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

Lecture - 06
Importance of Pareto Chart and Cause and Effect Diagram

Hello everyone, welcome back to session 6 on Quality Control and Improvement using MINITAB. I am Prof. Indrajit Mukherjee from Shailesh J Mehta School of Management, IIT Bombay. So, last session, what we are doing is that visualization of some tools which is helpful in quality.

And some inference what we can draw out of the data set we have seen by using histogram. We have also seen using box plot and those things we have tried to understand how plotting can be done in MINITABs like that.

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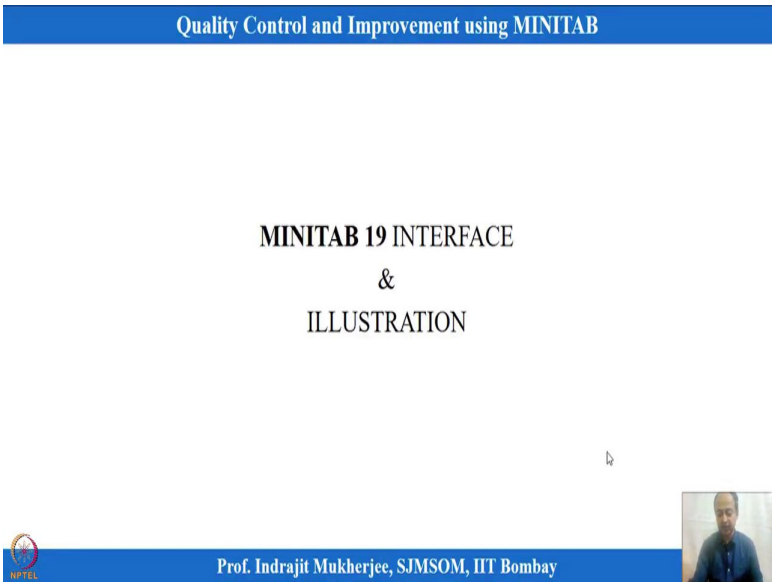

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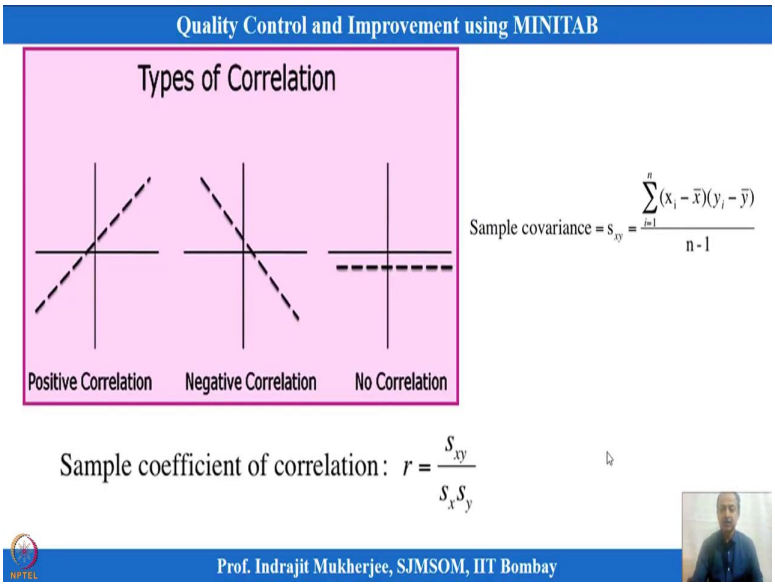

So, and also we have seen the scatter plot – how to draw scatter plots like that, where relationship between two variables we can try to understand by plotting those things, and also we how to calculate correlation using MINITAB, covariance using MINITAB. And we have seen that even if you do it calculators also, the values are very close in excel, also we can do that.

And in this session, some more quality tools which are extensively used also can be seen, but before that, we can also see some plotting types of graphs which can be used in chemical processes like that where time is one of the dimensions where the data how the data is moving how the centering is moving, how the center of the process is moving like that, that can also be plotted like that.

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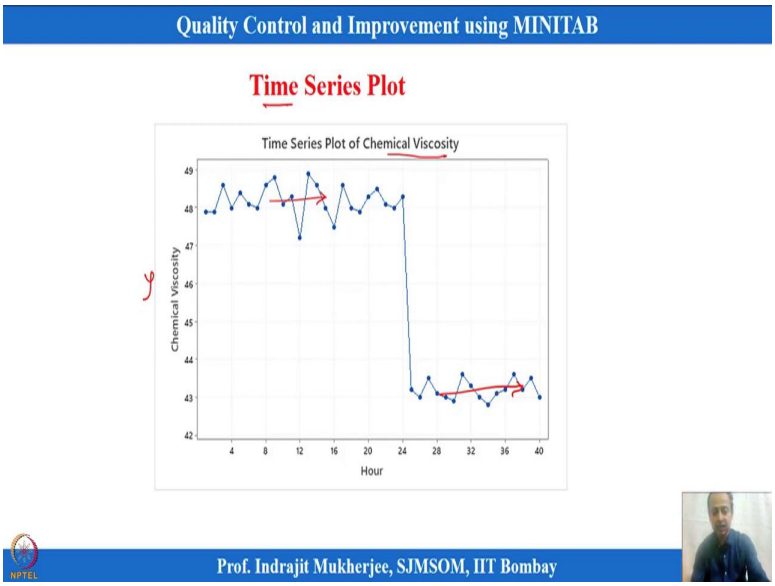

So, one of the important plotting technique which is also used when time is one of the dimensions like that, it is known as time series plots because time is one of the dimension over here. And this will be the variables that are monitoring, maybe CTQ with respect to time.

And in this plot, this is chemical viscosity which is plotted using MINITAB like that. What you can see over here is that the average or accuracy of the process is more or less over here, but suddenly it has dropped on the 24th observation, and the average is moved over here like that.

So, centering of the or the CTQ values are drastically drifted from one location to the other location with respect to time like that. So, I can monitor with respect to time and plot that one. Let me illustrate with an example over here how these types of time series plot is done in MINITAB.

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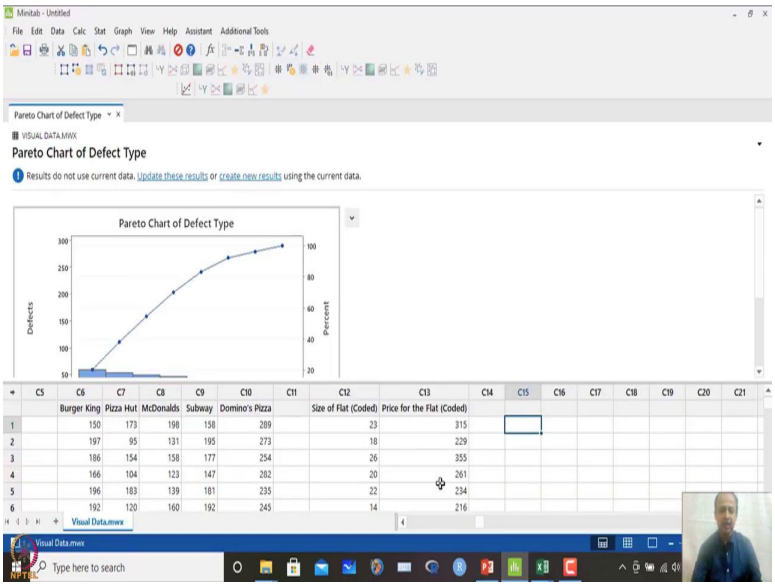

So, in this case what I will do is that I will use the same MINITAB worksheet which we are doing visualization data like this. So, I have kept the same file over here and what I will do, is that I will copy-paste some information data over here which is having time series like that.

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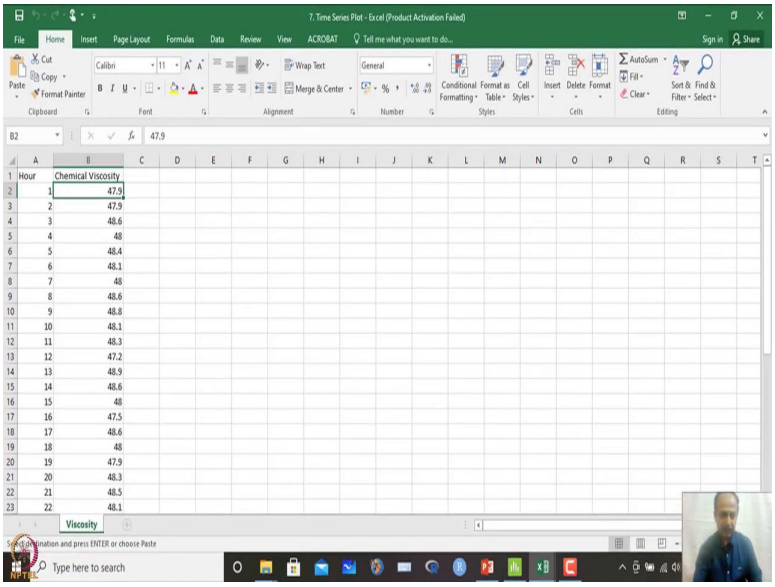

So, this is the hourly and chemical information that is there. And I want to copy because this first hour, second hour like this, the data is like that with respect to time.

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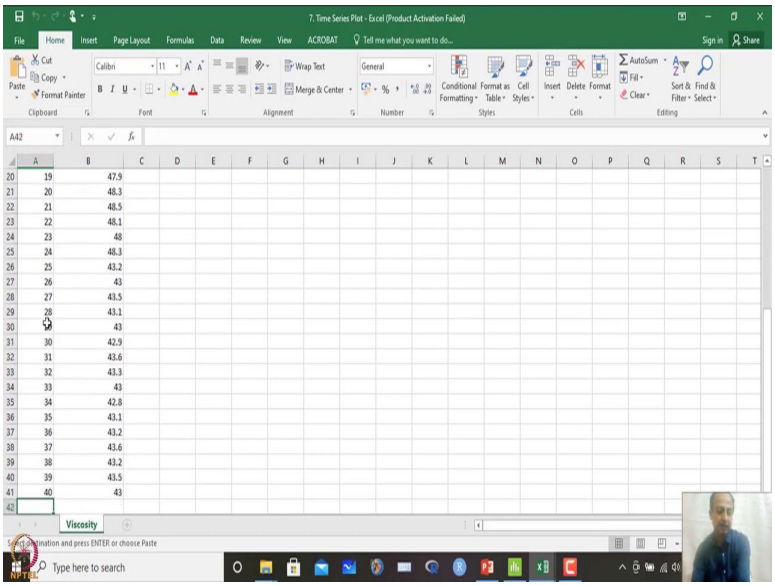

So, this is done with respect to time. So, 40th observation is the latest information that I am having over here ok. And the first information who is taken an hour 1, we can say this is coded hours so what we can think of. You start the process, and first hour you have recorded this one viscosity, second hour you have recorded this viscosity 47.9 like that. So, these things if you copy this one from here, and you paste it in MINITAB.

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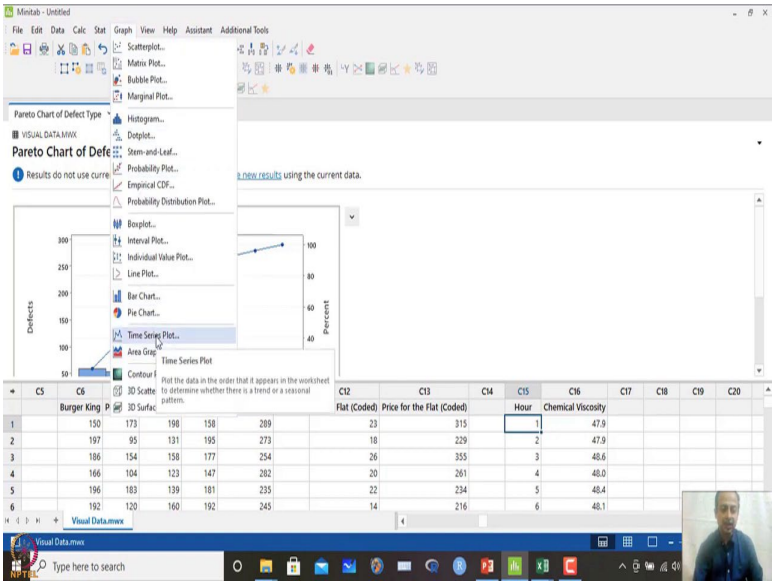

And then what you can do is that, you can just try time series plot. How do I do that? So, in graph, there is option of time series plot like that.

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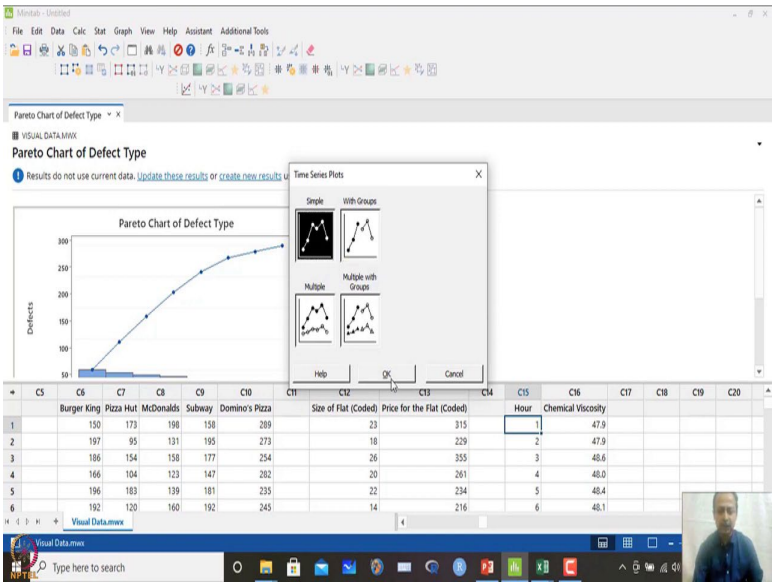

So, if you click this one, and then there will be options like that, multiple graphs can also be plotted which one example. We will take, but I am using a simple plot first of all. So, I will click ok.

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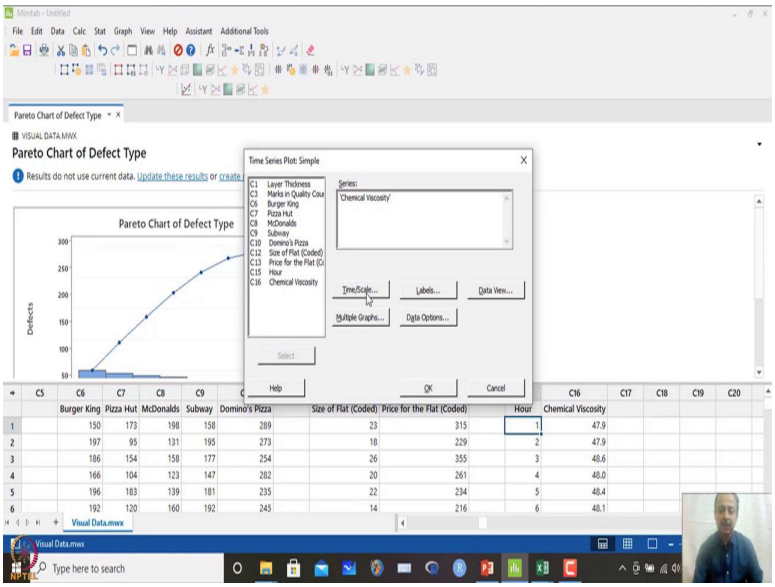

So, what is the series I want to plot? This is the chemical viscosity I want to plot that, I will indicate over here, but double-clicking this one.

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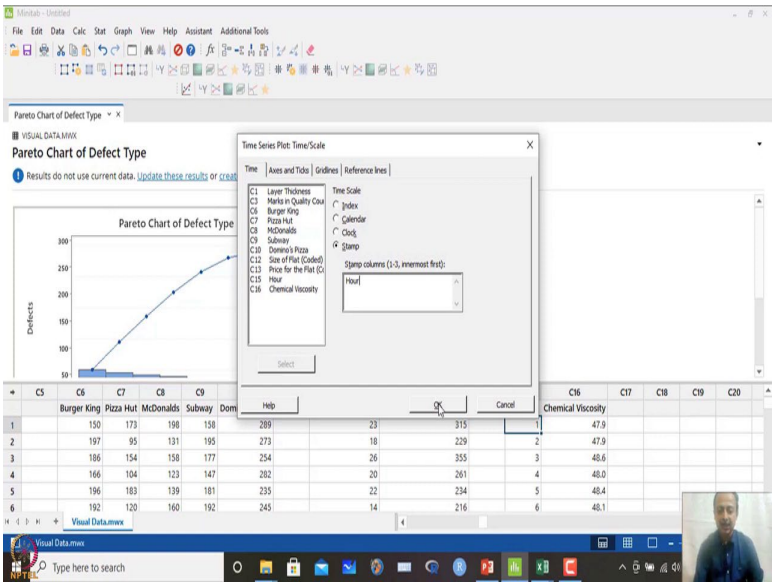

Then I will go to time and scale over here, one stamp option is there. Here what I will do is that I will use hour as the information which will be plotted in x-axis like that, and then I will click ok. So, there can be many more options what you can do over here.

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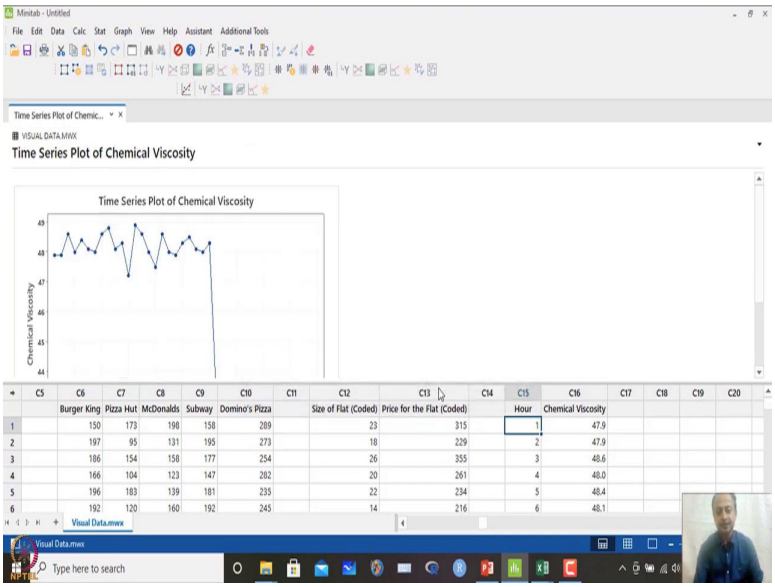

So, but I am not exploring that much, just wanted to see the data in time series plot.

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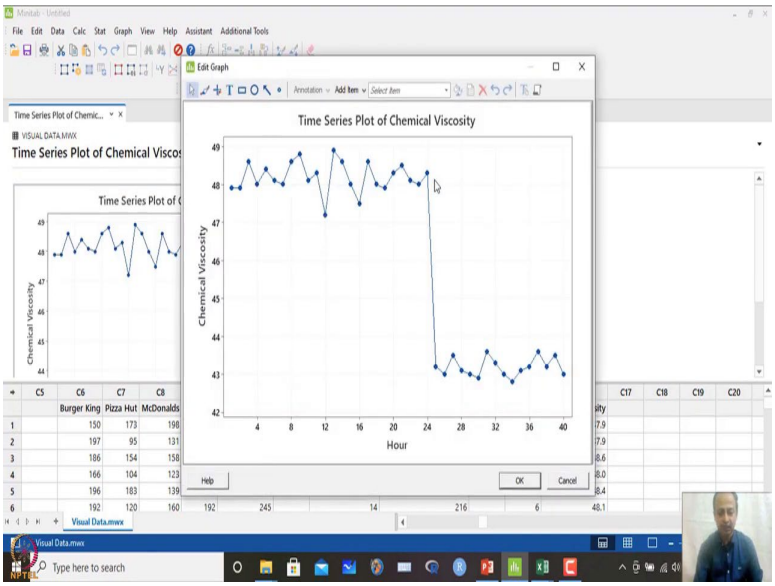

So, if you click ok over here, and then you can see the same graphs what I have copy pasted in the PPTs like that. So, this is the same graph you see. So, hour is on this axis.

