254 meter, 100 because difference dimensions you will get in a warehouse, some cases 4 centimetre you will have to get it to convert into meters, so I have given it on top.

Now, if you see these are the information that you require, what is the size of a carton, what is the size of a pallet, so write at the beginning you can understand that size of a pallet this is the area, so you can fit in how many carton in that area? Permissible height of the pallet that is pallet plus goods. So, length into breadth into height gives you the total volume that a pallet can store. And this is the volume of the carton.

So, you can easily find out how many cartons a pallets can store, a may understandable see that the pallet has a length and a breadth and this is the permissible height of the pallet, so this is the volume, length breadth height, the volume of pallet can hold and this is again the volume of a carton. So, volume of the pallet divided by the volume of the carton is equal to total number of cartons that it can hold.

Now, for example your solution comes in at 15.26 number of cartons, so how many cartons will you hold? You will hold 15 cartons, cannot hold more than 15. Now, here we are assuming a compact volume that means this is the volume and every product left right or centre will fit in that volume, you can modify the calculations further by taking whole numbers at every stage of the calculation that is for the length breadth height et cetera.

So, that it does not jut out, it does not protrude out a carton should not protrude out of the permissible volume of the pallet. Now, average inventory is EOQ by 2 that is your 40,00,000 units, 40,00,000 units is your average inventory, average means maximum minimum divided by 2, but at any point of time how much goods are coming in? That is 40,00,000 cartons multiplied by 2.

Because that is the maximum that coming , average is divide, average is this, what is maximum? This much, so the average is 40,00,000, so what is maximum cartons? So, 80,00,000, so how much space will you have to keep from the simple number of 4,00,000 how much space will you have to keep? You will have to keep space of 80,00,000 cartons, because average is half you have to keep space for all the cartons maximum number of cartons, because 80,00,000 cartons will come in at the same time.

Or at any point of time 80,00,000 cartons can come in with or without prior notice. Now, coming to the module calculation, width of the aisle for this is all that we have learnt width of the aisle 4,000 mm, clearance between pallets 200 mm number of pallets in a module 4, width of the iron rack, clearance above pallet, warehouse runs at 50 capacity, stacking height is 4 modules. So, basically this is what we have already calculated when we calculated the module area, module length, module height, module width, so with this we will proceed.

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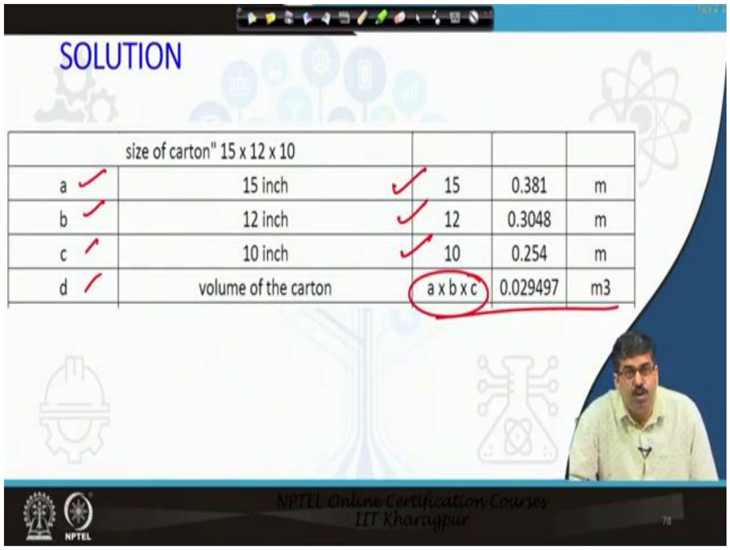

So, first we found out the volume of the carton as we had mentioned length breadth height and this is the volume for your understanding we have given notations a b c d everywhere so that you can easily understand in a simple manner this is the volume of the carton.

