Software Project Management
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Lecture - 44
Project Monitoring and Control (Contd.)

Good morning, now let us start this how to monitor the earned value.

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Last class we have discussed about earned value analysis; now let us see how to monitor the earned value.

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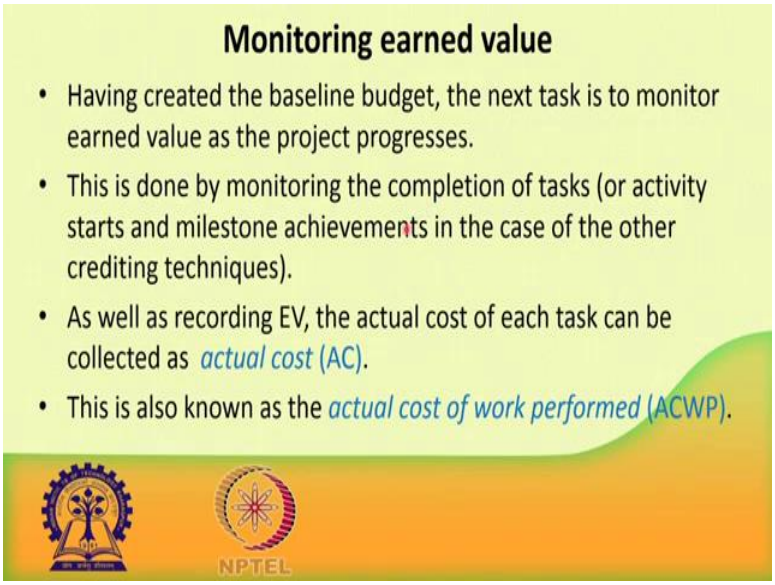

So, after creating the baseline budget; we have already discussed base line budget in the last class. So, after creating the baseline budget the next job is to monitor the earned value as the project progresses through time. So, this can be done by monitoring the completion of the tasks ok; this can be done by monitoring the completion of task or activity starts or milestone achievements in the case of the other crediting techniques.

So now, we have seen that how the earned value can be assigned, how a value can be assigned to the earned value. So, as well as recording the earned value the actual cost of each task also can be recorded; it can be collected which we call it as actual cost or AC. So, similar to a recording EV; the earned value, the actual cost of each task can also be collected this is known as actual cost or AC; this actual cost is also known as actual cost of work performed.

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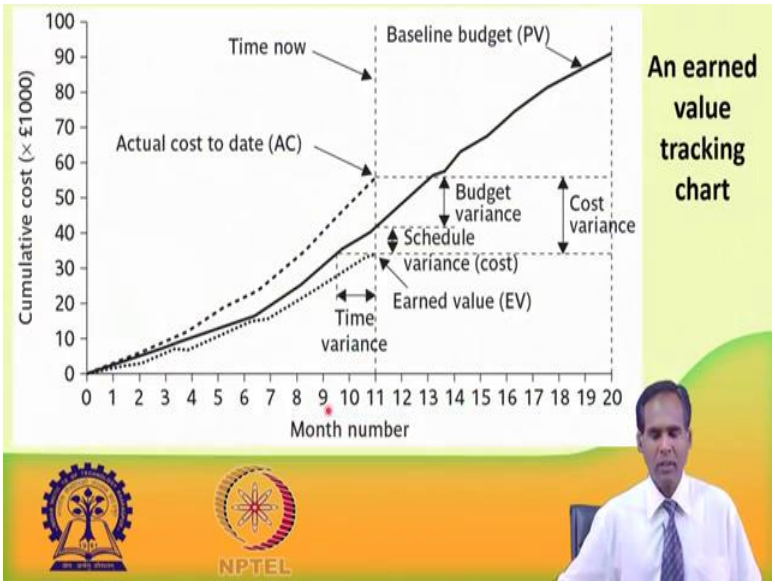

Now, we can use a chart called as earned value tracking chart; this chart can be used for monitoring earned value, we will see that three different lines are shown here; this initial this dotted line represents the earned value.

This middle line; solid line represents the baseline budget which is also known as the planned value and this upper dot line; it represents the actual cost to date up to date. So, suppose this is the time now this middle line this vertical line is the time now or today's time. So, given this we want to measure various parameters; you can see that in x axis; we have taken the month number and y axis we have taken the cumulative cost may be in terms of 1000s. So, you can see that the bottom line which represents the earned value and acts; this is the today's point.