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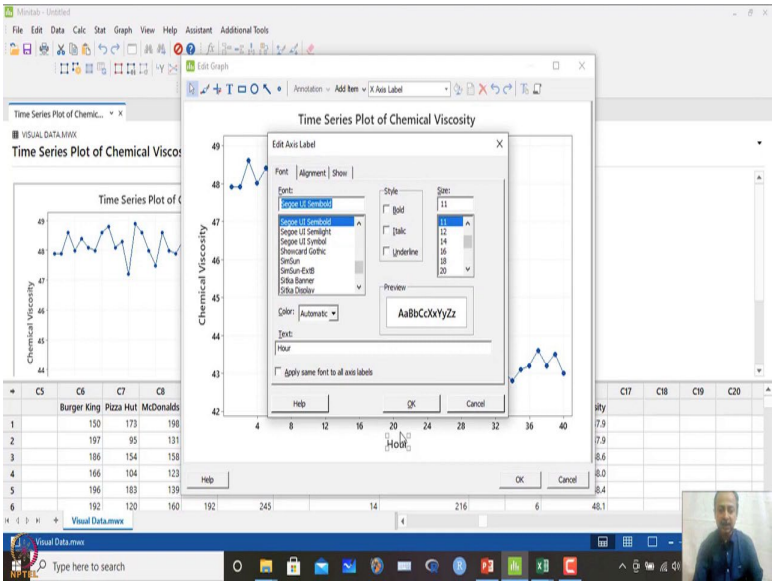

And then which can be changed also.

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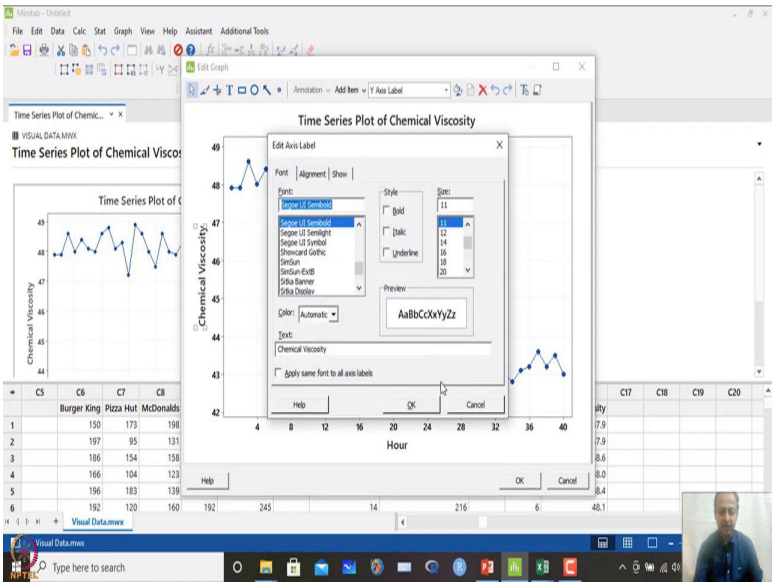

And this is the chemical viscosity y-axis that you can see which can also be changed like that ok. How it helps is that just by seeing the series just by giving the data is not possible to make an interpretation. Here it is clearly visible at a given time point 24 and 25th observation what has happened is that drastically the centering of the data has changed with respect to time.

So, many of the times what we experience is that with respect to time how the accuracy and precision is changing like that. So, variability of the data during certain time point and variability of the data after some improvement has been done. So, those things can be done in quality also.

So, one CTQ is monitored before improvements and after improvements. So, if there is drastic shift in the accuracy level or precision level that will be reflected in the time series plot like that. So, this is possible. And we want to see let us say I take another example from this.

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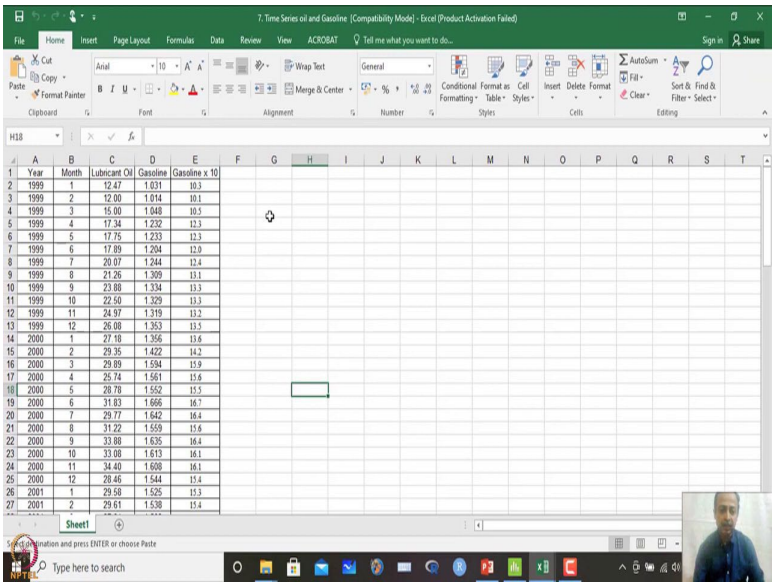

So, to make some inference out of this. So, this is another example taken from book. And this is year wise and month wise information and then lubricants oil price how it is changing, gasoline price how it is changing like that. So, somebody who has a doubt that price of gasoline is not changing as compared to the lubricant oil price like that.

So, people are not changing equivalently when it is going down lubricant oil price, gasoline price should go down, so it is not happening like that. So, somebody is claiming like that. So, whether it is true or not that we want to see like that ok. So, this is the data set and we want to draw a time series of this data set. And we want to compare the time series to time series like that. So, what I will do is that I will copy the same data set over here.

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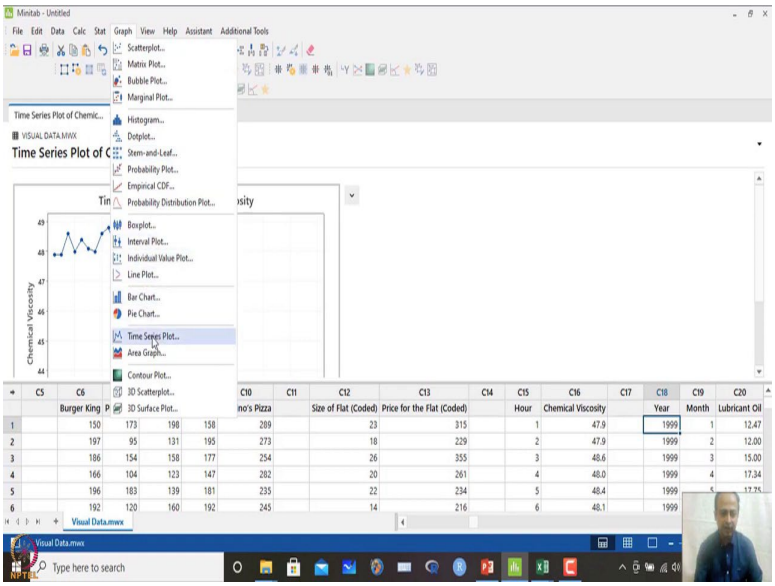

And you can draw individual plots like that. So, what you see is that with respect to time. So, graph time series what we can do is that.

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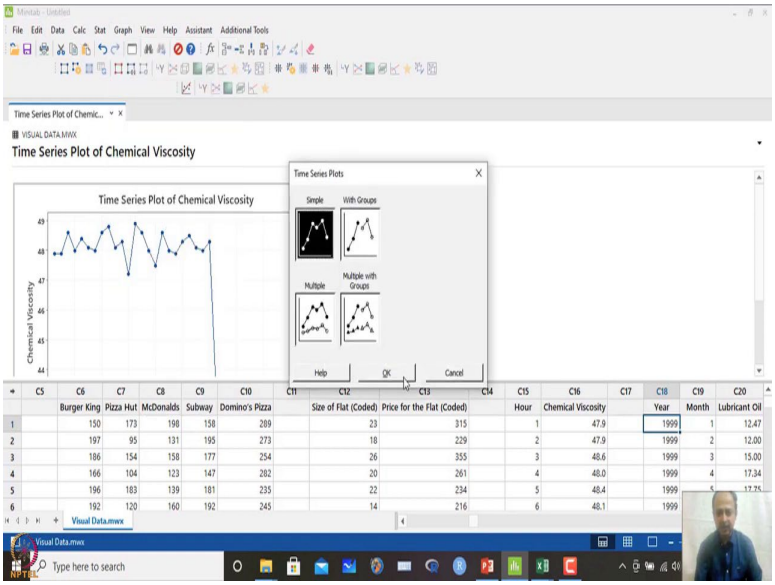

Time series plot over here, simple time series I do over here.

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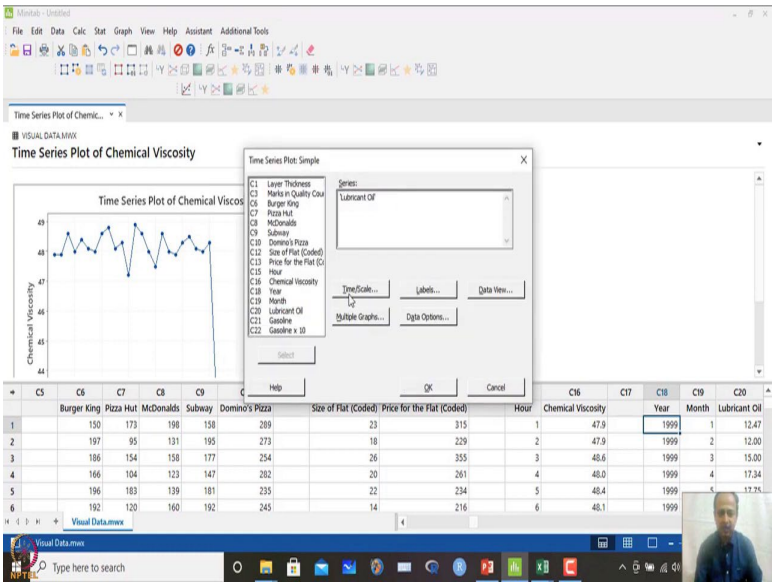

And then in that case lubricant oil and I paste the timing over here.

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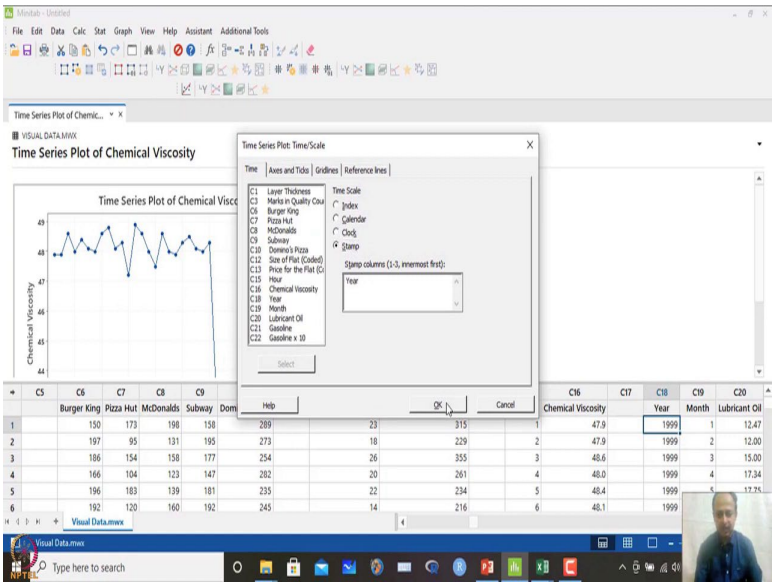

I change the stamp and I make it let us say year over here and I click that one and I click OK.

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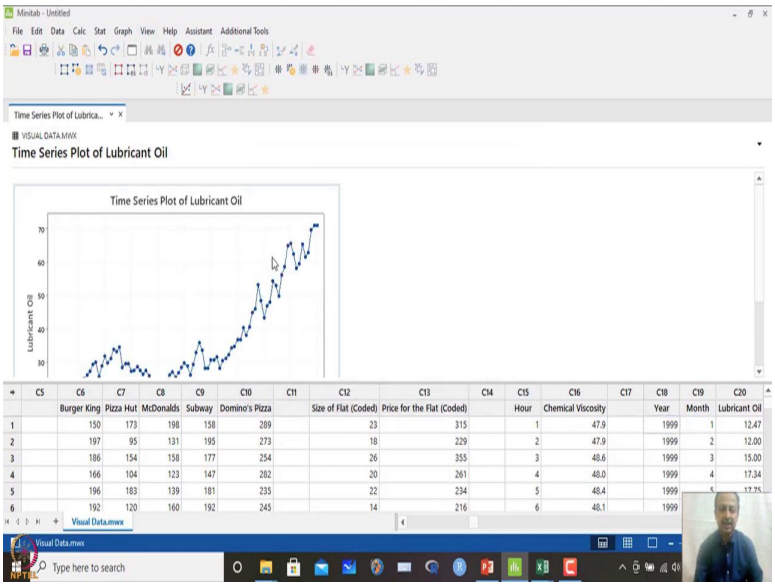

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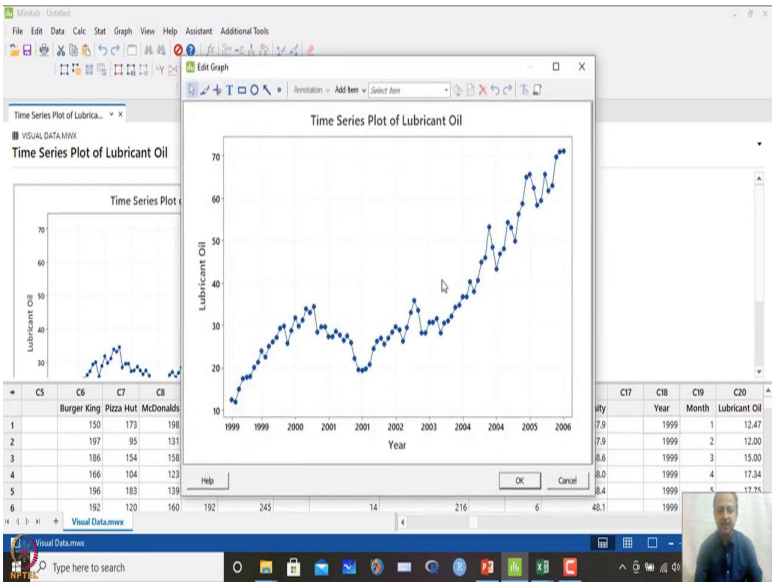

So, I get the trend of this data set, and I see that there is increasing trend that you can see over here time series plot of the data and quite obvious that with respect to year. With respect to time what is happening is that price is increasing like that.

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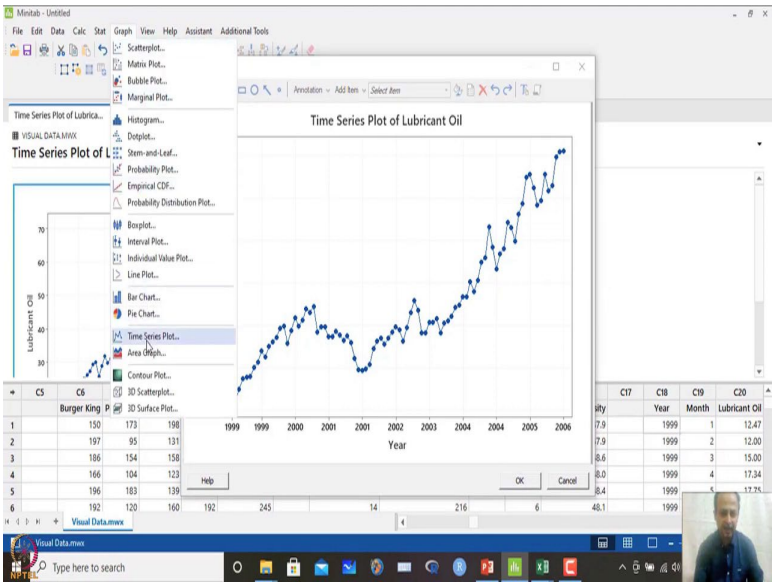

Similarly what we can do is that we can also see plots over here. Again I can draw a plot time series plot over here.

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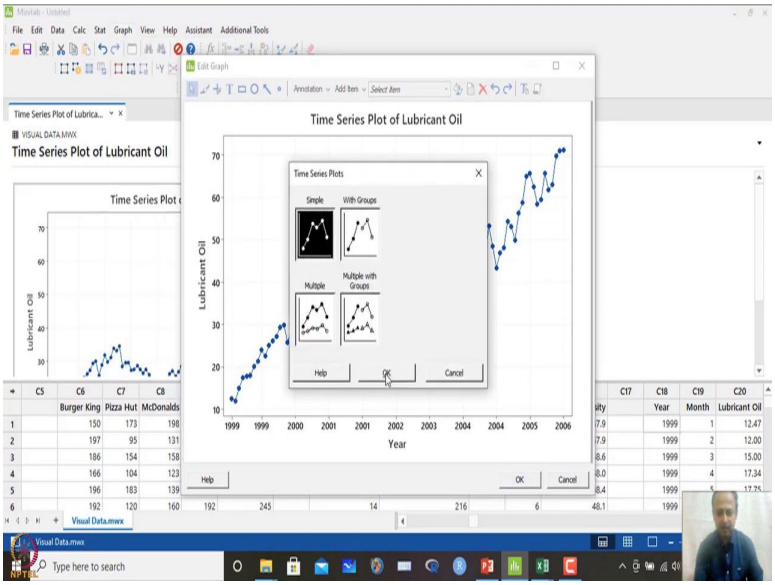

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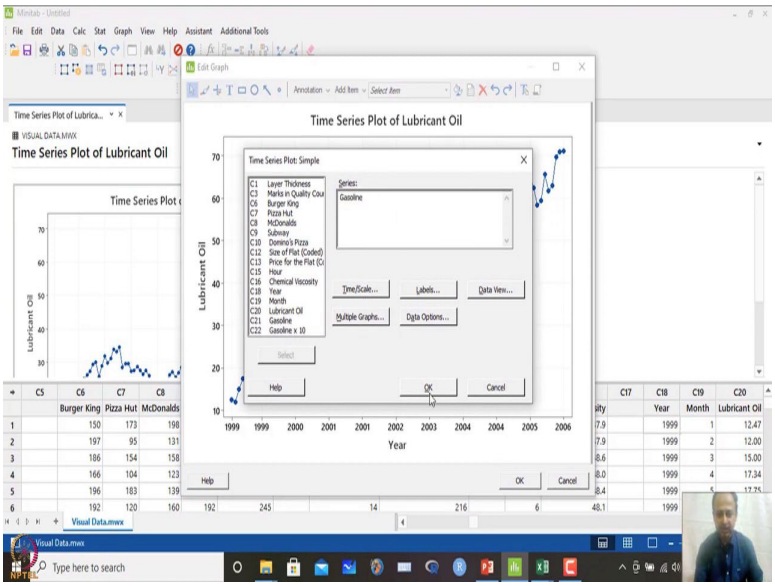

So, in this case, what I can do is that gasoline price also I can plot. So, with respect to time axis will be same because it is with respect to year.

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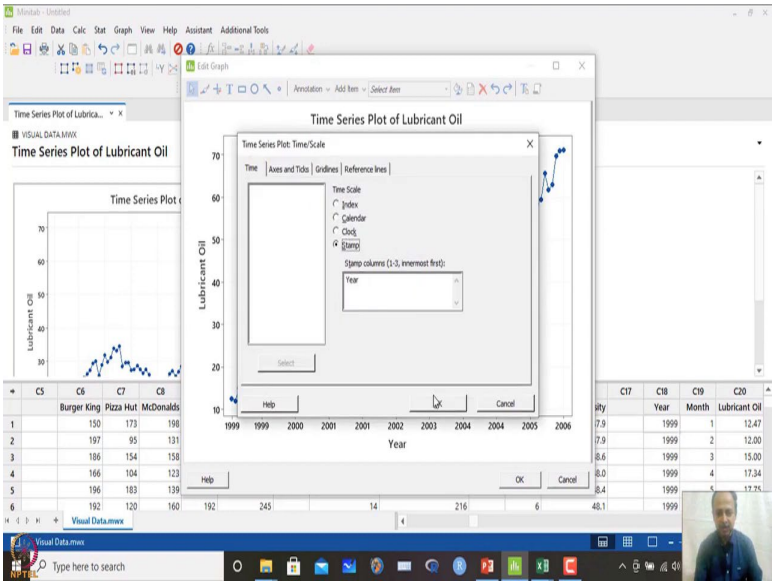

So, I can plot this one also.

