Quality Control and Improvement with MINITAB
Prof. Indrajit Mukherjee
Shailesh J. Mehta School of Management
Indian Institute of Technology, Bombay

Lecture - 01
What is Quality?

Hello, everyone. This is Professor Indrajit Mukherjee from Shailesh J. Mehta School of Management, Indian Institute of Technology, Bombay. So, I will be delivering this 20 hours lecture on Quality Control and Improvement using MINITAB and in the introduction video I have already mentioned that what are the topics that I will cover, which books I will follow, but for your reference I will again show the book list which I will prefer to use.

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So, number 1 is D. C. Montgomery's Douglas Montgomery's book on Applied statistics and probability for engineers, then same author Introduction to statistical quality control, Design and Analysis of Experiments also from the same author. Amitava Mitra's book on Fundamentals of quality control and improvement, Besterfield's books on Total Quality Management, Evans books on Management and control of quality.

These are the reference books that I will use. Along with this Phillip J. Ross books on Taguchi's method in quality engineering that books also I will prefer and suggest you to

go through. And, also on basic statistics one of the book is Keller's books on Managerial statistics that is also a good book to refer basics on statistics basically, ok.

So, these are the reference books that I will follow. So, I will start with definition of quality and then we will go ahead with the other aspects of quality before I enter into control aspects and improvement using MINITAB, ok.

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So, what comes to our mind when we are talking about what is somebody can ask that what is quality can you define what is quality? So, some of the definitions that I will prefer to use over here is that quality is fitness for use that is the definition of Juran, a quality guru ok. So, meeting customer requirements, what customer wants I am delivering that only.

So, that is fitness for use basically we can think of and that is first definition we can think about when we are talking about quality also in abstract form this is. Then the second definition we can think of right the first time; that means freedom from defects there is no defects in the process or products. So, that is right the first time that is another definition of quality.

And, then third definition may be reduction of variability basically, so, reduction of variability or consistency, ok. We want consistent products. So, nowadays people are also defining in terms of reduced variability ok. Then we also talk about improvement in

quality that is continual improvement. I go to the process at discrete time point and do some improvements, then again a discrete time point I do some improvements. So, continual improvement.

So, improvement is an important aspects in quality and overall finally, what we can think of is the attitude towards quality that is also important. So, attitude defines quality basically, ok. So, organization attitude, person attitude towards how much we will dedicate towards quality that depends that also creates quality culture and that is also important very important aspect.

So, when somebody thinks about quality he thinks about customer requirements first. So, what is what customer wants and I want to deliver that what customer wants then I want to do it right so that there is no mistake in that process what I am delivering. So, there is no defects in the process, so, freedom from defects.

Then we can think of that we want to reduce variability; that means, consistently I am producing a quality which is which does not have any variability as such. So, every time same products every time same products I am consistent basically. So, that is consistency in quality. Then we can think of improvement in the quality.

So, we can think of continual improvements. So, at discrete time point, we are making improvements and overall the attitude should be right. So, of an organization or a personnel who is dedicated to the quality. So, that attitude is also important. So, that we do something on we talk in terms of quality and we build a quality culture. So, these are the aspects when we think about quality in abstract form, these are the things comes to my mind when I am talking about quality, ok.

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So, then what is the goal of quality? Goal of quality we can think of as we want to satisfy customers. So, customer satisfaction is our goal. We want to improve the yield of the process; that means output by input. So, we want to improve the number of outputs as compared to the number of inputs. So, that is the classical definition of it. So, I am using the definition over here.

So, I want to improve the yield of a process maybe chemical process, maybe manufacturing process or something. So, I want to deliver and the outcome should be number of inputs and outputs. So, 100 percent yield we want basically. So, then we can think of reduced variation that we have already mentioned about that consistency. So, consistency important aspects in quality.

So, the goal of quality is to reduce variability, reduce defects that freedom from any defects that right the first time that we have defined earlier in the last slide also comes to our mind. So, customer satisfaction, improve yield, reduce variation, reduce defects, these are the goals of any quality improvement project. So, goal of quality is that in an organization, ok.