So, and it was the earned value, but what was the planned value? You can see the corresponding planned value is here. So, this difference; that means, what is the planned value and what is the earned value difference between this; it is known as what you can say scheduled variance which may be expressed in terms of for cost.

Similarly, this difference this is the actual cost and this is; this what we can say earned value. So, the difference between the actual cost and this earned value; this can be known as cost variance. And similarly, here you can see that the work is planned to be finished at this time, but you can see that it is finishing actually; initially, it was planned to finish at near about somewhat a 9.25 months or so and actually it is finished at what 11 months;

so this difference almost 11 minus 9.25 maybe 1.75; so this difference is known as time variance.

So, basically this earned value tracking chart here, it is showing us three variances; the schedule variance; sorry four variances schedule variance, cost variance, budget variance and time variance. So, let us see how you can compute these variances so that we can monitor the progress of a project.

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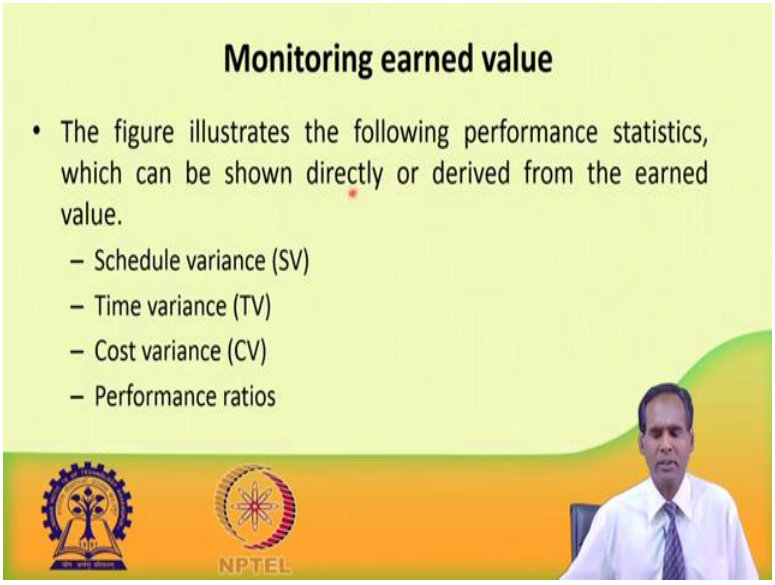

I have already told you this figure illustrates the following performance statistics which can be shown directly or they can be derived from the earned value. Those are schedule variance, time variance, cost variance and we will see some performance ratios; so those all these variances have been shown here. So, this is the; schedule variance that is difference between PV and EV and this is the cost variance; difference between actual cost and this is what you can see this is; this you can say earned value and this is the time variance.

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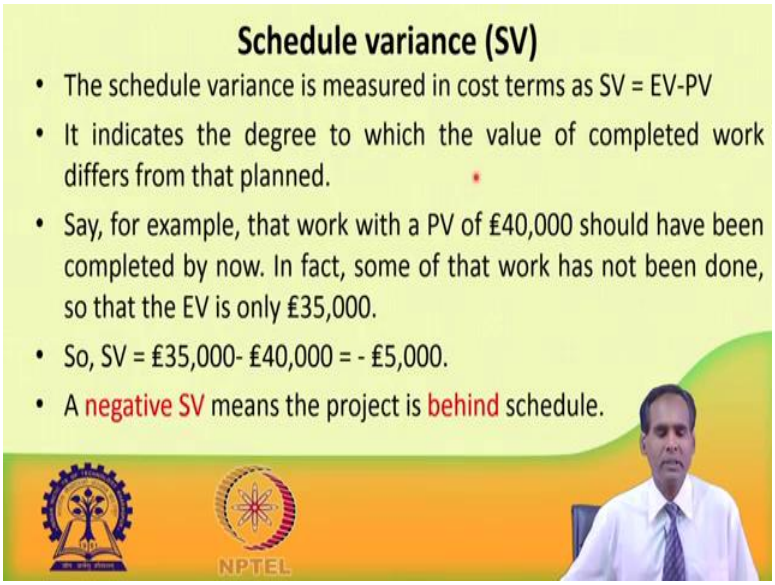

Now, let us define these terms mathematically; the schedule variance is measured in terms of cost. Mathematically we can say that schedule variance is equal to earned value minus planned value.

$$SV = EV-PV$$

What does it indicate? It indicates the degree to which the value of completed work deffers from the planned, what was the planned value and what are the earned value?