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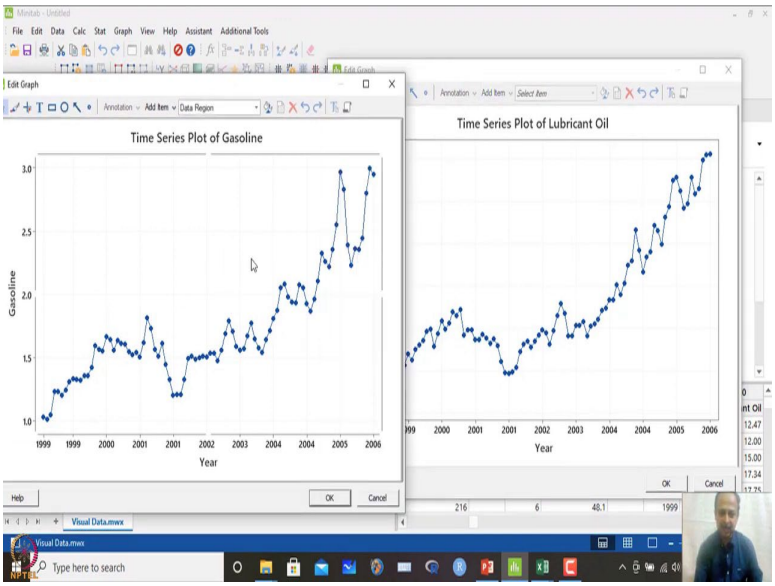

So, here also what we see is that, we can see that both the graphs is showing an increasing trend. So, in my mind, what comes is that one is increasing other is also increasing like that ok. So, when you do it in separate graphs and place side by side in that case because the unit of measurement is very different, here it is a unit varies from 1 to 3, and here the unit varies from 10 to 70 like that so in this case ok.

So, if you want to plot simultaneously one with the other like that in same graphs, what is the possibility we have?

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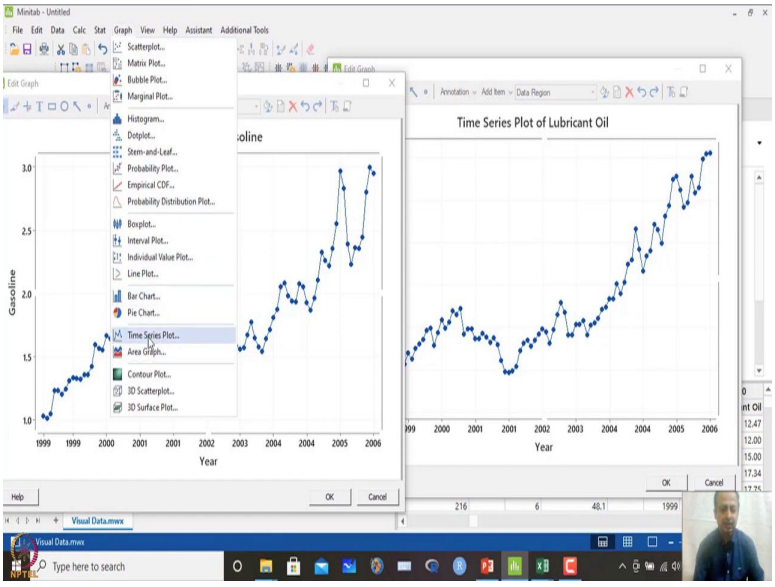

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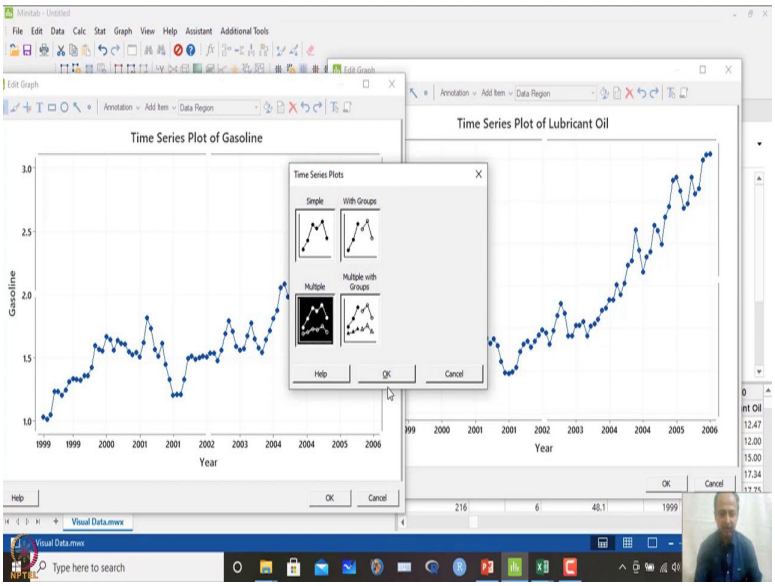

So, in graphs if you go to time series and then multiple graphs, you have options over here to see that both the series is like that.

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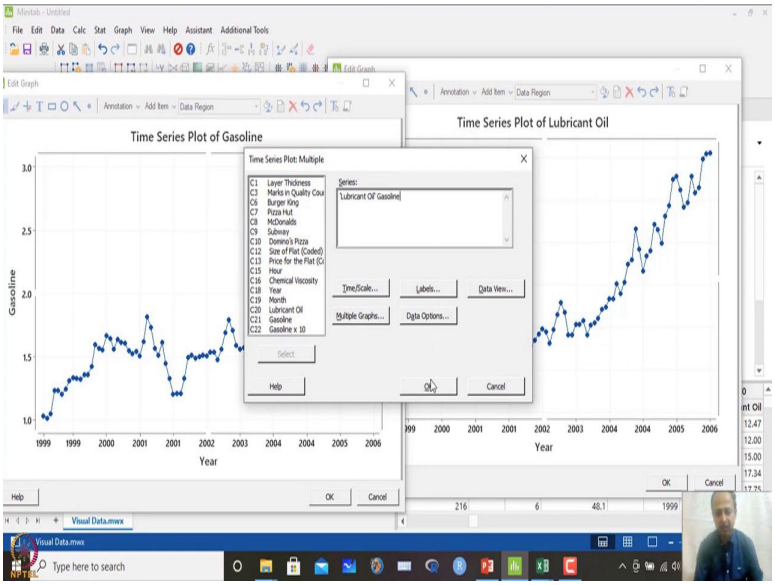

So, if you do like that and say lubricant oil and gasoline price I want to plot that in same and year remains same.

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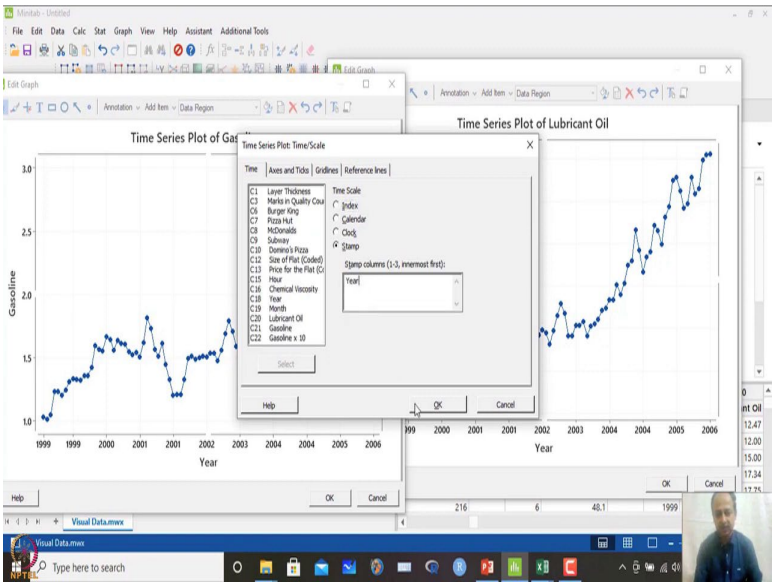

So, the same year I will use stamp over here and I use a year as the basis of this. So, this will be stamped like that. So, then you click ok over here what you will see is that you will find that this is not required.

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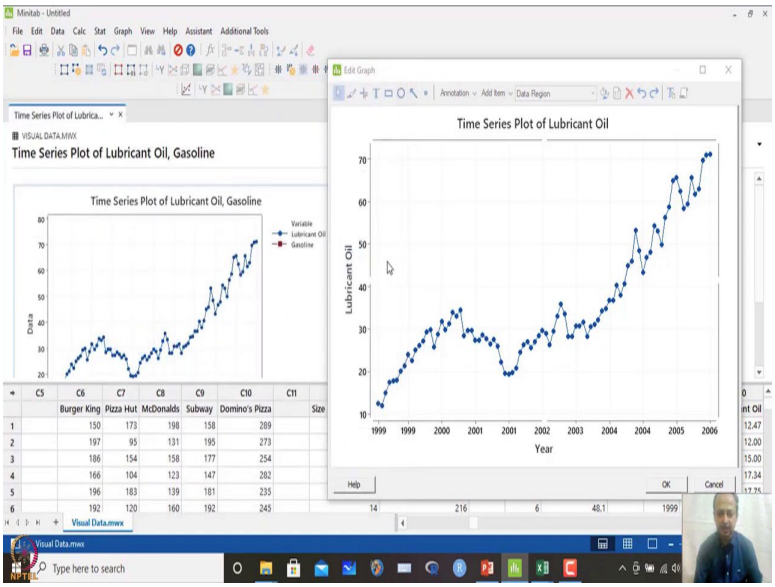

So, this is the graph where both the plots are done.

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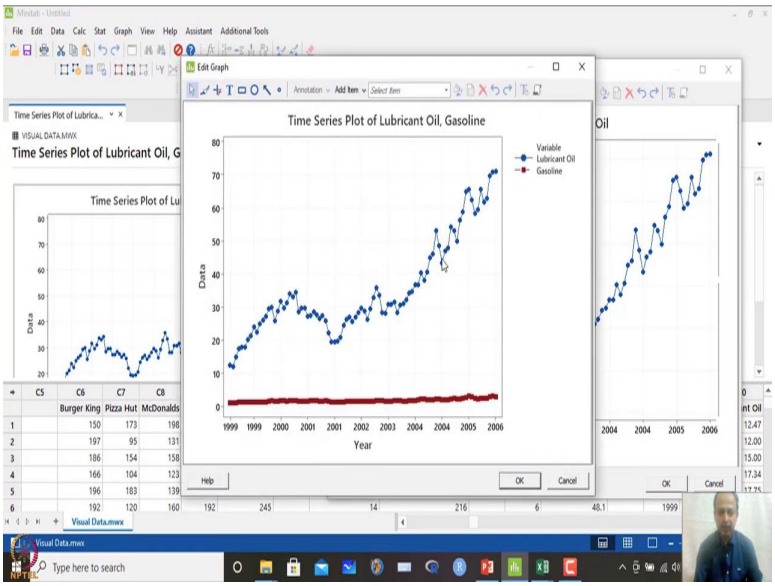

And the problem with this graph is that you see lubricant price is changing, but earlier graph what we have seen that oil price, gasoline price is also changing. But it is not showing like that because the axis that the MINITAB is using is very different because this is in a range of 1 to 2 scales or something like that and this is in a range of 10 to 70 like that. So, this will not match like that.

So, what we can do is that we can multiply this. So, this data set what I have done is that this gasoline price was multiplied with 10 and this is the only I have changed the scale only I have changed the scale, so that easy to plot like that and compare those two plots like that.

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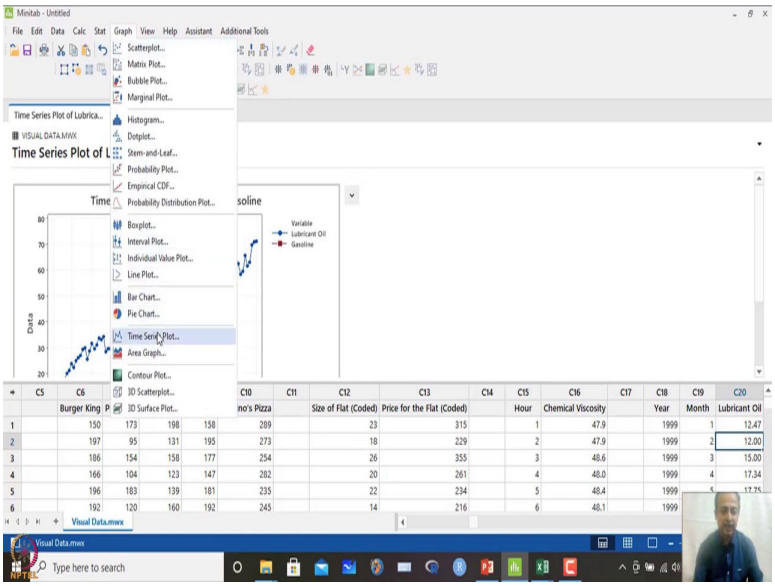

So, instead of what I have done is that instead of this type of plot what I will do is that, I will just use multiplication of 10 and then try to compare the graphs like that. So, in this case, whether both are changing in the similar direction or not that is the concern what people are raising questions, that one is increasing other is increasing, but when is one is decreasing other is not decreasing. So, they are saying that company is doing some manipulation over here. So, we want to prove that.

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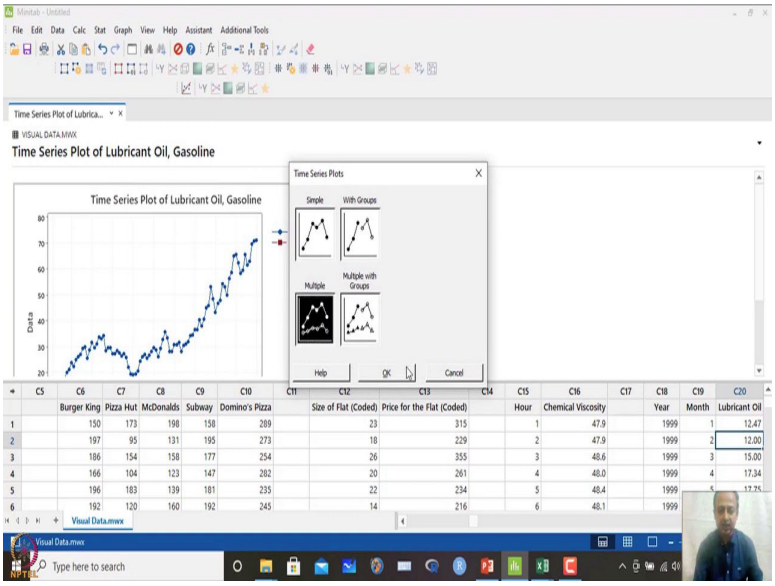

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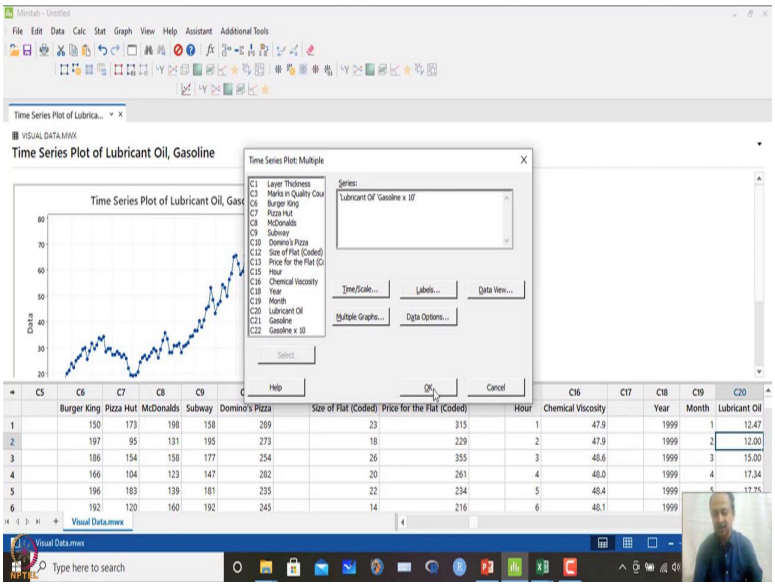

So, over here what we can do is that again we can do go to time series, and what we can do multiple time series like that instead of. So, I will remove this one. So, I will place delete this one, and then I will place lubricant oil, and gasoline multiplied by 10. So, in same, so I have just changed the scale over here.

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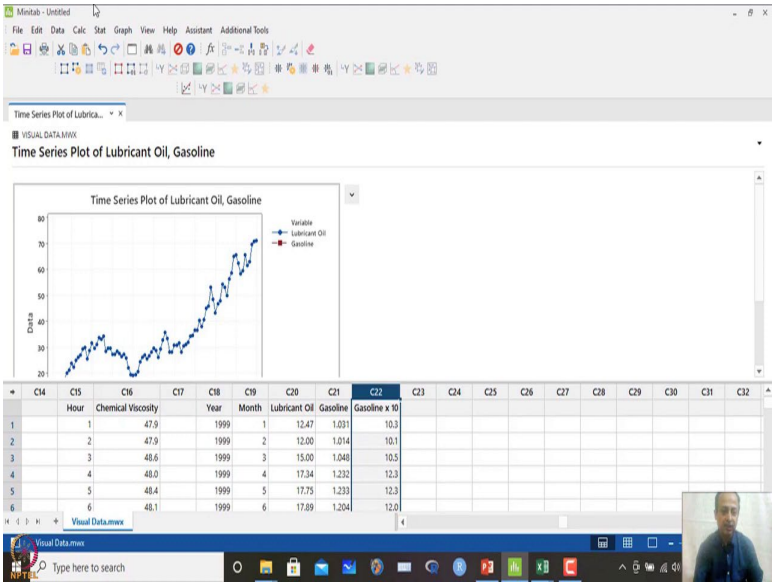

So, in this case, what you can see is that if you go on the right hand side, so this multiplied by 10 I have copy pasted this information over here complete information. So, I will plot lubricants and also gasoline multiplied by 10.

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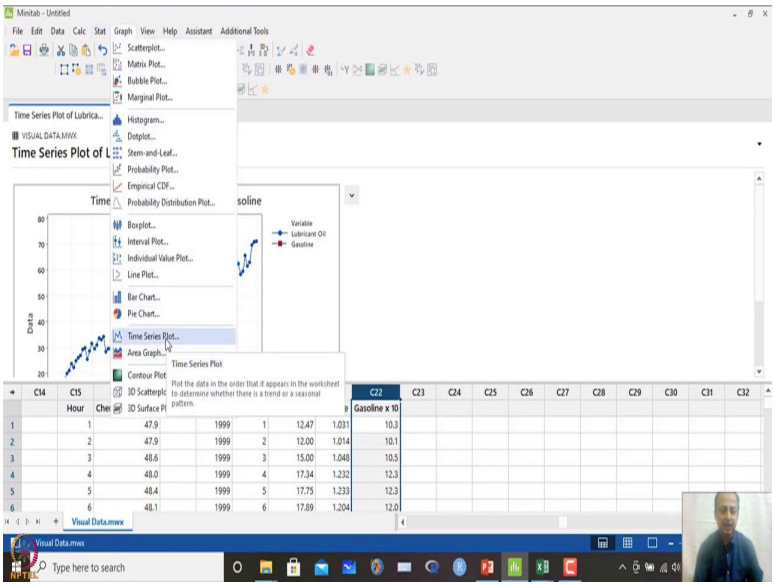

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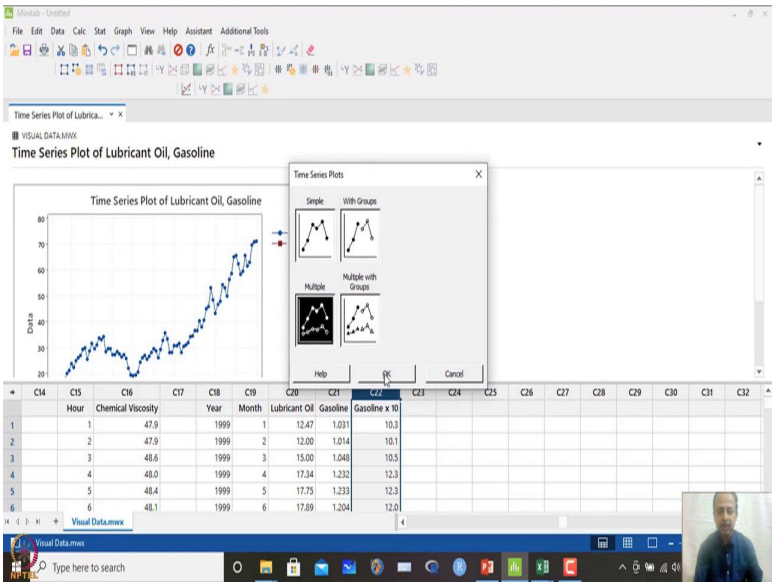

So, in this case, what I will do is that, I will go to time series, and then I will go to multiple chart and I will click ok.