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So, then why quality? Then why we should think about quality? Why people somebody can say why quality, why quality is so important over here? So, if you see the definition over here that I am using over here.

$$\text{Profit} = (\text{Price-Cost}) \times \text{Units Sold}$$

So, this unit sold will go up if my quality is good. People will buy more because my quality is good. So, then sales will go up basically of a particular product, ok.

So, when sales goes up profit increases. So, this has a direct relationship with the profit over here. So, unit sold goes up, profit also increases. But, over here the unit price over here is dictated by the competitors and policy of the company is. So, you cannot abruptly change the price. So, I if I increase the price it will not work basically ok.

So, price cannot be improved drastically. So, we need to be very cautious about that and that is not in my control, it is dictated by the market. So, what we can do is that basically we can reduce the cost over here. So, what we can do is that reduce cost per item cost if I can reduce and unit sold if you can improve this one that will also help in improving the profit over here.

So, sales will go up or unit sold will go up and cost will go down when we can improve quality basically ok. So, quality is all about reducing cost and improving the requirements improving what is required by the customer basically. So, we want to; we

want to reduce the cost and also we want to improve the sales so; that means I have to improve the quality of the product.

So, we have not defined we are defining in abstract way what quality means. So, you can think of that if quality increases if quality of the product increases people will buy more and that will also reduce cost. How it will help that we will see because how cost will go down somebody can ask how cost will go down over here. So, cost will go down because variation will come down. So, rejection will go down. So, that has a relationship over here.

So, there is a relationship which will explained as the course progresses. So, cost will go down if quality improves. So, rework, rejection will go down. So, that will improve. So, external failures, that is failure when it goes to the customer will go down and even internal failure that with process failure will also go down. So, that will reduce the cost, overall cost will go down.

So, price of the, or unique cost of the product and price we cannot do anything, but cost we can if we quality improves, rejection will go down, rework will go down. So, all this will impact cost of poor quality it will impact the cost of poor quality and so, if this goes down cost of poor quality also goes down. So, that way we can think of that why quality is so important, why people are saying that we should emphasize on quality.

So, that is the fundamental definition which I can take from books and that is what way we can explain that why cost is so important, ok.

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So, different aspects of quality that I will cover over here. One is quality of design, quality of conformance and if you are taking care of quality of design and quality of conformance basically, then the product will perform. So, quality of performance will definitely improve if the earlier two stages are taken care of.

So, there are three aspects over here we can think of – quality of design is what type of feature you are providing, what type of design flexibility is there and quality of design; that means, how well the design is how you have planned the design basically. So, if the design is very good robust, so, in that case what will happen is that you have a good products in the market.

So, and then whenever I have the design so, I have to implement that one and build it basically. So, that is quality of conformance, if and I have to adhere to the whatever is given in the design. So, initially it is developing the design and how much quality aspects can be implemented over there. So, quality of design is very important.

Quality of conformance means design is already completed and it is in production. So, in that case how much I can adhere to the quality of design, how much I can adhere to the design that is given by the designer basically. So, quality of conformance means how much we can adhere to the specifications that is given in the design ok.

So, and that will dictate that whether the products will be free from any deficiency. So, that will dictate. So, if these two things are taken care of in that case automatically we can expect that if these two's are of quality; that means, of high quality, so, in that case we can expect that performance will also definitely will be very good. So, we are manufacturing a car.

So, in that case let us say design of the car is very good and we are adhering in the process we are adhering to the specification what is given in the design. So, I am quality of conformance is also very good. So, and whatever is given by the designer we are delivering that one. So, and the overall then we can see then in field how it performs the car, how it performs in the field.

So, maybe oil consumption and anything we can think of. So, how it will perform in the fields so, that is quality of performance basically. So, when put to use so, that is the function or service when put to use. So, these are the three aspects of quality. So, we will slowly discuss about quality of design, then we will go to quality of conformance.

What are the things people are looking into that and then how to relate some data some information and using MINITAB so, to resolve some of the problem problems that we encounter generally in quality. So, that will be our agenda of this course ok. So, I will just go through the theoretical aspects of this and then we will come to the practical aspects how to use MINITAB in various scenarios ok.

