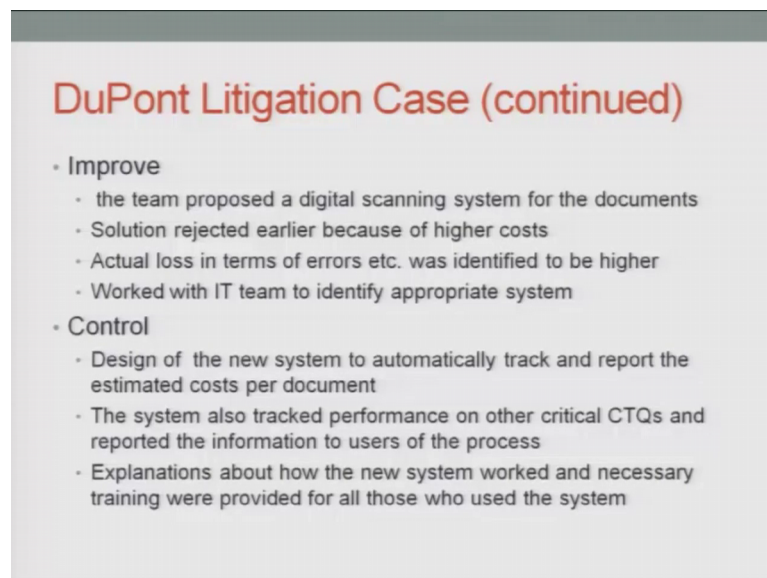


Total Quality Management - I
Prof. Raghunandan Sengupta
Department of Industrial and Management Engineering
Indian Institute of Technology, Kanpur

Lecture - 09
DMAIC examples and DMADV

Welcome back my dear friends. Very good morning or an evening an afternoon to all of you, hope all of you are fine. So, continuing the total quality management number one course I am Raghunandan Sengupta from IME department IIT Kanpur. So, this is lecture number 9. So, we are if you remember we are discussing the DuPont case. So, in after the DuPont case if we remember. So, there was a need to improve. So, the team proposed a digital scanning for the documents.

(Refer Slide Time: 00:47)



DuPont Litigation Case (continued)

- Improve
 - the team proposed a digital scanning system for the documents
 - Solution rejected earlier because of higher costs
 - Actual loss in terms of errors etc. was identified to be higher
 - Worked with IT team to identify appropriate system
- Control
 - Design of the new system to automatically track and report the estimated costs per document
 - The system also tracked performance on other critical CTQs and reported the information to users of the process
 - Explanations about how the new system worked and necessary training were provided for all those who used the system

So obviously, to keep in track what things were planned how things could be implemented with least error or a minimization error; obviously, you cannot make error as 0.

They would be variances, and as you know that we did discuss the normal distribution and how the normal distribution is an integral part of total quality management and statistical process control. The solution rejected earlier was because of the higher cost. So obviously, cost is an important factor which comes into the play in the total quality management, because at as you know for any implementation of any project whether it is

a company, whether it is a government project, whether it is basically a semi government work. Whatever we are doing on the shop floor trying to deliver goods to their customers or trying to deliver different type of services.

It be it a bank or restaurant an airline or railways whatever, there are issues that your cost concerned is one of one of the important factor based on which you will take the decision. So, in order to improve DuPont also consider actual loss in terms of errors. So, what was the effect of the errors, and they were identified to in order to basically take into consideration that the errors as they increase; obviously, that a huge amount of effect on the overall variance and the actual cost structure.

So, it may be cost structure increase it can be variance in the work environment increase, it can be basically quality being affected which are with the products or the goods or even the services which are being rendered to the customers. Need not be the outside one also it can be inside your company you as a design team are trying to pass on your products of the design to your customers who are on the shop floor or say for example, you are the purchase manager and you are trying to basically purchase different type of goods, considering you are trying to manufacture a motor an electrical motor or a fan or a or a diesel pump set or a transformer. So, they would be different items required it can be iron or it can be steel or different time of laminations copper so and so forth.

It can be different type of fuses circuit breakers. So obviously, if the qualities is lacking it affects your customers as I said who can meet down the stream, your own colleagues in the factory. And in order to implement this overall scheme DuPont also work with the I t team to identify the appropriate system such that the reporting and the in set of information which is available to all the players in the whole process of delivering goods or services everybody was aware where the goods were at what stage they were what was the overall problem they were facing if at all. So, things could be rectified on an urgent basis or on immediate basis. So obviously, once you improve you need to control that, because as you know if you keep a system as it is; obviously, the overall entropy.

