**Modelling and Analytics for Supply Chain Management**
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**Lecture 52**
**Information Distortions: Coordination and Collaboration Modelling (Contd.)**

Hello and welcome to Modelling and Analytics for Supply Chain Management. We are into Module 10, Information Distortions: Coordination and Collaboration Modelling. Now, you see, in our previous lecture, we have spoken about the information distortions and what exactly, information distortions create, what type of problems it create for supply chain and we said that the measure for information distortion is measuring the standard deviation.

That is measuring the variation among different elements, different nodes of the supply chain and how do we measure this? That term that we use is bullwhip effect. The measure is standard deviation and the terminology is bullwhip effect. Now how to calculate bullwhip effect? That we have done in the previous class. Today, we will deal with the elements first. So, yes, just a recap, previous day's module was information distortions.

Today is coordination. But they are very, very closely related, if you have understood it correctly. Without, with proper information, your supply chain will be coordinated. Improper information, incorrect information, not up-to-date information, your supply chain will not be coordinated properly.

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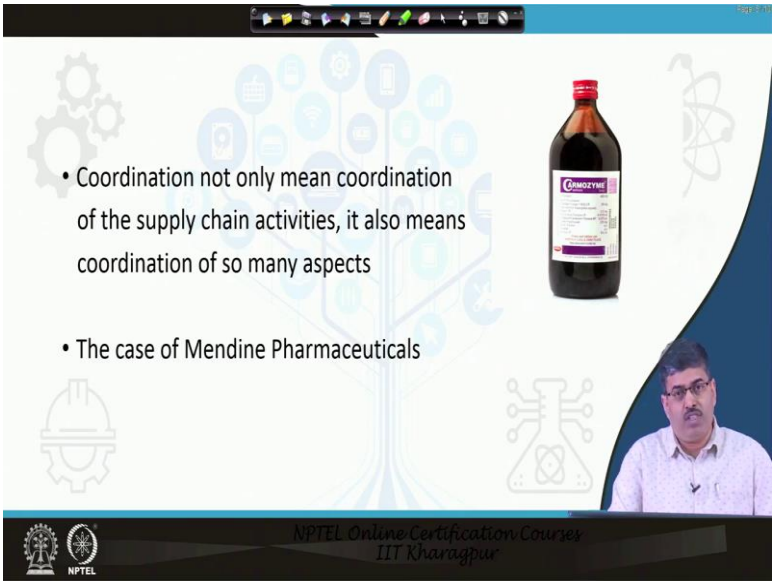


Now, so this, so today we will deal with coordination. Now see, coordination not only mean coordination of the supply chain activities, it also means coordination of so many aspects. Let

us take the example of Mendine Pharmaceuticals. If you see the medicine bottle on the top right hand corner of your screen, I do not know whether you are able to read the brand name. But the brand name is Carmozyme.

Carmozyme is a digestive enzyme that many doctors prescribe. Now, this Carmozyme is a very very popular brand in West Bengal and this brand is running for many, many, many years, even before, right after independence, this brand and it has given a very, very tough time to the multinationals, because the medicine is very, very effective, particularly for elderly people.

Now, this company is not a very large organization and its reach is only within the state of West Bengal. Why I am taking this example, you will understand. I will just tell such is the demand for this product, that one day a dealer from North Bengal, North Bengal is 12-hour express train journey, 12-hour journey by express train to Calcutta. So, one day a dealer from North Bengal came to the Calcutta office of this company and said, why are you not sending us medicines, we are not able to give it to our customers.

What I want to say through this is, such is the demand for this product and another beauty is people will not buy the smaller bottle size, the smaller pack size. People will buy the bigger bottles. Means it is a product, which people trust so much, that it is used by the entire family and that is a full month's sales or full month's demand, rather. Now, what happened is, what happened here is this. A problem came to the company and the problem was that this, the demand was there, there is no problem, no, no issues with demand. But supply was getting hurt.

For example, from the factory to a destination, which is just about 15 kilometers, 15 kilometers from the factory to the particular market. 15 kilometers within the city, a metropolitan city like Calcutta is nothing, nothing. So, that 15 kilometers, if there is an order, then the product was reaching in 2 days, just 15 kilometers and you know what, 20 kilometers, I mean 20, 23, 24 kilometers, 23, 24 kilometers, so another 8, 9 kilometers, how much time it was taking, you have any idea? It was taking 10 days to reach.

So, 15 kilometers within the city, that also taking 2 days and 10 days to reach just another 5 kilometers, another plus 5 kilometers, plus 5 kilometers. So, what is happening, what is the problem? Is it a transportation problem? No, Calcutta has enough enough and enough means

of transport. It is not a transportation problem. It is basically a coordination problem, it is basically a coordination problem. That is why I wanted to highlight this example.

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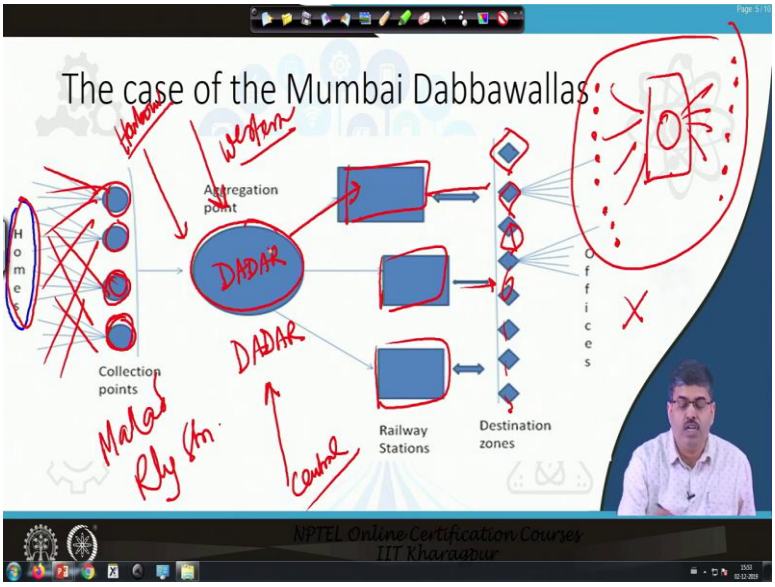