So, quality of design you have to remember that quality of design and quality of conformance we are talking about over here, ok.

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So, then somebody can say that what is what do you mean by. So, all the in abstract terminologies you are using so, can you define manufacturing quality? Yes, Garvin has given a definition that there are 5, there are 8 dimensions of quality over here in manufacturing quality we can think of. So, one is performance that is for example, car fuel consumption that I mentioned.

So, performance of the car – when it comes to road performance, on-road performance. So, that is we can think of performance is one of the dimension of quality. So, these are also abstract, but they he has clearly mentioned about this that these are the 8 dimensions we can think of. When we think of manufacturing quality this can be the dimensions 8 dimensions what we can how we can define quality basically, ok.

So, performance is one of the dimension then we have reliability; that means, with time failure rate, failure probability or time between failures we can think of. So, that is known as reliability of a product. So, then durability or strength of the products ok, so, how many years it will last basically? So, in that case durability of the products, strength of the products to withstand, so, that is durability.

So, then serviceability which is we can think of speed easy to repair, that aspects we can think about serviceability and then aesthetics beauty of that. So, beauty of the products that we are delivering, so, beauty is one of the dimension we can think of. So, although

in abstract form we can always think about that is one of the dimension that also when we are talking about manufacturing quality we are talking about these dimension also.

So, any additional feature that is provided that is flexibility in the design. So, that is also we talk about when we are talking about manufacturing quality what additional features are there. So, when we talk about quality of a product we are talking in all these dimensions; how is the performance of the product, what is the reliability of the product, what is the durability of the product, serviceability of the product, aesthetics of the products, additional feature what is provided in the design.

So, what can be accommodated in the design, so, is there any flexibility I can change these part or something. So, any additional features; that means, modular type of designs. So, flexibility in design, what is provided in the product so, in that case we can think about that dimension also.

Then perceived quality whenever I am using that products what is the quality level of that. So, perceived quality that means, when you experience the sales, when somebody has sold you the products and you have experience the product, you have used the product basically and what is the performance of the products that we want to also that we can think of another dimensions of quality over here.

So, then conformance to standard – consistency and precision in a product, that is also important over here. Conformance to standard means, when I am manufacturing that one defect free what freedom from the any defects and variation is minimum. So, when I am talking about consistency means whatever target that has defined, design has define the target. So, am I hitting the targets? Am I doing it with little variability?

So, that is the what we can think of as conformance to standard; that means, there is a specification how much we are attaining to the specification. So, these are the another we can think of 8 dimensions that is provided for when we define quality. So, that is that we can think about manufacturing quality, ok.

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Then in 1985, Parasuraman defines service quality. It was in abstract form. So, Parasuraman provided some definition of service quality. So, interface of marketing and operations over here. So, there is a interplay between marketing management and operations management. So, that way we can think of service quality.

So, this Parasuraman did extensive survey and based on the survey he has published two research articles in 85 and 88. So and based on the articles what came out is basically this 5 dimensions of quality service quality basically. So, 1st dimensions and this has nothing to do with the manufacturing quality 8 dimensions that I have mentioned earlier over here.

So, Parasuraman defines that service quality is different and we should address it in a different phase. So, service quality he has defined that these are the 5 dimensions of service quality. So, one of the dimensions is reliability, how much service this service is dependable or not, this is accurate service they are providing or not. So, that is any company that is providing that service delivering the service.

So, reliability is one of the dimension we should check so there service dependability can be depend on that, is it accurate whatever they are delivering. Then the 2nd dimension may be responsiveness that willingness to help the customer promptly. So, that is 2nd dimensions of service quality.

Then assurance means, how much they are knowledgeable, how much they are confident is the assurance what they can give. So, that is another aspects that customer sees when they are talking about service quality. So, this is the 3rd dimension there sees.

Then there can be empathy another dimension is empathy, how much they are caring to the customers are they approachable that is the empathy aspects or dimensions that Parasuraman has mentioned over here ok. So, then tangible aspects; that means, whenever I am delivering service some products or goods I am also delivering. So, that can be also be can it is not a pure service maybe. So, goods are also delivered.