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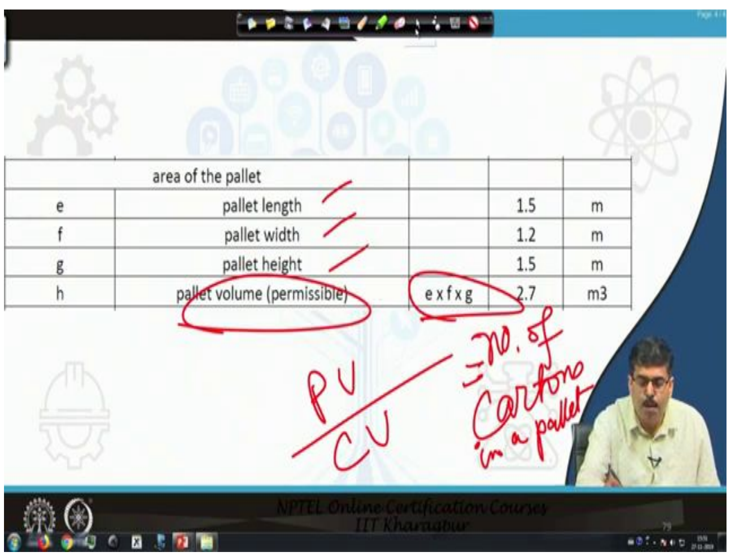

This is the area of the pallet, pallet length, width, height this is the permissible pallet volume, so what is our next step, pallet volume divided by carton volume, what will this give you? It will give you the, it will give you the number of cartons, number of cartons in a pallet. So, this is this.

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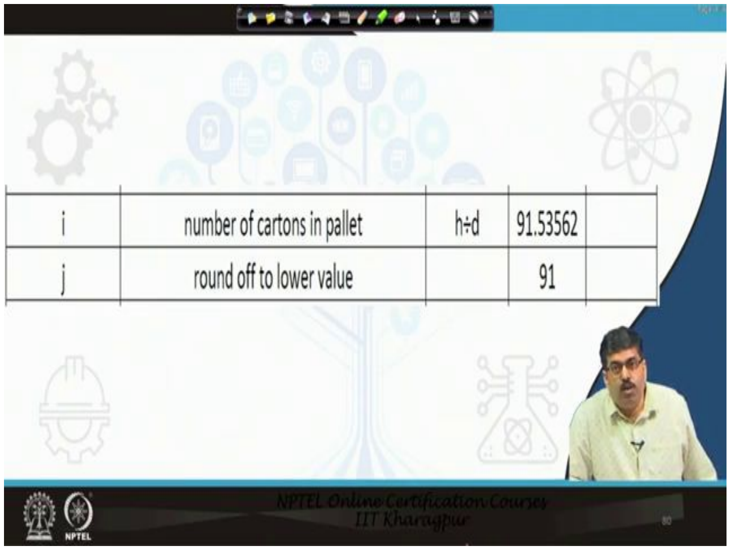

And we mentioned lesser number of cartons should be there, this is all we have discussed round off to number of cartons in a pallet.

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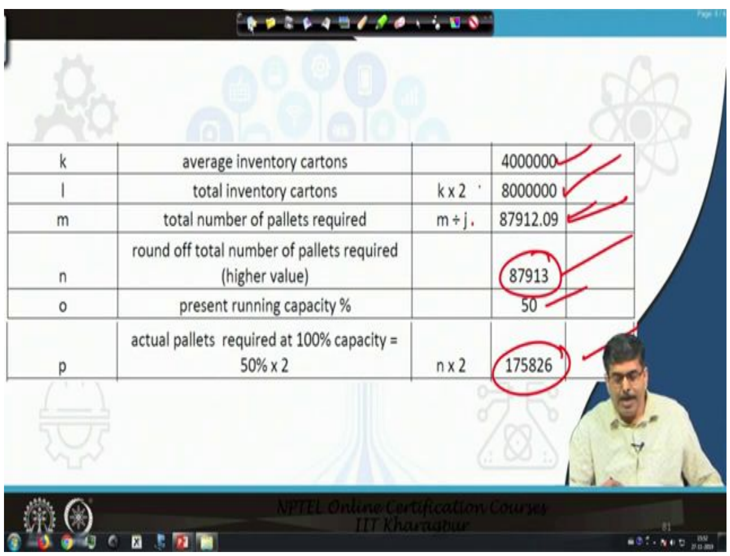

Now, in average inventory is 4,00,000, so total inventory 8,00,000, so total number of pallets required this much, because this is the total number of pallets because this is the total you have already got how many cartons can we kept in one pallet. So, total number of pallets required is this, so round off total number pallet required you require one more next higher digit, present running capacity 50 percent, so you should have permission for 100 percent. So, actual pallets required 100 percent capacity is this much. The simple arithmetic, class 5 arithmetic.