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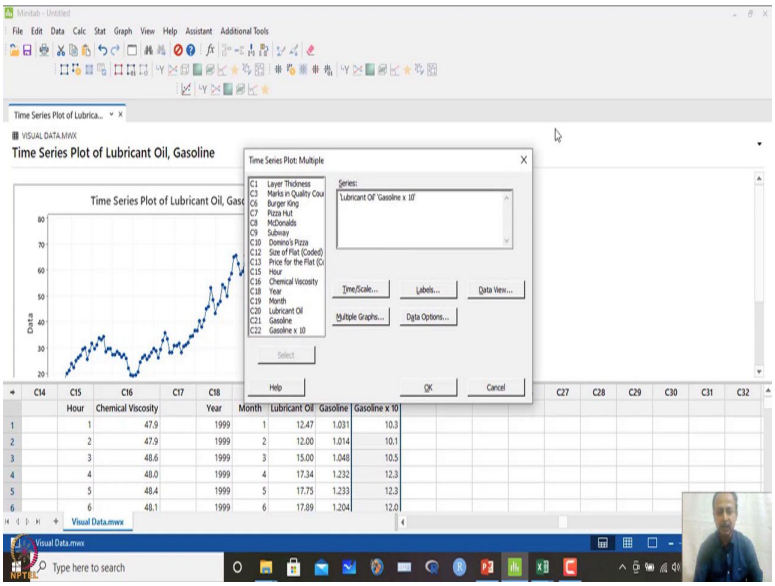

So, I will write lubricant and I will place gasoline multiplied by 10.

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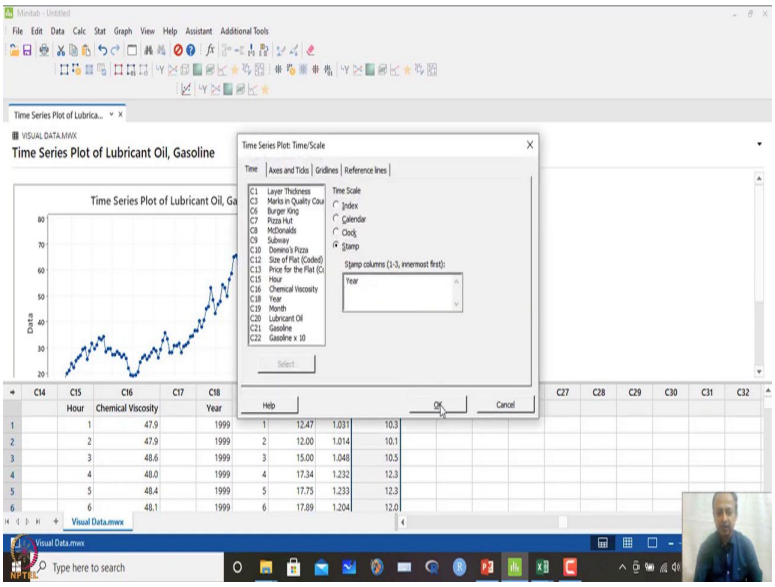

Time stamp over here, year it is stamped already. So, in this case, I will click OK.

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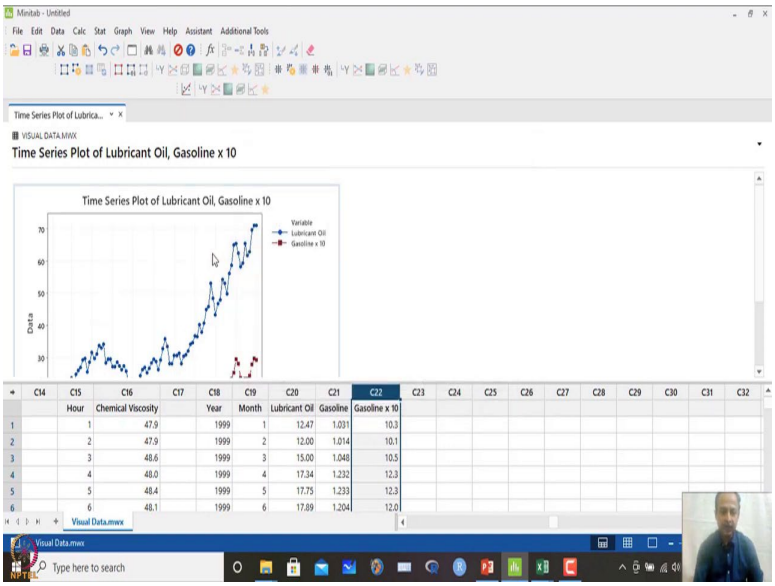
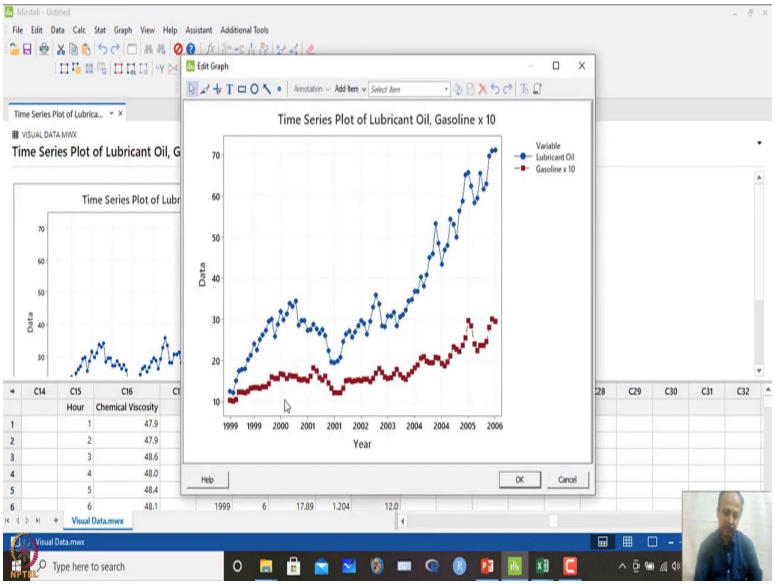
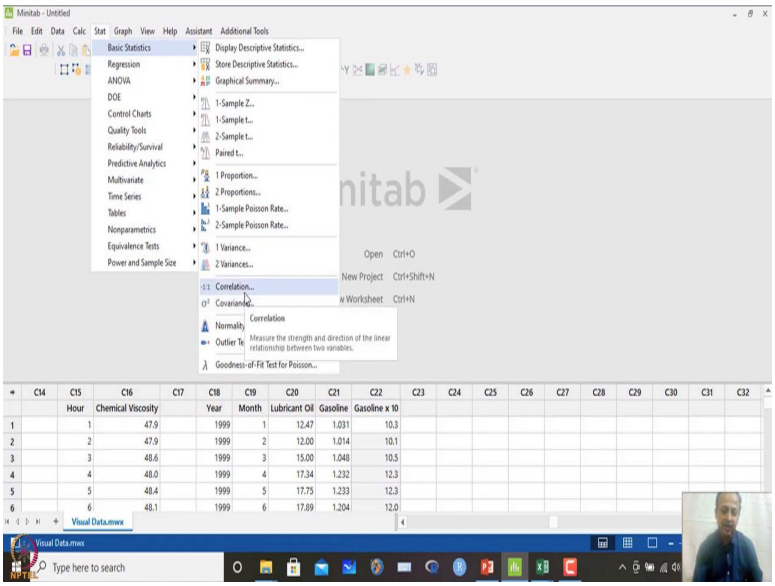


(Refer Slide Time: 10:08)



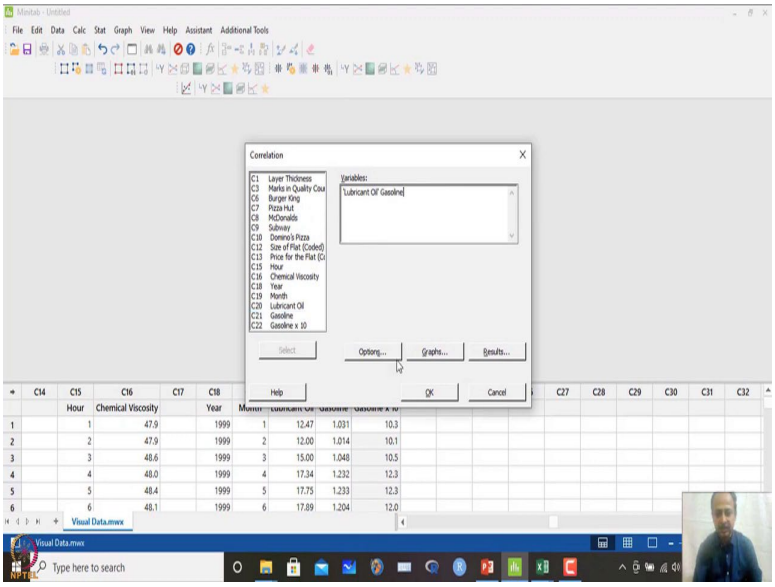
So, now, some fair comparison can be done. You see some amount of variability is increasing trend, not so much increasing what is seen in gasoline lubricant oil, but it is steadily increasing. So, what we can see the trend is also following a pattern, but the gap is quite high over here because the scale is different over here.

(Refer Slide Time: 10:37)



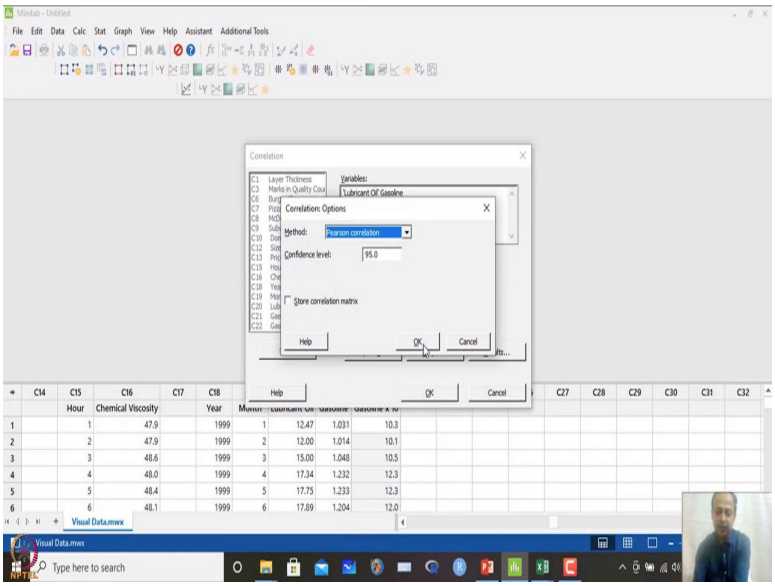
So, to verify whether both are changing simultaneously on the positive side, we can also see the correlation between these two data sets like that. So, what we can do is that, we can also see the correlations. And for that, what we can do is that, we can go to stat again – basic stat.

(Refer Slide Time: 10:47)



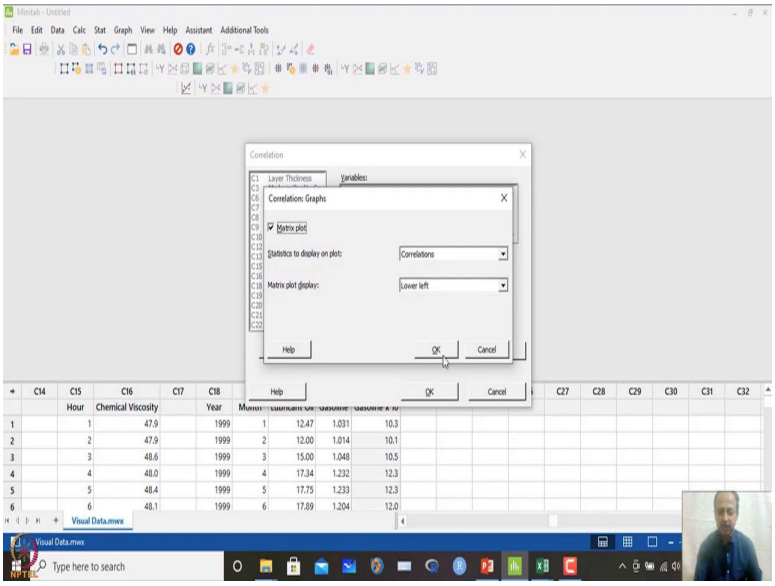
And I want to see let us say correlation between these two variables. So, lubricant and gasoline price I have just highlighted this one. Any of them can be placed first or second, it does not matter.

(Refer Slide Time: 10:55)



So, in this case option I want to see Pearson relationship between linear relationship I want to see so, but non-linear relationship kind of Spearman correlation can also be used for that. So, if it is I am having an anticipation that there can be non-linear relationship also. So, in that case, we can use the other one options also. So, I am using a linear relationship because more or less it is linear what we have seen. And so what we can do is that Pearson correlation.

(Refer Slide Time: 11:24)



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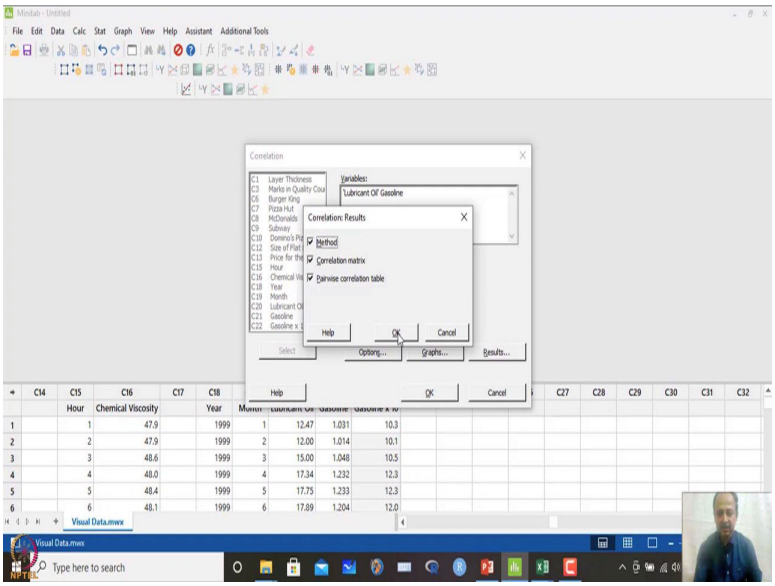

And then matrix plot of this. I want to see correlation. And then results what we can see is that this also is possible, what we can do.

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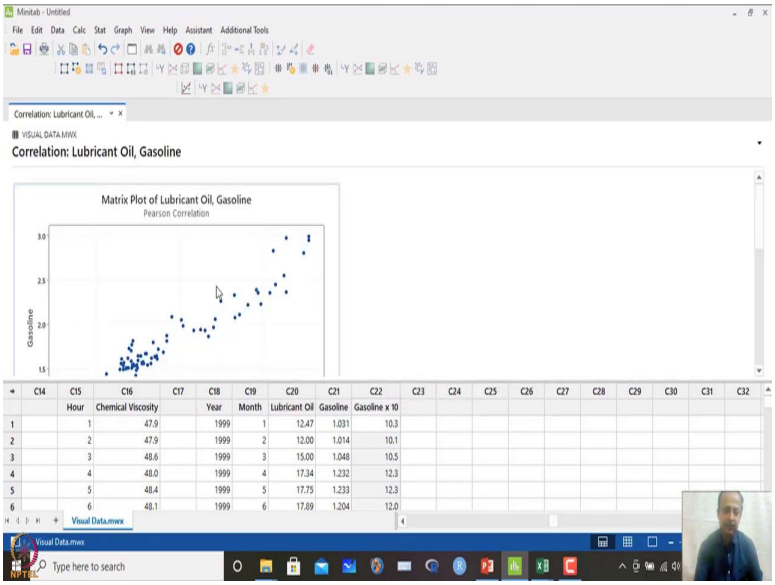

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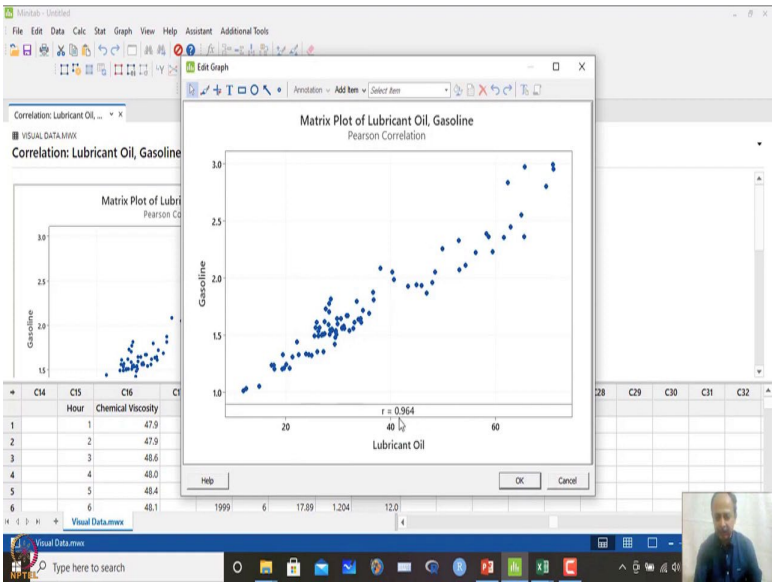
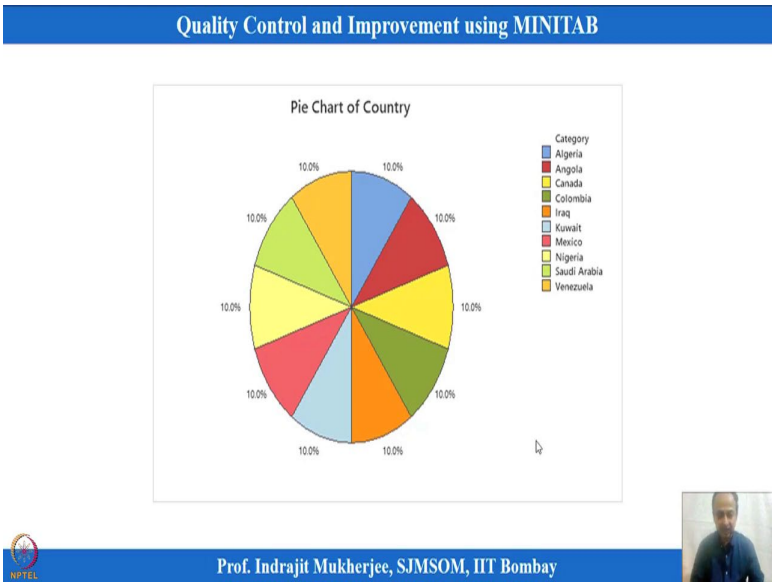


So, then what we what we will do is that from this data set, when you are plotting gasoline and the r correlation coefficient what we see is that about 0.964. So, you can see that high correlation exist between lubricant oil price and gasoline price like that. So, there is no doubt that when one is increasing, other is also increasing because there is a positive relationship and 0.96 means strong positive relationship basically.