You see, another classic case is the case of the Mumbai Dabbawallas. I do not know how many of you are from Mumbai or you have been to Mumbai. But if you are or if you have been to Mumbai, you will see dabbawallas. Who are these dabbawallas, the tiffin carriers and such is the demand for these people, that Indian Railways have earmarked on the railway platforms of junctions, like Dadar, etc, places for the dabbawallas to keep the tiffin boxes or the dabbas. Such is the demand for dabbawallas.

Now, this is a classic example of coordination in supply chain. What do I mean by this? Let us see. See, these are our residences in Mumbai. These are our residences in Mumbai. They may be Andheri, they may be Vile Parle, they may be Bhayandar, they may be Malad, Mulund, any place and from there, from the apartments, Bombay has very, very few individual residences, that also very olden day allotments. But all the new allotments are apartments.

So, from the all apartments, the boxes, the tiffin boxes will come and these are the collection points, where these tiffin boxes will be collected and so assume, assume your house is in let us say Malad. From Malad only, all the tiffin boxes from the Malad region is being collected and they are being brought in to a collection point, which will be definitely the Malad Railway Station, Malad Railway Station.

Now, from Malad Station, what will happen, they will go to see, what they will go to an aggregation point. What is aggregation point? Aggregation point is Dadar. I am writing again below. Aggregation point is Dadar. What is happening in Dadar? Trains are coming from central line, trains are coming from western line and trains are also coming from the harbor line. So, central line, western line and harbor line. Trains are coming from all the, all these points, with so many tiffin boxes, dabbas. We took an example of the Malad Railway Station.

So, all these will come to Dadar and from Dadar, they will be arranged according to the end destination points. These are the end destination points. These are the end destination points. So, from Dadar, they will go to the next railway station and from the next railway station, they will go to the particular offices, where the people are working. So, it is station, station, station, station, aggregation, then again station, station and then again, here are the people, who will take the tiffin boxes.

So, if you look at it. So, if you look at it very, very effectively now, so this diagram, this is actually your supply chain and who is at the central point, Dadar Railway Station or the coordinating railway station. So, if this coordinating station does any mistake, then your entire supply chain will now be gone. You will give wrong deliveries of food to different people. So, that is where the role of coordination lies. So coordination is very, in that sense, role of coordination is very important.

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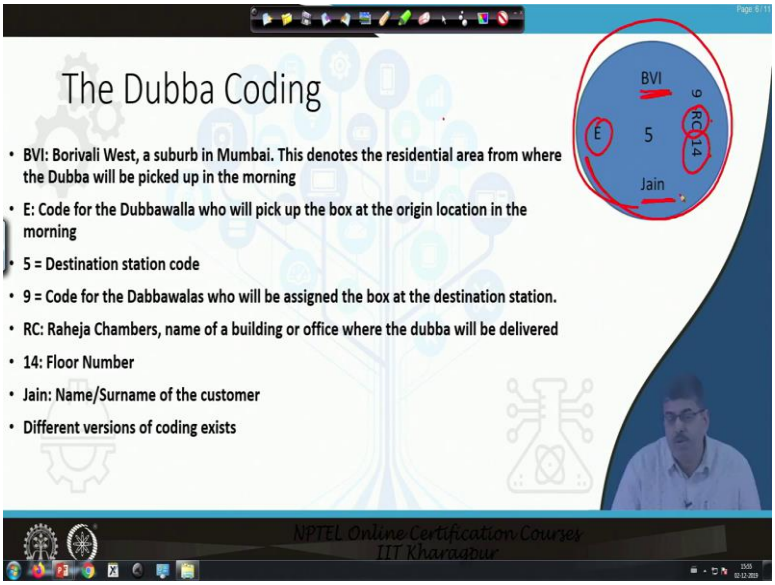


Now, this is just for your understanding, later on, nothing to explain as such. Now, these dabbawallas, as you know, as you must be knowing, the dabbawallas are mainly people, who

have very little, who have had very little education. So, most of the dabbas, most of the dabbas here are, they have a label on top, they have a label on top, which we call it as a dabba coding, which we call it as a dabba coding. The codes are given and these codes will tell you, what the, where the tiffin box or the dabba is going.

For example, as we have mentioned, BVI is Borivali West. E is the name or the code name of the dabbawalla, who will pick up the dabba. Similarly here, 14 is the floor number, where the dabba will be delivered. RC here is Raheja Chambers, means the office where the dabba will be delivered.

So, Raheja Chambers, 14th floor and Jain is the name of the person, whose dabba it is. So, you see, this is, If you look at it, this is the most simple method of coordination, that we have seen, involving 0 mathematics, involving people with not too many, not too much idea of numbers. So, this is a simple way of coordination.