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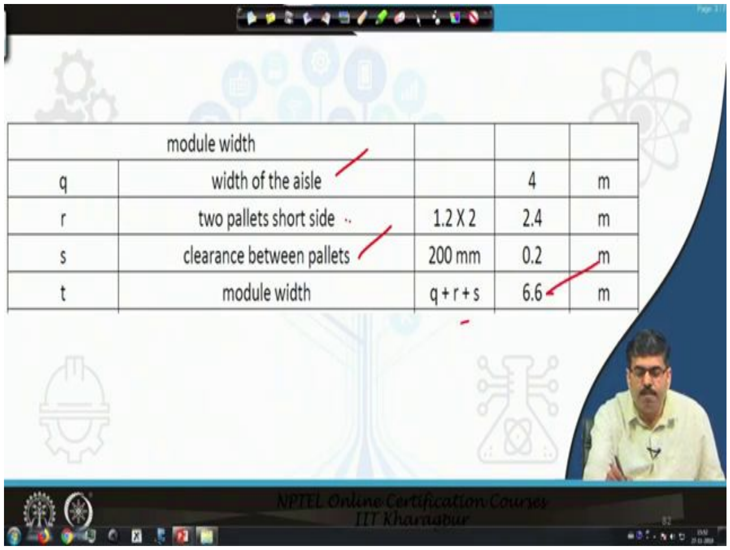

Module width we know the calculations, width of the aisle 2 pallets and clearance, so this will give you the module width plus plus plus.

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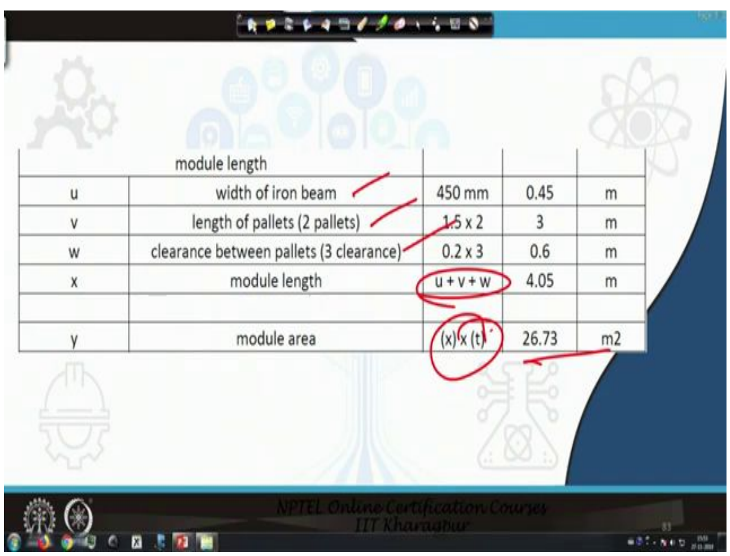

Module length we again you have just calculated width of the iron beam, length of pallets 2 pallets, clearance between the pallets 3 clearance, so the module length is this plus this plus this and module area is the previous one.