So, our understanding on correlation relationship like that is showing you giving you some interpretation, and that will leading to this will lead to some inference out of this, that means, both the prices are increasing together and decreasing also together like that.

So, there is no as such ambiguity over here, or there is no we cannot blame the companies or something like that manipulating like that. There is a high correlation one is increasing other is also increasing like that. So that is another type of data what we can do in analysis over here which is known as time series part and core relations we have used to do that ok.

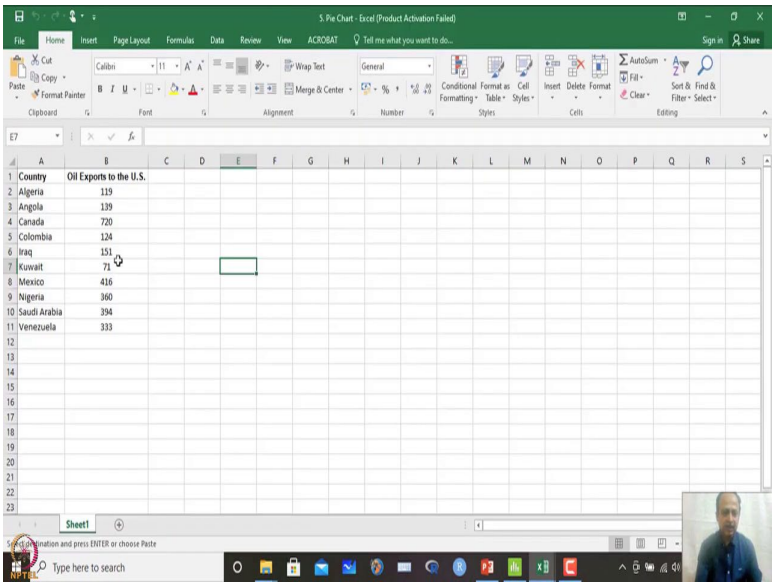
(Refer Slide Time: 12:37)



So, there are other possibilities also like if you have a categorical data like that. So, this is one of the example that we will use over here. We have multiple examples like that also. So, in this case, what happens is that country wise I have some data information of consumptions and in that case I want to see which country is consuming how much in one chart I want to see like that. It is not a continuous data one is categorical variable over here and one is having a numeric variables like that.

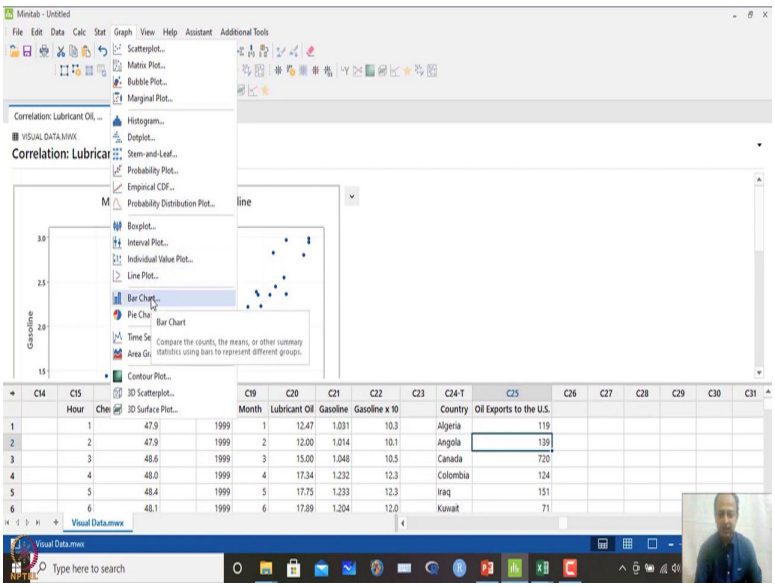
So, in that case, this pie chart and bar diagram are very useful like that. So, I will open a data set which is which can be used for demonstration like that.

(Refer Slide Time: 13:14)



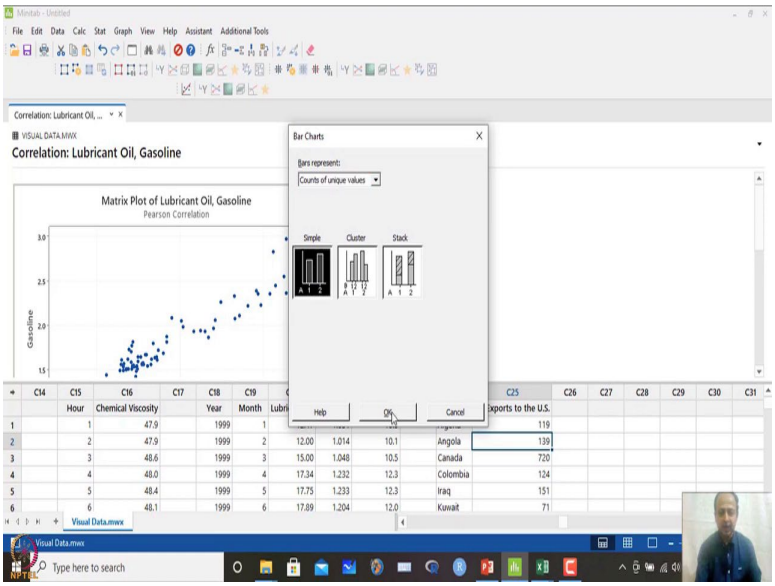
So, I am using a data set which is which shows the country information is given and oil export to US maybe in thousands of dollars like that. So, we can think of some coded data variable over here. So, I have a categorical variable, and I have a numerical variable or continuous variable over here. So, what we can do is that, we can just copy this one and I want to see graphically the distribution of this data.

(Refer Slide Time: 13:44)



And in that case, what I will do is that, I will copy paste this data set over here. And what I can do is that, I go to graph and then there is option of bar chart over here.

(Refer Slide Time: 13:51)



When you go to bar chart, simple bar chart, so count of unique values, so these are unique values. So, I am not taking anything else over here. So, this is the option I have to click.

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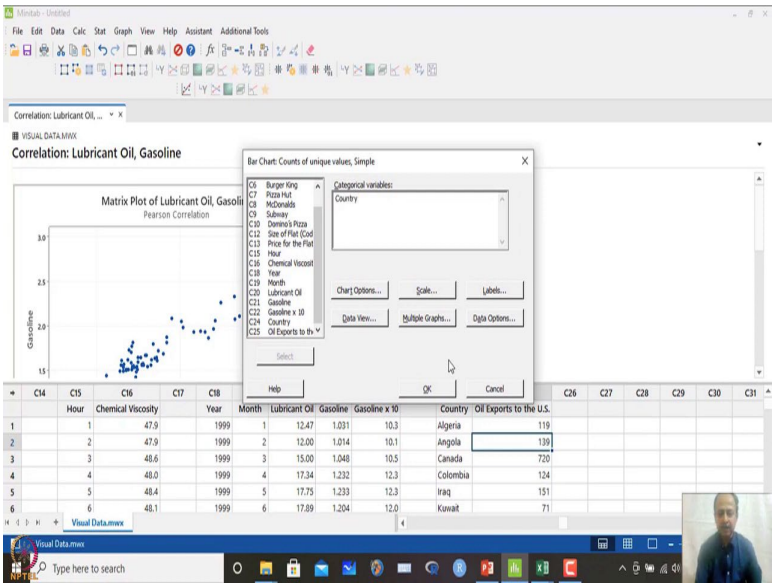

So, simple bar chart like that. So, categorical variable what we can do is that country is the option. So, it is automatically taking. So, I have you can also just type this one as country over here.

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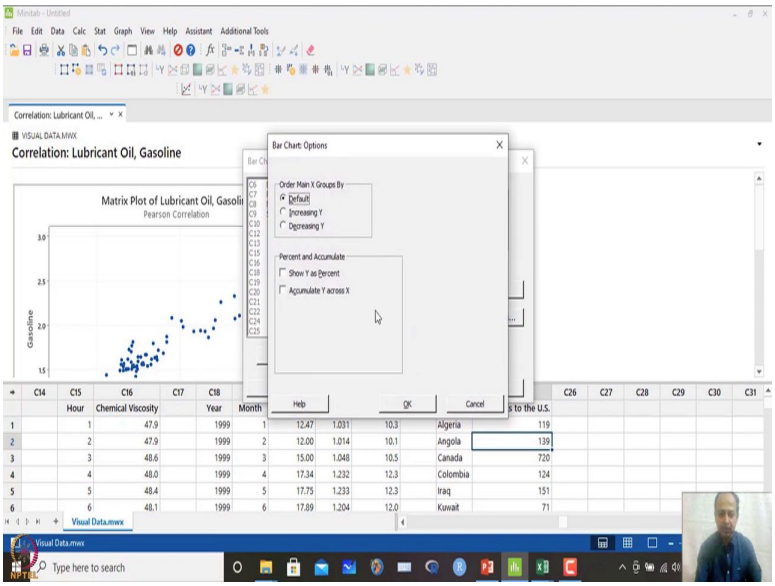

And chart option over here, nothing you have to do scaling and all is not required.

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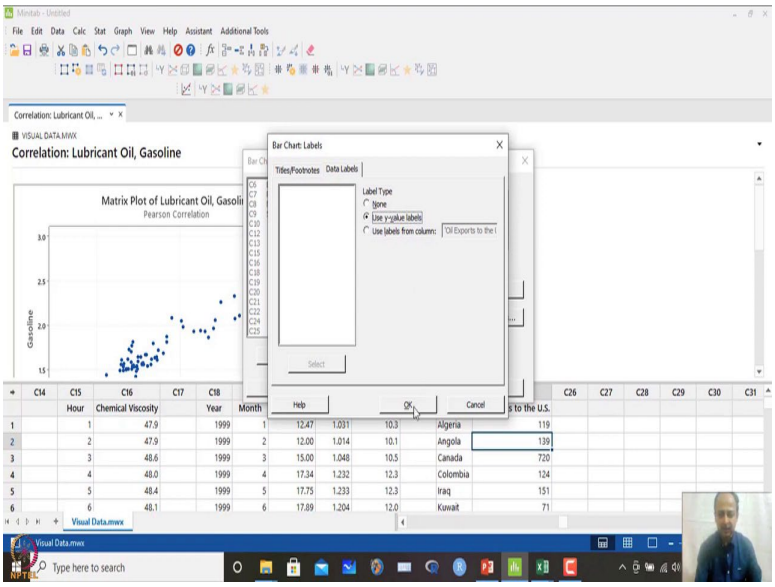
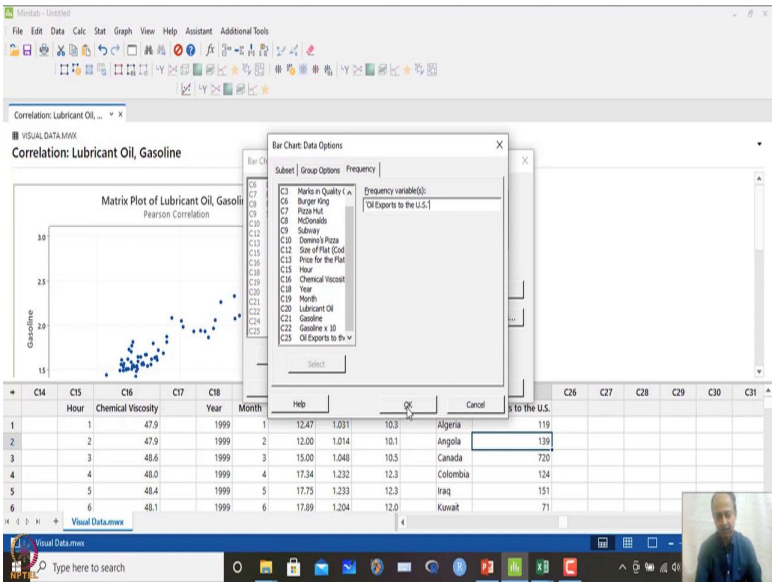


Data labels, if you want to see. So, I am using either you use none, or the frequency can be shown, so how many observations like that. So, this, this can be seen like that. So, what is the value of that like 139 for Angola, 139 will be plotted on top of that will be written on top of that on the y-axis ok.

(Refer Slide Time: 14:38)



So, data option over here which is the data options. So, in this case, frequency can be used and I have taken oil export as the frequency variable over here.

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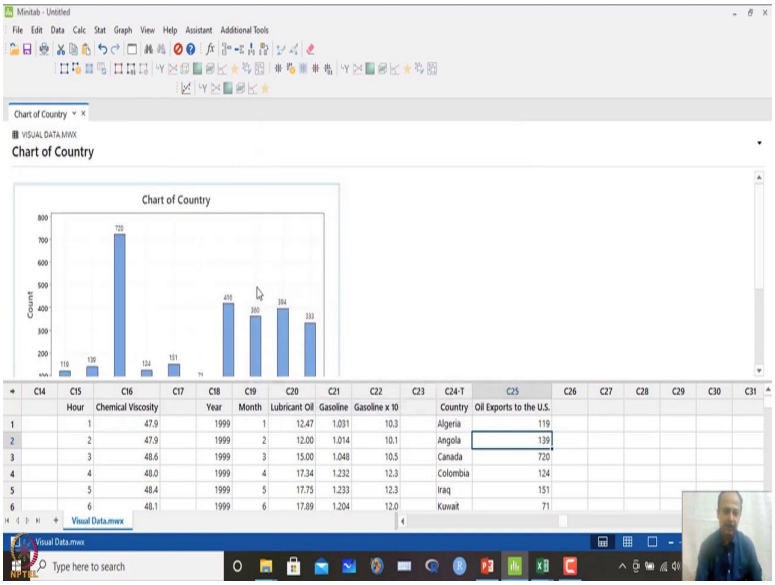
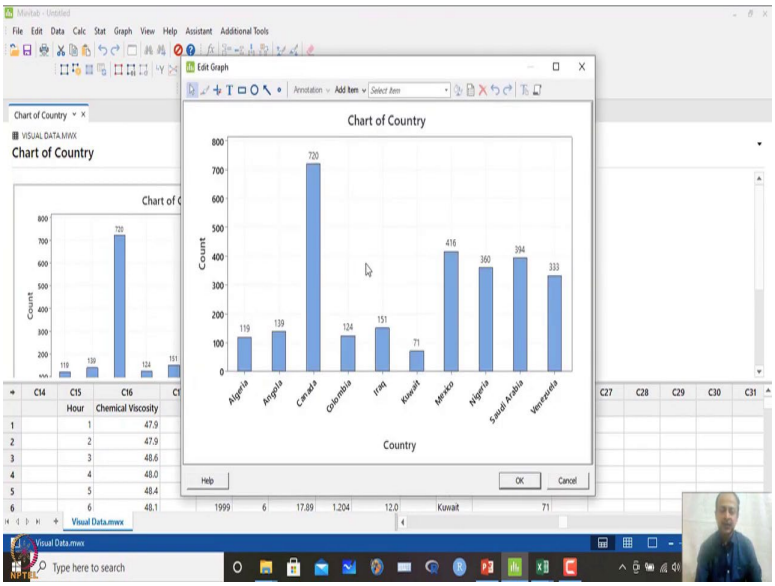


So, in this case, if you click ok what will happen is that you will get this graph over here which shows bar diagram over here.

(Refer Slide Time: 14:52)

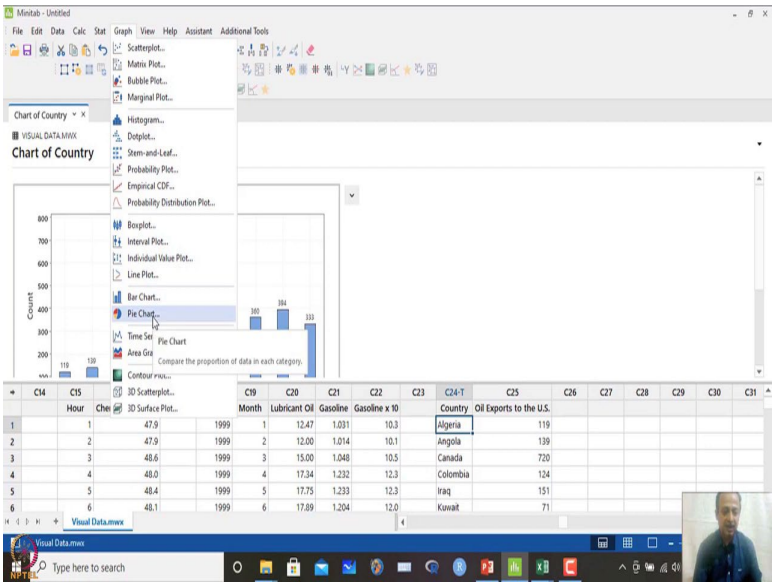


Canada is having the maximum over here – 720 is the values, and others are like this. So, this can be plotted like this way also ok. So, this is bar diagram. So, in that case, you do not see that like histogram that all are congested means there is no gap between one bin with the other bin over here because this is discrete or categorical units on the x-axis.

So, in that case, this bar diagram will be will have some space in between like that. So, this is one of the reasons why we can differentiate which is a bar diagram, and which is a histogram like that. Histogram will not have any gap, but bar diagram will have this gap like that.

So, and this can also be placed in a different way like pie chart like that. So, this is the total amount. And how much percentage one is consuming as compared to the other one like that like market share when you are showing that one in a pie diagram also is possible. So, this same data I will plot in pie diagram which sometimes helps in a data interpretation. So, I want to see Algeria how much is the oil export as compared to the other one. So, some comparative analysis can also be done.

(Refer Slide Time: 15:59)



Then I use a different types of graph which is known as pie chart like that.

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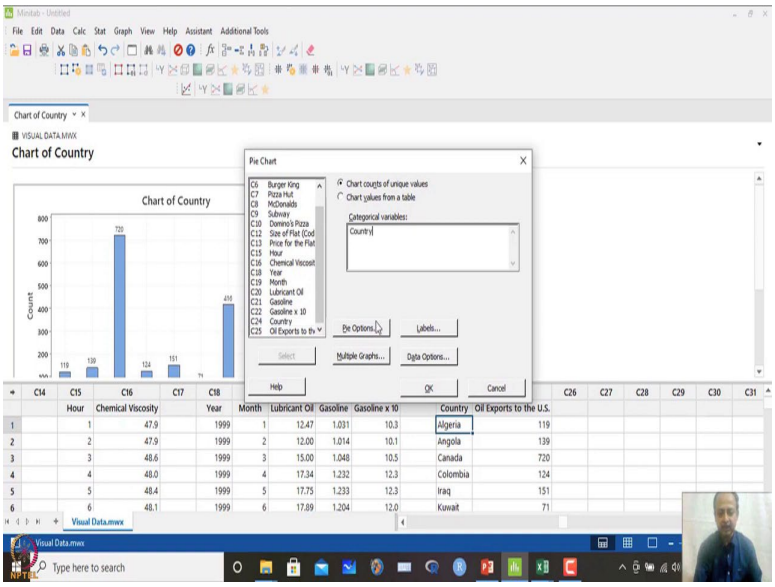
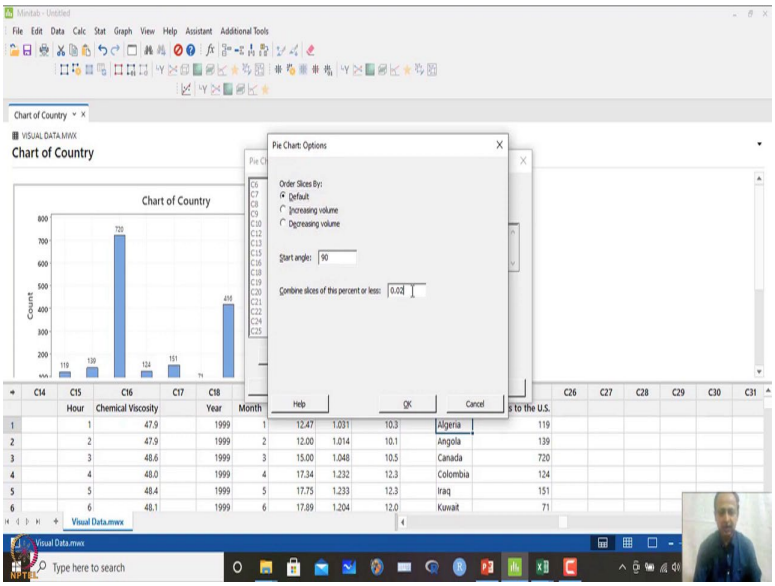


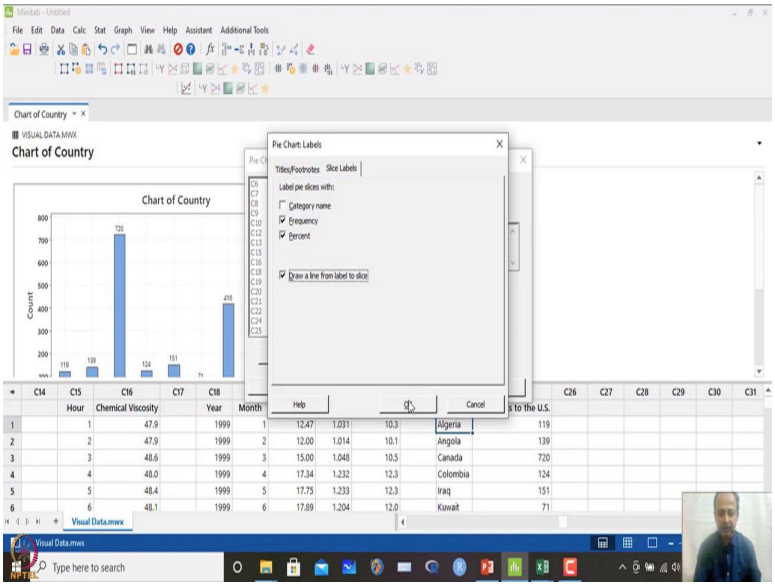
So, in this case, pie chart what we can do is that we have to identify what is the categorical variable which according to which we will stratify. So, I will mention country over here.