So, when you go to a restaurants also you see the environment that is given lights and environments that is created over there that is the tangible aspects, what I can see basically what I can see and feel that is the tangible aspects of that. So, if you have to improve service quality you have to improve in all 5 dimensions like this all these 5 dimensions. And, Parasuraman has define these dimensions based on extensive survey; extensive survey he has defined all this 5 dimensions all this.

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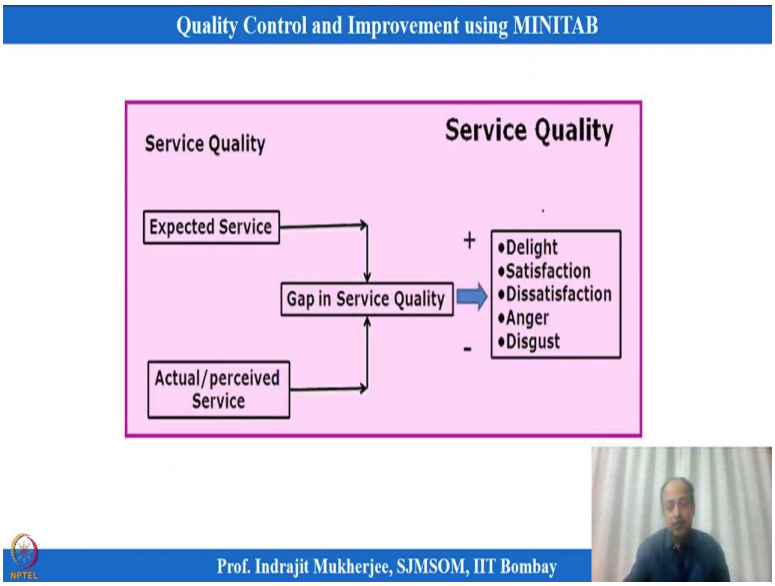

So, then Parasuraman what he has mentioned is that there is whenever a customer goes to a service organization so he thinks about means he has certain expectation. So, expected service is basic things that somebody has to. So, expectation is one of the aspects that they. So, before encountering the service they have certain expectation about

the company ok about the organization what type of service they will deliver. So, some expectation is there.

So, it can be from word of mouth what people have told them, it is the need what defines expectation and maybe experience of their service earlier. So, if I am using a some refrigerators, so, I will prefer some of the brands maybe. So, which I have purchased some other products of them and so I have some expectation in build I know their service previous service.

So, experience is one thing that builds expectation and need also builds expectation and also word of mouth what you hear from others that also builds expectation basically. And, what do you perceive basically after the service is being delivered what do you; what do you; what do you after you have encountered the service and what is your idea about the service quality of this organization basically.

So, one is expectation before I enter the process and one is after experiencing the process what is my idea of quality of the service that was delivered basically. So, always there is a gap between expectation and actual service that is or perceived service basically and this gap what did what Parasuraman has defined this is known as GAP 5 in Parasuraman's Gap model basically, ok.

So, a difference between expectation and perception that is a service quality gap that we are talking about. So, and Parasuraman has also told that in a scale we should survey was done in a scale, so, they so that was defined by that. So, nowadays any surveys we have a scale of 1 to 5 which is well defined over here what you can see is that – I am delighted with the service, I am satisfactory service or dissatisfactory service or I am not satisfied at all or very bad service.

So, I can have a 5 scale pointer. So, I can have a scale where I can; where I can just mention the expectation part of that. So, maybe I am expecting is out of 7 points I want 7 out of 7. So, one should deliver 7 or it can be if I am not if expectation is low it can be 3, 4 or.

But, when I actually encounter that one like rating what you give. So, when you go to a after you have experience they will ask you for feedback in a scale of 1 to 5, in a scale of 1 to 7. So, all in scale, so, Parasuraman says that you try to understand what is the

expectation of that every dimension what is the expectation of all these 5 or sub dimensions of that we talk about items.