So, entropy I am using the word very, very philosophically in the sense entropy is the overall variance or overall disturbance which you have in a system so that increases. And just for the information for many people who may have a engineering background. So, entropy is basically something very poor or fundamental to mechanical, and civil

engineering basically it comes from the concept of thermodynamics. So, if entropy or the variance of the overall system increases. So, it needs to be controlled.

So, for control there was a design of new system to automatically track and report the estimated cost per document, and how the cost could be reduced whether you need to take a paper printout whether you need to basically have the e copy uploaded and people can look and do the new (Refer Time: 04:38) the system also track the performance of other critical quality things or So, called areas where work was been done and reported the information to the user of the process. Obviously, user we would only mean the people who are using it, but it does not mean that we are the only people who are getting the benefit or trying to do the work. Because whatever work we do the outputs of say for example, shop floor one becomes the input shop floor 2.

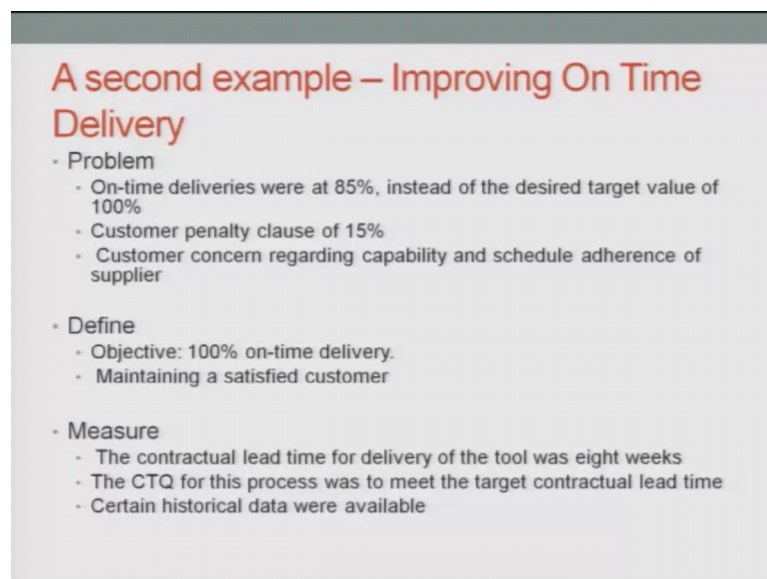
And obviously, if there are some errors in the shop floor or the processing unit or the department or the set of persons who are supplying, the goods the services to shop floor one shop floor I am using in a very generic term. So, if there are errors there. So, it should be so, called visible so called they should be aware of these things. So, things can be improved accordingly obviously, scientifically. So, once you identify you control them and for control reporting items or you implement the system using different type of mathematical tools should be remembered. And obviously, if there are errors you need an explanation. So, why the errors occurred? What are the reasons are the errors controllable? Or the errors are so called white noise or the effects which are coming from the environment.

Now, if say for example, you are manufacturing some goods in us in a place where humidity is very high; so obviously, humidity would be affected it is not that humidity is being created by the people who are working there. So obviously, you they would be white noise if there is huge amount of dust if there is huge amount of noise if there is huge amount of pollution. So, all these things should be taken care of. Or say for example, the machine which you are working on is very old. So, whether you need to change the machine or whether the quality control check for the machines working should be done. So, all these things are so called explanations which you need to understand in order to have a overall view of how the control has been done.

And how the improvement can be taken care of, so explanation about how the new system worked and necessary training need to be provided and they were provided. So, say for example, if I have a new machine and of the worker is not aware of the how the new machine should be worked on how it should be operated; obviously, it will affect the overall quality of the products or the goods which are coming out. So, he or she or the worker needs to be trained training can be on the machine training can be on the philosophy how you work training can be on the raw materials how you process the raw materials. Say for example, you are working on the accounting part.

So, if the accountant or the charter or the cost or the person who is manning the overall accountant process is not aware of the new rules and regulations, he or she should be trained such that things can be tied up in it is overall plan in an order that control and improvement can be done.

