Six Sigma
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Lecture – 53
SPC: Minitab Applications

Hello, friends. I welcome you to our ongoing journey on Six Sigma and we will be discussing lecture 53, SPC Minitab Application. So, we have seen in detail statistical process control, in this lecture we will try to appreciate the application of Minitab for the same. I would like to remind you that we have systematically progressed in our DMAIC cycle and now we are in the last phase of DMAIC that is the control phase.

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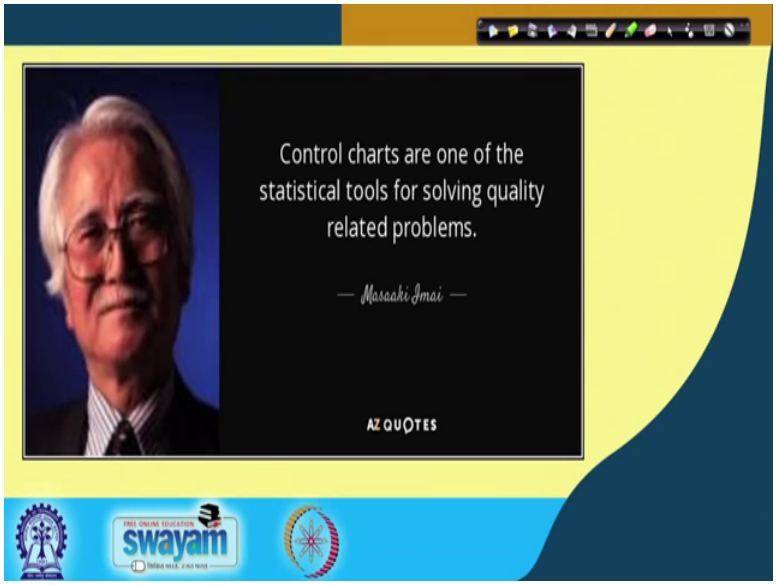

Once again I would like to remind you that we cannot underestimate the importance of the control chart and it is a valuable tool in establishing the control over my processes.

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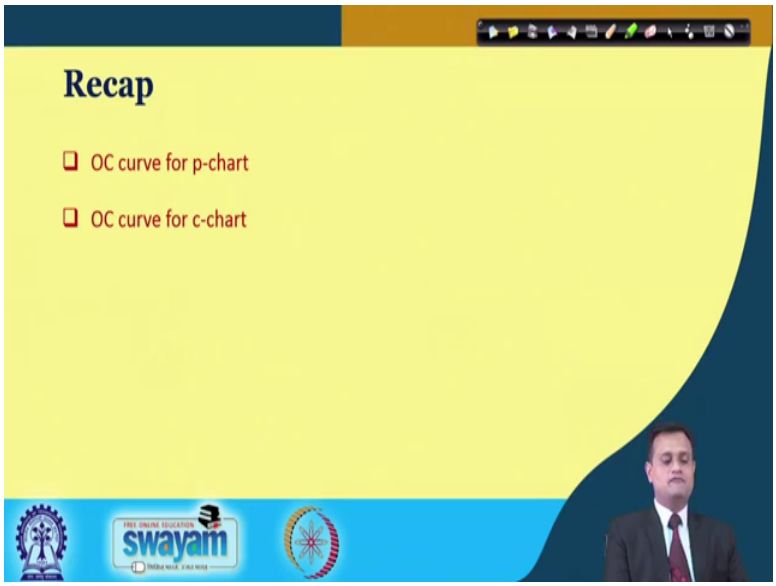

So, we have talked about the operating characteristic curve that is the performance measure of a given control chart for p-chart as well as OC curve for c-chart in the last lecture.

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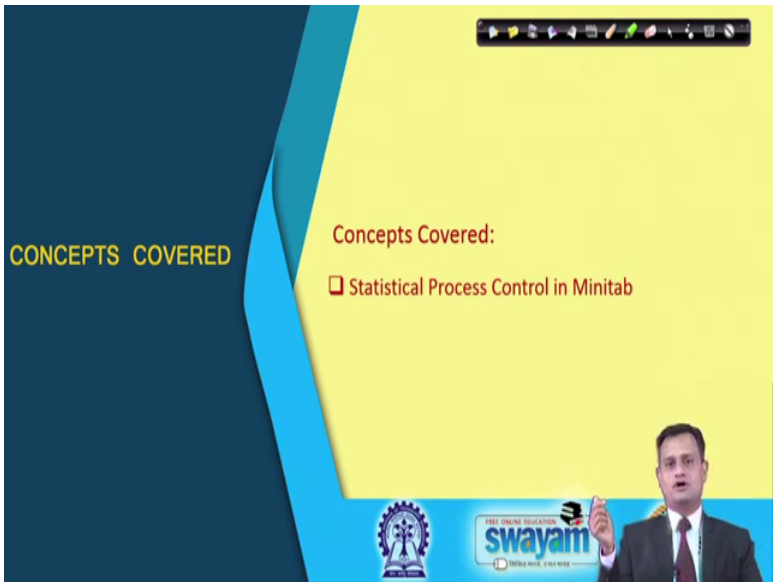

This lecture typically we will focus on the Minitab application for statistical process control. This would really help you if you are doing some academic project of your if you are an industry professional; this will really help you to do the analysis very easily.

And software will take care of your all the computation parts so that you need not to bother about manual calculation as well as manually plotting the graphs.

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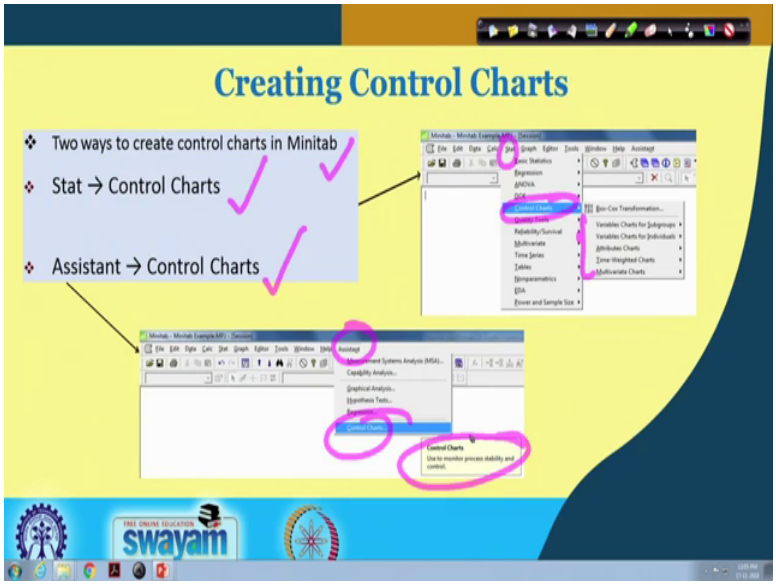

So, let us try to see how it works. So, creating control chart you have two ways to create control chart in Minitab you can see. One is stat control chart and another is assistant control chart. So, if you go to stat you will have a control chart in drop down menu and then you can see the various kinds of options available. If you go to this then assistant you will have control chart and used to monitor process stability and control. So, both the way you can go ahead.

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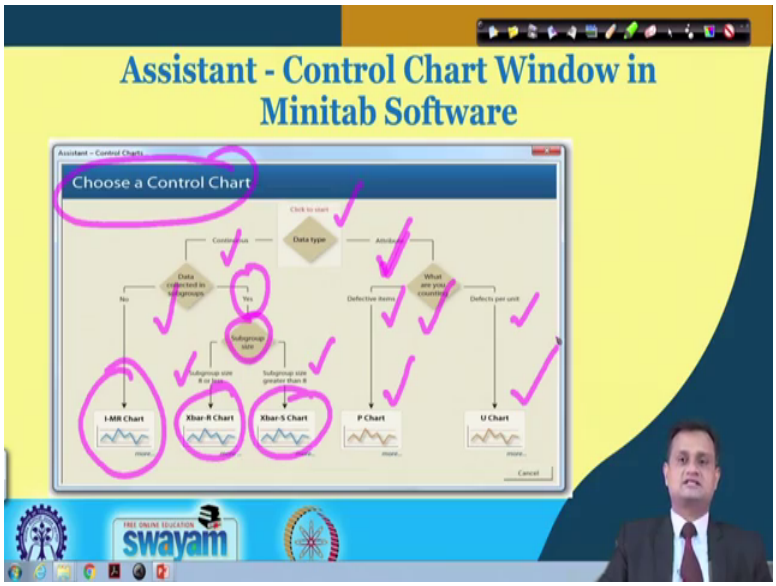

And, this is the flexibility that you have in Minitab. Now, if you go to assistant where you get some insights or you get some guidance also then choose a control chart. So, there is a guideline available, that check to start what is the data type whether it is continuous or attribute; if it is continuous then, obviously, you will go for the variable control chart and data collected in subgroup if yes, because sample is there then subgroup size you have to determine and then you can use Xbar-R chart or you can use Xbar-S chart.