(Refer Slide Time: 16:15)



Similarly, pie option over here something we will keep it as default. So, MINITAB will keep it as default. So, combine slice this portion either we keep it 0 or we and this is MINITAB default 0.02 anything less than 0.02 will be combined together like that slide will be combined like that.

(Refer Slide Time: 16:35)



So, I am not going to I am using the default option over here. So, label, if you want to see the labels over here, I can click any of this.; frequency, you want to see percentage, I am interested in percentage. So, I want to see both frequency and percentage let us say. If

you want to see the names of that also that is possible, but we have. So, draw a line from label to slice that is also gives you some visual impact like that.

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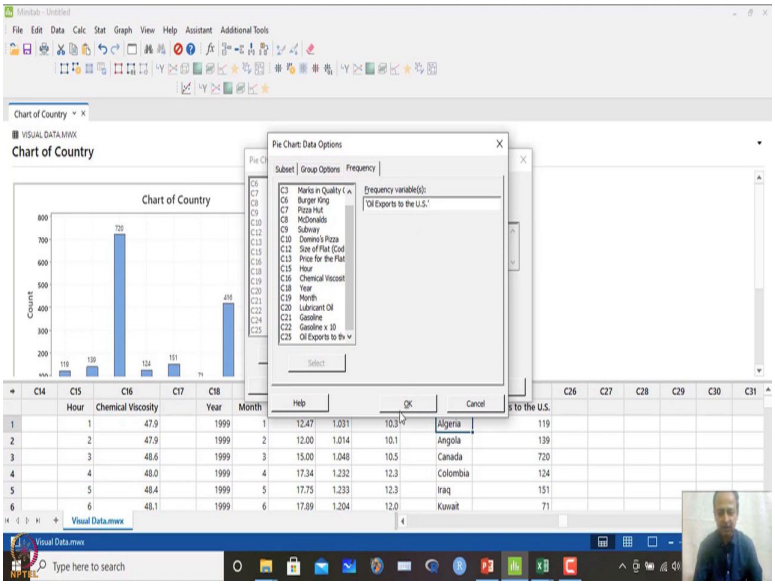
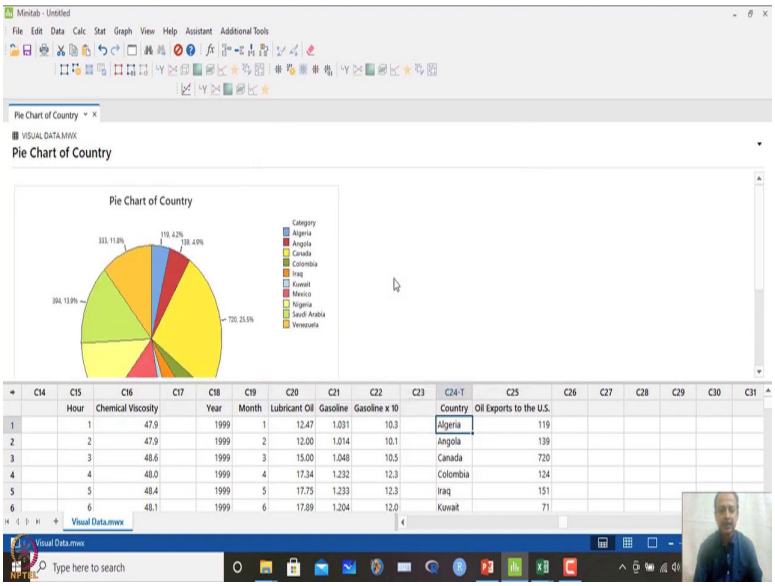


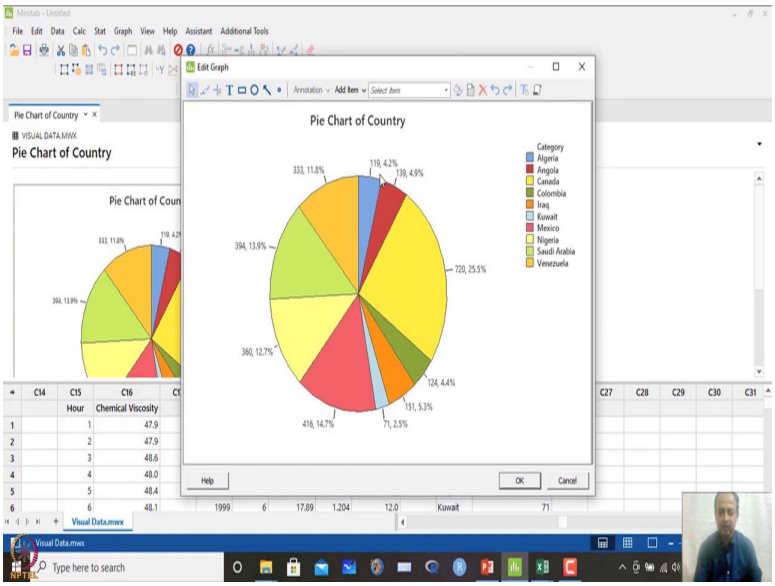
So, in this case, data options frequency over here. So, here already it is taken automatically. So, I will give again oil. If it is not there, you just double click that one. All oil exports is the variable which will be used for this pie diagram like that. I click OK over here and then I click again OK over here.

(Refer Slide Time: 17:16)



What you get is that this diagram you get over here.

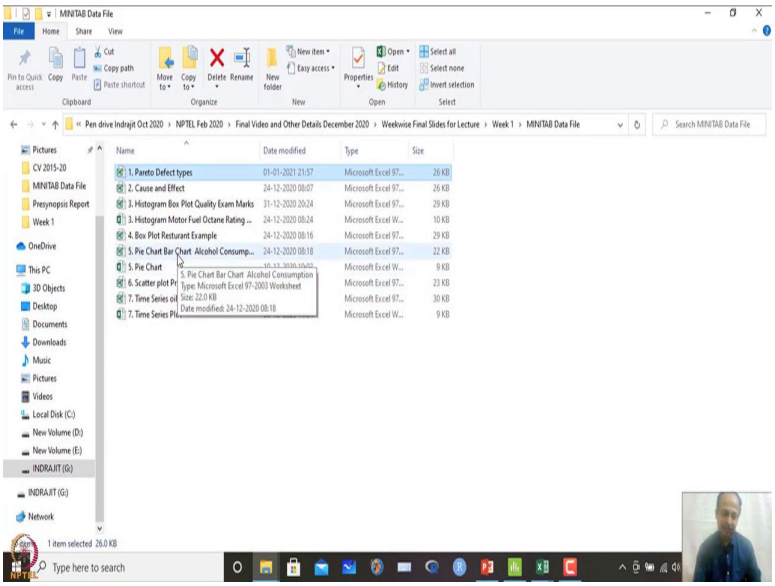
(Refer Slide Time: 17:18)



So, not only the colour of this. So, this is Algeria, so it is having a frequency or value is 119. It is contributing about 4.2 percent. So, maximum contribution is let us say 12 point this is this may be 25.5 this is the biggest one slice that you can see. So, in a cake slice with different colours you can think of that.

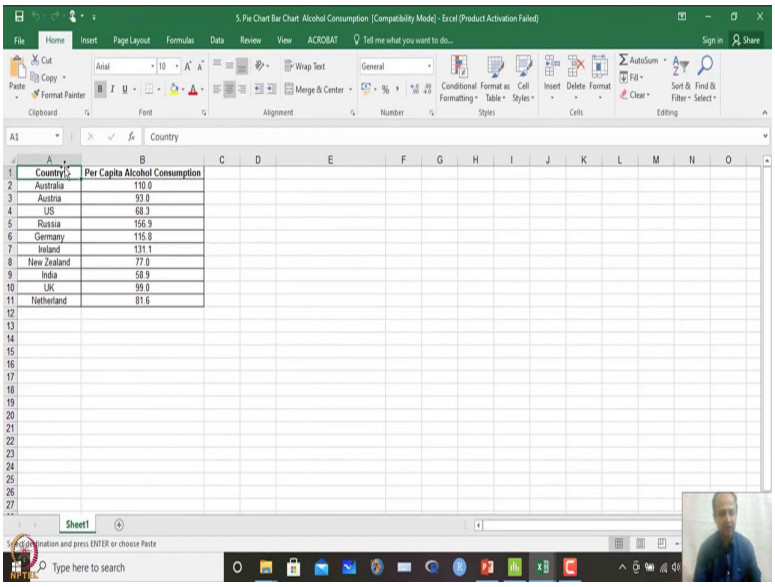
And this is the way I can think of that which country is contributing how much like that for this specific scenario over here. So, in this case export scenario. So, in US who is contributing how much, so that we can differentiate like country wise also differentiation is possible like that ok.

(Refer Slide Time: 18:05)



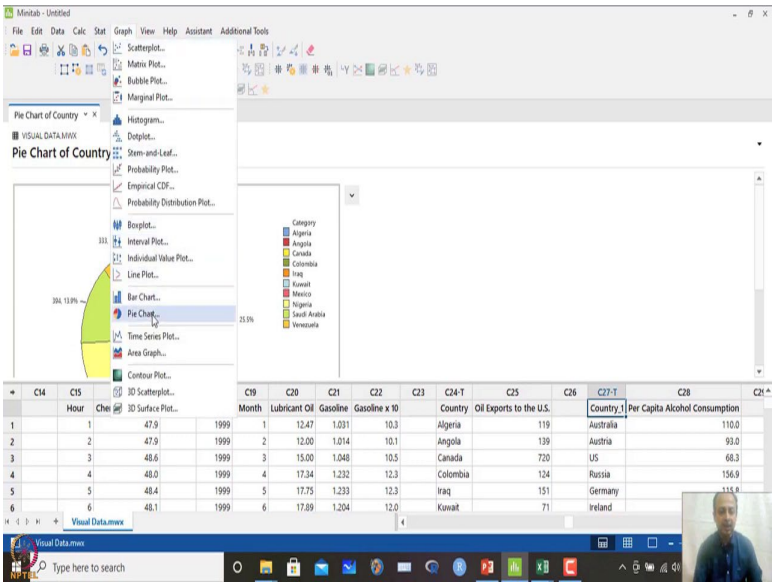
So, similarly, we can draw a another graphical interface over here.

(Refer Slide Time: 18:10)



So, this is same so, country wise per capita consumption. So, this also we can just illustrate again for your benefit like that.

(Refer Slide Time: 18:20)



I am just copy pasting this one. And in this case, and you see the variable name country is already taken. So, next time MINITAB automatically defines a new variable which is country dash underscore 1 like that. So, in this case, what happens is that MINITAB if there is a same name and MINITAB will automatically change the name and place it like that. So, this is a different variable, we will understand. So, again we will go to graph and then go to pie chart like that.

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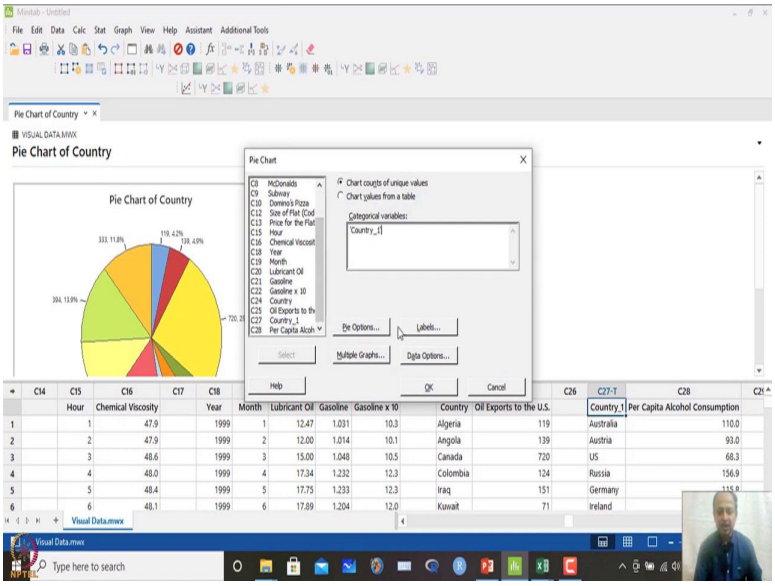

And instead of country, we will take country 1 like that and labels over here.

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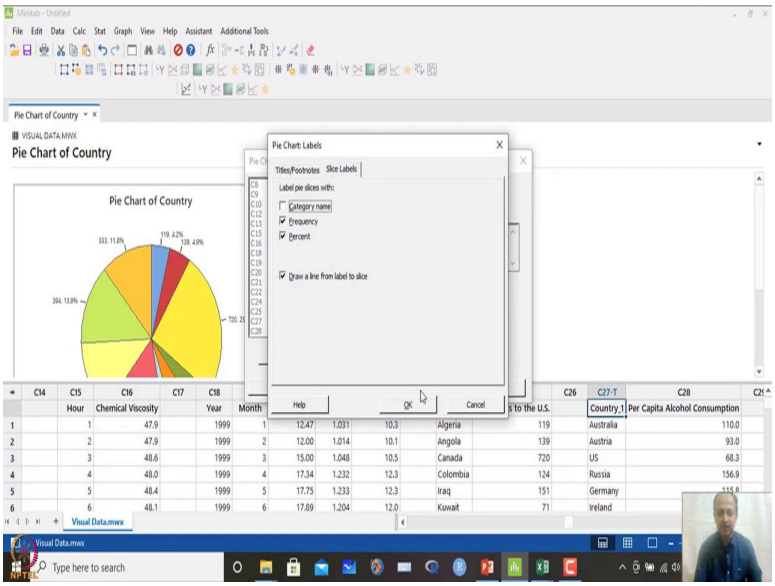

What we will do is that slice this is frequency is ok.

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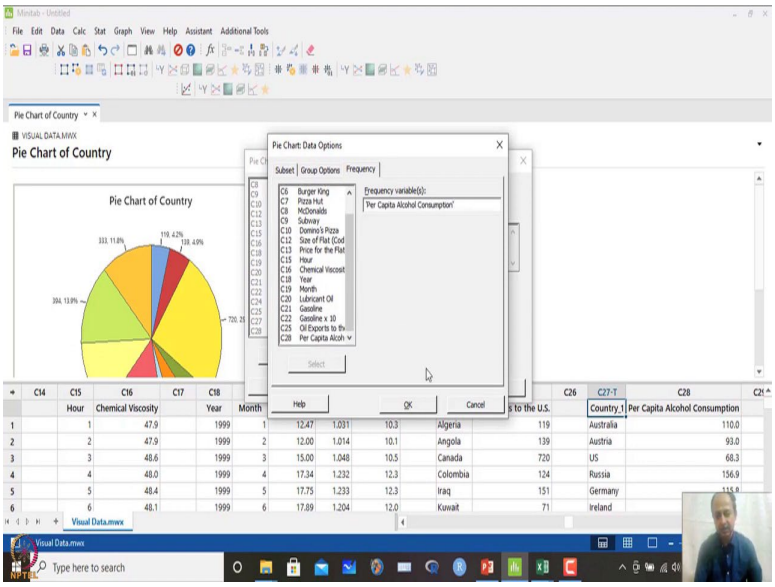

And then data options over here, frequency will be different. So, in this case, frequency will be per capita alcohol consumption let us say. And this click, I will click OK and OK.

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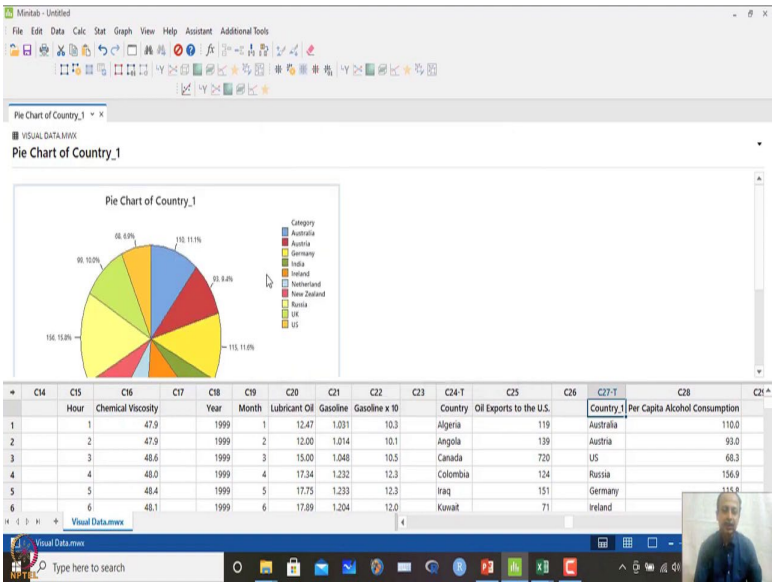

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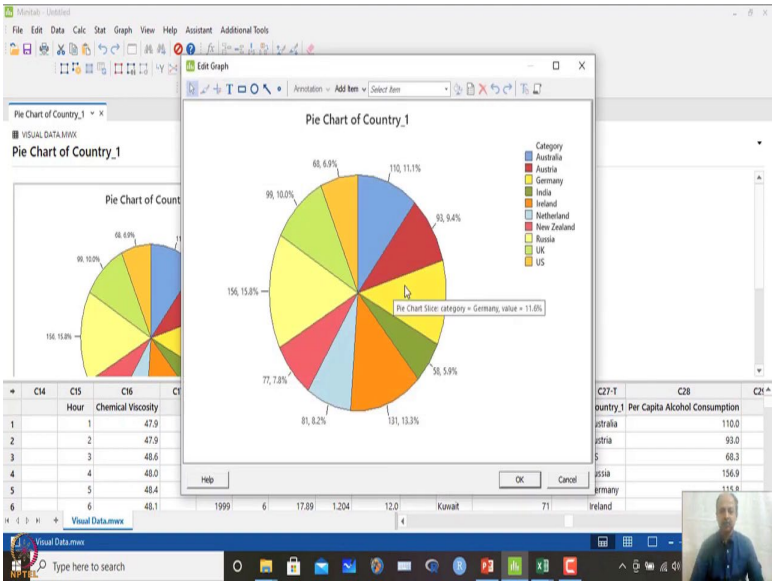

So, this will be the graph which will demonstrate that country wise.

