Modeling and Analytics for Supply Chain Management
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Lecture 51
Information Distortions; Coordination and Collaboration Modeling

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Hello, and welcome to Modeling for Supply Chain Management, Modeling and Analytics, today we will deal with modeling coordination in supply chain. Now, you see, whatever we see around us, you look around everything is centered around coordination. For example, you have to leave your home, and go your institute for taking classes.

Now, that is also you have to synchronize and coordinate certain activities. To addend a classes of the faculty at 9 am, you will have to get up at a certain point in time, finish of your breakfast at a certain point in time, then leave your home. Wait, waiting time for a bus, and then again if you have to take multiple buses in the route you have to get down at a certain point.

Again, you will have to wait for some time, again board the second bus and then you will have to reach your destination institution. And then again you will have to reach class in time. So, unless you synchronize all these activities. Getting up, having breakfast, getting ready, boarding bus number 1, or transport number 1, then getting down taking transport number 2, reaching the destination, so unless all these activities are properly coordinated then you cannot reach your destination on time.

Now, what happens if any of these activities are suddenly going out of the way? For example, you get the first bus, get down at a particular stop and you are waiting for the second bus, but

the second bus does not come on time. And might be you have an examination that day so everything goes astray.

Now, so what will you do, if you have an examination on that day? To take care of that, you are having a buffer time, that means you are leaving your residence, may be half an hour early. To have enough cushioning if the bus does not arrive on time. Even if the bus is late then also you can reach the examination hall on time.

So, you are having some sort of a buffer time or some sort of a cushioning time. But, what happens in real life is, in supply chain you cannot effort such a cushioning. Now, if think very, very very objectively, what is cushioning in supply chain. Cushion or buffer, cushion or buffer, in supply chain is basically your warehouse.

Your warehouse is basically a buffer between production and consumption or it acts a cushion between production and consumption. But what I am trying to say is that you cannot effort such cushioning because warehouse in supply chain cushioning is equal to warehouse, cushion or buffer is equal to warehouse but that warehouse is equal to lot of money spent. That is equal to it is a cost center. So, more you want to have cushion, more you want to have buffer, what is happening, more your cost increases.

So, if you can coordinate the supply chain activities in such a manner, that one activity then the next, then the next, then the next all are very very beautifully synchronized then there will be very little, very negligible storing cost in the warehouse and so your warehouse cost will become, almost 0. So, that is why your synchronizing or coordination becomes very important in supply chain.

That is why the role coordination comes in. If you see, in your real life also, what is happening in examination you have 8, 9, 10 papers to cover but that is limited? Your time is limited. So, what are you doing, you are coordinating among all these papers which one to study first, which one to study second, which one last, which one to revise, two times, three times. So, unless these are synchronized in a proper manner you cannot do well in all the subjects.

So, coordination is the in our real life everywhere. And I just gave you the example of bus transportation and then I gave the example of supply chain. So, coordination is very much required in supply chain for smooth functioning, for smooth flow of materials. Now, the smooth flow of materials if it is there, then what will happen, my warehouse cost, my storing

cost will become very very minimal. So, that buffer or that cushioning may not be required to that extend. So, that is where your coordination becomes very very important. And today we study coordination.

Now, having said that, we will introduce something more also, that is see, if you go back to, you are going to the institute as a student on a particular day if you go back to that example, what is happening? You are getting up from bed at 7:30 and you are supposed to attend the classes at 9 a clock, so you have one and half hour time to get prepared. Board bus number 1, get down, board bus number two 2 and then reach the destination.

Now, what is happening, if you have information that bus number 1 will be late by let us say 10 minutes then what will happen? If it is a say of the exam, then accordingly you will have to plan your journey may be you will be looking for some alternate modes of transport. Because you do not know whether that 10 minutes late will be delayed, will be any further delay.

Now, suppose you know that your bus will be 2 minutes early, then accordingly you will have to prepone your other activities to get the bus. So, what is important here if you notice, that if you have access to information, if you have access to correct information accurate information, timely information, cost effective information.

If you have access to information then you can synchronize your activities very very effectively. You can synchronize your activities very very effectively. So, information sharing becomes an integral part of now coming to supply chain, information sharing becomes your integral part of supply chain. Because if you can share information, then your coordination becomes very very easy.

For example, look at from a supply chain prospective. Which truck is coming into the warehouse at what time, when is the next dispatch from the warehouse demand from the wholesalers. If the demand from the wholesalers is at 3 pm that is in the afternoon. And the truck is arriving at 12 noon so that is the gap? A 3 hour gap, between the receipt and the dispatch, situation 1, take situation 2, demand, that is demand from the wholesalers for the goods is still at 3 pm.