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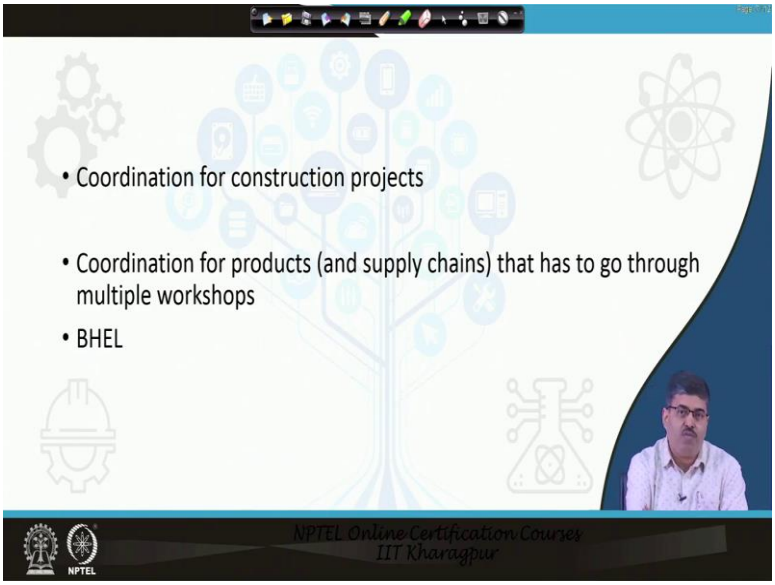


We will give you another example of coordination. Coordination at BHEL, you know Bharat Heavy Electricals is known to manufacture heavy electrical items. Now, this Heavy Electricals is something, which takes lot of time in different workshops and since they are project based, sometimes the project is delayed and the workshops have manufactured already, project is delayed. So, the item or the equipment is lying outside in the rain and the sun and might develop some rust. All this happens because there is lack of coordination or synchronization.

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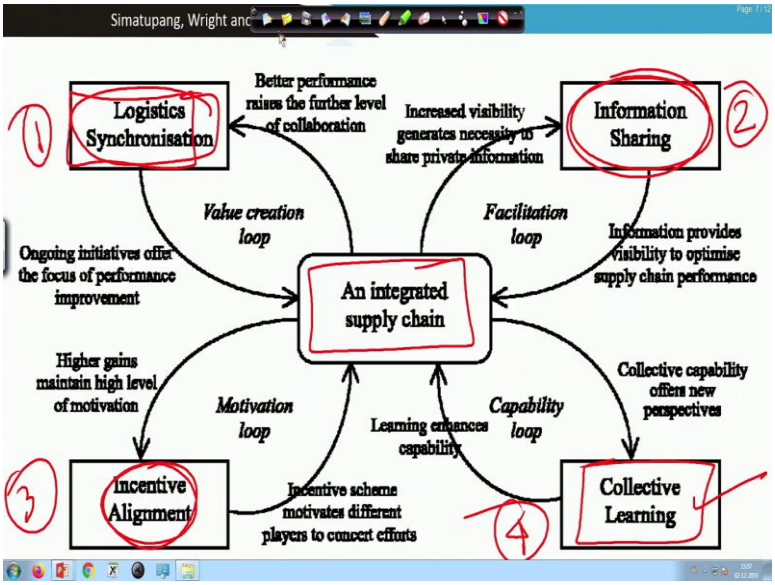


This is a model for supply chain coordination. Nothing to get worried about. It is a very, very simple model. What we have, if you want to have a proper supply chain coordination, you will have to have proper synchronization of your transport systems, proper synchronization of your transport systems. That is what is called as logistics synchronization.

Now, the other part is definitely what we have already mentioned, that is information sharing. Unless you share information, your logistics synchronization will not work. The second, the third thing is incentives alignment. I am doing some work. How much time am I saving? How much cost am I saving? And is that getting transferred across all the members in the supply chain?

So, incentive alignment and the last one is, have we learned from our mistake since cycle 1. So, that we can redo the supply chain in cycle 2. So, that is what is called as Collective Learning. This is the general coordination model. So, four elements, Logistics Synchronization, Information Sharing, Incentives Alignment and Collective Learning. So, four elements of supply chain coordination.

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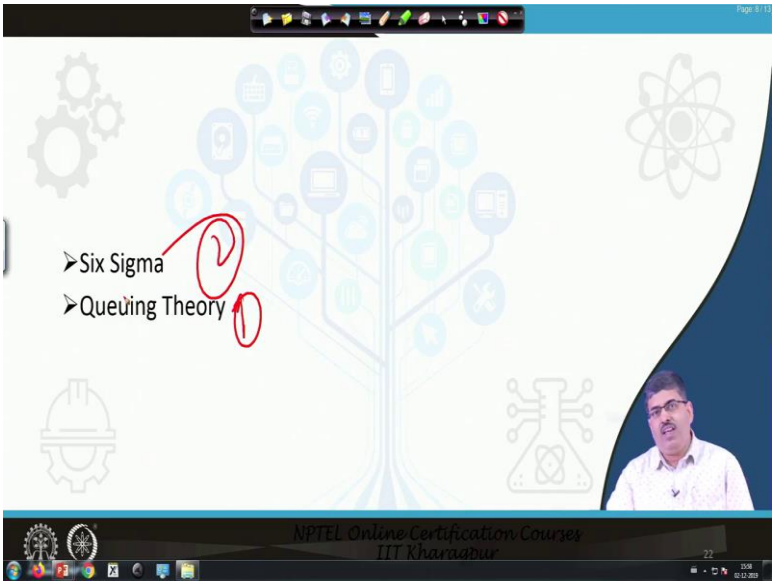


How do you coordinate? This is the most important question. How do you coordinate? Models are fine, theoretical models are very fine. But how do you coordinate? This is how you coordinate, Six Sigma and Queuing Theory. Rather, though we have arranged it this way, but actually it is queuing theory and six sigma. Now what is six sigma? That is my next question. What is six sigma? We heard the word very much. But what is six sigma? Very few of us understand, what effort goes on behind having something called six sigma. Let us see.