So, that is what we are. So, that is one rating we are getting and after you have encountered the service then again you rate on those aspects. So, that is the perceived service. So, the gap between this will define what is the quality level and where to improve basically. So, Parasuraman has defined this Gap model after extensive research and he has identified those 5 dimensions and that is the SERVQUAL scale what he has defined at the time point ok.

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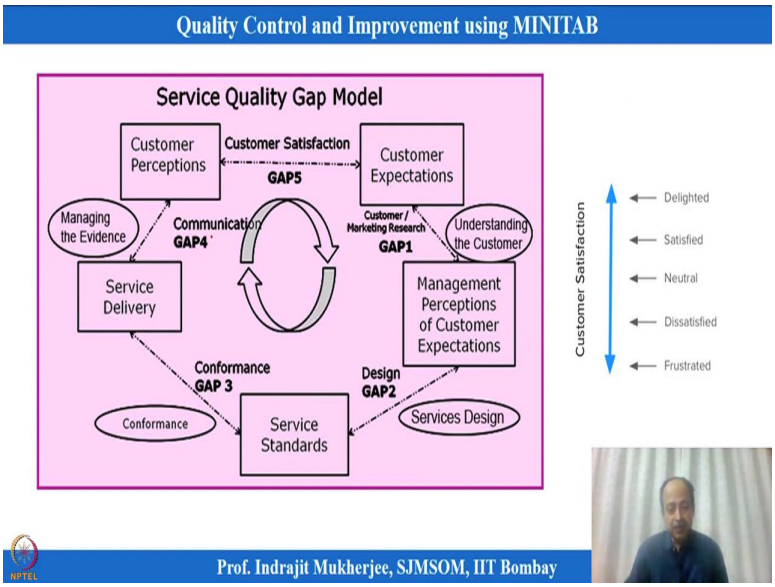

So, this is the service quality Gap model what Parasuraman has given in these aspects. GAP 1, 2, 3, 4, 5 - so, GAP 5 what I mentioned over here, so, this is the GAP5 what you can see over here. So, this is the difference between perception and expectation basically. So, when it is delivered to the customer and how customer perceive the quality and initially what was the expectation, the difference between these two will tell whether the customer is delighted, satisfied, neutral, dissatisfied or frustrated basically, ok.

So, there is GAP 1; that means, customer is having some expectation, but management feels while designing this one. So, there is some difference. So, that is GAP 1 basically. So, when we collect what customer expects and if we cannot exactly imitate what they expects then there will be gap in that. So, management perception of customer expectation is a GAP 1.

Then GAP 2 is management has the perception then it is converted into specification service standards or standard practice. So, there will be certain gap over here also. So, and the third gap is whatever service standard and what was delivered basically by the organization. So, that is GAP 3.

And, sometimes what happens is that what you have communicated and what you are delivering basically there can be gap between these two also. That is GAP 4 basically. So, that will create GAP 4 and this is the overall Gap model what Parasuraman explained. So, GAP 5 may be a function of GAP 1, 2, 3 and 4 basically ok. So, that also explained by Parasuraman that GAP 5.

So, people are working in this idea. So, analyzing GAP 5 in different scenarios and using Parasuraman scale SERVQUAL model. So, people are trying to understand this service quality model given by Parasuraman and still people are working in this area. So, this is a open area still.

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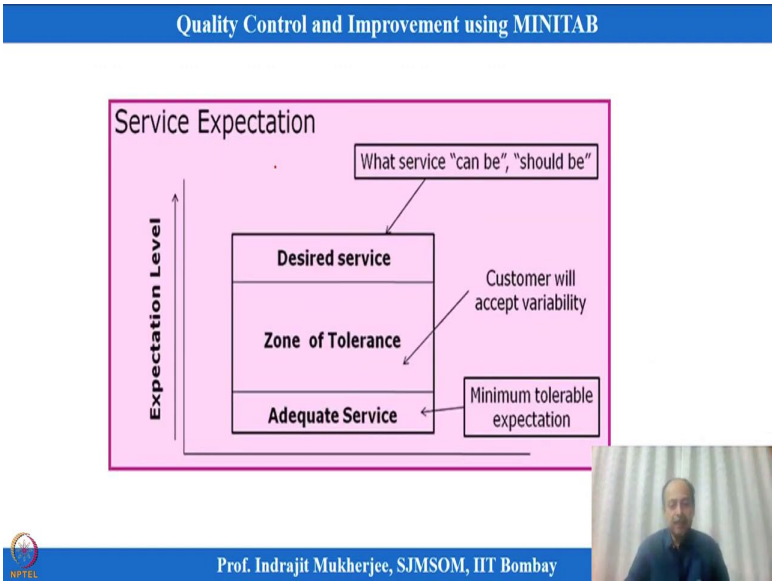