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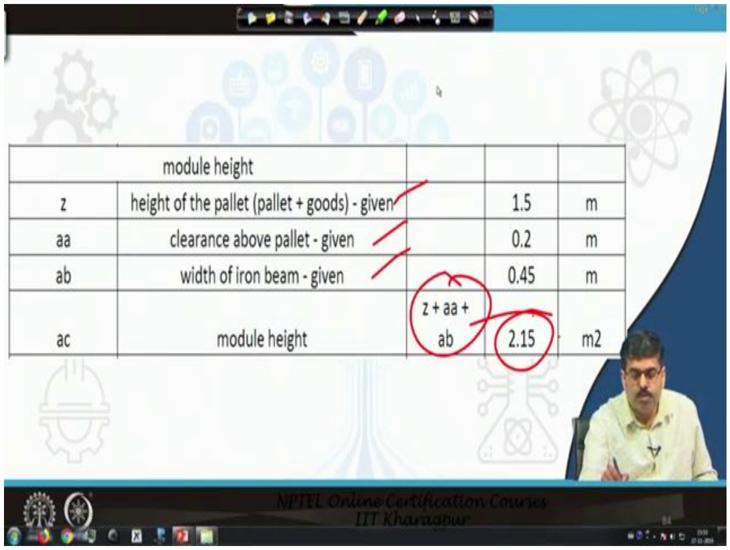

Module height again, we have just now learnt to calculate height of the pallet, clearance of the pallet, width of the iron beam, so module height is this plus this plus this is this much.

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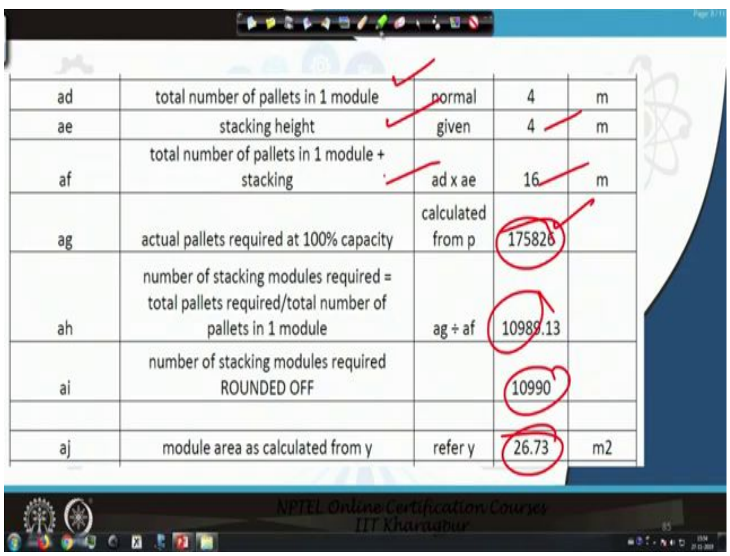

Now, simple calculations total number of pallets in one module, what is the your stacking height 4 we are assuming only 4 such pallet can be kept in 1 module, total number of pallets in 1 module plus stacking actual pallets required at 100 percent capacity we have already calculated this, total number of stacking modules required divide this take it to the next higher number and modules modular area is 26.23 as calculated from y we have already got this. This is simple arithmetic no need to panic about it.

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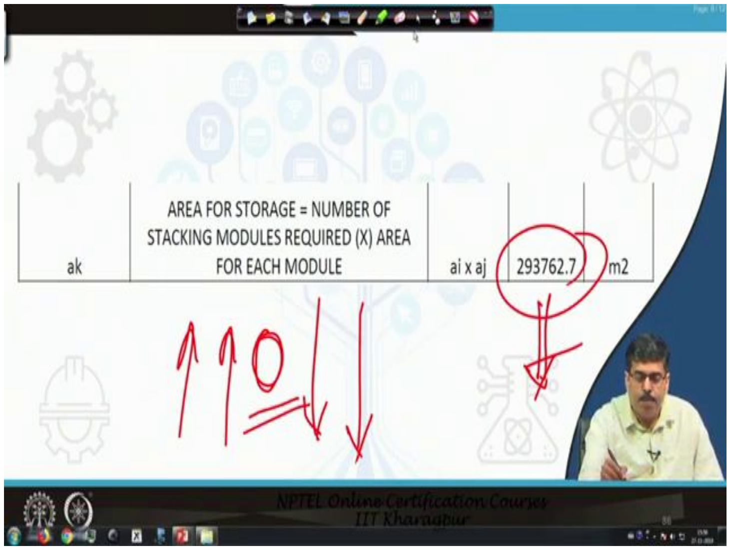

So, area for storage number of stacking modules required into area, so this is my area required for storing purpose. It is just simple arithmetic only request is when you have these numbers take a piece of pen and paper and calculate it on your own, later on you look at these slides if you have made a mistake look at where you have gone wrong. A word of caution your solution and my solution may not match for one reason that is I have considered volume, we have considered volume as a total for carton storing in the racks and in the pallets.