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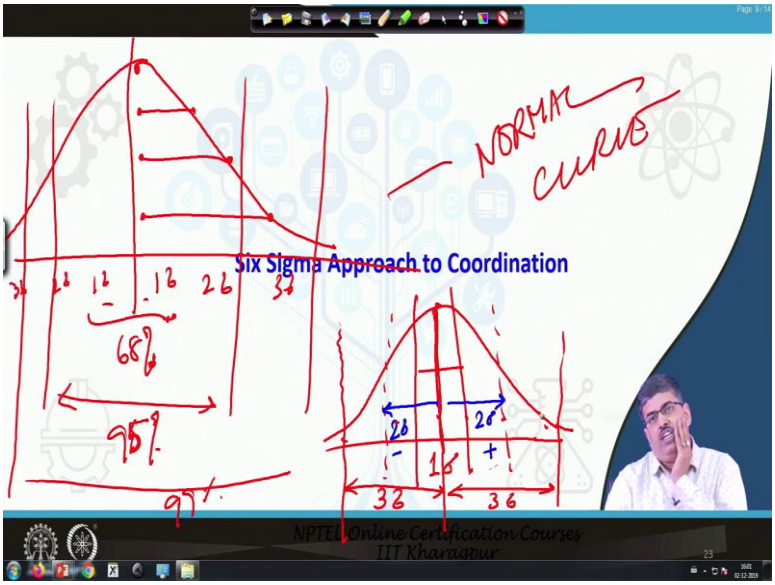


Let us see six sigma approach to coordination. Now see, you have already mentioned. If you remember, we have already mentioned, like the bullwhip effect. My retailer, his demand is this much. Retailer is facing this much of demand. The retailer is ordering to the wholesaler this much.

Wholesaler is ordering to the distributor this much. Distributor ordering to the factory this much. So, if you can draw, this is my normal curve. This is my normal curve, this is my normal curve. This much on both sides of the mean is equal to 1 standard deviation. This from the mean, this is the mean. This is the mean. Hold on. From the mean, to this much and to this much, what is this, 2 standard deviation.

So, 2 standard deviation plus 2 SD minus and from mean to this end point and from mean to this end point, this is my mean, to this end point is 3 standard deviation. So, basically, 1 standard deviation, 2 standard deviation and 3 standard deviation. 1, 2, 3 standard deviation. So, wherever we get a situation, when 68 percent of all the observations are within plus, minus 1 SD. 95 percent are including the 68. 95 percent are within plus, minus 2 SD and 99 percent are within plus, minus 3 SD. We get something called a normal curve.

We get something called as the normal curve. This is the essence of the normal curve. Now, if you see. So, this is the essence of the normal curve, 1 standard deviation, 2 standard deviation, 3 standard deviation, 1 standard deviation, 2 standard deviation, 3 standard deviation. Now just, what is the standard deviation all about, let us see.

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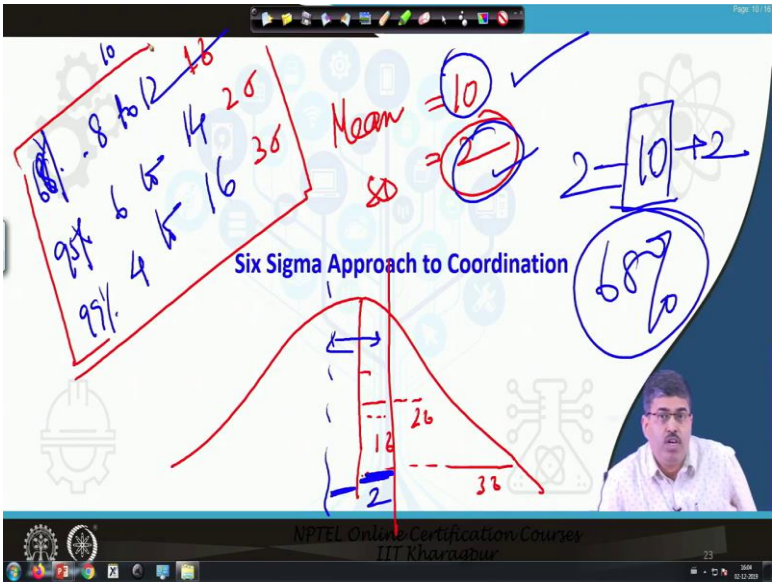


The standard deviation, you know always in statistics, those of you who are a bit jittery about statistics. Always you have learned that a certain distribution has mean 10 and standard deviation of 2. What is that? This means that this is 1 standard deviation, this much is 2 and this much is 3.

This standard deviation of 2 means 1 standard deviation, this much, 1 standard deviation value is 2 units. So, if it is an examination marks, average marks obtained by the students are 10 and the standard deviation is 2, means that the average marks obtained by the students are 10 with a plus 2 and with a minus 2, with a plus 2 and a minus 2. So, what it says is the average marks obtained by the students is 10, with a plus 2 or minus 2. That means the marks range between 12 and 8.

How many people's marks range between 12 and 8? 68 percent of the people's marks range between 12 and 8. That is the essence of my normal curve. 68 percent of the values are within 1 standard deviation. So, 68 percent of the marks of the people, 68 percent of the people range from 8 to 12. What does this say? 95 percent range 2 standard deviation. What is my standard deviation 2. This is 1 standard deviation. What is 2 standard deviation? 2 into 2, 4. So, 4 is the value. So, 10, this side will be 4. So, 6 to, how much is this, 10 plus 4, 14.