So, dispatch will be at 3 pm but your goods are arriving at 7 am in the morning that same morning. So, the products are staying in the warehouse from 7 am to 3 pm. And you cannot

ask the transporter to keep his truck there, he has to unload, then gain reload, so lot of time and cost gets involved.

If you could have synchronized, if you knew, if you knew from the distributers well in advance, when they will be ready with an indent that is when they will requisition some products, when they will ask for some products and if accordingly you could have informed the transporter to reach exactly at 2:30, the products will be taken at 3 pm, the dispatch, so the receive should be at 2:30 and accordingly the transporter also will synchronize where scheduled a vehicle in such a manner that it picks up from the factory exactly at a matching point in time.

So, it picks up from the factory at a particular point in time, travels the distance, then it inters the factory at 2:30, at 3 of a clock again there is a dispatch. So, what is happening, is there a storage? Answer is no. So, simply by sharing information among everybody, among the warehouse, dealer, transporter, factory. So, sharing information among everybody, what have you done? You have been able to coordinate the transportation system very easily, and in the process what have you done? You have removed a, or you have potentially, removed a cost or an activity of storing the product.

So, what you wanting to say is, coordination. A synchronization of coordination with the power of or with the aid of or with the tool of information. So, information will help you to coordinate your supply chain activities very very effectively. So, information sharing is an integral part of supply chain coordination. So, but we are looking at supply chain coordination we are also invariably looking at supply chain information sharing. Let us proceed, so this is what we want to do today, our job is to study how we can model supply chain coordination.

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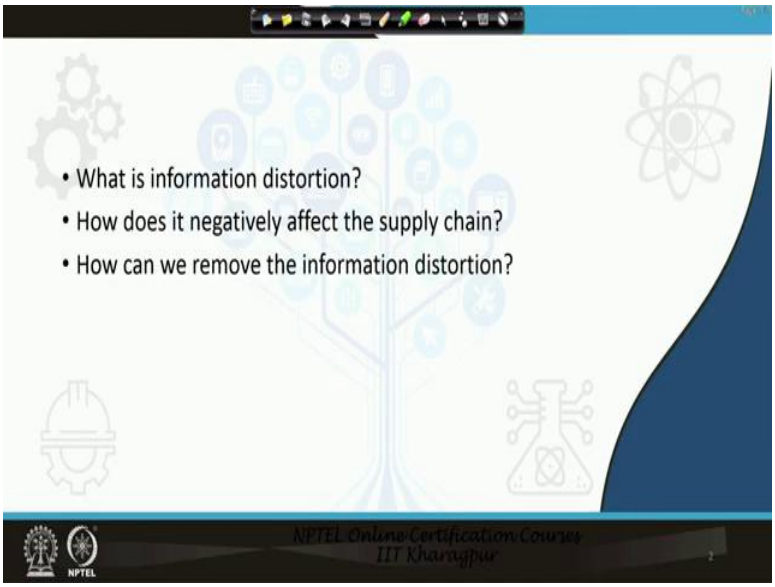

Now, see, the first question that we should ask is what is information distortion? How does is negatively affect the supply chain? And how can we remove the information distortion?

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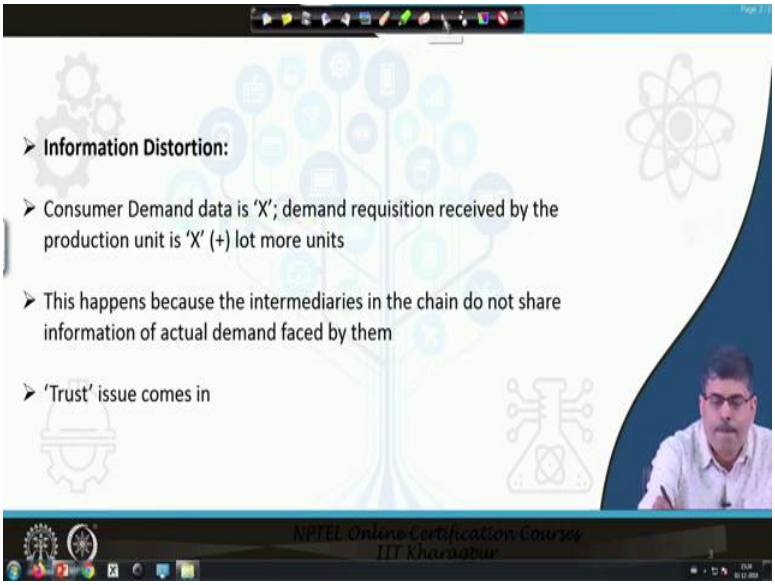

Now, see information distortion, what is information distortion? Information distortion, is simply, let us look at the first bullet point, consumer demand is X and the producer is receiving an indent or an order of X plus lot more items. So, consumer demand is X, producer is receiving a demand to manufacture which is equal to X plus lot more items. Why is this happening? So, basically, this happens because, the intermediaries in the chain do not share information of the actual demand faced by them.