So, once again I would like to remind you that R chart and S chart they basically deal with the variability, but when your sample size is large simply plotting the R chart will not solve the purpose, the effectiveness of the R chart with respect to s chart is less. So, you have to select Xbar and R or Xbar and S, so, you can see it very well here that subgroup size 8 or less you will can be happy with Xbar and R if it is more than 8 then go for Xbar and S. Here you will plot individual say mean and range chart if your data is not subgroup.

Now, if you come to attribute type then what are you counting? Whether you are counting the defective items or defect per unit? So, we had seen the examples that you may have number of defective items in a particular lot or you might be counting number of defects in may be 100 meter square cloth and this would be defects per unit. So, if it is

defective item then it is p-chart; if it is defects per unit you will go for the u-chart and this is how you can make an appropriate selection of your control chart.

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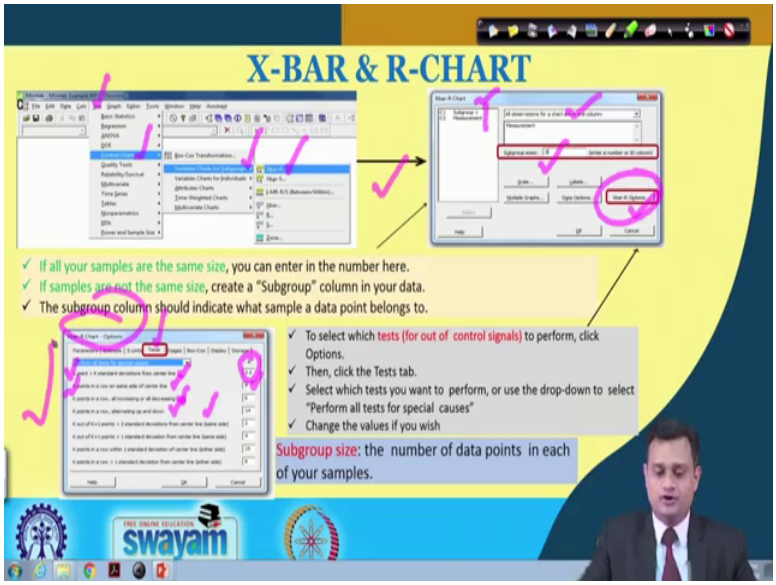

So, once you have done this you can go ahead in your Minitab and what you can see here that you can go to stat, you can go to control chart, variable charts for subgroups you can choose and you can choose the Xbar and R chart. So, once this is done you will have Xbar in R chart window where you click all observations for a chart in one column, you have subgroup one and measurement C 2 you define the subgroup size and you go to Xbar-R options.

So, when you open this Xbar-R option you can see here you will get a particular window and you click on test. Now, in the test you need to specify the value of K and K is nothing it is just the number. Now, this number is interpreted in a different way for different as say rows. So, if you see the first one, one point greater than K standard deviation from the center line. So, here it is in multiple of the standard deviation. You define 3, because we usually go for plus or minus 3 sigma limit K point in a row on the same side of the center line say 9.

Now, here you will see various cases K point in a row all increasing or decreasing K point in a row alternating up and down K out of K plus 1.2 standard deviation from center line and so on. So, I would like to remind you that we had seen various cases in which the process or the points they are not falling outside the control limit, but they may

be stratified, they may form some pattern, they may be concentrated towards center line or some of the points are falling on one side or there is sudden jerk. So, such kind of phenomena also we would like to capture and for that there is a provision in the Minitab. You would also like to set the warring limit and the control limit, so, all these things you can set in your Minitab window and this will really give you a very comfortable way of maintaining.

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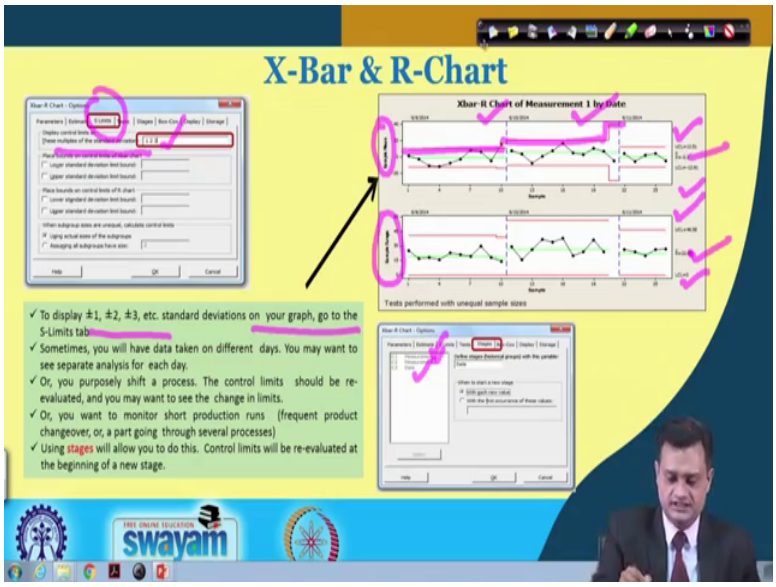

And, reading interpreting your control chart. So, once you have done this you also specify the s limit. So, multiples of the standard deviation you say 1 2 3. So, you may be interested to have three limits with respect to the centre line and plus or minus 1, plus or minus 2, plus or minus 3 this will be displayed on your graph and go to the S-limit tab.

So, then you have measurement 1, measurement 2 and you have the date. So, what do you get here you get the Xbar and R chart for the measurement 1 by date. So, you have a choice you can put it by date. So, here you have sample mean, you have sample range and you have plotted X double bar, you have R bar, your upper control limit lower control limit is 0 and upper control limit and lower control limit.

You can see here that your control limits are varying and this could be because of your sample size is different. So, if you do not have a constant sample size then your control limit will vary and it is. So, Minitab will plot the entire control chart for your display as well as interpretation.

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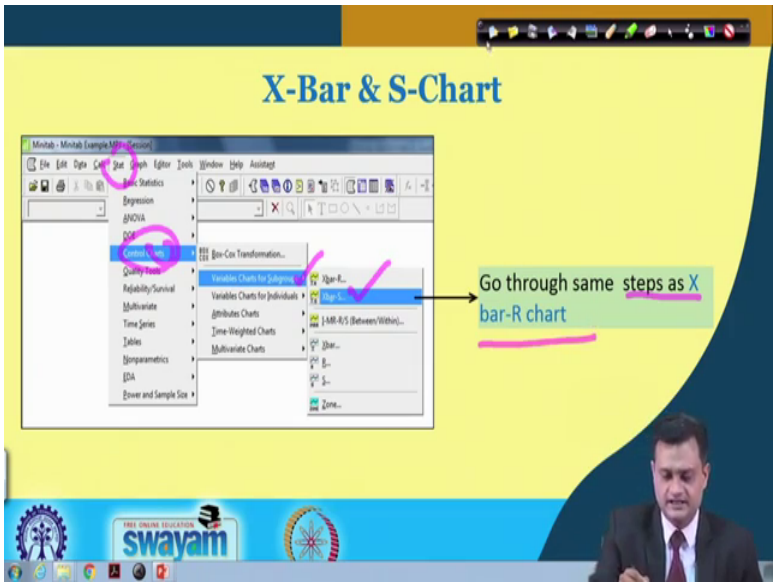

Then you go to again stretch control chart and then variable chart for the subgroup and same way you can plot the Xbar and S chart. So, go to the same step as we have followed in Xbar and R chart you will get Xbar and S chart. So, there is no difference.