So, 95 percent of the observations are between 6 to 14 and then if you take 3 standard deviation, so 6. So, it will be 4 to 16. So, 1 that is 99. So, 1 SD, this is 1 standard deviation, 2 standard deviation, 3 standard deviation. So, this is my, so, this is my concept of Six Sigma. This is a my concept of, six sigma, this is concept of normal curve. Let us, so, 1 standard.

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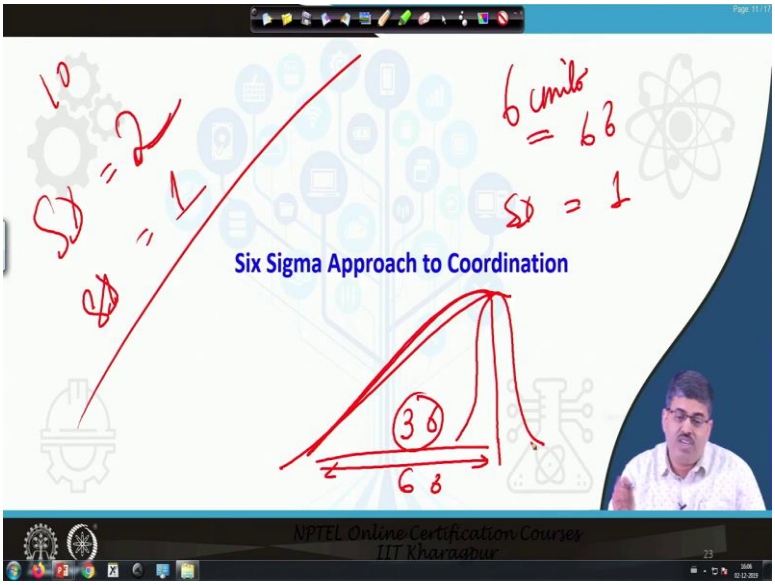


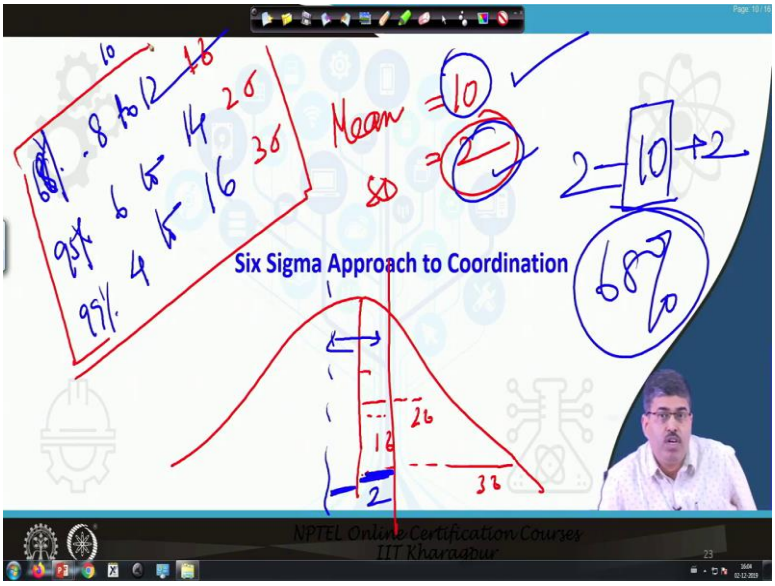


Now let us again, let us again go back to this part. So, on any side we are saying, that there is 3 standard deviation. What was my standard deviation earlier? My standard deviation earlier was 2 units. Remember? You were doing a standard deviation, this thing, 2 units was my standard deviation, mean 10, 2. So, 2 units standard deviation.

Now, here, so, 2, 2, 2. So, 6 units is equal to 3 standard deviation. Now, we are saying that this thing is no more 3 standard deviation. This thing is 6 standard deviation. So, what was my total here, 2, 2, 2, 6 units. So, 6 units was 3 standard deviation. Now we are saying, no 6 units is 6 standard deviation.

So, what is SD now? SD is 6 units by 6 1. Earlier SD was 10, 8, 10, 2. Earlier SD was 10 and 2. What is the new SD? New SD is just 1 unit. New SD is just 1 unit. So, what has happened?

My normal curve is becoming squeezed. Normal curve becoming squeezed means what? Normal curve becoming squeezed means what? Normal curve is getting squeezed. Means what? My variation is reducing. My variation is reducing. That is the essence of six sigma.

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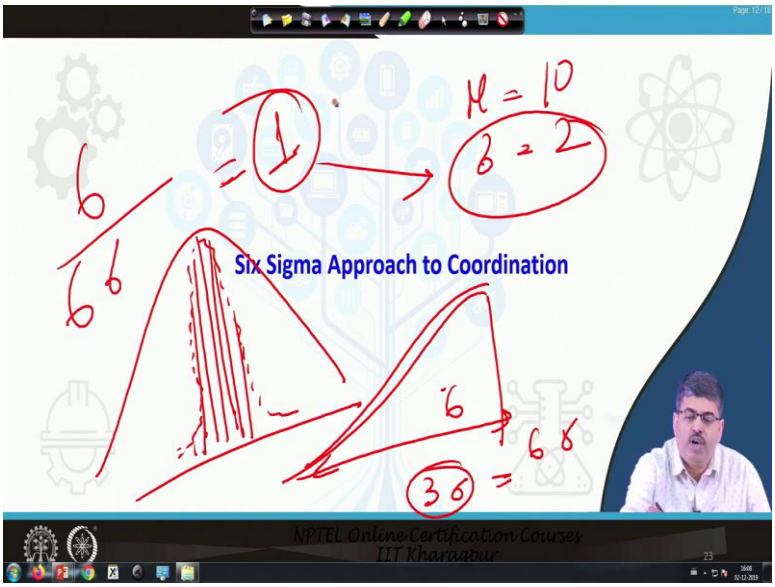


So, what is Six Sigma again? This side of a normal curve. This side of a normal curve, standard deviation was 2. That 2 means, remember, mean was 10 and standard deviation was 2. Mean was 10 and my standard deviation was 2. Now, so this is 1 standard deviation and this side of a normal curve is how many standard deviations, 3 standard deviations.