Why? Because trust issues come in. Again let us have a brief recap, what we said that, my consumer demand is X, the most common example will be let us explain this in a different manner. Most common example will be, you have seen in books stalls at the railway platform or at prominent places in book stalls, the magazines.

Now, normally are published at the beginning of a month, what you will see, when you are going there on the 20 or 25th of the month, there can be two things, that has happened, there can be two things, that will happen, one is you go to search a magazine, the magazine is not there, sold over, the second thing that might happen is, the magazine still there in such quantity.

Huge, why, what has happened? Somewhere down the line, the retailer who is selling the magazines have sent a wrong demand information to the printer or to the publisher of the magazines. So, what has happened? If the end consumer demand was, if the end consumer demand was X, how much has the retailer sent the data for? Retailer has sent the data for, let say X plus 100 or X plus 200. So, this is what has happened.

So, information distortion is happening. Information distortion leads to stockpiling or stock out. If the producer had the actual information on what will be my customer demand. Then he go to manufacture exactly that quantity, okay, so consumer, your consumer demand, consumer demand data if you have accurate access to consumer and data, that actually gives you an exact information or the proper information about the demand.

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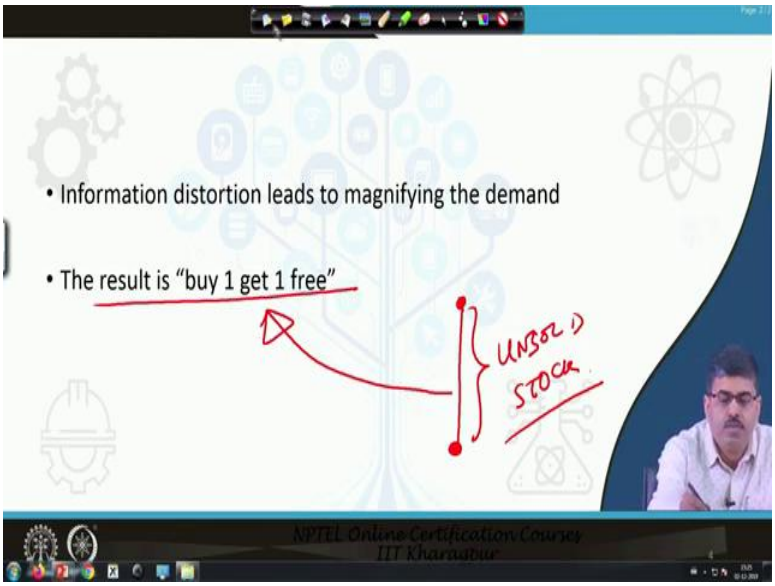

Now, information, this is my next point, information distortion leads to magnifying the demand. Now, this is the result, information distortion leads to magnifying the demand and the result is buy 1 get 1 free. Why? Because my demand was this much, and how much is the retailer told the demand is? The demand is this much.

So, what has happened? This much is the unsold stock. This much is the unsold stock, so this is what is the result of information distortion. So, how do you get rid of the stock, you get lead of the stock by this buy 1 get 1 free. Agreed? So, this is what in a sense is information distortion.

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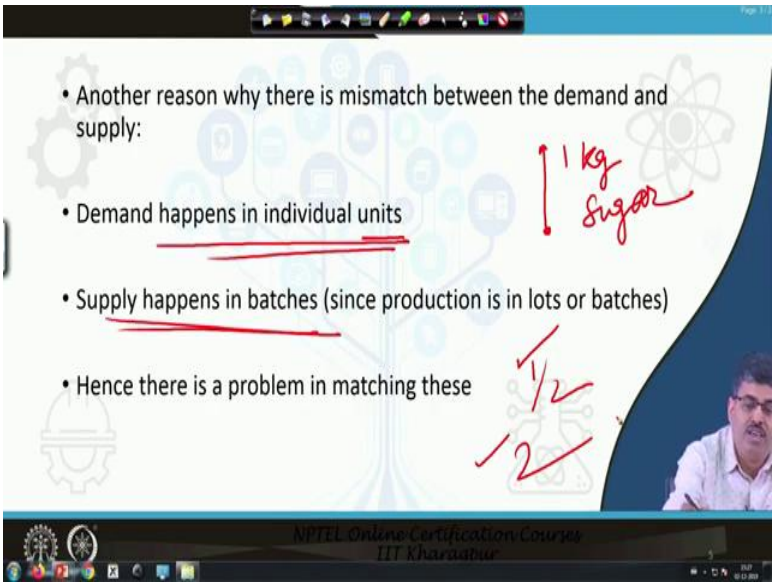