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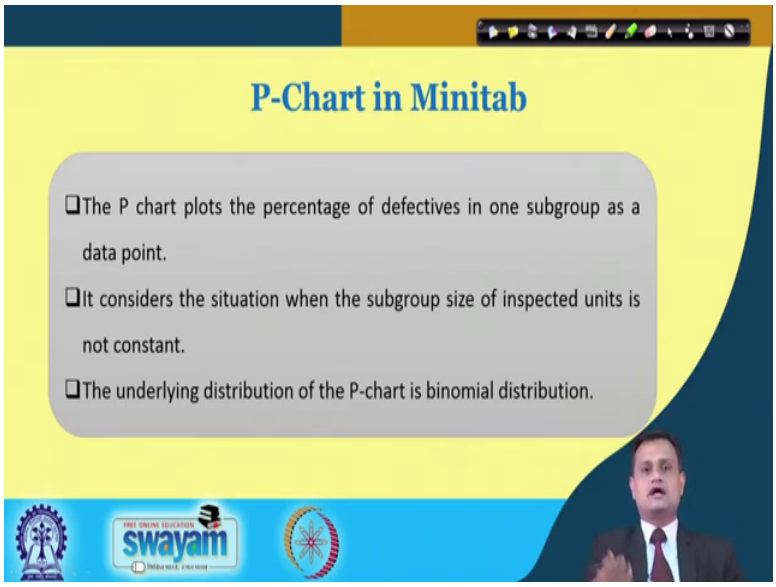

Now, let us look at the attribute that is P chart in Minitab. So, P chart plots the percentage of defectives in one subgroup as a data point and it considers the situation when the subgroup size of inspected units is not constant. And, the underlying distribution of the P chart is binominal distribution, that we have discussed.

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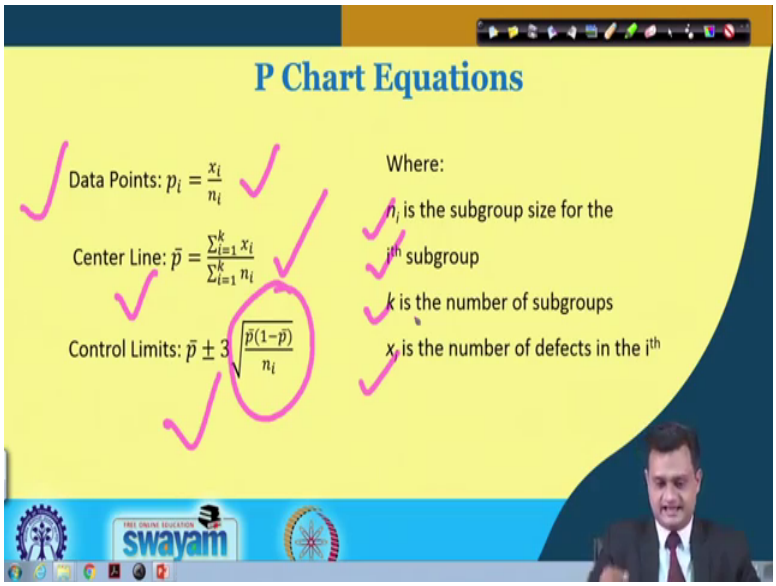

So, you have something like this data points p i x i divided by n i. You can compute the center line; if already the p 0 is given the target line then you will use that if not then you compute the p bar. So, p bar you are computing and then you have control limit p bar plus or minus 3 or k sigma. So, you will have square root of p bar 1 minus p bar divided by n i. So, n i is the subgroup size it may vary, i is the i-th is the subgroup, k is the number of subgroups and x i is the number of defects in i-th.

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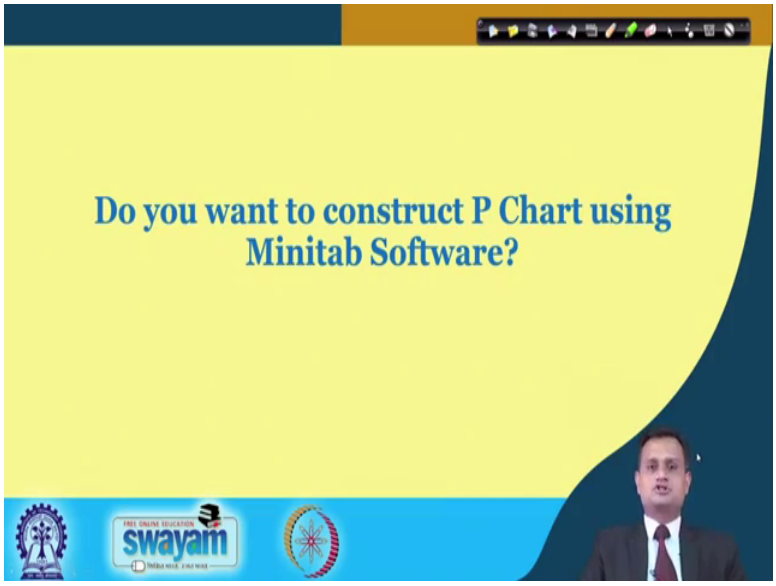

So, now with this you can proceed with your Minitab control chart analysis and do you want to construct the P chart using Minitab?

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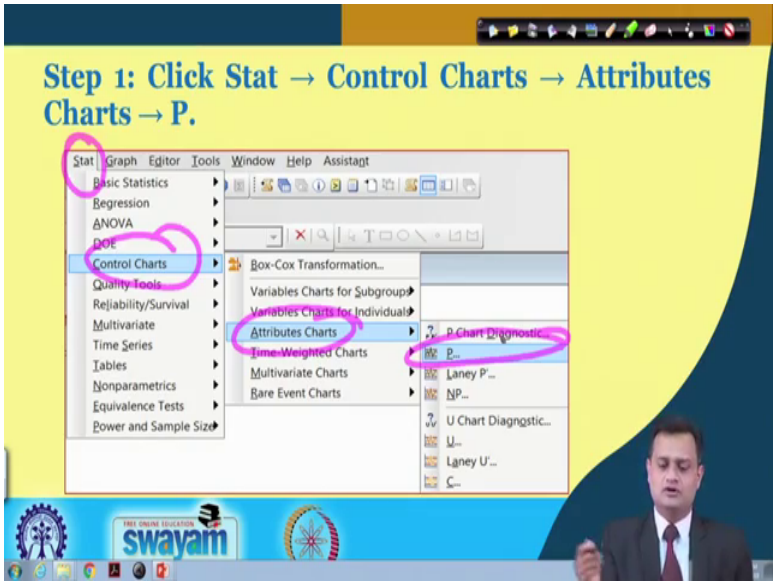

If yes, then this is the step which is very simple to follow. So, control chart you again go to Stat, Control Chart, you choose the Attribute Chart and then you choose the P Chart. So, very simple window it will open and that will help you.