So, 1 standard deviation is 2. So, 3 standard deviation means what? 6 is the value, 6 is the value. Now we are saying that this side is no more 3 standard deviation. This side is what, 6 standard deviation. So, what is the value? My value has remained 6 here. 6 was the variation, divided by 6 standard deviation.

So, what is the value of 1 standard deviation? Value of 1 standard deviation is just 1. What was the earlier value of 1 standard deviation? 2. So, what is happening? My normal curve, which was earlier like this, is now becoming, is now becoming very less, very thin. Because all, all the standard deviations are now within this range. So, this is the essence of six sigma. This is the essence of six sigma.

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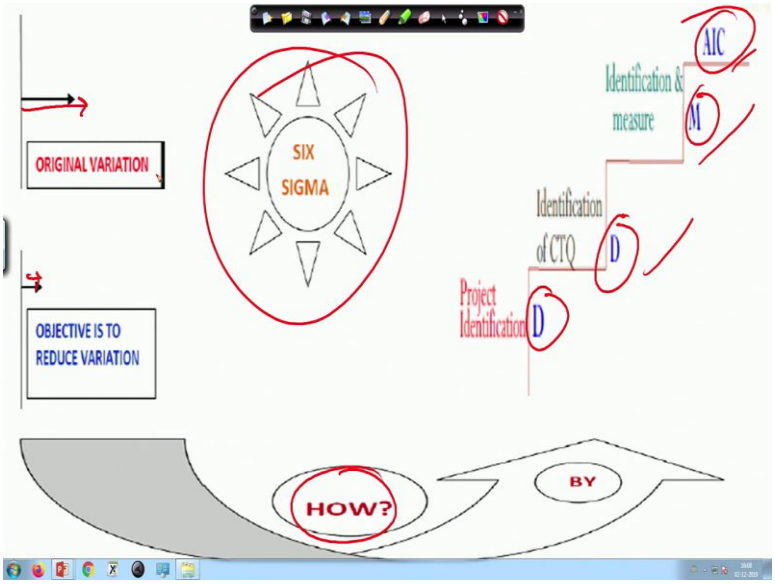


As we said, this is my Original Variation is this much. My objective is to reduce the variation to this much. How do I reduce it, to a process of D, M, AIC, define, measure, Analyze Improve Control and this is what your Six Sigma is all about?

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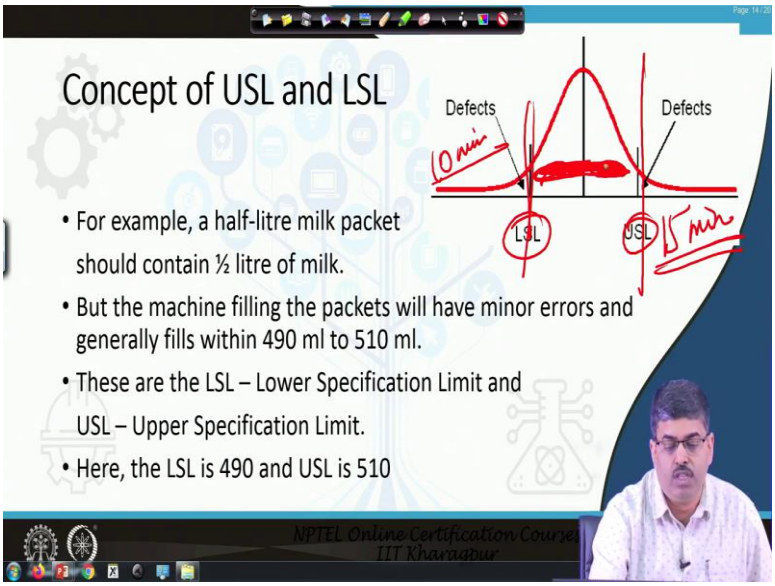

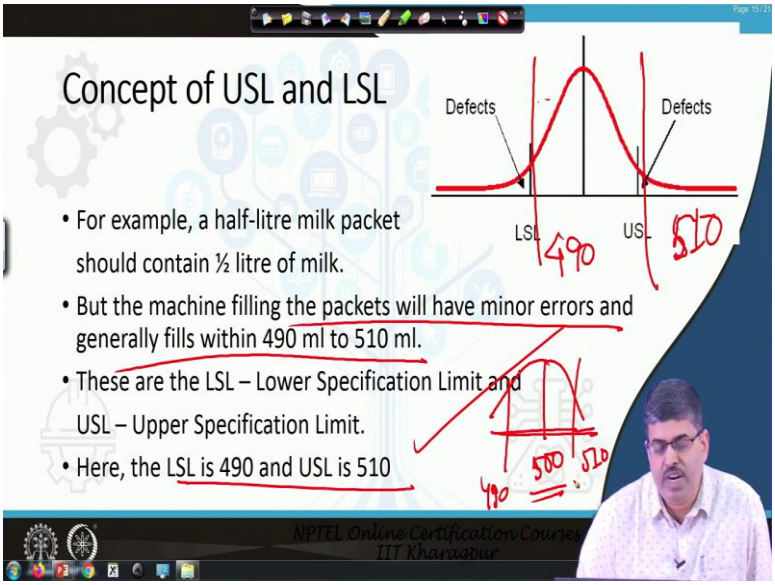


Now in Six Sigma, there is something called USL and LSL. What is USL and LSL? Upper Specification Limit and Lower Specification Limit. You see, all of you has given exams in life. What happens if you are late by 15 minutes? They will say, you are not allowed? So, that is your upper specification limit.