Now, another reason, why the there is lot of mismatch between the demand and supply, it is because this is all of us know but we seldom appreciate what it is, that is demand happens in individual units. Demand happens in individual units, but supply happens in batches, means you and I will go the shop and buy 1 kg sugar, 1 kg of sugar, buy 1 kg of sugar.

So, demand is happening in individual units, 1 kg, next person goes and buys half a kg, next person goes and buys 2 kgs. But production is happening in lots. It is happening in bag sizes, you are buying 1 pen, somebody is buying another pen, so1 pen, 1 pen, 1 pen, the pen that we used write you are buying 1 pen, somebody is buying another pen fine, but then the production of pens is happening in lots of 1000, a lots of 500 or batches of 100.

So, demand is happening in singles, and your supply is happening in bulk, supply is happening in lot. So, this is something also why, there is tremendous amount of stockpiling that happens in the supply chain.

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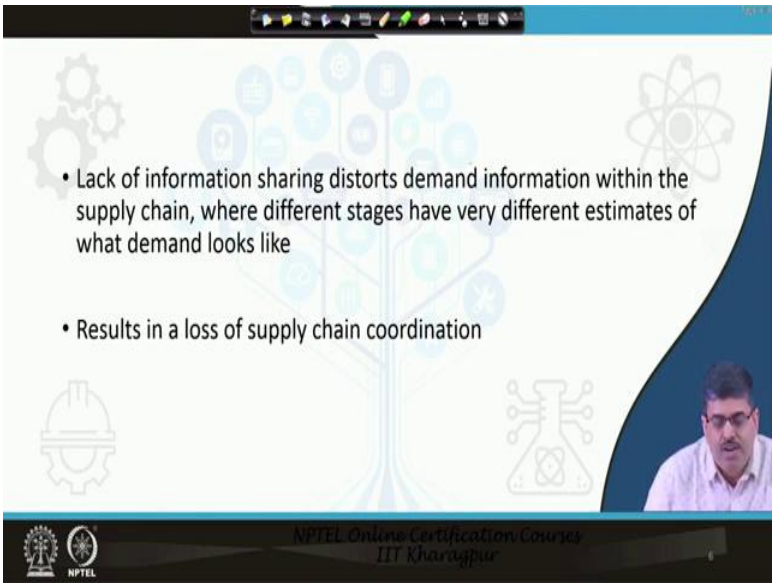

So, lack of information sharing is the result for demand distortion, result is a loss in supply chain coordination.

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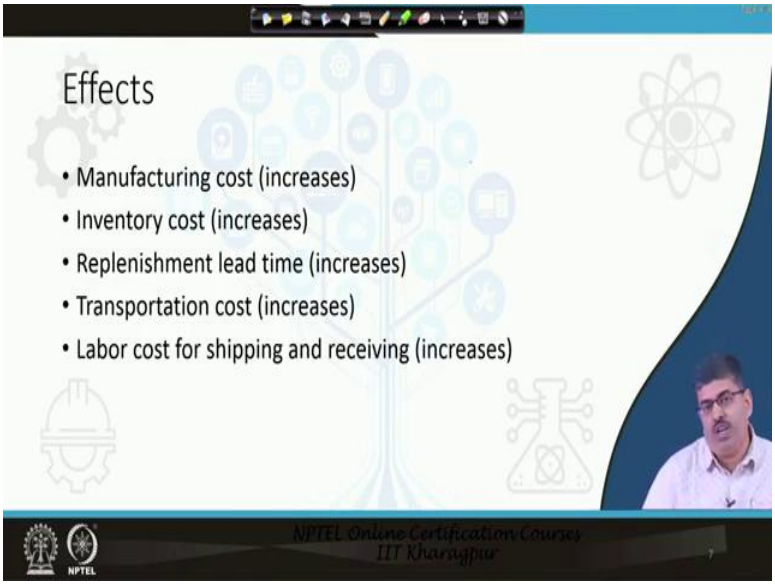

What are the effects? All of us known this is just a generic discussion. My manufacturing cost increases, my inventory cost increases, my replenishment lead time increases, my transportation cost increases, and labor cost for shipping and receiving also increases. Why? Because I am receiving lot more than what I needed.