So, it will indicate the degree to which the value of the completed work; that means, the earned value; it is differing from what from the planned value. Let us take a small example; suppose a work with a PV of planned value of 40000 pound should have been completed by now; by today a work with planned value of 40000 pounds should have been completed.

In fact, what had happened? Some of some portion of the work has not been completed; so far has not been done so that its earned value as in today is only 35000. So, what does it mean? So, schedule variance we can compute like this earned value minus planned value. Earned value, we are saying 35000 minus planned value is already we have shown 40000 that is minus 5000 pounds, so; that means, it is negative. So, what a negative S V represents? A negative schedule variance means the project is behind the schedule, here you can see actually why it is not 40000? Because some portion of the work has not been done and what does it mean? That means the project is lagging behind the schedule.

So, a negative S V means the project is lagging behind the schedule. So, this I have already shown in the graph that schedule variance usually EV minus P V. So, this is schedule variance; so this is the; what EV, this is the P V. So EV minus PV, it gives what this schedule variance and you can see that a negative; that means, it is what it is lagging behind is this is less. So, this is lagging behind the planned schedule; this is lagging behind the schedule.

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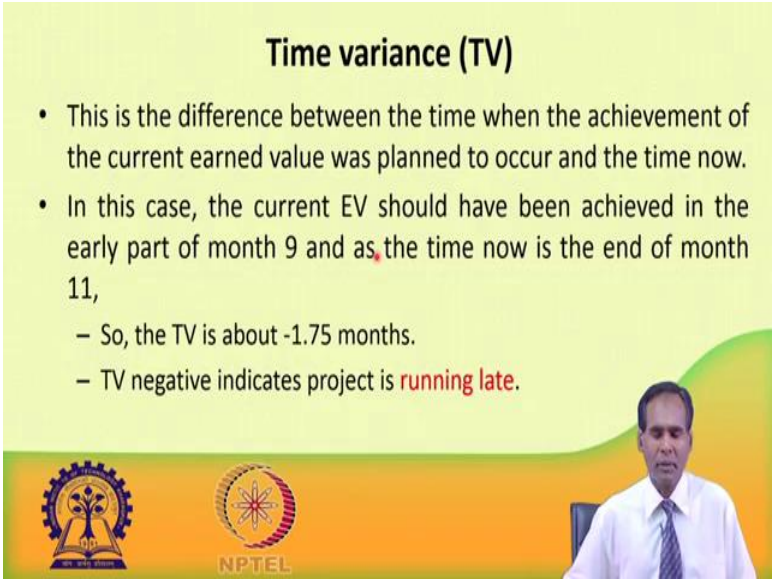

Now, let us see about time variance. So, how time variance you can calculate? So time variance is defined as the difference between the time when the achievement of the current earned value was planned to occur and what is the time current now?

So it is defined as the time when the achievement of the current value was planned to occur, it was originally planned to occur and the time now. So, what you can see here? When to occur and what is the time. So, you can see that this is the current time and if you will see; it was planned to be finished at this time, this is roughly 9.25. So, in 9.25 months it was planned to complete but it is as on today; it is 11th month; it is almost completed on 11th month. So, time variance will be how much? 9.25 minus 11. So, coming to be almost 1.75 minus 1.75; so that is what we do show here.

So, in this case as I have already told you; current EV should have been achieved in the early part of month 9; early part of month 9 means around 9.25, but it is completed on 11 month 11. So, time variance is 9.25 minus 11 coming to be minus 1.75 months; so again

here it is negative. So, negative time variance indicates what? It indicates the project is running late; the project is running late. You can see here that the project it should be completed what by 9.25 months, but so it is completely 11; that means, the project is running late the project is running slowly; it is running late.