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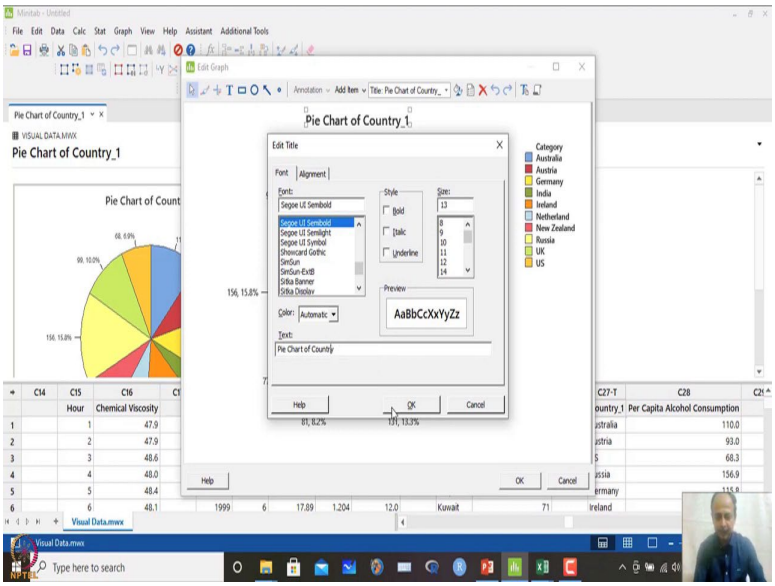

So, then I can change this graphical over here, and then this name I can change over here. So, this can be country like this. So, I can change this one.

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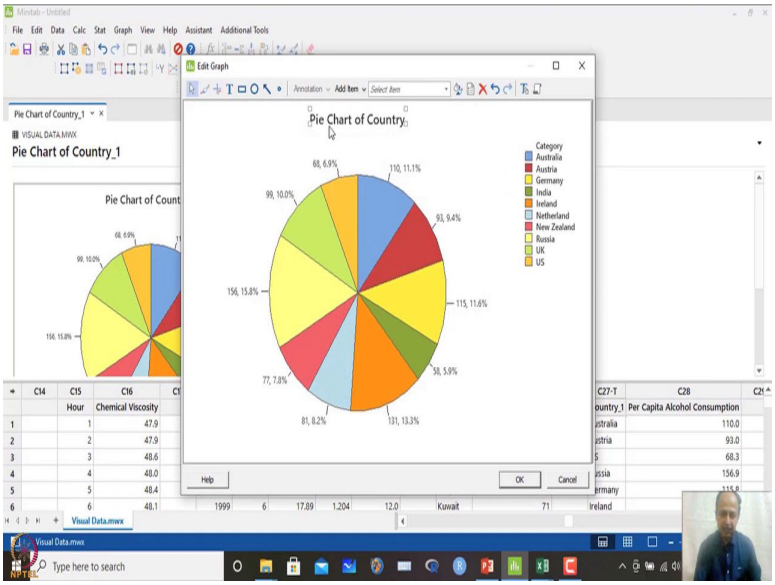

So, all possibilities are there. So, I can change this one. And again I can copy this graph and place it like that. So, when I do that, I can do that. So, if I click OK, it will be changed like that ok. So, this is bar diagram and pie diagram which is also used in quality sometimes in certain scenarios like that whenever I have a categorical data, and I

want to see the classifications like that. This is another option. The same thing also let us try to see one another diagram also used in this case which is known as Pareto diagram.

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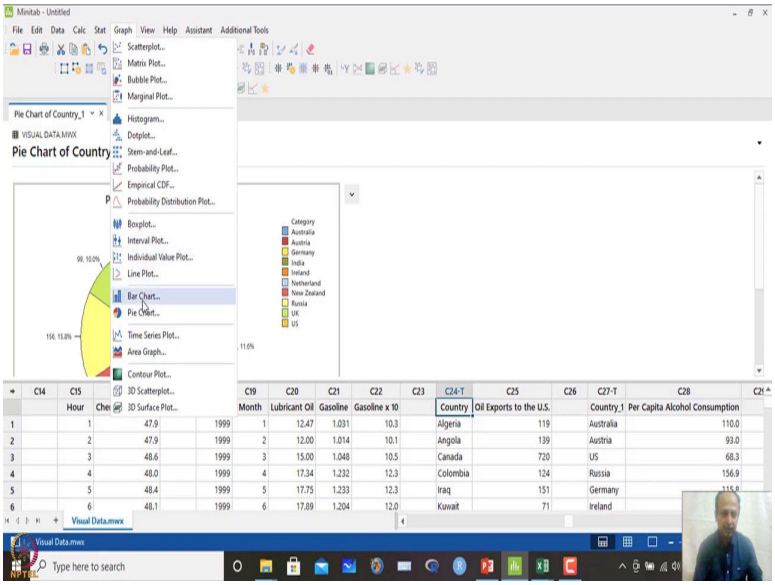

So, I want to see that. So, I have drawn the bar diagram what you see is that I have drawn the bar diagram over here.

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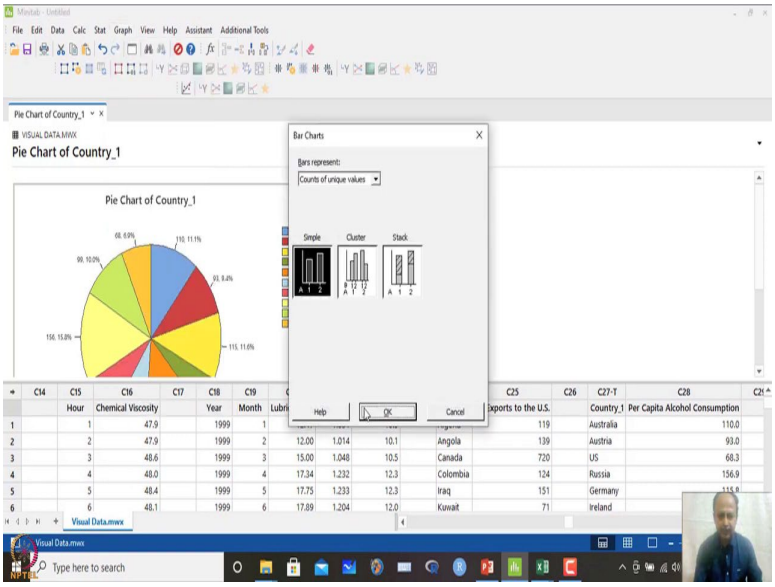

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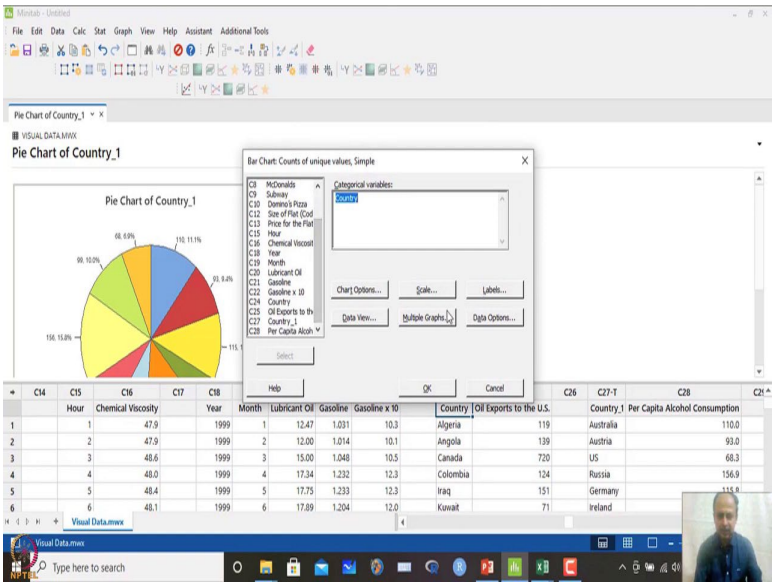

And, in this case simple bar diagram. So, this is country wise.

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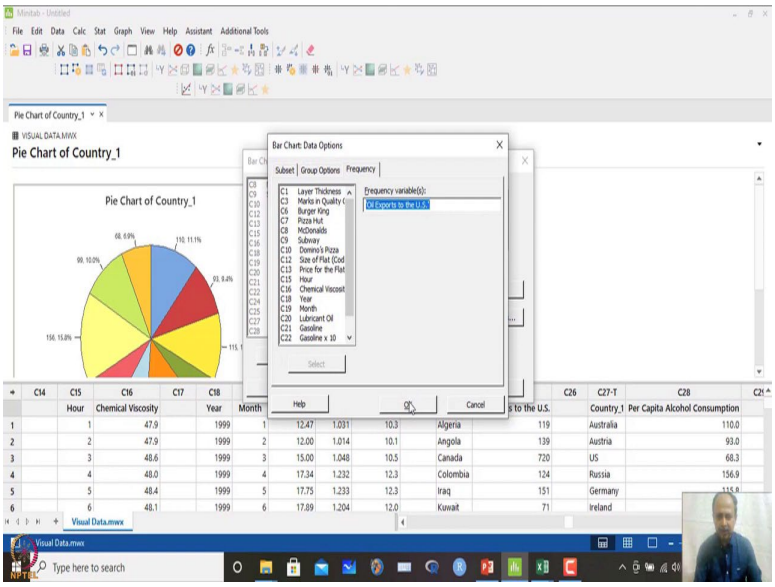

And then let me see the data options what I have taken over here.

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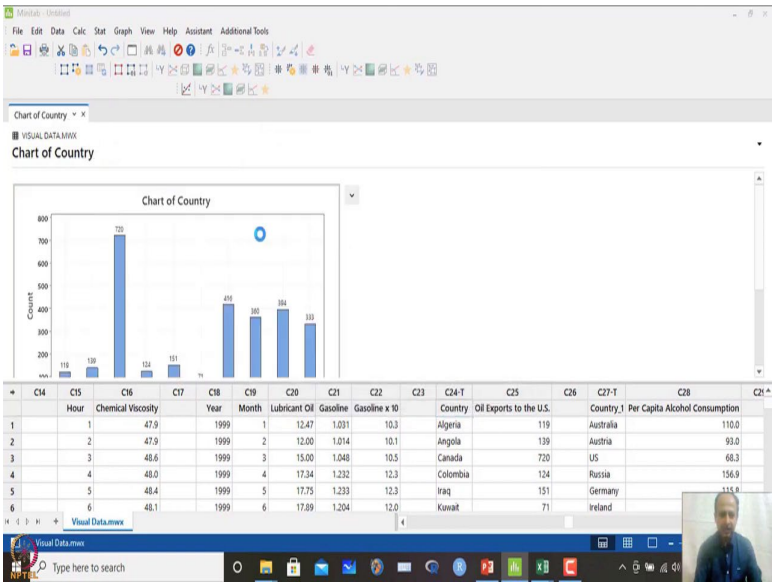

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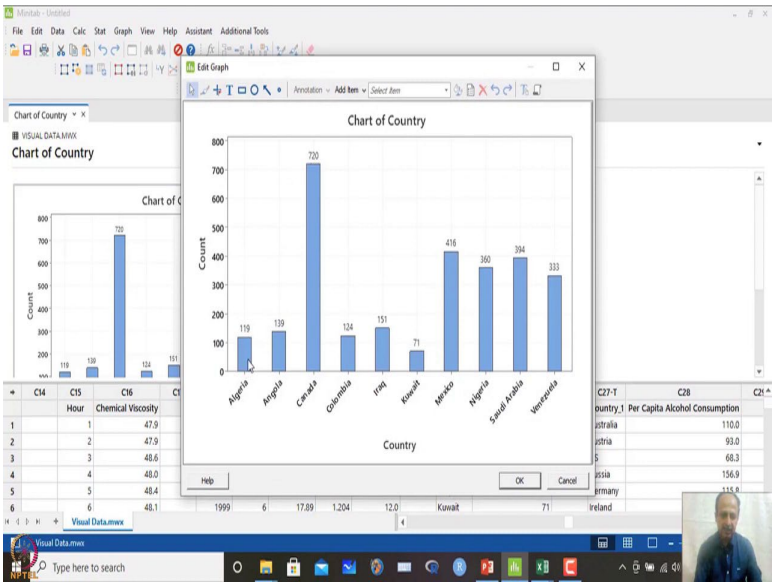

So, oil export like that. So, when you draw the bar diagram what happens is that you see that it is scattered it starts with lower value over here Algeria. So, this is randomly plotted like that. So, one suddenly has gone up. So, this is the maximum one. So, in this case, sequence of this is not showing means it is not starting from highest to lowest values like that.

So, it takes arbitrarily any other. So, bar graphs can be drawn arbitrary like that. So, if you want to make it systematic like that, and see from which is contributing which country is maximum, then minimum like that.

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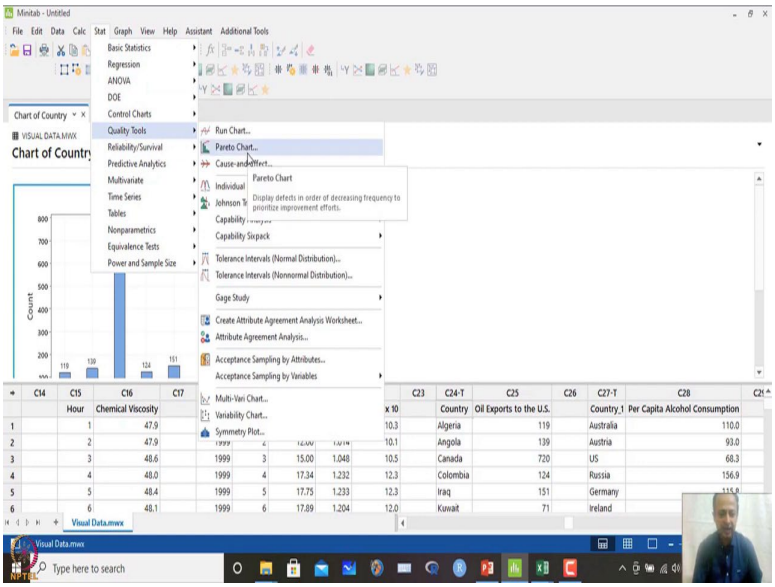

So, in descending order if you want to see like that, so this can be also plotted like that in one diagram which is known as Pareto diagram. You may have heard of Pareto diagram and that is also an important tool in quality. So, this can be. So, it will start with highest to lowest like that. So, that is also possible. And this Pareto diagram is available in quality tools in MINITAB. And when you go to this quality tools, you have a Pareto chart option like that.

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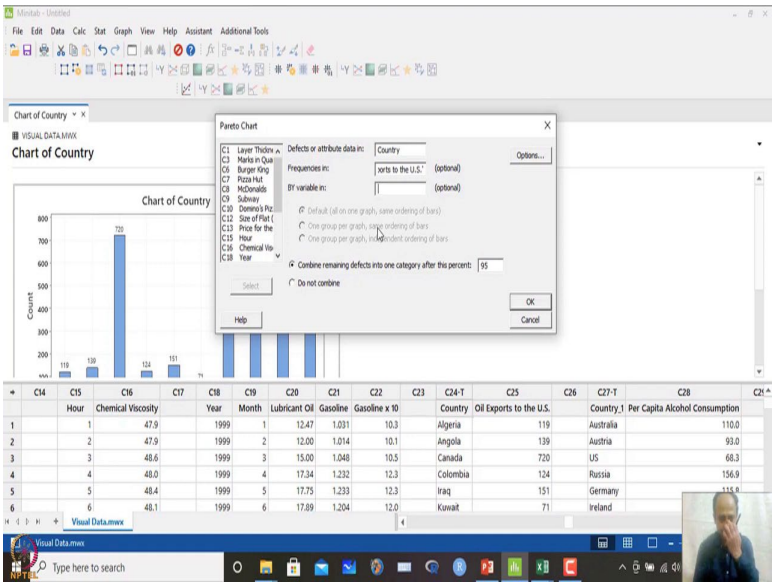

So, I will use the same graphically who is contributing maximum, how much percentage it is contributing. So, I will go to this Pareto chart option. And what I will do is that, I will go to that country defects this is category is given in let us say country over here. And frequency is given in this what we can take is oil export over here.

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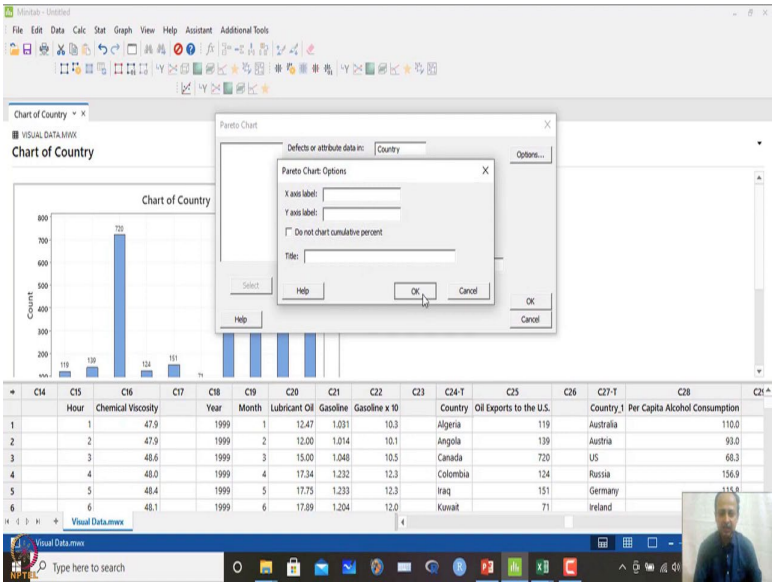

So, this is country and oil export like that. Combine this. Any options you can label this one, you can title that one that you can just see. So, I am combining anything more than

95 percent like that combined into one category like that. So, this is by default MINITAB text.

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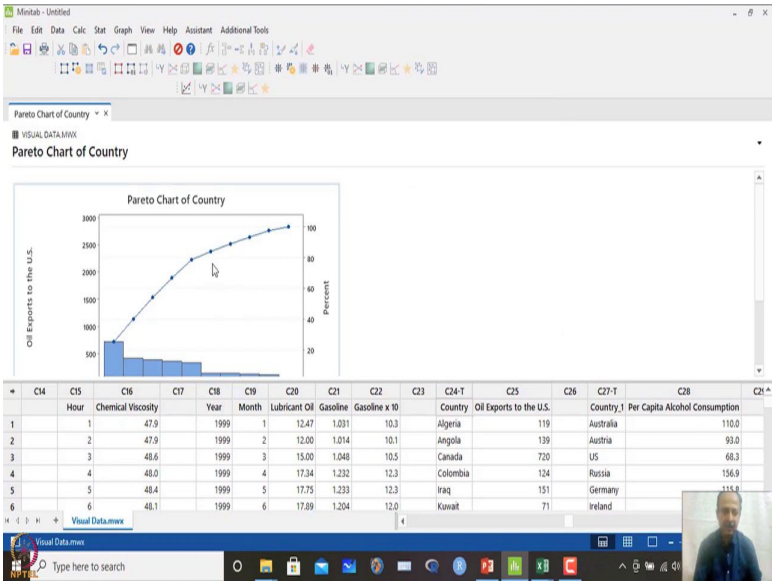

So, when you click ok, what will happen is that this type of graph you will see.

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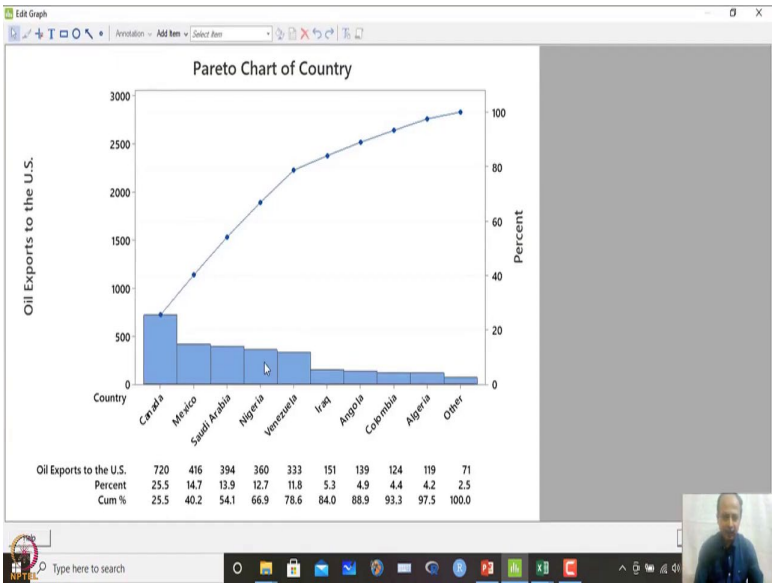

Where from the highest value to lowest value some descending order it will show, so Canada. And it will also show you what is the contribution, so Canada is contributing is about 25 percent of the exports like that. So, value is given, percentage is given, and cumulative percentage is given also.