(Refer Slide Time: 07:32)



A second example – Improving On Time Delivery

- Problem
 - On-time deliveries were at 85%, instead of the desired target value of 100%
 - Customer penalty clause of 15%
 - Customer concern regarding capability and schedule adherence of supplier
- Define
 - Objective: 100% on-time delivery.
 - Maintaining a satisfied customer
- Measure
 - The contractual lead time for delivery of the tool was eight weeks
 - The CTQ for this process was to meet the target contractual lead time
 - Certain historical data were available

A second example: so we will consider that can be on improving the time of delivery. So, if you are aware that in say for example, the supply chain. So, in supply chain I as a distributor I as a as a manufacturer, I make products and deliver it to the distributor and the distributor further on basically delivers the products through either trucks or buses or say for example, train or flight.

Whatever it is it delivers to the retailers and the retailers, basically then further on as the customer needs this customer comes and buys it. Or whatever the mode of operation of

this products are they are delivered. Now if whenever is required say for example, if I am I am in the goods manufacturing and I am manufacturing such goods which are on high demand during the winters. Maybe it is warm clothes maybe it is a heater or in the summers things are needed are in demand are say for example, the air conditioner, the fridges, the fans just to give you an example. So, the problem would be that there would be problems that goods are not delivered on time. So, if there is a not deliver on time and if the customers are already ordered that.

So, there is a loss of face because you are not able to deliver the products as on as on time as needed. Or say for example, if goods which have been delivered they face a problem. So, you need to have a good customer service office or a customer care center which are able to take care the difficulties maybe say for example, the goods are not delivered on time goods or defective goods need to be repaired or the wrong goods were supplied consider this like Amazon is supplying goods, but if there is an error that if x object was ordered like x design of clothes were ordered and in if the y was delivered actually.

So obviously, there is a mismatch. So, that has to be basically taken care of and right on time. So, on time delivery is worse say for example, for this company were 85 percent instead of the desired target of 100 percent. So, say for example, if I am delivering goods. So obviously, the customer would want the delivery of the goods to be happen on time, and if it is not there is a problem. So, in a considered in the hypothetical company if it 85 percent of the goods were delivered on time, instead of 100 so obviously, there are some problems which need to be taken into consideration. And customer penalty obviously, would they would be there because if I am I am a customer.

And I am not getting my products delivered for which I have already made the payment; obviously, they would be litigations people will go to the court people will go to the consumer, court and file cases people will ring up my company where I am delivering goods and basically ask questions why the problems happening they would be loss of faith they would be loss of customer satisfaction. So, all this would basically affect the overall reputation of the company which is basically manufacturing and delivering the goods. Customer concern regarding capability and schedule adherence was basically not met. So, what you need to do as from the company point of view is basically deliver the product right on time as needed depending on the quality.

And what is specificity is like if I specify as I said I want x type of item, but if I am delivered y type of items. It does not meet my purposes like, I order a trousers for men if I a ladies garment so obviously, it is a there is a mismatch. Or say for example, if I order in a restaurant I am ordering some food which should be made which should be made say for example, from a certain type of vegetables and if I get a different type of a product or a food; obviously, there is a mismatch and that is one another would be say for example, I get the right food, but I have to wait very long in the queue for getting the items in a medical shop.

So obviously, that is also a problem because I am not getting the medicines or not getting the services right on time. So, you should define the objective which is 100 percent on time delivery. And you should also maintain a satisfied level of customer satisfaction. So obviously, it does not mean that you are able to deliver like as in products they would be variances for delivery of goods so obviously, we would not need to basically minimize it to the maximum possible extent. Like as I was talking about a supply chain you as a customer you pick up the phone order goods So obviously, it means that the moment you order the goods if they do not arrive So obviously, there is a lead time.

So, for you as a company you should see that lead time would definitely vary it will have a some distribution. So, what it should be more concerned about is the lead time variance is as low as possible and as the time of deliverance based on the call which you are getting to deliver the goods should be as low as possible; obviously, it may not be possible to deliver instantaneously, but you will try to basically minimize that time as well as the overall variances or the dispersion of the time variances which would be there in trying to deliver the products. So obviously, you will try to basically measure.