You might take for each one you might take convert it to the next higher digit, so then your area required for storage will be much more. The question is how will you reduce this area required for storage? Again as we mentioned have regular deliveries even sometimes have 2 3 deliveries a day, so total quantity physically stored in the warehouse will come down. 2 deliveries per day and 2 moving out, 2 dispatches per day definitely your warehouse space at the end of the that is required is 0. So, try to design a good distribution system, so that the delivery becomes very smooth and as a result the warehouse space required is very much less.

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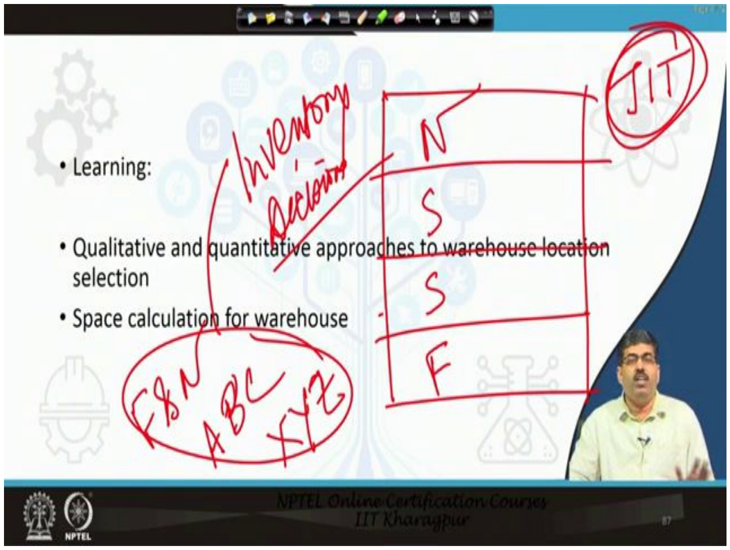

Now, so what is the learning outcome of this warehouse location models and space calculation models qualitative and quantitative approaches to warehouse location selection we have done and we have calculate the space required for warehouse location selections. Now, one question that still remains inside the warehouse, inside the warehouse I have calculated this space, I have calculated this entire space, how do I arrange the products? Which product should be kept in front? Which product should be kept in the middle? And which product should be kept at the end?

There are other analysis for it called FSN analysis, ABC analysis, XYZ analysis, which you will learn in inventory decisions. So, what is our objective? Our objective is to since warehouse location since warehousing is a cost centre, our objective is to have mathematical models, which will bring down or help to bring down my warehousing cost to a great extent.

To that pursuit we have found out models that help us in locating the warehouse the one that is at lowest cost location, with that in mind we have found out the storage space required and there again we have said that if your delivery, if you received in delivery is properly synchronised then there will be no material in the warehouse theoretically and that theoretically is what we called as the just in time system the JIT system.

So, theoretically if material in and out is synchronise there will be no requirement of any warehouse, for a continuous production system. So, this is the mathematical way to justify as to how I will synchronise when material in and material out, so that my warehouse cost becomes very very minimum.

Now, so this is if you see this is the mathematical part of warehousing, but one part or we forget which is not a such related to mathematical modelling but as we are mentioning that is the how to stage goods, how to keep the goods, racking et cetera. So, if you see we were saying about ABC, XYZ, FSN et cetera.