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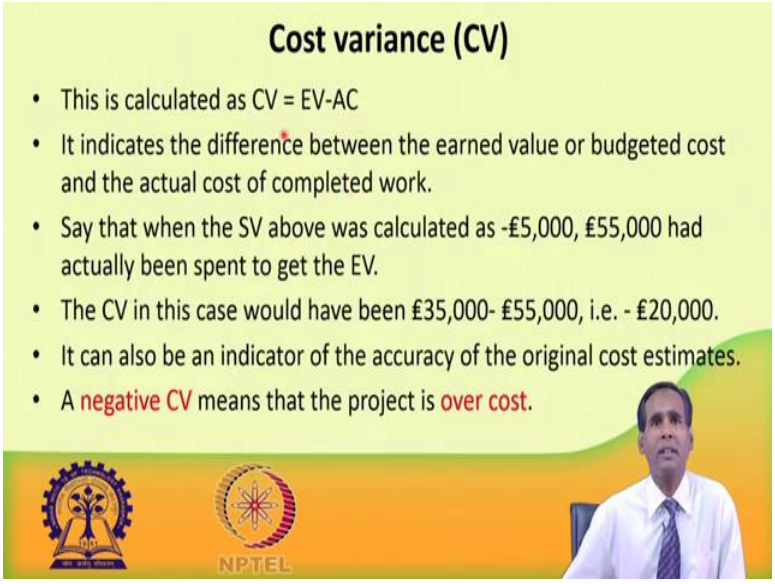

Next variance is cost variance as its name suggests cost variance; it can be calculated as what? We denote it as CV and is calculated EV minus AC from the graph you can see cost variance.

$$CV = EV-AC$$

What is the actual value on today? This point AC and what is the earned value? Earned value is which one? This one, this is the earned value. So, EV minus AC it will give you the cost variance that we have shown here. This is calculated as EV minus AC; what does it indicate? It indicates the difference between the earned value or the budgeted cost and the actual cost of a completed work ok.

So, cost variance is calculated; is defined as the difference between the earned value or the budgeted cost for the completed work and the actual cost of the completed work. So, now so that means, CV is equal to earned value for the completed work minus actual cost of the completed work. Now let us take a small example the previous example let us take; so say that when the S V above was calculated minus 5000 for the previous

program for the previous problem; we have already seen S V is coming to be minus 5000 pound. So, say that the S V above was calculated minus 5000 and actually 55000 pound had been spent to get this EV. So, to get this earned value actually 55000 pound have had been spent.

So, now what will this CV then accordingly? So, CV in this case would be how much? 35000, which is the EV value minus 55000; what is the actual cost? So, this is coming to be how much? So, 35000 minus 55000 coming to be minus 20000 pound; so you can see that again it is negative. So, a negative means what? A negative CV means that the project is over cost, the cost that is budget you have planned; so, it is the it is costing more than that; so it is over cost.

So, a negative CV means the project is over cost had it been positive; that means, the project is below cost it is under control. So, here as we have seen that here negative cost variance means it represents that the project is over cost. It can also be an indicator of the accuracy of the original cost estimate. How accurate was your original cost estimate that can also be indicated by the CV. So, CV also indicates the accuracy of the original cost estimates.

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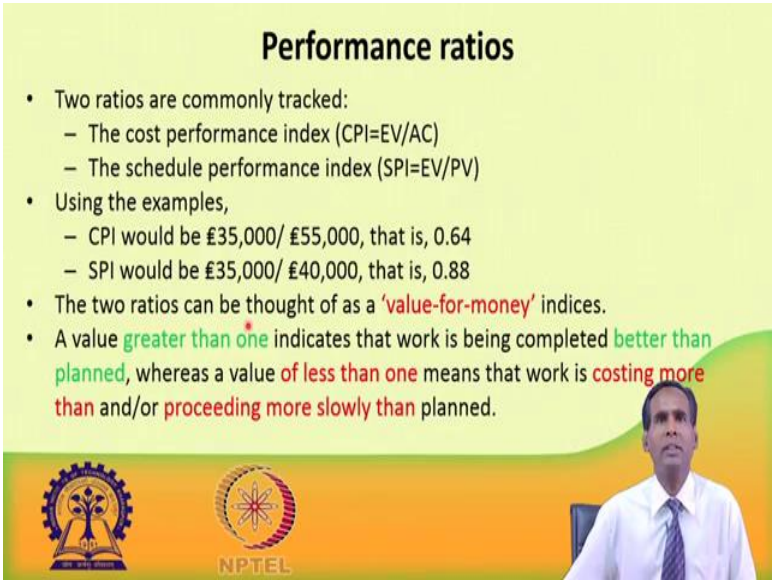