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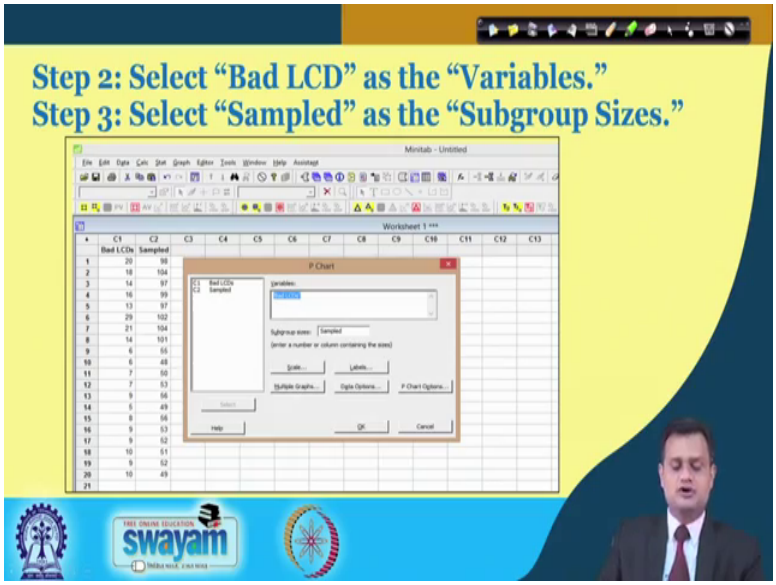

So now, you have put the data here and just try to see what is the data. You have some LCD production and Bad LCD and this is the Sampled. So, you have let us say sampled

98 and bad LCD are 20 your sampled 105 and bad LCD are 18. So, they are put in one column and now you have column 1, that is C 1 it is Bad LCD and C 2 is the Sampled. So now, your variable is bad LCD, sub group size is sampled and then you press OK in order to proceed in your Minitab analysis.

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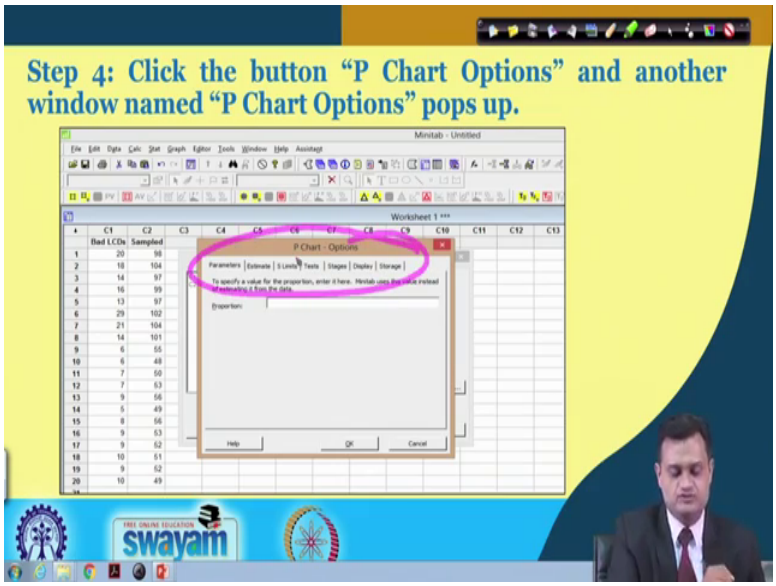

So, now once you have defined this bad LCD and this you also try to specify the subgroup size in your Minitab application and you can define the proportion. So, you have the various P chart options that are more or less similar to Xbar and R-chart we have seen and now in this you will further proceed to proportion.

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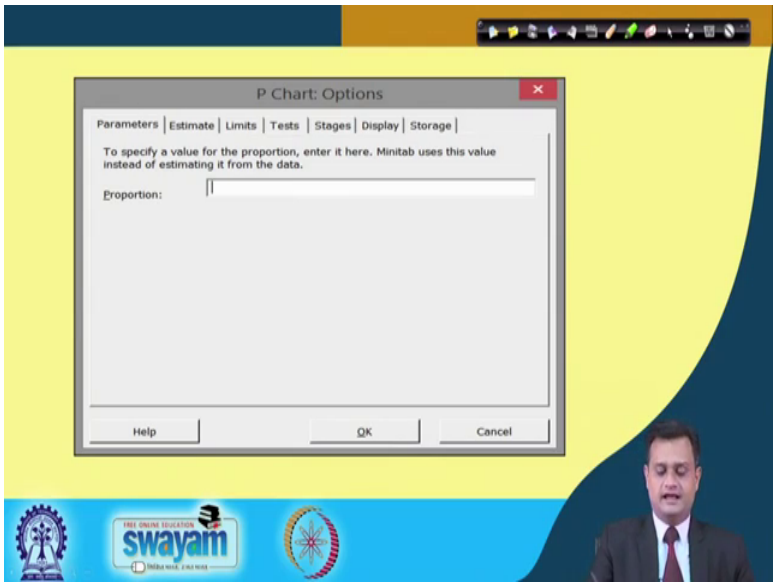

And, you put the value define the value in test.

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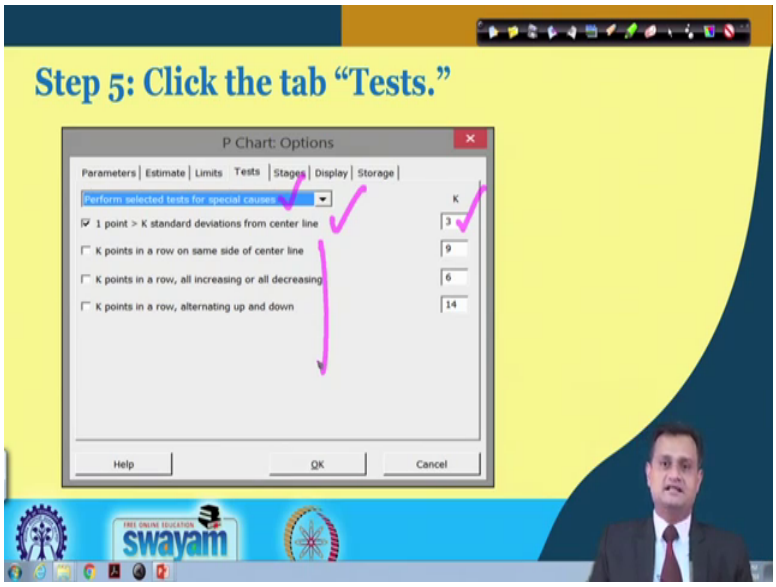

So, Perform selected test for the special causes – there could be some special cause and let us say greater than one point one point greater than K standard deviation from the standard line you put the value K is 3, so, plus or minus 3 sigma.

Similar way if you want to choose the other options for analyzing the different kinds of pattern in the control chart you can tick mark it and that would be taken care by the Minitab.

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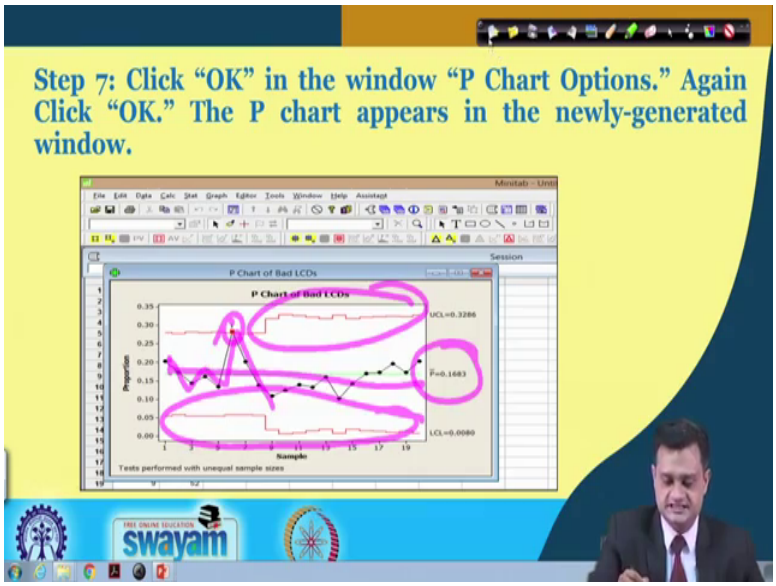

So, now what you can see here that you have variable sample size. So, you have control limits are varying. You have the center line this is the P bar value and you have plotted the points here. So, one point here is falling outside the control limit and it is indicated by my control chart.