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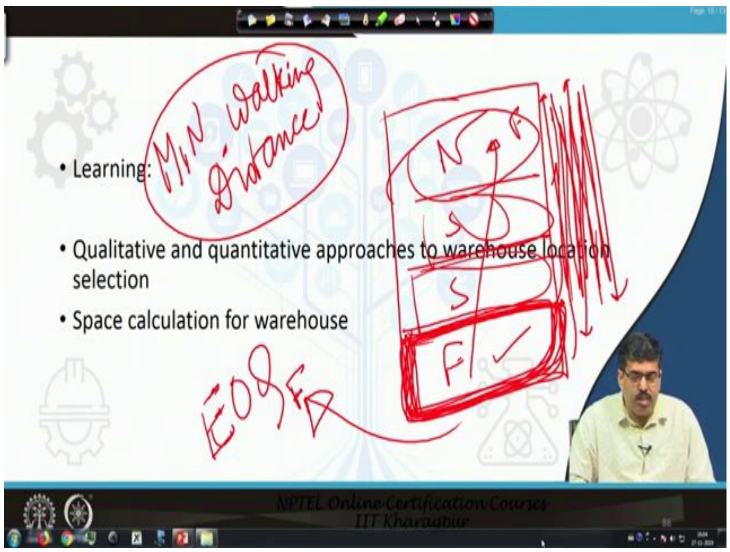

Now, if you see and we were just saying that this will be the fast moving, this will be the slow moving, slowing moving and this is the non-moving, see but how do I decide on that the next question that comes in is again very crucial say we know that fast moving products will be kept right in front because they will any way move, but what is the logic behind it? The logic behind is, if the fast moving products are kept here then the worker is spending all his time walking down and coming in front for dispatch, walking down coming in front for dispatch, that is not proper.

Because he has to go so many time up to the end, so his productivity decreases, so what is my objective in deciding on which product is to get how much of storing area, which product is to get how much of storing area? What should be the objective? Maximize profit? No, minimize cost? No, repeating, what should be the logic behind allocating this many square meter of space for F? Lesser square meter for this, lesser square meter for this.

One is your EOQ, how much products you have received, so it has a storage area required, if you have received 1 lakh units, 1 lakh units into let us say 10 meter cube is the volume, so that much space you require for F. This is the most simple way, the amount or space you have allocated for F fast moving is actually a function of the EOQ, how much quantity of fast moving good you have received or you will receive normally at a point in time for every risk consignment delivery.

So, EOQ, EOQ of fast moving EOQ of fast moving is actually the determining factor in determining how much space you require for the fast moving goods. But, there is another issue that issue is you have just now we have told you how much distance the worker is moving up moving down, moving up moving down, how much distance, so what is the other approach? The other approach is minimize, minimize walking distance that is your linear programing objective, minimize walking distance.

Then you can multiply by total number of units taken and how many yards you were walking, total number of units moved multiplied by how many yards you are walking and that has to be minimized. So, this is another way by which you can decide on how much area you require for each particular segment, but repeat and I am again repeating this area that you require for a segment is ultimately depended on how much goods you are receiving at a time from the manufacturer.

Now, in this connection let me also tell you certain things that is very much pertinent to warehouse operations may be not be directly deleted to modelling as such but then very very important, see all of over the world warehouses (())(17:45) as we are mentioned at at the beginning, warehouses tremendous effort on reducing the space of warehouses and ultimately remove them together.

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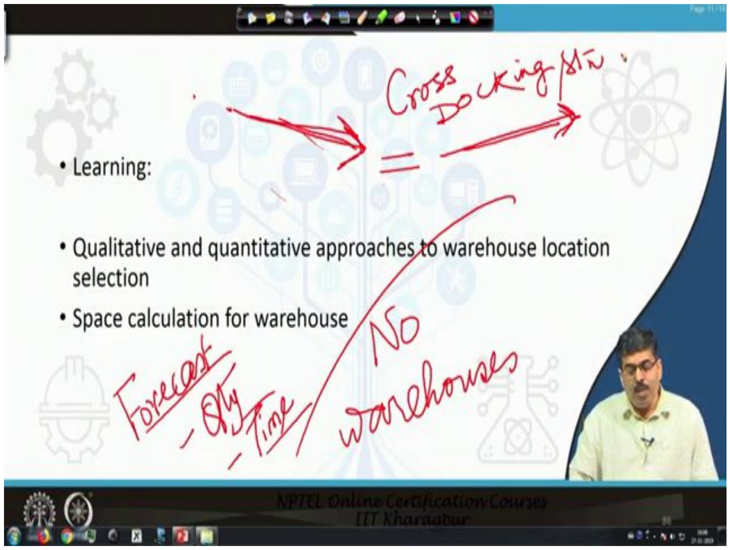