Now, with this three terms cost variance, schedule variance and time variance; we can measure, we can compute some performance ratios. So, we will see two important performance ratios; here two ratios are commonly what tracked here. One is this cost

performance index known as the CPI, this is defined by as EV divided by AC earned value divided by actual cost.

$$CPI=EV/AC$$

Similarly, another parameter is the scheduled performance index; in short we write as SPI which is calculated as earned value divided by the planned value.

$$SPI=EV/PV$$

Now, let us take again the previous example and let us calculate CPI. So, CPI would be how much as these definition? CPI is equal to EV by AC. So, what is the value of EV and AC you can see? In the earlier example, we have seen that EV is equal to here you can see EV is equal to 35000 and AC actual cost is how much? 55000.

So, this is equal to how much? 35000 by 55000 that is a ratio is coming to 0.64. Similarly, what is the SPI? SPI is equal to EV by PV earned value by planned value. So, what is the earned value? Again it is 35000, but what is the planned value? We have already seen earlier planned value is 40000; planned value is 40000; so 35000 by 40000 coming to be 0.88. So, now let us see what is the interpretation, what is the inference? The two ratios, they can be thought of as some value of money indices; they can be treated as that as if this represent the indices of value for money ok. The two ratios can be what considered as can be thought of as value of money indices.

Now, let us see if the value there are two possibilities the values may be less than 1, the values may be greater than 1. A value greater than one will indicate that the work is being completed better than the planned ok. If the values are greater than one, then this indicates that the work is being completed better than the planned whereas, a value of less than one will indicate that the work is costing more than it is planned or you can say earned or the work is proceeding more slowly than it is planned.

So, it is desirable that it should be the value should be greater than one; if it is; that means, it we are moving better. But if it less than one, then two possibilities will be there; the cost is over shooting the project is over cost than what planned and the project is moving very slowly than planned ok. So, in this way these ratios will help in monitoring the progress of the project.

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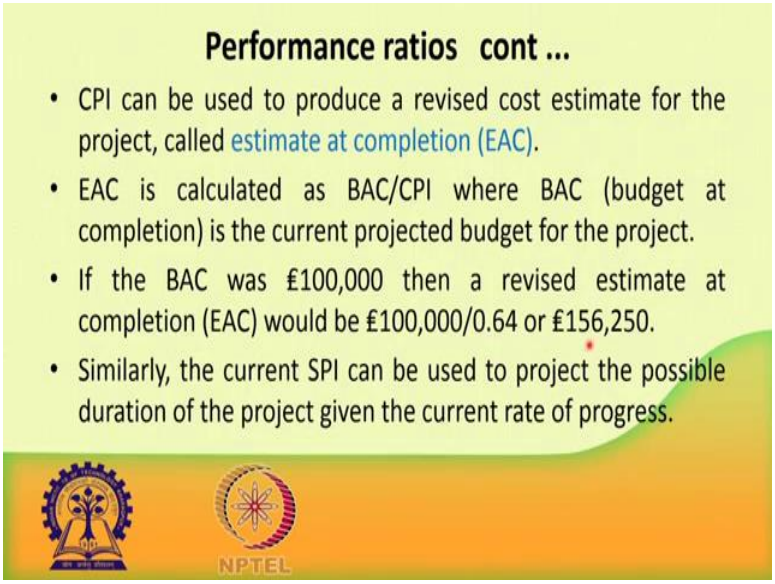

So, the CPI value that we have already seen; here CPI is equal to how much EV by AC or let us see what it is used. CPI can be used to produce a revised cost estimate for the project called estimate at completion ok. The CPI value it can be used to generate a revised cost estimate and updated cost estimate for the project we call this as estimate at completion or a EAC. And EAPs, EAC can be calculated mathematically can be represented mathematically as BAC by CPI.

EAC = BAC/CPI

CPI we have already known earlier and BAC represents budget at completion; that means, it will say that what is the budget at completion? That is BAC.