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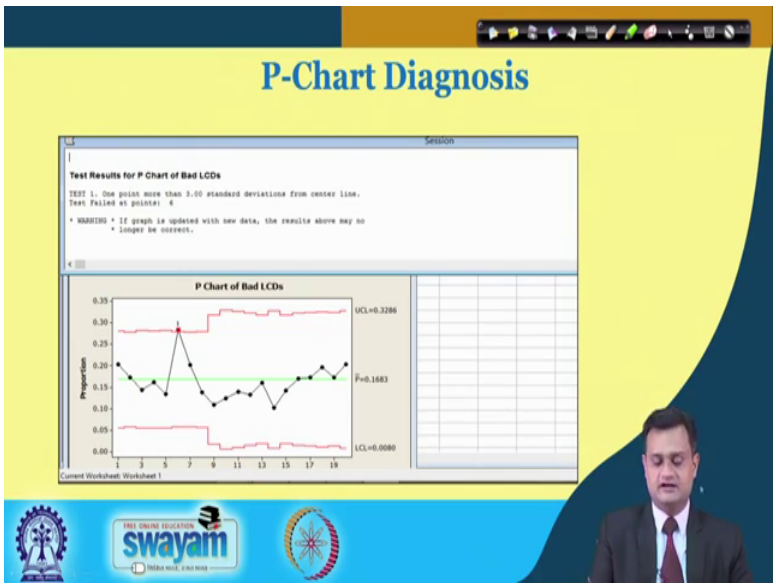

So, same way you can analyze and you will have diagnosis of the P control chart and you can think about the corrective action based on a cross functional understanding or

discussion that what could be the reasons that this point has gone outside the upper control limit.

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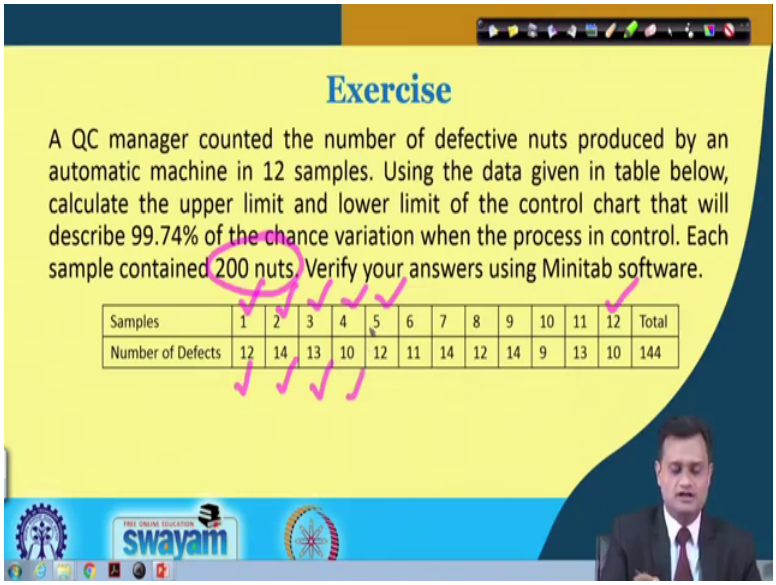

Let us see the example a QC manager counted the number of defective nuts produced by an automatic machine in 12 samples. So, there is a sample of 12 and he is counting the number of defective nuts in each particular sample. So, he wants the upper control limit and lower control limit of the control chart that will describe 99.74 percent of the chance variation when the process is in control.

So, more or less 3 sigma limit you are referring. Each sample contain 200 nuts. So, your sample size is constant it is 200. Verify your answer using Minitab software. So, this is the data sample 1 2 3 4 5 and up to 12 each sample is of size 200 and out of 200, 12 is the number of defect, 12 nuts are basically defective and this is what I have identified.

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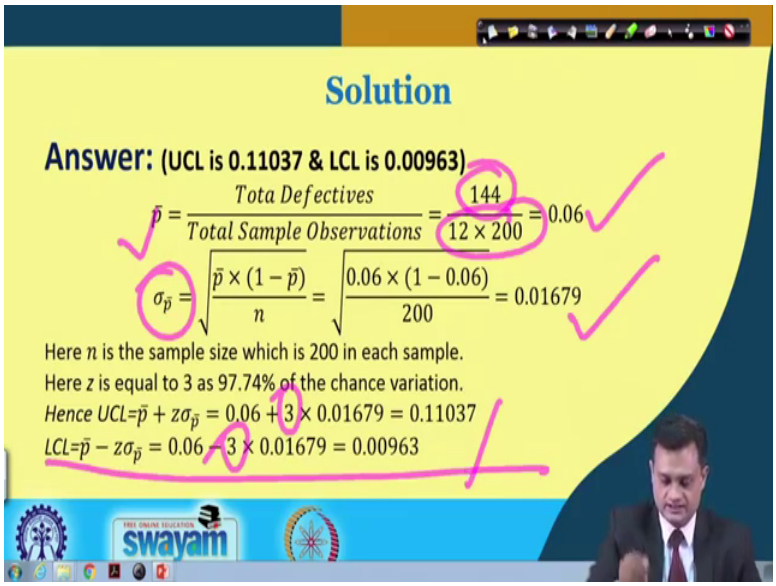

So, now once I have this data I can definitely find p bar which is the total defectives 144 divided by total sample observation, so, 0.06. I can also find the standard deviations. So, this comes out to be 0.01679. Now, I can easily set my control limit with respect to plus or minus 3 sigma and my control limit comes out to be upper control limit 0.11037, 0.00963. So, fine, this is what I have calculated manually.

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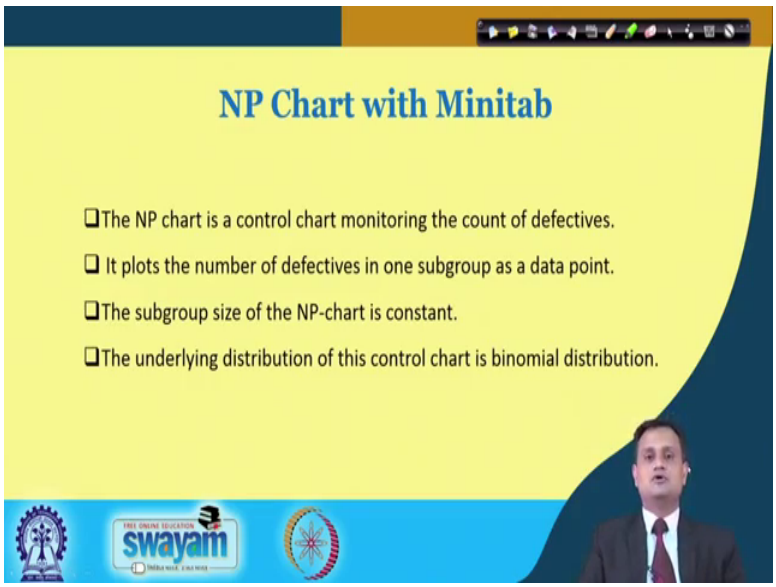

And, you can also use your Minitab software to check that whether your computations are exactly plotted or not. So, NP chart with Minitab if you see, then is a control chart

monitoring the count of defectives how many defectives are there. It plots the number of defectives in one subgroup as a data point and the subgroup size of the NP chart is constant. Underlying distribution of this is binomial distribution; so, just to remind you.

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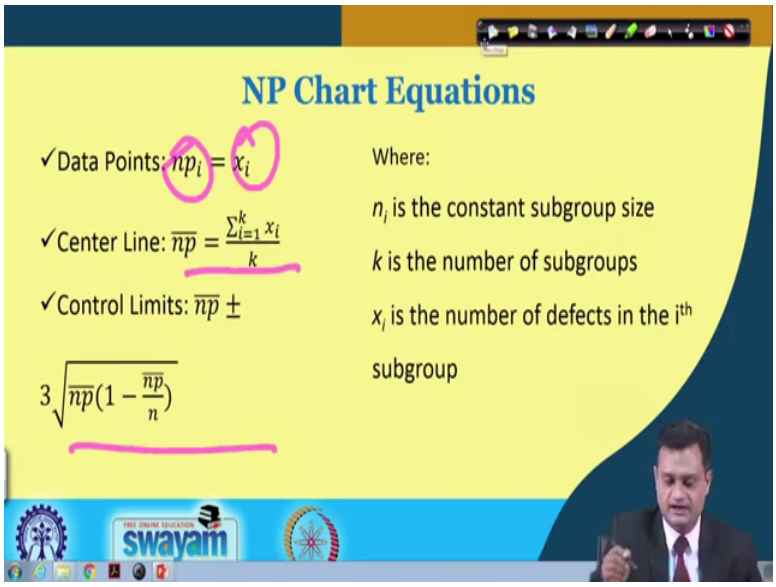

So, now NP means I am just multiplying this with the n. So, np i this is x i. np bar you can find and you can have np bar plus or minus say 3 sigma. So, you can compute this.