When does the examination hall open? 10 minutes before the exam. That is your lower specification limit. So, your entry is between 10 minutes before and 15 minutes later. So, that is basically your, that is basically your this thing, 10 minutes before and 15 minutes later that is your this thing and the upper specification limit, this line you cannot come after this.

Upper specification limit is 15 minutes. Your lower specification limit is 10 minutes. So, all your observation, this is your lower specification limit, upper specification. So, whatever you need to see is within this. So, that is your USL and that is your LSL. Now let us, I have explained this in in a simple manner. Let us look at the slides. A half-liter milk packet should contain half-liter milk. No doubt. But the machine filling the packets will have minor errors and generally fills within 490 ml to 510 ml.

So, what is happening? What is your lower, the machine filling the packets will have minor errors. The machine filling the packets will have minor errors and generally fills within 490 ml to 510 ml. So, 490 ml is your lower specification limit and 510 is your higher specification limit or upper specification limit. Here, LSL is 490 and USL is 510, 490 and 510. So, now if you see the, now if you see the diagram, if you see, your mean is what. It has supposed to fill 500 ml, 510, 490.

So, the mean is at the center of the spread. We will come back to what we mean by center of the spread a little bit later on. So, now, for the time being just remember that the mean is at the center of the spread.

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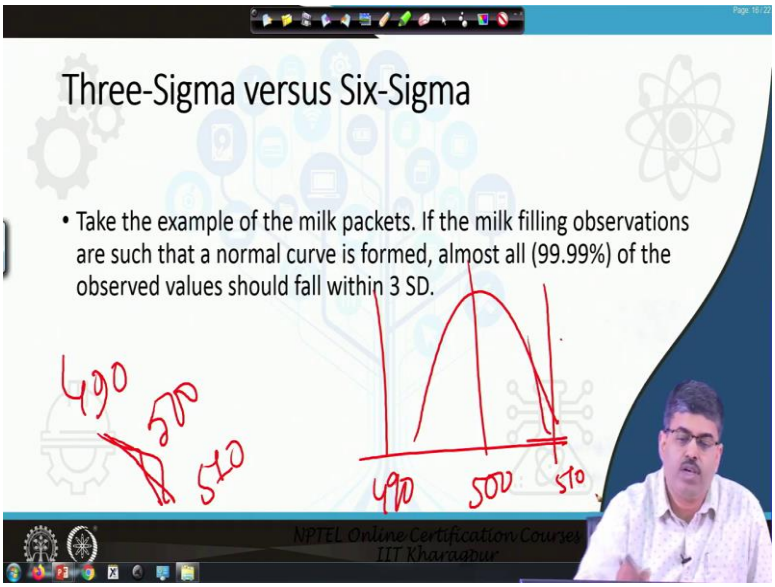


So, I am just drawing it here. Your mean, your upper specification limit was 510, 490 and the mean was 500. So, 490, 510, mean is at the center of the spread, this is it (())(28:18) meaning so, center of the spread, just remember this one. Now, 3 sigma versus 6 sigma. Take the example of milk packets. If the milk filling observations are such, that a normal curve is formed, the observed value should fall within 3 standard deviation. It should fall within 3 standard deviation.

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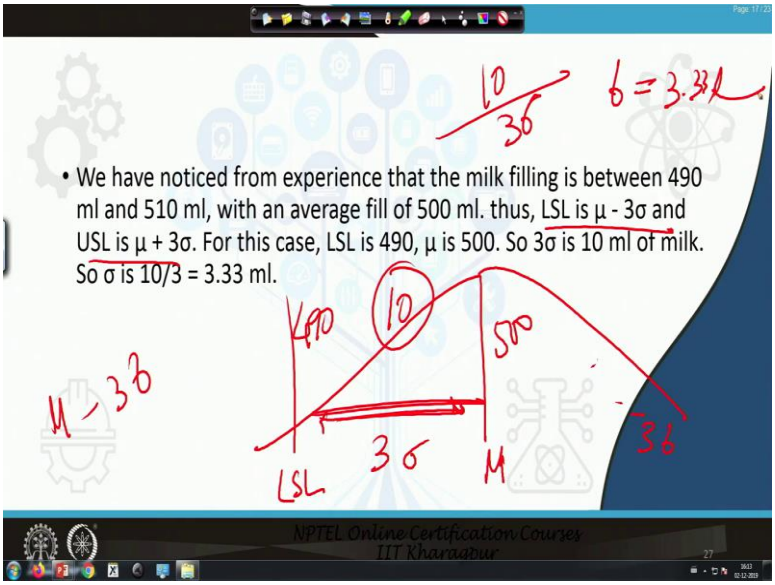

We have noticed from experience that the milk filling is between 490 and 510, just mentioned that. With an average fill of 500 ml, thus LSL is u minus, great. So, let us stop here. The LSL is this one. This is my LSL. This is my mu? What is this distance? 3 sigma and here is another 3 sigma.

We are not into 6 sigma up till now. So, here is 3 standard deviation, here is 3, so. What is LSL then? LSL is mu minus 3 standard deviation. What is USL? Mu plus 3 standard deviation? LSL is mu minus 3 standard deviation, USL is mu plus. This is the area, this, this is the area. For this case, LSL is 490, mu is 500. LSL is 490, mu is 500. I am just erasing this for you to understand. LSL is 490, mu is 500. So, let us go to mu. Mu is 500.