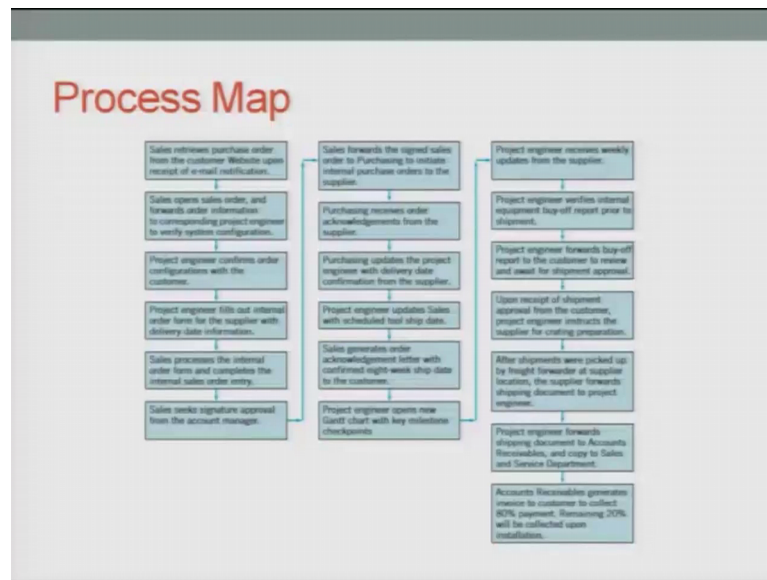
So, for the measures as in the second example it states the contractual lead time for the delivery of the tools was basically 8 weeks. So, if you remember I did mention few seconds back the concept of lead time. So, it was basically 8 weeks. The quality control or the basically the overall the fact and the company's deliverance was for this process was to basically meet the target or the contractual lead time which was basically 8 weeks. And certain historical data was available so obviously, we look into the historical data where is the problem occurring is it that that we are not able to process the payment which the customer gives.

So, based on the fact that you as a company will only act once you get the payment. So, if there is there a payment problem happening between the customer and your company. Or is it the bank which is creating a problem you should basically check. Or the company would be as is being mentioned here in the discussion I have not mentioned the name. So, they would look into the fact whether there was problem in the delivery, in the delivery of the money because you will only act based on the point that once you get the money you will act. Or is it that say for example, the specification which was mentioned by the customers, you are not able to understand that or maybe that you thought that you would be able to deliver.

But that specific order which was placed by the customer has some problem is very difficult to manufacture is very difficult to design it. So, if that is the case you should basically take tuned actions what were the problems which you faced. Or was it that you over committed based on the fact that you want to have a good business. So, all these things if are there you basically need to take a very rational decision on those practical facts. And this is and this would only be available from the historical data both on the customer demand both on the delivery of the product both on the cost price of the raw materials based on which you are doing.

So, say for example, it may be that the cost price of the raw materials based on which you go into manufacturing different items which are which are demanded by the customers which are ordered by the customers they are fluctuating very high. So, if they are fluctuating; obviously, very high. So, you would basically try to purchase them when the raw material causes the least. So, if you wait too long; obviously, it affects your total commitment which you are made for the customers. So, all these things needs to be understood in this right perspective. As mentioned I am just mentioning as an example which happen in different practical situations, and for this the bullet points which are very relevant to one example which is there after the DuPont case I am just discussing as we progress with the course.

(Refer Slide Time: 15:42)



Now, in the process a map it is a not very complicated, but it is a very detail. So, basically you would have the sales receive the purchase order from the customers. The sales opens the sales order. So, you as a customer you make a phone call to the company in the company takes the order so obviously, you process the sales order. So, once the sales open the sales order then if it is a project it goes a project engineer. So, I am following the main heading of the of the bullet points which are they shown on the slide here. So, the project really confirms the order of the configuration with the customers has asked. So, it may be that the customer demands such a product which you may not be able to deliver.

So obviously, you should basically be aware of that take a stock of the situation and then commit accordingly which are deliverable and actually probable things which you can make and deliver to the customers. It may be a goods it may be services whatever it is. So, in the project engine I fits out the internal order form. And based on that the sale process of the internal order form and completes the internal sales of the entity. And then the sale signs the approval for the account manager because; obviously, there are financial implications. So, if the customer wants a certain product at a price x.

And if the and even if it is implementable; that means, the product can be designed, but if the input cost is very high; obviously, you have to take a rational decision based on that for which you need the overall approval overall analysis from the accounts or the finance

person. The sale forwards the So, I am coming to the second column. So, sale forwards the sales order to the purchasing team the purchasing receives the order acknowledges it purchase updates the projects and engineer. So, the just to give you a hint the overall diagram which is there in front of you in this slide, gives you a so called flow process of how the overall order from the customer till it is he or she gets that order is being said.