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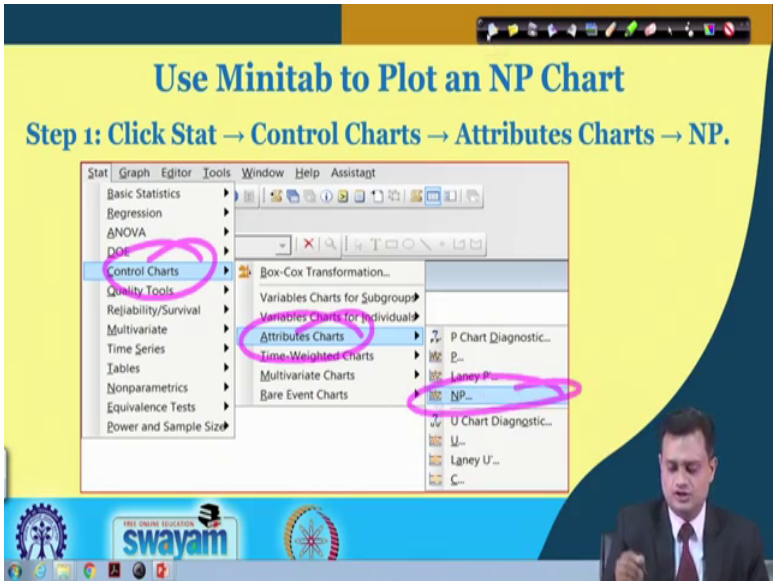

Now, let us try to see the application of Minitab. I have shown some of the manual calculations also. So, you go to Control Chart, then Attribute Chart, then select NP.

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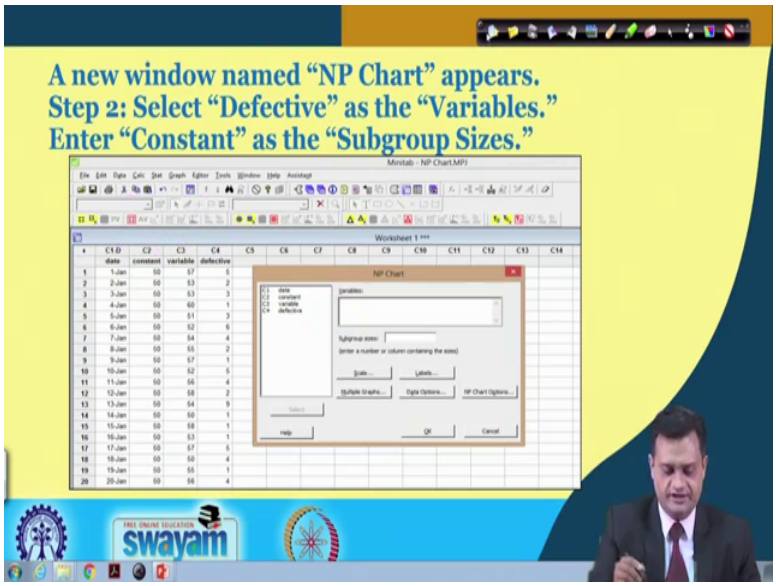

Once you have done this, then you go to your datasheet and just try to see what you have done. So, you have the date, you have the constant, you have the variable, you have the defective.

So, this values you have already say inserted, inputted it in your Minitab excel sheet and now you have data, constant, variable and defective here. So, this Minitab window will get open.

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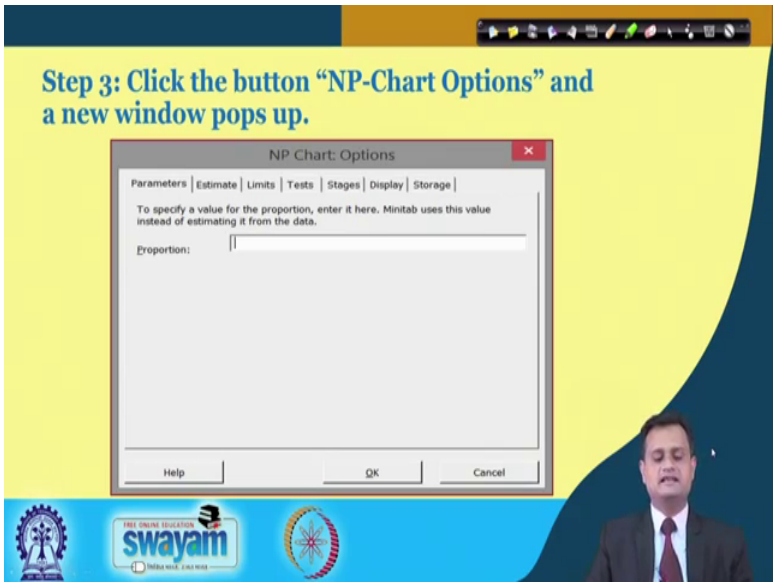

Now, you define the proportion. So, to specify a value of proportion enter it here and Minitab uses this value of estimating from the data. So, you have already given the data, Minitab can estimate it or you can insert the value of proportion.

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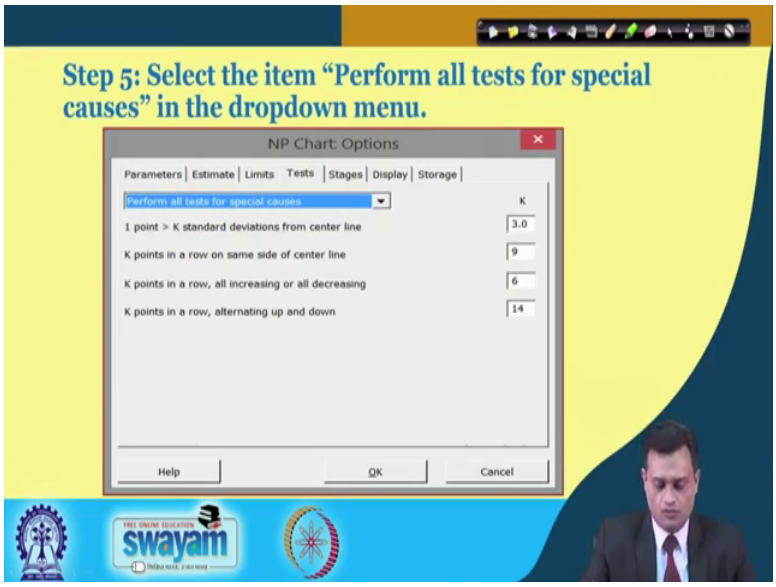

Now, here again you will go to this particular window and you will select the Test to be performed and you will just specify the value of K. K is nothing, but the number. In order to set my upper control limit, lower control limit or to identify some of the patterns prevailing within the control limits and I am just giving the number value in the Minitab.

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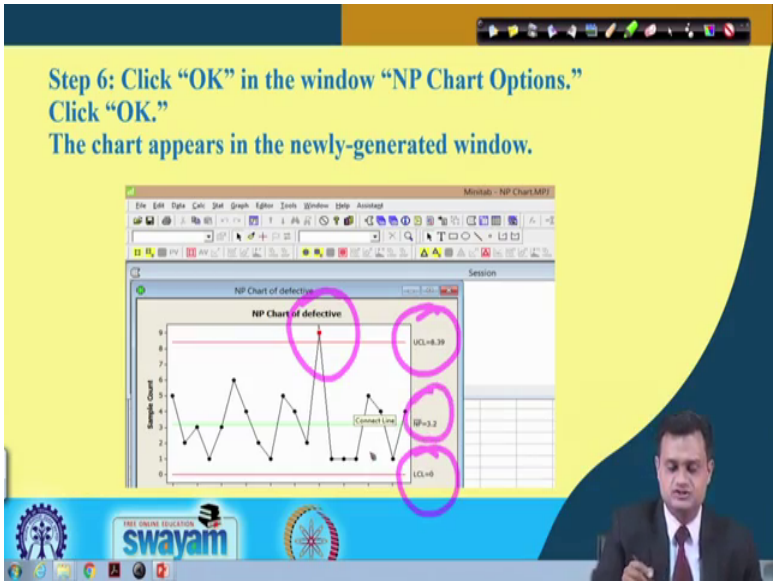

So, once you have done this then you can click OK and, your Minitab will generate a chart for you. So, you have NP chart of defective. So, you have one point going outside the control limit. Your upper control limit on NP chart is 8.39, this is 0 and NP bar is your 3.2.