Parasuraman has also told that there is a zone of tolerance. So, there is a desired service, there is adequate service and there will be zone of tolerance. So, minimum tolerance tolerable expectation basically and what is desired basically, what service can be should be. So, that is the expectation level of that.

Then there will be zone of tolerance – customer will accept variation within this zone. So, I need adequate service and there is a desired service. So, you cannot go below that. So, my expectation cannot go below that one. So, that is one thing that we will want to what Parasuraman has mentioned. So, zone of tolerance. So, what Parasuraman has explained over here?

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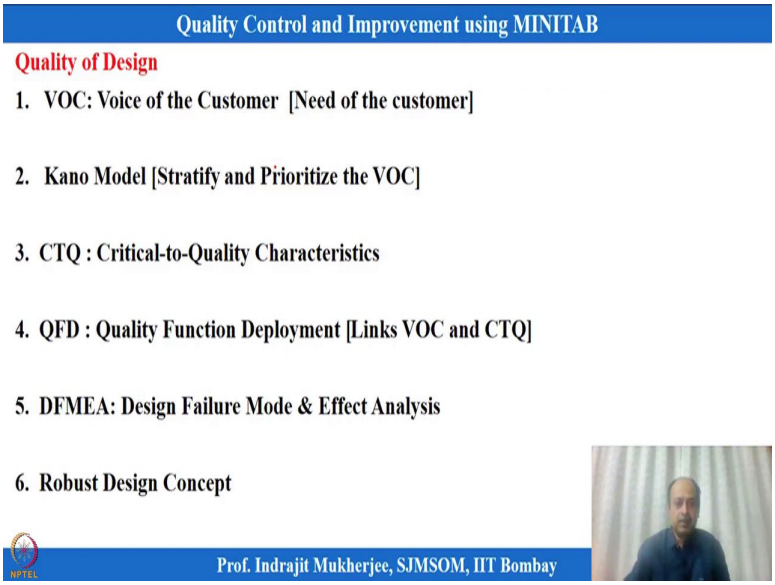

So, then within quality of design, what we will discuss in this course? 1st thing is voice of quality sorry, voice of the customer; voice of the customer or need of the customer basically and then how to prioritize this voice that is known as Kano model. Kano model is used for this identification of or differentiation of different voices. So, stratify the voice and prioritize the voice because I want to make it priority which voice is important which is not.

So, 1st is capturing the voice 2nd is prioritizing the voice using Kano model, then we will talk about converting the voice into critical to quality characteristics what we will deliver in the products basically or which has specification. So, conversion of voice of the customer into CTQs how this is done basically. So, that also we will simultaneously try to cover over here.

Then, we will discuss about QFD; Quality Function Deployments or house of quality that links between voice of the customer that links between voice of the customer and CTQs. So, that also we will try to cover over here in preliminary lectures that we will

deliver. Then we will talk about, so, in quality of design also we talk about design failure mode and effect analysis.

So, some basic idea of that also we will discuss and when we use design failure mode effect analysis and then, we will briefly discuss about robust design because this will be covered again in quality of conformance about Taguchi's principle of robust design ok. So, in design aspects of people also try to experiment. So, this is coming under experimentation or improvement aspects of that.

So, in design also they try to improve the design. So, they uses a robust design concept of Taguchi. So, we will discuss about that, but in quality of conformance parametric design parameter design basically we will try to discuss that one when we are talking about this. So, Taguchi's method we can say this robust design has concept developed in 1980.