So obviously, they may be different nuances different type of flow processes are happening for different type of industry. It can be for say for example, for a hotel industry or a restaurant industry it will be different it may be say for example, for the airline industry it would have a different implication it may be say for example, for goods manufacturing actual mechanical goods electrical goods, engineering goods manufacturing and delivery it would have a different implications. But I am trying to give you as far as possible the general flow starting from the order till the deliverance of the product to the customers. Then it would be the project trainee updates the sales with the schedules in that and the other details.

Sales generates the order the project engineer opens new Gantt. Chart Gantt chart if you if somebody has an information in the project management case is basically gives you the way the works would be done and what are the implications or the works how they are implemented how they are independent or interdependent on each other whether the type of work which you do in stage a is dependent and it would have an implication to stage b and what are the time durations of between them. So, they have to be looked into in details, then the project engineer receives the weekly updates from the supplier how the work is doing; and depending on the products which have to be delivered or the raw materials which need to be delivered.

The project unit verifies the internal equipment and so on and so forth. The project engineer forwards the buy off report to the customer upon receipt of the shipment approval from the customer the based on that the project instructs the supplier for creating the so called goods or the or the things. Things means what I am saying is the basically the actual product of the services. After shift what picked up by freight it is forwarded to the suppliers location, project engineer forwards the shipping documents to accounts And accounts generates the invoice for the customer for the payment.

So, payment scheme can be 100 percent can be on delivery so an So forth so many of the cases you will see just for an example. For Amazon or for flipkart it would be in Indian context there are many things which are cash on deliveries; that means, you only make the payment once you get that goods in other cases you have to make upfront payment and get this products depending on the availability. So, improving on the time delivery concept would be you should basically analyze improve and control. So, what are the points on analysis are supplier quality issues are there That means the supplies whose supplying the goods or the so called products.

(Refer Slide Time: 20:09)



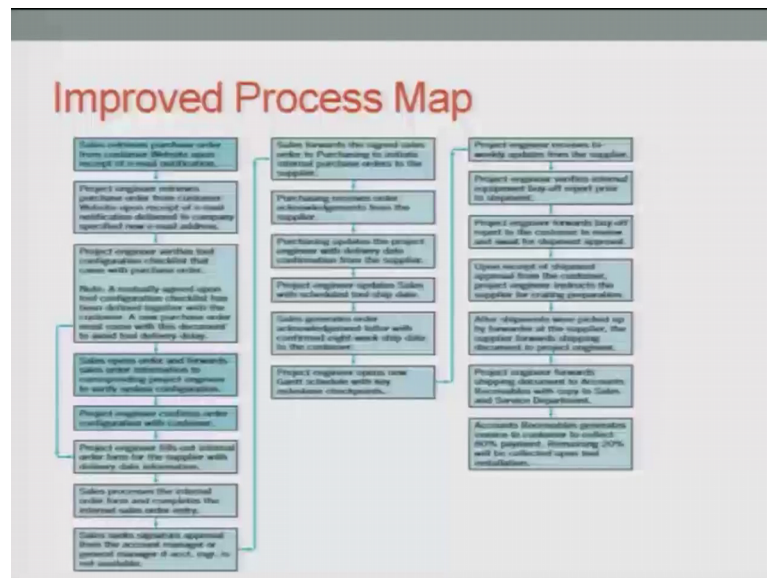
It can be purchase order process can be delayed or the vendor requirements are not made or the quality of the vendors is in issue. So, you have to take care of this. Delay in the customer configuration also would be there. Say for example, it can be that the customer has a very specific requirements. And one once you send it to the vendor or the supplier or the supplier of the raw materials will supply the goods at your end for you to manufacture the product which you have to supply to the customers. They may be mismatch like the customer once type of variety of goods which you are not able to deliver or the commitment from the vendor side is much more than what it can deliver.

So obviously, they would be mismatch both you can be both from the customers end as well as the vendors, end the suppliers end it can be say for example, you have over committed. So, those mismatch have to be taken into consideration. They may be

different type of an incorrect tool configuration. So, this point I am only talking from the manufacturing concept. So, tool configuration may be say for example, the jig fixtures the grinding tool and all these things are a misfit based on what the customer requirement is you have to take care of that and basically rectify or analyze where the problem is coming from then you need to improve.