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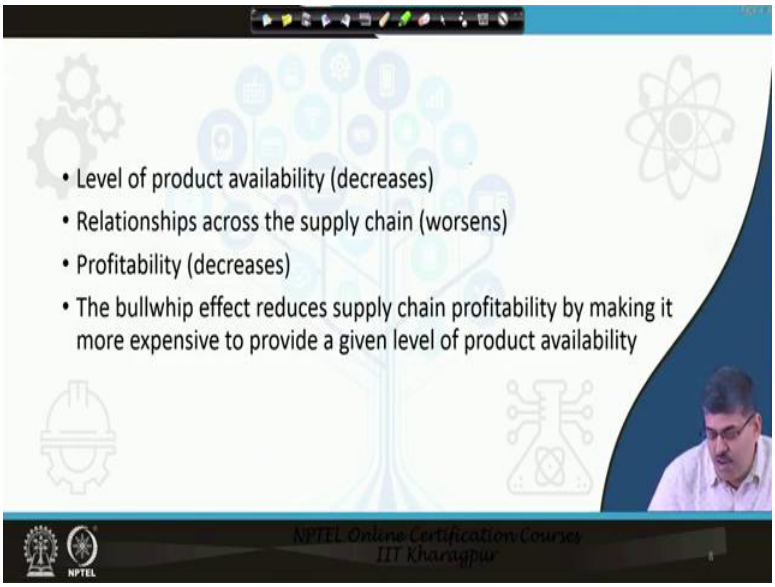

The level of product availability decreases. The relationship across the supply chain worsens, profitability decreases, all these things the bullwhip effect reduces the supply chain profitability by making it more expensive to provide a given level of product availability. What are these we will discus.

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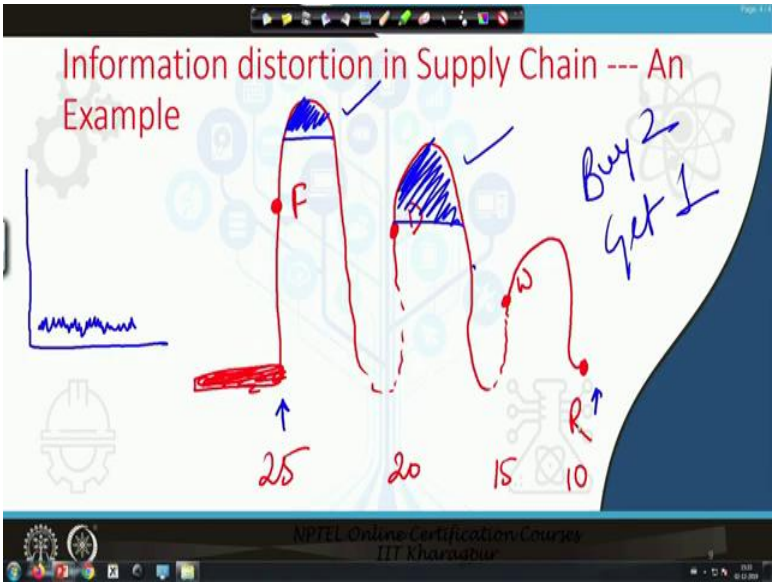

Now, information distortion in supply chain this is what we want to show you, information distortion. See, what is happening is let say you go, let say you as a customer go to the local retailer. And you buy bread which is required for having breakfast. What is your normal demand? Some days 1 pound, some days half a pound of bread, etc, etc.

Similarly, there are many people like you who buy bread, but if you notice that the demand of bread of a family as a whole as a unit, demand of bread for a family as a unit, that will remain fixed, means your family will buy only 1 packet of bread or 1, 2 packets of bread. 2 packs of bread not more. So, similarly if there are 10 families in the locality, the demand will be 10 packets of bread or 10 lopes of bread, not more.

That demand might fluctuate by 1 unit or 2 units not more than that. So, this is the demand which is actually faced by the retailer. But what does the retailer? Because of that minor or very minor fluctuation every day. Buy 1 packet or 2 packets from 10 packets it might go to 11 packets or it might come down by 1 packet to 9 packets.

Just because of that minor fluctuation the retailer wants to make more profit, so he does not want to have a lost sale. So, he to safeguard against this, he is ordering this much quantity. He is ordering this much quantity, he is ordering this much quantity. Now, from whom? From the wholesaler.