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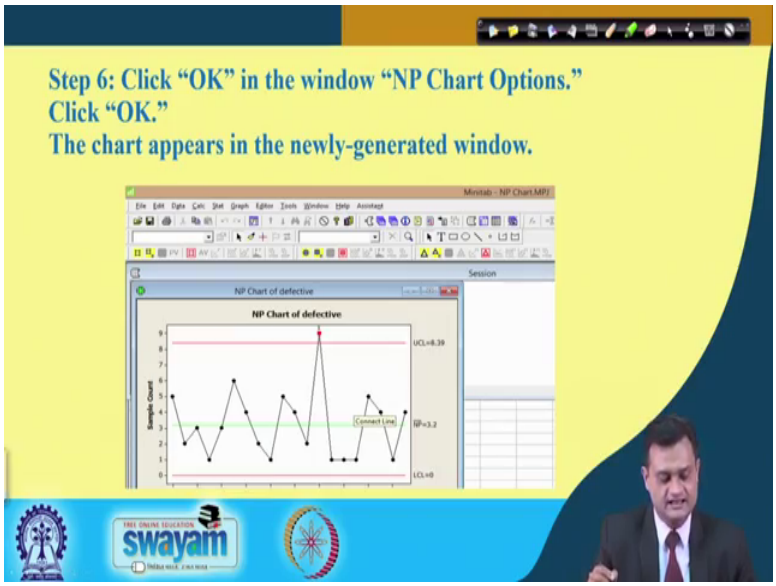

So, once you have done this you can also verify your result in the NP chart of defective and same thing you have just done here. So, you have UCL 8.3539, NP bar 3.2 LCL. So, this is your NP chart of defective.

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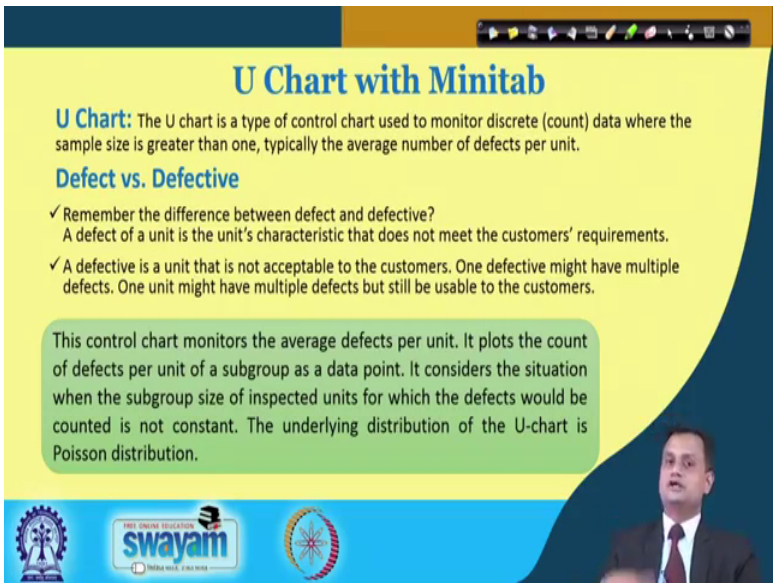

Now, you can also plot the U chart with the Minitab. So, typically a U chart is a type of chart used to monitor discrete count data where the sample size is greater than one, typically the average number of defect per unit you are interested in. So, defect versus defective, I hope the idea is clear that the difference between defect and defective is very simple. A defect of a particular unit is units characteristic that does not mean the customer satisfaction. When I say defective is that unit that is not acceptable to the customer and one defective might have multiple defects.

So, you just take the example of your textile cloth and you are taking a sample of 100 meter square and you will find that there are many defects like faded color or maybe thread is coming out or some tearing of the cloth and many thing. So, each one will call a defect and if you declare this particular sample as reject then it is defective. So, this part we can very well appreciate.

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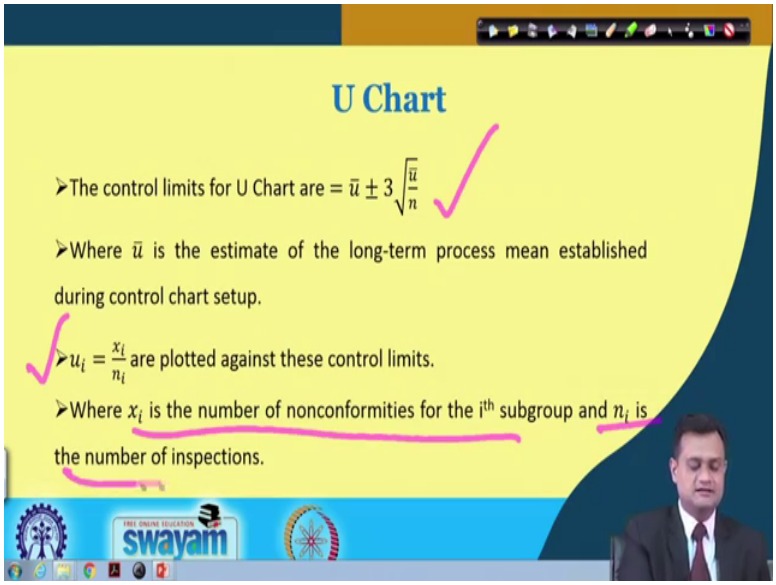

So, U chart when you see then you have u bar plus or minus 3 square root of U bar divided by n and u i is nothing, but x i divided by n i. So, x i is the number of nonconformities for the i-th subgroup n i is the number of inspections.

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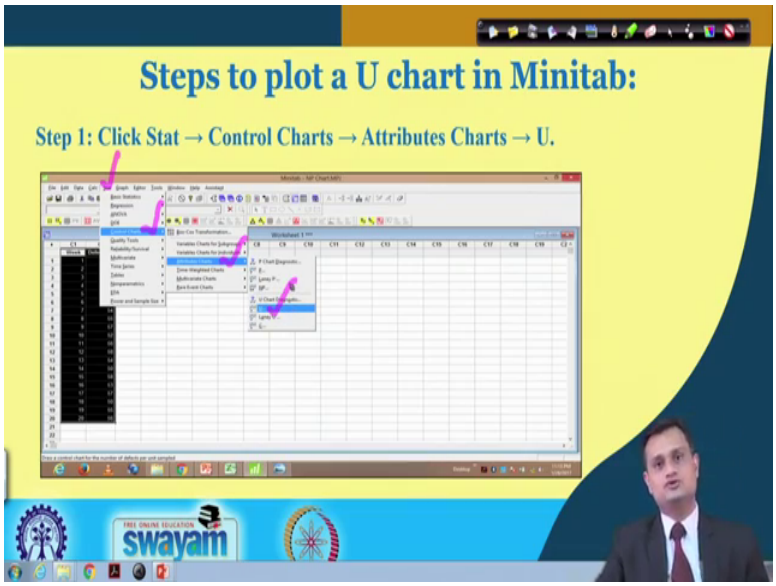

So, with this preliminary understanding, now once again you can go to Stat, you can go to Control Chart, you can go to Attribute Chart. Now, you select the U chart. So, procedure remains same just for your convenience I am displaying each and every chart.