So, it can be supplier quality control improvement is required. It can be improved the internal purchase order how you can basically purchase the raw materials from the from the vendor. So, if the if you are basically having a problem in trying to basically make the payment to the vendor So obviously, it will affect the payment and to the vendor and the vendor would also delay the product being delivered to your end which would in the long run basically affect your services or your goods being supplied to the customer. So, you will also try to improve the ordering process with the customer and how it can be streamlined. And once you basically do that you control the and developer overall flow process and how the processing can be done starting from the customers requirement till his or her goods is delivered as at the customers end.

(Refer Slide Time: 22:30)

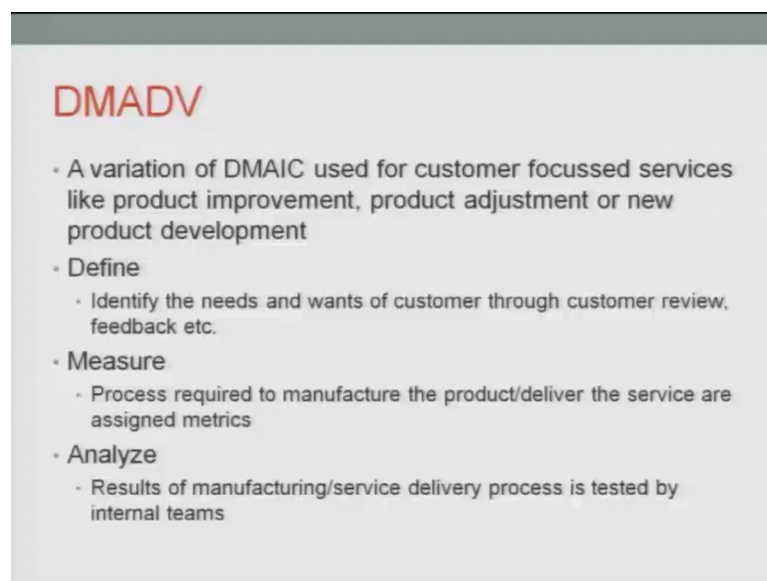


So, for the improved process I would not go into the details if you consider the last 2 last slides where the sets of the flow process was given in blocks the column one column 2 column 3 it is the same thing, but you can improve the whole over a process. So, if you make a comparison I am not going to go into the details. Because I would request urge

and want the participants who are taking this course at least to compare. On a nutshell this just an example they can be variations of the example to compare the last to last blocks of the flows with this one which again starts from the sales retrieves the purchases to the last stage which is in the third column the accounts receivable; and how the payments are being made by the customers.

So, there would be some internal changes how to improve the system where the problems are and then you control how the overall flow process is occurring.

(Refer Slide Time: 23:26)



DMADV

- A variation of DMAIC used for customer focussed services like product improvement, product adjustment or new product development
- Define
 - Identify the needs and wants of customer through customer review, feedback etc.
- Measure
 - Process required to manufacture the product/deliver the service are assigned metrics
- Analyze
 - Results of manufacturing/service delivery process is tested by internal teams

So, a variation of this process used for customer focused services like productive movement can be there product adjustments can be there or new product development can be done. So, you need to basically define the needs and wants of the customers. So, through the customer review process the feedbacks like say for example, when you are delivering some product in the bank you giving services or you are basically trying to sell some product or you have started a new business.

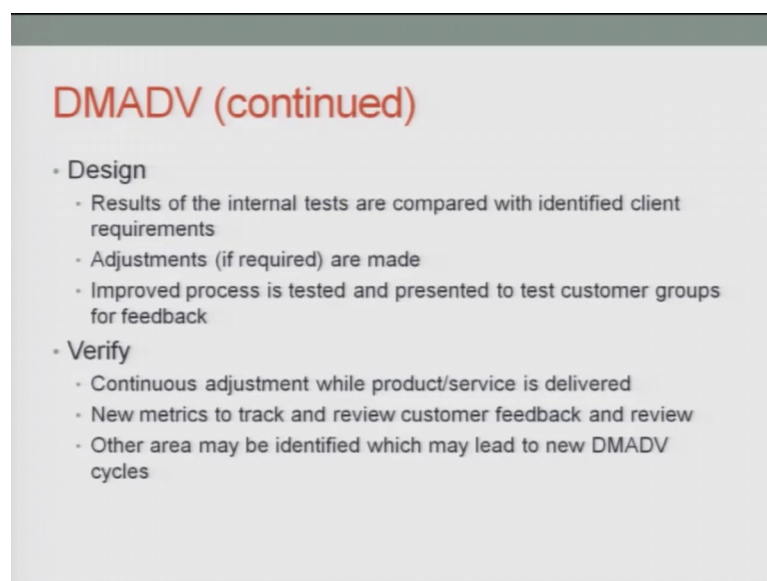
And trying to deliver some product some services you get a feedback from the customers. So, how fast is it deliverable schedule which has been promised to the customers what is the overall way how you handle the purchases and the sales, or whether a time delivery is met for the products to be delivered or whether the products are immediately available of the shelf as the retailers end or whether the actual focus or what the customer wants based on that whether your product makes the needs. So, say