Now, the, this is, so this is my retailer, this is my wholesaler. Now, the wholesaler again does not actually know what is the retailer's demand, wholesaler only knows that the retailer has told give me 15 packets. What is the retailer's demand that we know? We know what is the retailer's demand, we know retailer demand is 10.

So, wholesaler does not know that, wholesaler, retailer has asked the wholesaler to give 15. Now, wholesaler is thinking tomorrow what will happen? I am serving not 1 retailer, I am serving so many retailers. So, tomorrow the demand may suddenly increase. So, wholesaler is asking the distributer to supply 20. Distributer again does not know what is the actual demand of the wholesaler and what is the actual demand of the retailer and what is the actual demand faced by the customer.

So, the distributer now orders 25 to the factory, sorry distributer orders 25 to the factory. So, what is happening, what is happening, if you see this is the pattern, this is the pattern by this the demand is behaving like which the demand is behaving. So, if you now look at it, it looks like a whip which is used to make a bull move forward, move fast.

So, that is why, this effect is called as the bullwhip effect. Where is the largest fluctuation? If you see, the largest fluctuation is at this factory level. Largest fluctuation is at this factory level, and the smallest fluctuation is at the retailer level, so this effect is actually called as the bullwhip effect.

Now, what would have happened if the retailer had shared actual demand data of 10 packets of bread with the wholesaler and the wholesaler would have shared his data with the distributer, distributer would have shared his data with the factory. Then the demand and the production, the difference would be roughly like this. Everybody is sharing information so everybody has access to the data so my demand will not fluctuate or behave in that manner for long.

So, if you share information your demand will not be not much and so what is happening if this is the extra demand, this is the extra demand, this is the extra demand, so, this extra demand everybody is trying to put pressure and there is tremendous pressure on the marketing team to sell of these extra and that is why you get buy 2 get 1 free. Sometime the situation is further more worse you get a, we get something called buy 1 get 1 free. So, this is what is called as the bullwhip effect. There is an information distortion.

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So, this is the concept of bullwhip effect.

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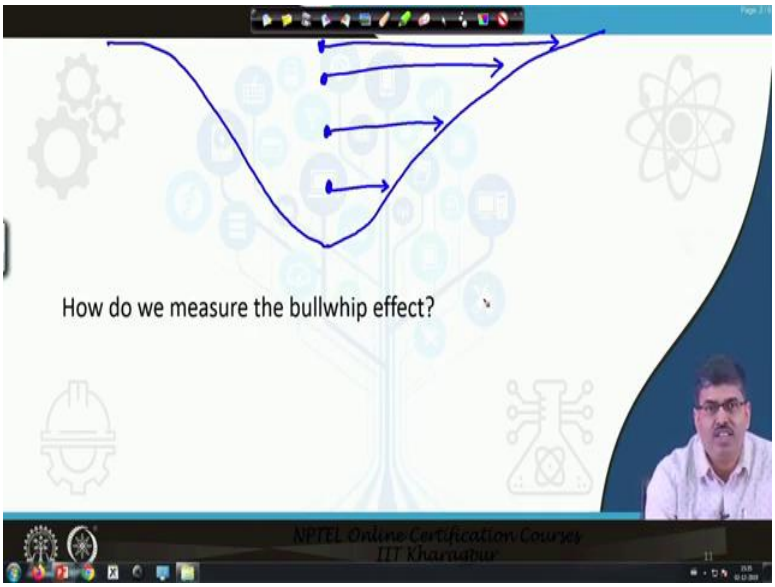

Now, the question is how do you measure the bullwhip effect. How do you measure the bullwhip effect? Now, if you see, if you see very carefully, bullwhip effect if you see, this is my demand, this is my actual demand, what is happening, I am ordering this much to the wholesaler, here is the wholesaler.

So, ideally if there was proper information sharing the wholesaler and the retailer will face the same demand. Because wholesaler is just supplying to the retailer so whatever the demand is from the retailer side, wholesaler will also face the same demand, but wholesaler is ordering this much to the distributor.

What is the distributer facing? Ideally if the retailer and the distributer should do the same demand, because retailer is buying from the wholesaler, the wholesaler is also again just buying from the distributer. But what is happening? Distributer is happening this thing and what is happening to our poor producer? The producer is producing this thing. So, if you see what is happening, there is a huge variation. Huge variation, this much is the variation if I am, I may be wrong in putting it but I am unable to resist the temptation to draw this.