So, if you have a system by which material in is equal to material out, then what is the outcome? Your outcome is no warehouses, but to have this material in is equal to material out what do you require? You require a tremendously beautiful and affective forecasting technique not only forecast, not only forecast of the time, some forecast of the quantity, but also forecast for the time of sale, not only forecast of the quantity but also forecast of the time of sale.

So, only when you can get these 2 data, accurate forecast or quantity and the time, not only, then you can pass on this information to your factory and they can synchronise there production and send it. So, basically then there will be no warehouse require, what will you require then? You will require something that we call as a cross docking station, you will require something call it cross docking station.

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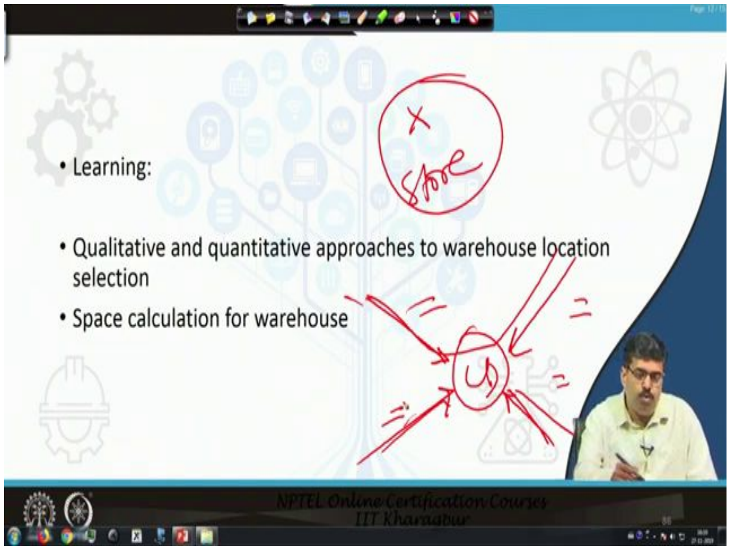

What is a basic idea of a cross docking station? Basic idea of a cross docking station is it does not stored anything, it does not store anything for which you will see that now a days most companies are trying to synchronise their demand with the demand from it. Synchronise there production and delivery with the demand from the market and that is why you will that most of these places cross docking centres are basically beside the highway, maybe just beside the highway some empty space 2 trucks are coming and just shuffling the goods as such no warehouse is required.

So, the next big thing that will come in, in warehouse modelling is not warehouse location decision, but next big thing that will come in in warehouse modelling is locating the cross docking centre, not warehouse location decisions, locating the cross docking centres, so there your objective is to synchronise the time and decide on the location, given of course the cost, distance the demand everything, but most importantly synchronising time.

So, though we have learnt modelling for warehouse et cetera but be sure the days are to come when we will have to look at modelling for cross docking centres. This is another aspect that I wanted to tell you. Again, what is cross docking? It is just products which are produced in one area and then it has to be brought in bulk and then shifted to small small shifted in small small numbers to different dealers different districts different distributers everyplace.

Earlier model of cross docking one was I bring this much from these 2 locations here is a cross dock and another 2 come products are brought in from these 2 decisions, so these trucks take my product and go, these trucks take my product and go and these trucks take this product and goes away, but then to have such a cross docking there has to be equal demand all over the country or at least more or less equal so that the cost suffice but this is in theory only this is not feasible not possible.

So, cross docking basically now a days mean, it is basically a break bulk station, bulks good coming in braking the bulk and giving it to multiple distributers which is essentially the function of a warehouse. So, now we are saying that instead of warehouses we will have something like cross docking stations and that cross docking station will not be under any shade, under any roof it will be just beside the highway trucks coming in and just moving out, the entire concept of truck terminals coming in earlier was called as a transportation hub, today we will have to be looked into as a modelling point for designing cross docking centres.