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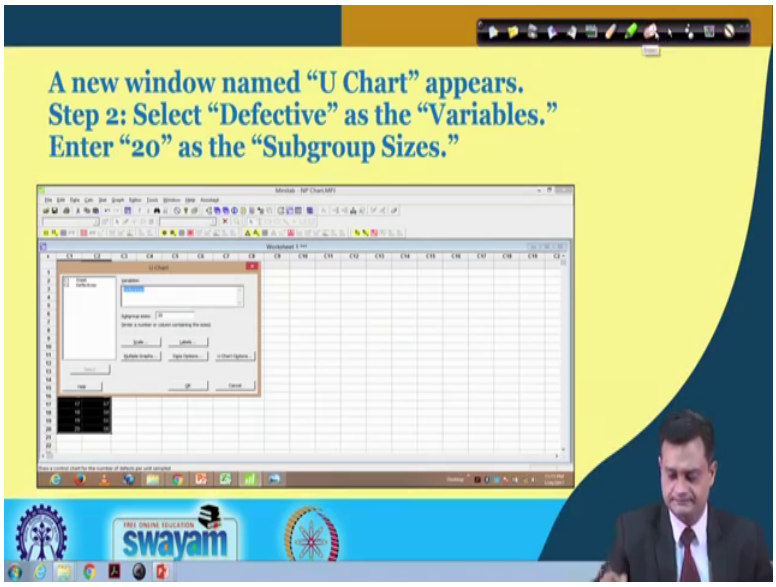

So, you select the value, suppose you have weak and defective, so, you select the variable as the defective you define the subgroup size also and then you click OK.

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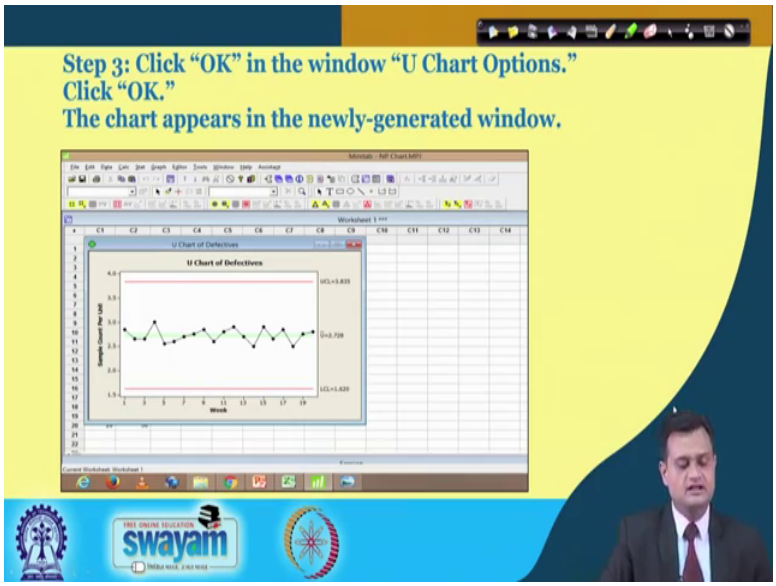

So, once this is done you will get a control chart for U and what you can see here that more or less your points are well within the control limits and this gives you initially an indication that your process is in statistical control, unless you observe a typical pattern which is an indication of some assignable cause otherwise if the points are falling well within the control limits you say that you have the process within statistical control.

So, once this is done you can establish a control over your process by taking the appropriate step for removal of the assignable cause. If you are in the initial stage trying to set up the trial control limit then let your control limit to be stabilized, use this control chart as a gauge to monitor your processes continuously for a given quality characteristic and wherever the point is falling outside you must investigate and take the appropriate action.

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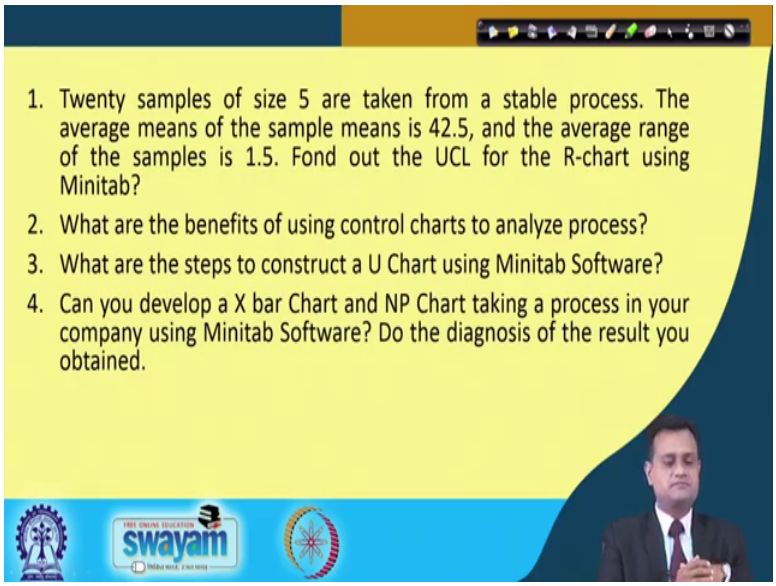

So, just some simple think it. 20 simples of size 5 are taken from a stable process. The average mean of the sample mean is 42.5 and the average range of the sample is 1.5 found out the UCL for the R chart using Minitab that you can do very easily what are the benefits of using control charts to analyze the process? What are the steps to construct u chart in Minitab and can you develop Xbar chart and NP chart using some steps in Minitab?

So, I would advise you to take some hypothetical data, follow the steps I have demonstrated, plot the control chart, try to interpret it and then you will have better hold over the concept and you would be able to internalize them.

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So, please try to do it and digest the concepts properly. Once again I would say that you can refer Mitra, Montgomery and other suggested books for strengthening your understanding on control chart.

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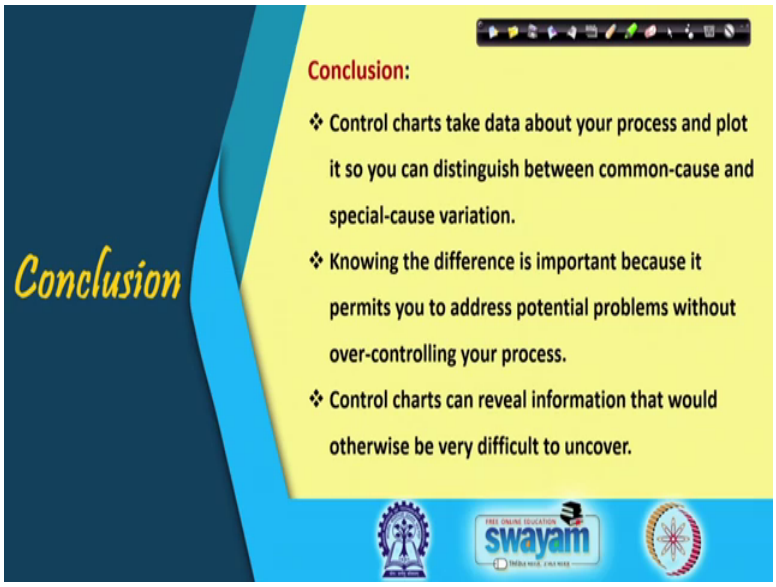

So, control charts take data about the process and plot it so you can distinguish between common cause and the special cause and knowing the difference is important because it permits you to address the potential problems without over controlling your process. It is a very important point. I do not want to control my process too much if you control the

child let us say too much what will happen child will become say too much rebellion and he or she will not obey your advice or instruction. So, I do not want any such thing to happen means I do not want to disturb my process again and again. So, control chart gives me a way when to act when not to act, when really there is a need to address the assignable cause, when I should not touch the process and allow it to run uninterruptedly this is what I can do with the help of control chart.

So, thank you very much for your interest in learning the various concepts on control chart. As well as a part of this lecture minute of application for control chart and keep revising we are in the final phase of DMAIC that is the control phase. And, we have seen each and every phase in detail, discussed all the topics with greater criticality, examples, case studies, conceptual part and I hope now you are on the way to execute your six sigma project maybe as a part of university project or maybe in your day to day industry life and I wish you all the best that you can succeed in your six sigma project.

So, we will continue with some more topics left in our six sigma journey. Till that time keep revising introspecting. Be with me. Enjoy.