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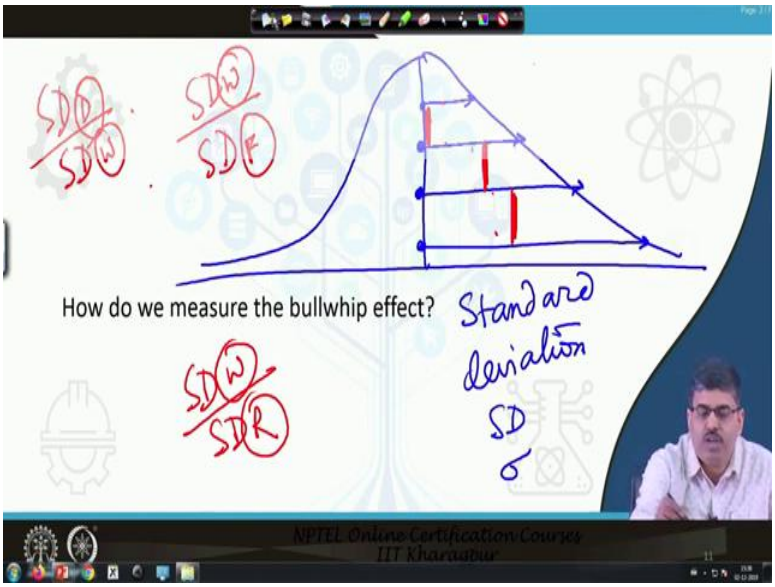

So, I am just putting it like this, this like it went away, this just putting it upside down this is the retailer same thing, this is the wholesaler, this is the distributer is giving this demand and this is my producer. Just repeating, retailer is receiving this demand same demand, actually only 1 person has demanded, retailer is ordering this much, wholesaler is ordering this much, distributer is ordering this much, and the factory is producing this much. So, what is happening? And I cannot resist but do this type of a thing.

So, what is this basically? So, how should we measure the bullwhip effect. How should we measure, if you see this in statistics the normal curve how should, what are these? These are basically my standard deviation or SD or this. So, I should measure the standard deviation.

So, what is the bullwhip effect between, now let me ask you what is the bullwhip effect between the retailer and the wholesaler, bullwhip effect between the retailer and the wholesaler, this part. That means standard deviation of the wholesaler by standard deviation of the retailer. What is the bullwhip effect, between the wholesaler and the distributer? Standard deviation, let me write it on top. Standard deviation of the distributer by standard deviation of the wholesaler. What is it between the wholesaler, and the factory? Standard deviation of the wholesaler by standard deviation of the factory.

So, bullwhip effect is basically a ratio of the standard deviations. Standard deviation of the wholesalers demand, standard deviation of the wholesalers demand, standard deviation of the retailers demand. Standard deviation of wholesalers demand, factory demand, distributer demand, wholesaler demand so it is just that. Now, this is the individual effect, individual effect of between this and this, this and this, this and this, got it, what will be the total effect?

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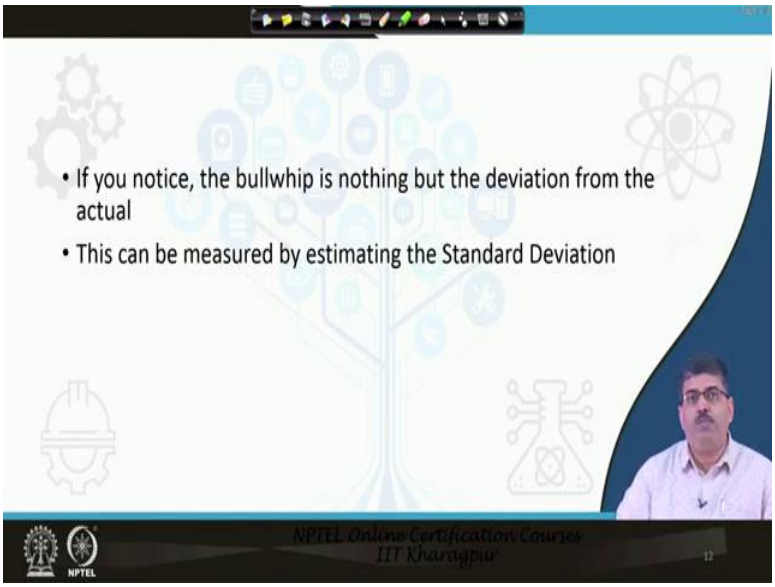

As we mentioned, this can be estimated by standard deviation.