So, this is basically what we will have to look into in the future and I am telling you the days are not far away when you will have to remodel things in this panel. So, with this we end the warehousing module.

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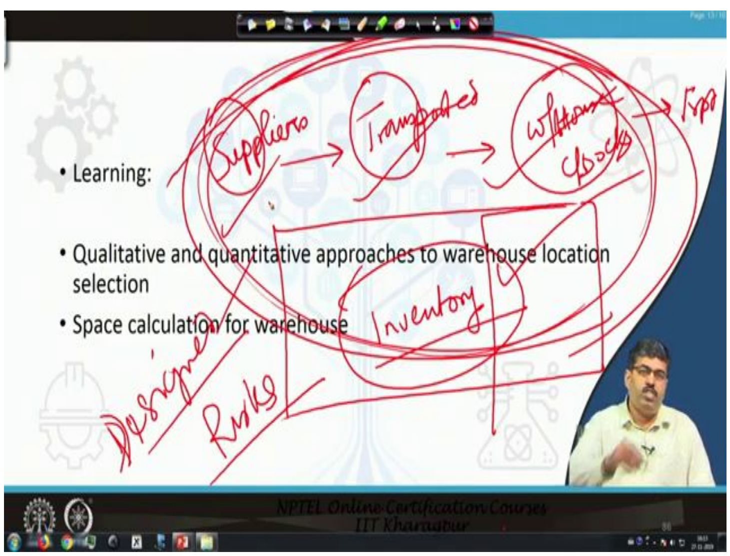

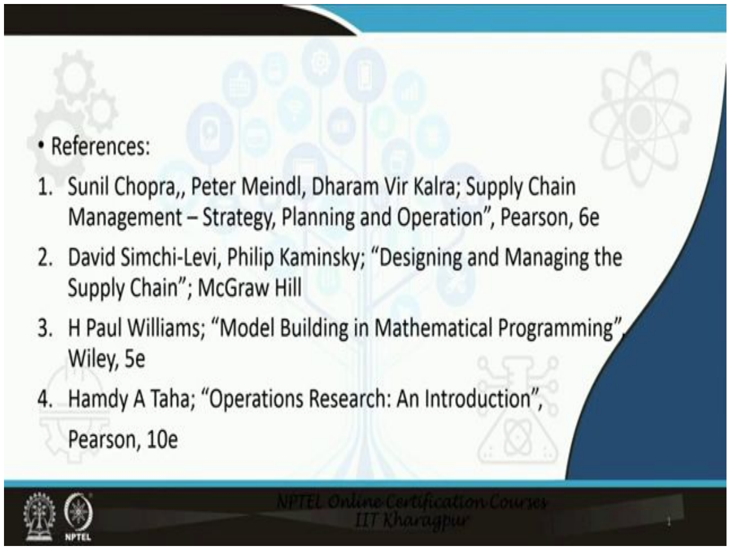

So, what we have if you notice, what we have learnt till now is once you have done a proper forecast you select your suppliers, once your suppliers are selected then the product are to be transported where, to your warehouse, in the recent concept it is the cross docking centres. In some cases cross docking centres, we can use the same models, which are used for warehousing also.

So, this is the scheme of things that we have completed till now. Now, what happens here the underlying part here is your inventory, next we will have to go into the other aspects of supply chain design, that we will pick up in the subsequent weeks what we will come in now if you see it that will come in is secondary transportation again secondary transportation and this entire thing has to be now designed as a model and what will come in? Your risks will come in, so all this things now we will do.

So, we have basically taken you through the structure of modelling for the entire supply chain, we have selected supplier, we have done the transportation modelling, we have done the warehouse location modelling, so we have and we have also touched upon the inventory modelling which professor Kunal Ghosh has shared with you. So, we have basically given you the entire structure of modelling the components, now we will go for a full blown modelling designing of the supply chain coupled with risks and coupled with so many other issue in supply chain which we will take up in the subsequent weeks. Thank you.