for example, you have delivered a fridge and if the consumption of electricity of the fridge is very high or if the cooling of the fridge is not up to the standard So obviously, there is a mismatch.

So, we need to basically understand the overall customers requirement based on what your products can deliver and then basically take the customers feedback for that. So, we will measure a process is required to manufacture the product delivery the services or the products to the customers and you basically have a set of matrix. The matrix can be some quantitative as well as qualitative points based on which you assign some score assign some level of importance, on the different deliverable points based on which you can basically improve your overall quality.

So, quality word I am again using in a very generic sense it can be to do with the finances it can be to do with the level of confidence of your staff who are trying to do the good it can be say for example, the overall quality of the raw materials which you getting it may be say for example, level of cleanliness which you have in your factory or in a shop floor or in your restaurant. It can be how curtis you are you curtis your employees are in trying to basically handle with different type of customers. It can be different things it might be how good your quality of the products are for which they have been designed or manufactured. Then you analyze the results of the manufacturing in the services delivery process and then they are tested it tested by the internal teams.

(Refer Slide Time: 26:01)



DMADV (continued)

- Design
 - Results of the internal tests are compared with identified client requirements
 - Adjustments (if required) are made
 - Improved process is tested and presented to test customer groups for feedback
- Verify
 - Continuous adjustment while product/service is delivered
 - New metrics to track and review customer feedback and review
 - Other area may be identified which may lead to new DMADV cycles

So, other important bullet points based on which you can have an analysis of the overall quality improvement can be designed. So, in the other would be verify. So, on the design you will basically check the results of the internal tests and they are compared with identified client requirements. Because if there is a mismatch in between what the customer wants and what you are trying to deliver; obviously, they would be the huge amount of quality issues. So, if the customer wants the x product even if your product y is very good So obviously, he or she is not going to buy that. So, if you force somebody to buy your product; obviously, they would be mismatched. So, these requirements should though till depending on what the customer is able to get.

So, in case say for example, if the customer wants certain type product and if you are not able to deliver So obviously, the overall communication between the customer and the company should be that that, they should not me any mismatch in their overall analysis and what the customer wants and what the company is able to deliver. So, adjustments as required need to be made maybe say for example, the customer wants the overall error in the dimension of certain product which is wants to manufacture manufacturer from your end. It is say for example, in thousand microns, but if you are not able to deliver that that level of accuracy you will basically talk with the customer.

And check what is the technical specification and where the thousand microns are actually needed it may be the overall the variance or the overall change in the dimension may be not that accurate, or they may not be needed to that accuracy level. So, we will basically talk with the customers. And check whether a less level of dimensionality or less level of stringentness on the dimensionality is at all required if it is not; obviously, you will talk and basically try to find out what can be the other implications and how they can be met. This met means the customers requirement can be met. So, improved processes are tested and the presented to test customer groups And for the feedback.

Then what you need is basically you need to verify the continuous adjustment while the product services is delivered is analyzed and verified. New matrix to track the overall improvement the quality and the overall customer feedback and satisfaction are studied in details. And then basically you implement that changing though of the previous system such that things can be done in much better way. So, other area may be identify with may lead to improvement in the quality, and those should be implemented accordingly as required.

So, with this I will basically end the ninth lecture. And start with the tenth where we will continue the discussion of the quality and how it can be implemented and we will proceed accordingly, and also as I discussed we will go more into depth about the quantity part and solve problems accordingly.

Thank you very much, and I have a nice day.