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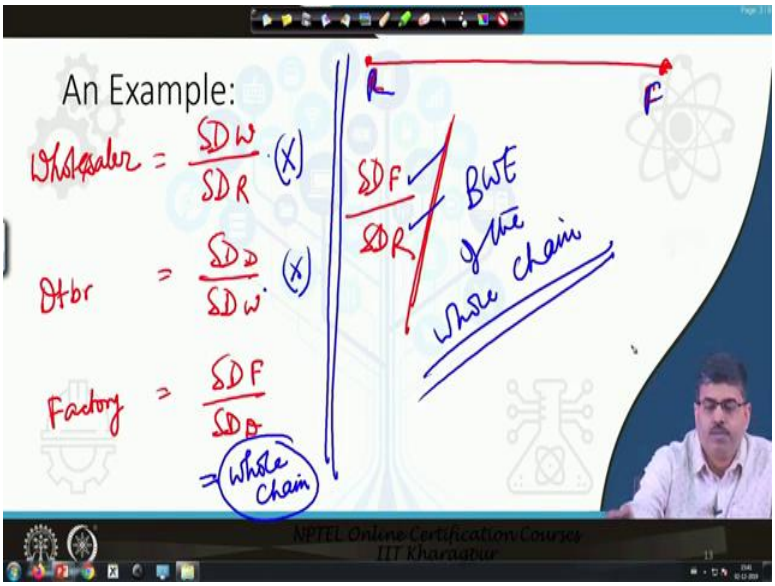

So, what we said, what did we say, we mention that it is, so at the wholesaler level it will be standard deviation of the wholesaler by standard deviation of the retailer. At the distributer level, it will be standard deviation of the distributer by standard deviation of the wholesaler. At the factory level, it will be standard deviation at the factory by standard deviation of the distributer. Standard deviation of the factory.

How to calculate standard deviation all of you know. So, just calculate the standard deviation of the demand, standard deviation of the demand faced by the factory, wholesaler, retailer, etc. Now, this is the individual bullwhip effect, what is the bullwhip effect of the entire chain

right from the retailer to the factory? Very simple standard deviation faced by the factory by standard deviation faced by the retailer. Standard deviation faced by the factory, standard deviation faced by the retailer.

Other simple way is, other simple way is, I am rubbing this, now let me just, another simple way is, this multiplied by this, multiplied by this is equal to whole chain, this multiplied by this multiplied by this is equal to bullwhip effect of the whole chain, this again is the bullwhip effect of the whole changel, bullwhip effect of the whole change, that is standard deviation of factory by standard deviation of the retailer.

That is both the ends, retailer and the factory, here also we are, since we have calculated the individual standard deviations, we are multiplying the individual standard deviations to get the bullwhip effect of the whole chain. So, this is the simplest formula by which we can get the bullwhip effect, done?

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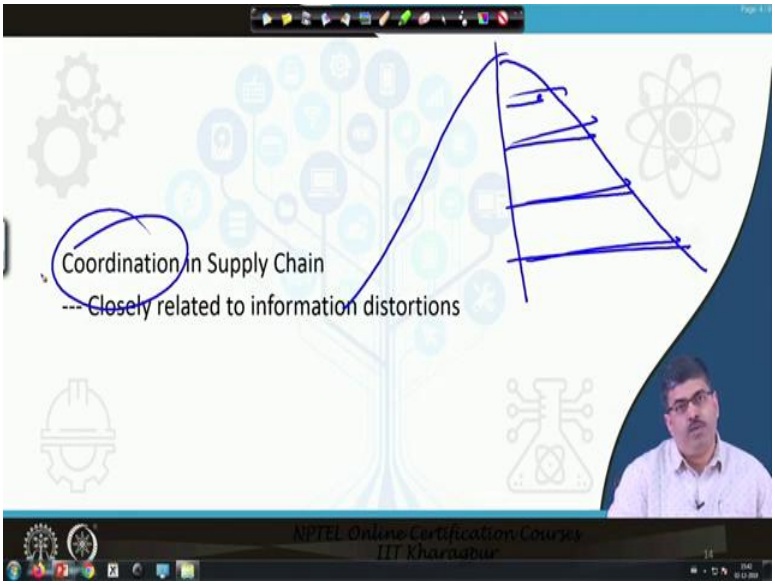

Now, see a coordination is closely related to information distortions, just now what have we done? We have calculated the information distortions and if you go back to the normal curve that we just now drew, if you go back to the normal curve which we just now drew, if you go back to the normal curve which we just now drew, if there is so much of distortion, how will you coordinate that becomes the problem. This we will take up in the next lecture. Thank You.