So, what is cumulative percentage? That means, Mexico and Canada combined, how much they are contributing? About 40 percent like that. Then Mexico, Canada, Saudi Arab, it is about 54 percent. So, cumulative percentage will also be given over here. And overall total percentage will be 100 anywhere like that. So, this is the cumulative percentage axis what you see over here. So, this is moving like this. And this is the highest category.

And this analysis is sometimes used when we want to prioritize in quality that which type of problem I should tackle first, because there can be n types of problems which problem I should solve first to resolve the process to be excellent. So, in that case, which problem I should take.

So, if you see over here in this Pareto analysis also that 80 percent of the problem is contributed by 3, 80 percent of the exports is contributed over here by 5 countries like that up to Venezuela we can think of 78.6 approximately like that; others are contributing very less like that. So, 80 percent is contributed by 5, and rest of the 5 is contributing very less like that. So, that way we can interpret. And this Pareto chart analysis can also be used in quality analysis.

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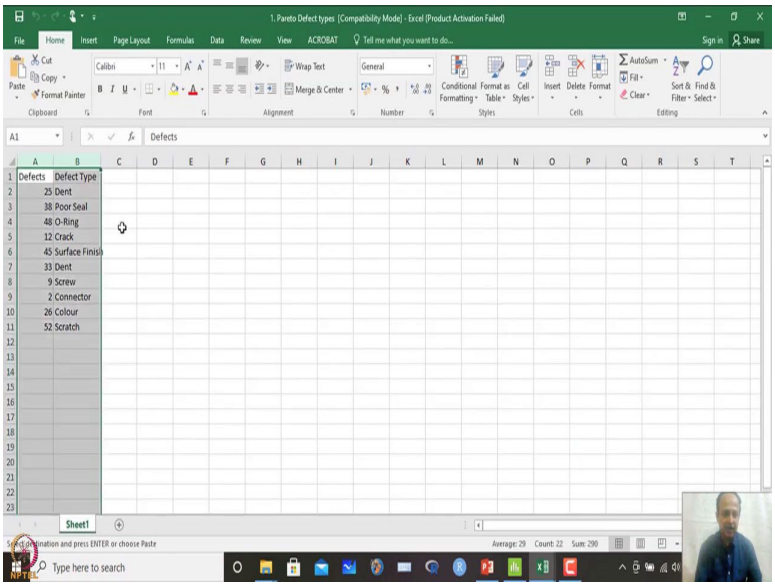

So, let me take an example to illustrate that one. So, let me take an example where I have defects, number of defects and types of defects. So, in a process you are getting some defects. And we are also categorizing and noting down what is the type of defect

basically. And then what we are doing is that when I have identified the types of defects and I take frequency so for that.

So, you can maintain charts like that in a month, what are the different categories of defect, and what are the frequency of that. So, this is the frequency and category. So, this can be copied. And when you place this one in MINITAB let us say there is this one.

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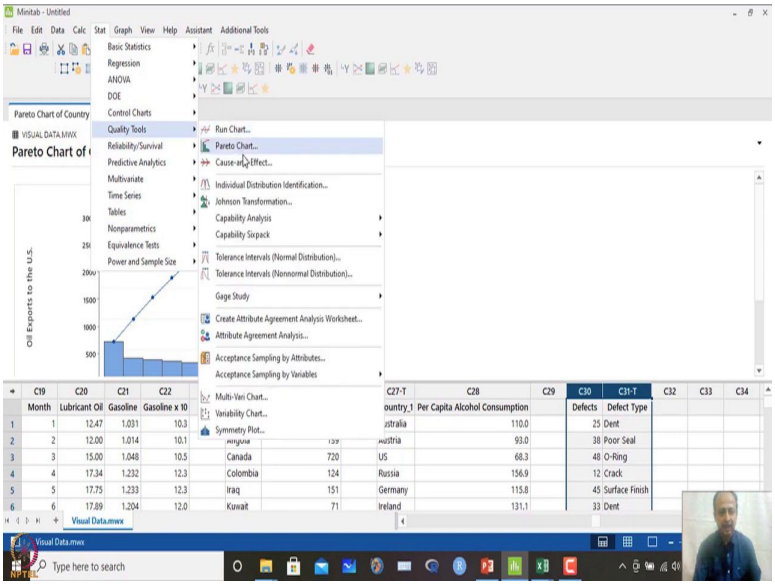

So, I want to I want to prioritize which type of problem I should address first in the process. So, this defect type which problem should be we should eliminate first ok, and find out the cause of this why this is happening like that. So, in quality also this tool is extensively used. So, and Pareto analysis can be used also over here like that.

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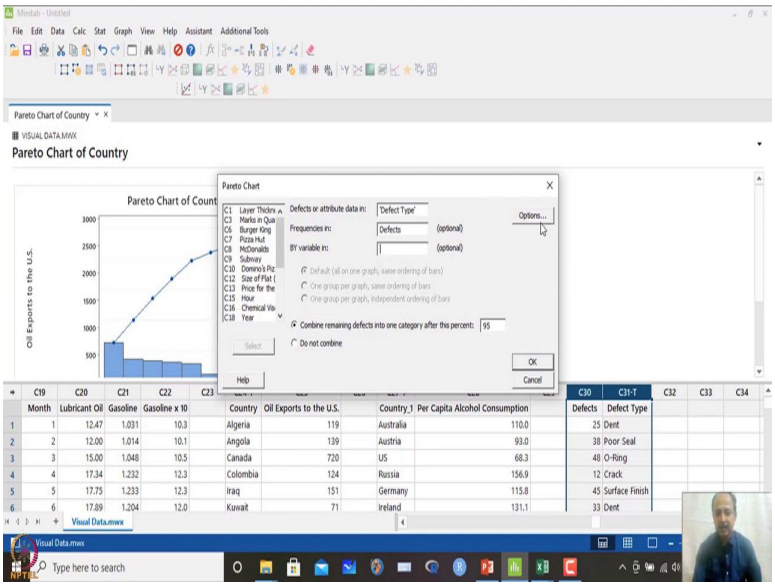

So, if you go to stat again quality tools like that and I want to do Pareto out of this, so instead of country what I will do is that I will go to defect types. And then what I will do frequency is given over here in this is defects, and then other options remain same. So, I am not concerned about that.

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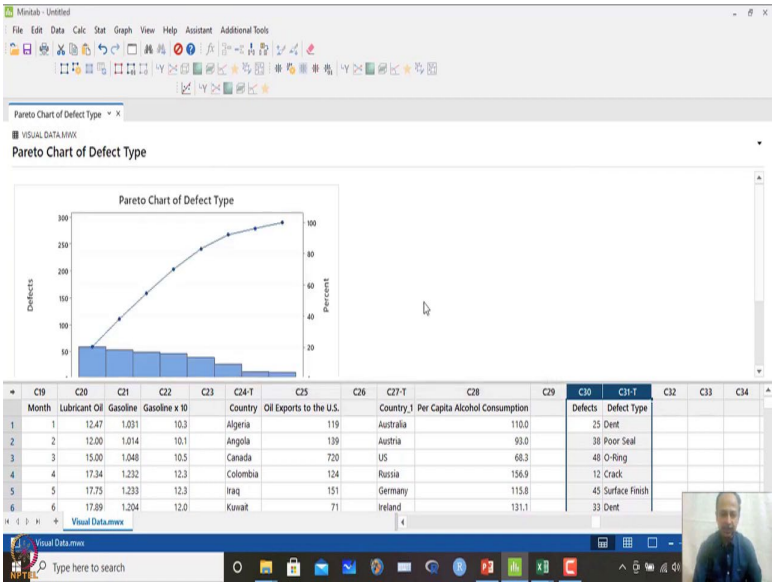

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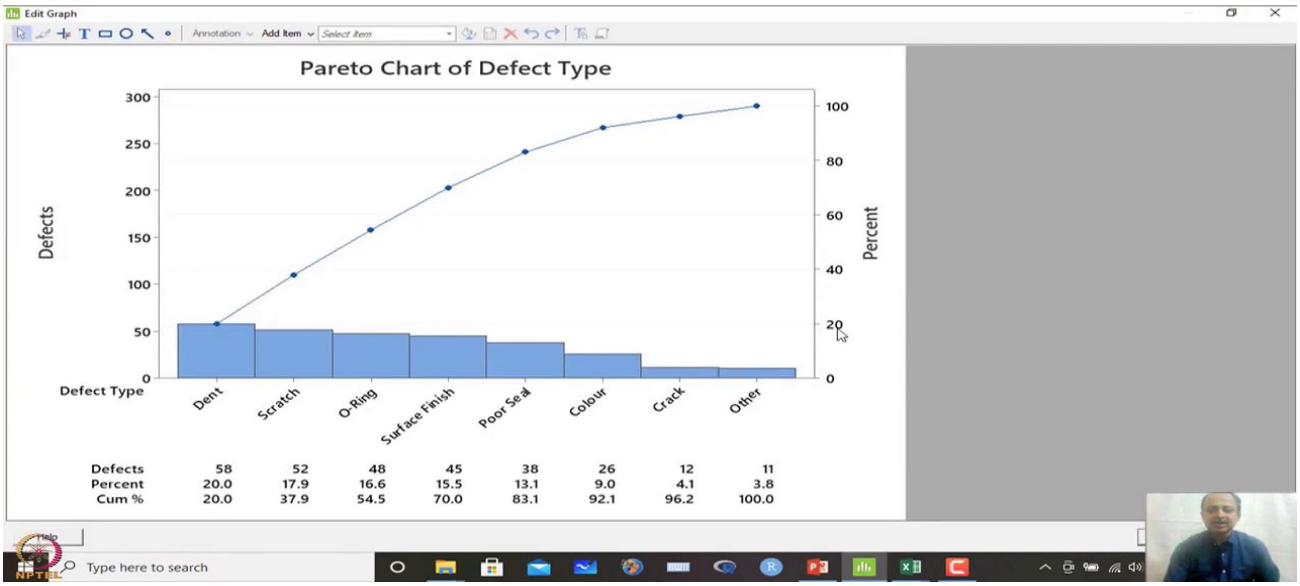

So, when you do this one, what you get is that this is the analysis that was done. So, dent is one of the problem which is contributing 20, and scratch and dent is contributing 37.9 approximately. And O-ring if you include this one about 54, so if you go up to so 80 percent of the problem is if you can eliminate this 3-4-5 types of defects that is coming you will eliminate most of the problems basically.

So, 80 percent of the problem can be solved, 80 percent of the problem will be not there if I can remove the causes for dents, scratches, O-rings problems, surface finish, poor seals like that. So, that will contribute I can element. Other things can be taken off later on like that they are not contributing so much.

So, Pareto diagram gives you what types of defects are coming frequently which is having more frequency, let us tackle those types of problems first and find out the root cause of that and eliminate that root cause. And in quality we have extensive use of this Pareto charting techniques like that. It comes under 7 QC tools quality control tools like that. So, this is one of the tool an effective tool which can be used in our analysis well while we are dealing with quality like that ok.

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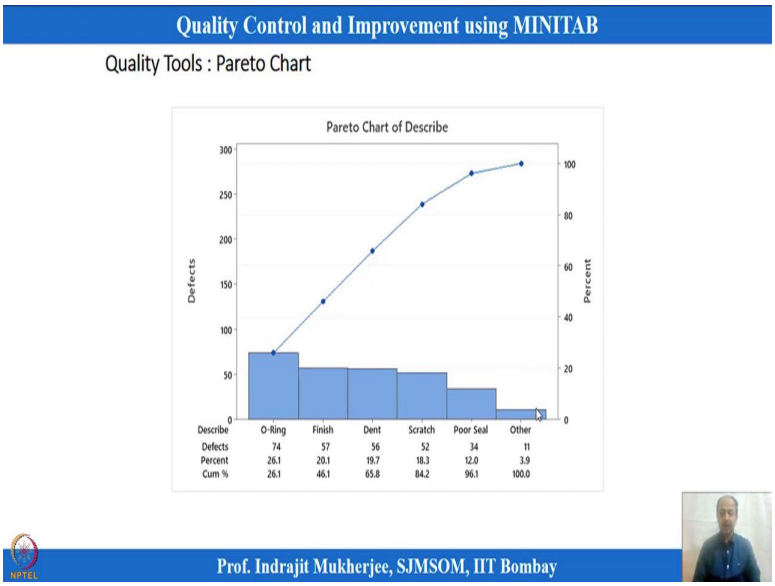

So, this is another important chart over here Pareto tools that we have discussed over here, and what I told is that whenever there is a problem. So, whenever we have a defect type, we have segregated that one let us say. And then what we do is that there is another quality QC tools or quality control tools which is very important which is known as Cause-and-Effect Diagram like that.

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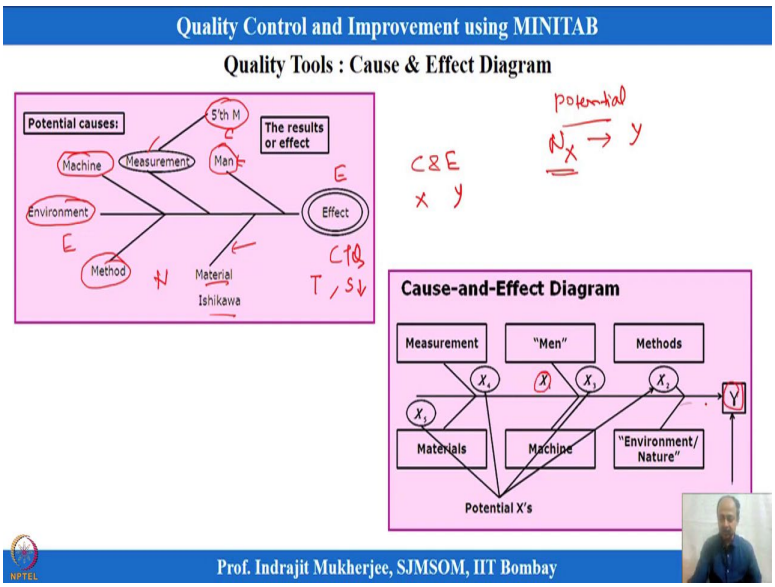

MINITAB has an option also to plot the Cause-and-Effect Diagram over here ok. So, Cause-and-Effect means what over here. So, Cause-and-Effect means this is CTQ. You

can think of if something is going wrong in the CTQ what are the primary cause for that variation or cause that inaccuracy what is happening in the CTQ. So, I am interested to bring it to the target, and also I want variability to be very less towards 0 like that.

So, what are the primary, primary causes for this? So, it can be due to man-to-man problem that is coming. So, maybe skilled operator and unskilled operators like that in a process, maybe we are using a faulty instrument in measurements over here, or maybe the machines that is vibrating.

So that may be the reason, maybe environmental humidity condition and other conditions are influencing the process outcomes like that, maybe the method that we are using over here let us say paint shop and we are using spray types and different types of options are available. So, which method is more effective like that, so there can be that can also lead to variations like that in the final characteristics like that what we are interested CTQs ok.

Then the material can also change. So, material that we are using for processing like that, so that can also be this is known as Cause-and-Effect. So, these are the causes and this is the effect over here ok. So, this is C and E Diagram – Cause-and-Effect Diagram. So, 5 Ms and 1Es what you see over here; 5 Ms and 1 E is over here.

So, this type of Cause-and-Effect Diagram was given by Ishikawa. So, this is also known as Ishikawa diagram, Fishbone diagram. So, many definitions are there. But this shows a Cause-and-Effect Diagram. So, cause is X we can think off, and effect is y we can think of; y is the CTQ and X are the different causes which is influencing.

And this is very important, this tool is very important because this is used for experimentation also. Before we go for experimentation, what are the potential causes that means, which we know that clearly affects some evidence is there that these are the causes which affects the CTQs like that which will be considered.

There can be N number of causes over here and which can fall into any of this 5 M category or E categories like that and N number of variables that can. So, N variables maybe X variables over here that can impact my CTQ or that is Y over here.

So, out of this X condition and all are potential cause basically. Potential means we have some evidence that the influence is y; it is not like brainstorming. And you think about anything over here. So, there should be some evidence or either from engineering conceptualization or engineering concepts or designer indicates, or you have evidence in the process like scatter diagram what we have used that this variable impacts Y.

So, let us consider that variable for experimentation. So, this Cause-and-Effect Diagram is very effective when you select the variables like that for experimentation. So, this is an important tool 5 Ms and one Es. So, what you can see over here is given as X variables and how it is influencing Y variables over here.

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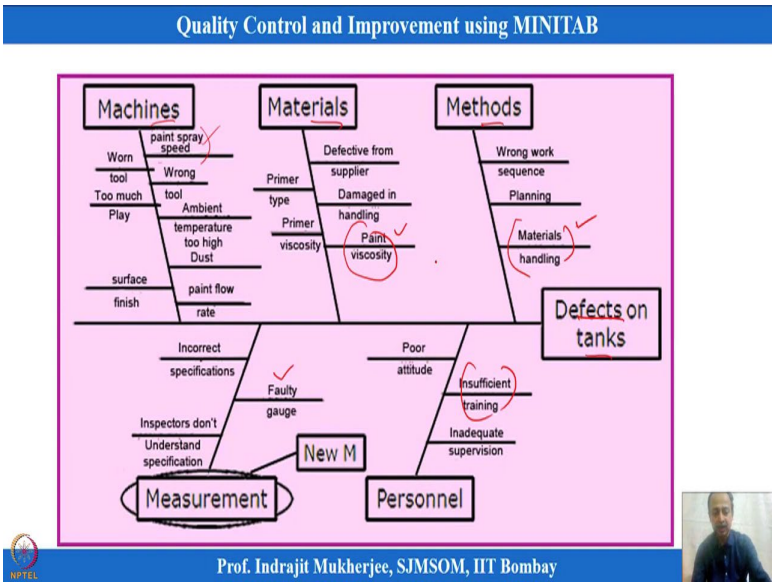

So, one example we can just discuss over here. So, maybe defects in the tanks are coming. So, this may be material handling, the way methods it comes on the methods. So, this can be one of the cause over here. So, may be paint viscosity in materials, we have different types of paint. So, this can be one of the reason like that. These are all potential reasons what I am just indicating

So, from machines may be painting using spray speed. So, this may be one of the variables that impacts the defects or leads to defects. So, there are some evidence what people have seen or from engineering sense, they have some or process sense process people who are or maybe operator is telling that this is a factor which influences and creates defects in the tanks ok.

So, measuring, instrument faulty gauge if you are using gauge means instrument that is used to say ok or not ok like a type of scenario. So, in this case, maybe measurement is also influencing whether it indicates defects or no defects like that, or if it is faulty it will indicate more defects like that, so that can be one of the reason.

So, personal means insufficient training operators who are doing that inspection or they are not trained like that, they are misleading, they are giving which is not a defect they are indicating defects like that that can be one of the reason like that. So, these are all reasons causes what you see over here.

And we have to eliminate each and every causes, so that we do not get defects like that. So, a Cause-and-Effect will give you ideas of potential X that can be considered and we have to eliminate all those causes and block those causes, so that or minimize the effect of the causes. So, that there is little variation in the final outcome like that.

So, we will continue from here and then we will go ahead with other techniques which is important other techniques that is used also in quality of design, all quality or conformance like that ok. So, we will discuss about design failure mode effect analysis also.

And we will cover some more topics over here before we go to the actual quality control aspects and how MINITAB will help you to see behaviour of the process, and how to optimize the process means all those things will be discussed with subsequent lectures like that ok.

So, thank you for listening. We will stop over here. We will start from here in session 7.

Thank you.