So, this was popular in 1980 basically Taguchi is started the work in 1950. So, it was not popular at the time point. It took 30 years to people to accept this idea. So, in 1980 it made a paradigm shift in the idea of quality. So, from goal post mentality it transforms to a robust design concept. So, it is hitting the target every time with minimum variability. So, that is with a loss function.

So, Taguchi explains that one the societal loss something, if you deviate from the target you will have losses. So, that is the concept Taguchi has given. So, we will discuss about voice of the quality, we will discuss about CTQs, how voice of the quality voice of the customer is linked with CTQs and then we will try to see how Kano model can be used to prioritize the voice of the customer.

And then we will talk about QFD that relates between voice of the customer and CTQs, quality function deployment or which is known as house of quality. And, then we will also mention about design failure mode and effect analysis with some examples how it is done basically and then we will talk about brief discussion before we enter into other aspects of quality so, control aspects and improvement aspects using MINITAB. So, some basic definition we will try to emphasize.

So, what we have covered till now is that, so, let me just recap that one. So, I have given you the reference book what we will follow over here, then what I have told is that what

is quality; that means, we are talking about fitness for use, right the first time, consistency reduce variation, continual improvement and attitude of the organization that is all about quality.

Then we have talked about goal of quality; that means, we want to improve customer satisfaction, improve yield, reduce variation, reduce defects. Then I told that if you have to improve quality what we have to do is that we have to if we can improve quality what will happen is that number of items sold will increase and also the cost will go down. The number of items sold will increase and cost will go down. So, that is why we should emphasize on quality. So, price is dictated by the market that also mentioned.

So, profitability, increase in profitability this was also mentioned. So, then we told that there are three aspects of quality which we will cover quality of design first, quality of conformance and if these two is very good in that case we can expect quality of performance will also be good. So, quality of design is important, quality of conformance and then we have a quality of performance which is interlinked with design and conformance. So, that is also we have discussed.

So, we have discussed that 8 dimensions of manufacturing quality given by Garvin. So, this is performance, reliability, durability, serviceability, aesthetics, additional features, perceived quality and conformance to standard; conformance to standard. So, this was definition what was given by Garvin's 8 dimensions of quality.

So, that is then we talked about Parasuraman's 5 dimensions of quality service quality and this is very different from the manufacturing quality. So, reliability, responsiveness, assurance, empathy, tangible aspects of service quality. So, these dimensions was developed by survey extensive surveys, interviews and based on that he has developed a scale to measure service quality using gap concept. So, SERVQUAL model was developed at the time point.

So, this was used afterwards by many different organizations, many different scenarios and try to prove whether the scale is this is efficient to measure service quality. So, and people are using this scale even now people are preferring to use this scale when we talk about service quality and measuring the gaps so, in that case.

So, then we told that service quality is all about gaps. So, gap model was used over here. So, he has conceptualized this one as Gap model. So, Parasuraman mentioned that there are 5 gaps over here. So, GAP 5 is the last one that is what customer expects and what was delivered. So, that is a function of other 4 gaps over here.

One is what customer expects and what we understand or as a organization what we understand. So, that is GAP 1. Then GAP 2 is what is the we have understood something, but can I translate into service standards. So, specification basically, so, that there can be gap over there. So, and then whatever standards we have developed are you delivering that one there can be gap over there also and there can be communication also before I deliver that one.

So, I promise something. So, over there can be communication. If there is gap between gap in our communication what we want to deliver and what we have delivered there will be GAP 4 over here. So, these are the 4 gaps which is basically leading to GAP 5 which will lead to GAP 5. So, that is also important. So, that part also we have explained over here in this session.

So, then there is a zone of tolerance of any customer. So, he has a desired he has an expectation. So, what should be and he also understands that what is the basic minimum adequate service definition, so, what is adequate service. So, below that I should not deliver. So, there in between there can be variation over here. That is known as the zone of tolerance over here ok.

And, these are the topics that we will cover. So, in the next session we will cover these topics. So, we will close it over here. So, see you in the next session, ok. So, we will break over here and we will continue in the next session.