So, what is this gap? This gap is 500 minus 490, 10 units. The 10 units is equal to what? 10 units is equal to 3 standard deviation. 10 units is equal to 3 standard deviation. So, what is 1 standard deviation? 10 by 3, that is equal to 3.33 liter, 3.33 liter. 1 standard deviation is equal to 3.33 liter.

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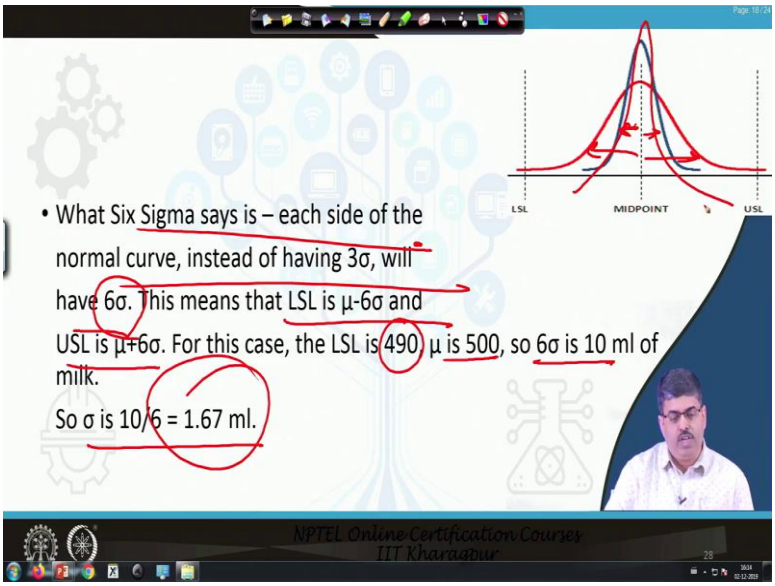

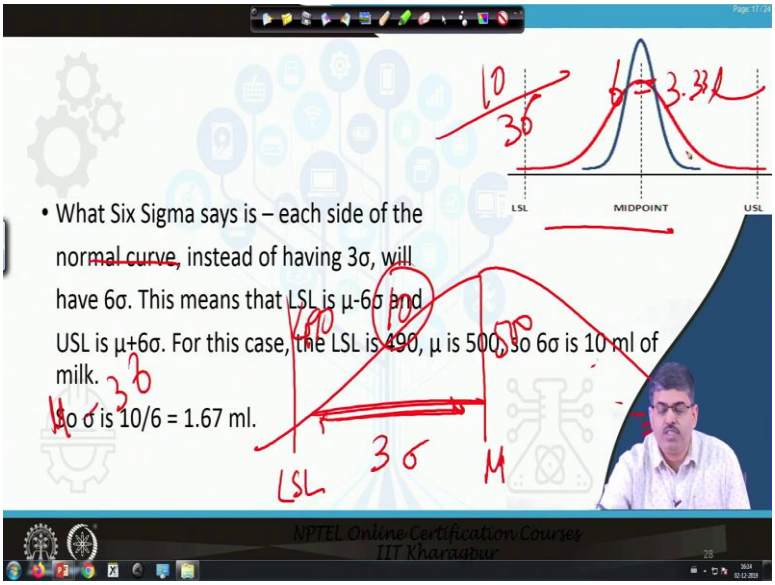


What six sigma says is, each side of the normal curve, instead of having 3 standard deviation, will have 6 standard deviation. This means that LSL is mu minus 6 sigma, USL is mu plus 6. For this case, the LSL is 490, mu 100. So, 6 sigma is 10. So, sigma is 1.67 ml. What was the earlier sigma, if you remember? What was the earlier sigma? It was 3.33, 3.33.

Mu sigma is 1.67. So, what is happening? Your standard deviation is reducing. New standard deviation is 1.67. Your earlier standard deviation was this, your new standard deviation is this. So, your standard deviation is reducing. So, in a sense, your curve is becoming very, very thin.

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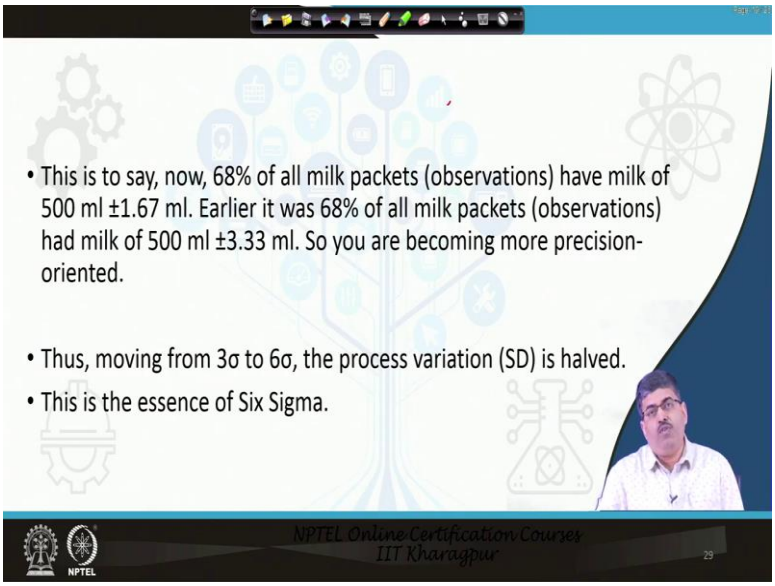

This is to say the 68 percent of all milk packets have milk of 500 ml, plus minus 1.67. Thus, moving from a 3 sigma to 6 sigma, the process variation is halved. This is the essence of 6 sigma. Now we will stop here for today. We will move on with 6 sigma coordination in the next class. Thank you.