So, EAC is equal to BAC by CPI; so here. So, BAC is the what current projected budget for the project. So, as you have seen that EAC is equal to that BAC by CPI, where BAC which transfer budget at completion; it is the current projected budget for the project if BAC was 100000. Let us again take the previous example or we can take also this as a may be a fresh one; if the BAC was 100000 pound; then a revised estimate we can prepare by computing EAC; where EAC will be equal to BAC by CPI. So, what is the BAC value? BAC is estimated to be 100000 divided by CPI we have already computed CPI in our earlier case; it is 0.64.

So, 100000 by 0.64 is coming to be this; that means, say initially it was what initially it was the current project budget was almost BAC was 100000, but then as we progress projected as the progress; as the project is progressing; we can revise it we can estimate it observing the current progress and as CPI is equal to 0.64, then you can see that now it is exceeding the 100000 value.

Now, it is 156250; that means, we require more cost, we require more money to complete the job. So, similarly the current value of SPI you can calculate by using the formula you know what EV by PV. Similarly, the current SPI can also be used to project the possible duration of the project given the current rate of progress. You can also what use SPI to what; you can also use the current value of SPI to the or for the project the possible duration of the project given the current rate of progress. So, what is the; what possible duration that it will take to complete the revised duration that it will take to complete the project that also can be computed if you will use this what current SPI value.

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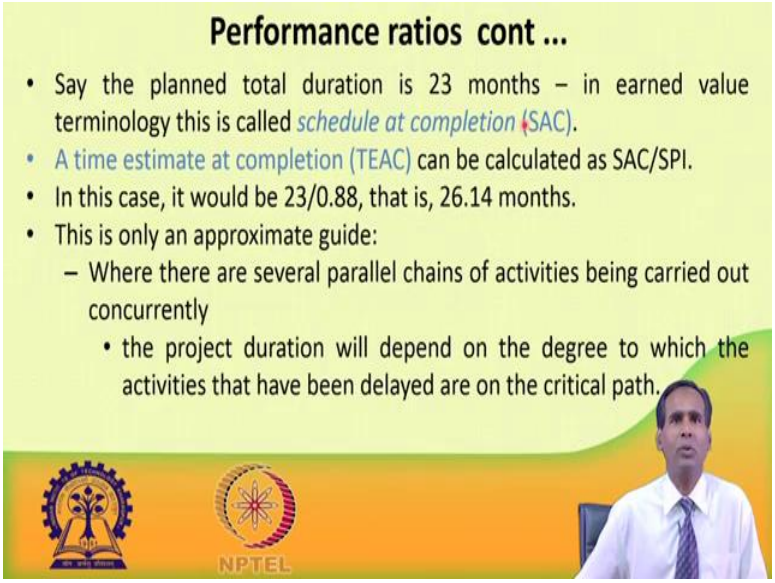

Now, let us see take another performance parameter. Suppose the planned total duration is 23 months; initially it has planned that it will take 23 months to complete the job. In earned value terminology this is called as scheduled at completion ok; say that the planned total duration is 23 months. In earned value terminology; it is called as schedule

at completion using this term scheduled at completion, another parameter can be calculated which known as a time estimate at completion.

What is the estimate for this completion; a time estimate completion a time estimate at completion which is in short is written as TEAC; it can be calculated as SAC by SPI.

TEAC= SAC/SPI

What is the SAC? We have already seen schedule at completion, SPI is that schedule performance index. I think SPI you have already seen here SPI is the schedule performance index.

So, this will be equal to how much? This would be equal to see SAC is given is 23 months and SPI you have seen in the previous slide SPI is coming to be 0.6 0.88; SPI 0.88. So, then this ratio is coming to be 26.14 pounds; that means, from the current progress; we can measure that the work cannot be completed in 23 months; it will require another 3.14 months extra; that means, the revised duration for completing the project would be 26.14 months.

So, this is only an approximate guide; where there are several parallel chains of activities being carried out concurrently. Then; this can be this is not a hand hard and fast rule; this is only an approximate guide, but where there are several parallel chains of activities are being carried out concurrently, then the projected duration will depend on to the degree; to which the activities that have been delayed to which the degree to which the activities have been that have been delayed are on the critical path. How many of them are in the critical the activities we are delayed how many of them are on the critical path; so that factor will also decide that what will be the revised duration.

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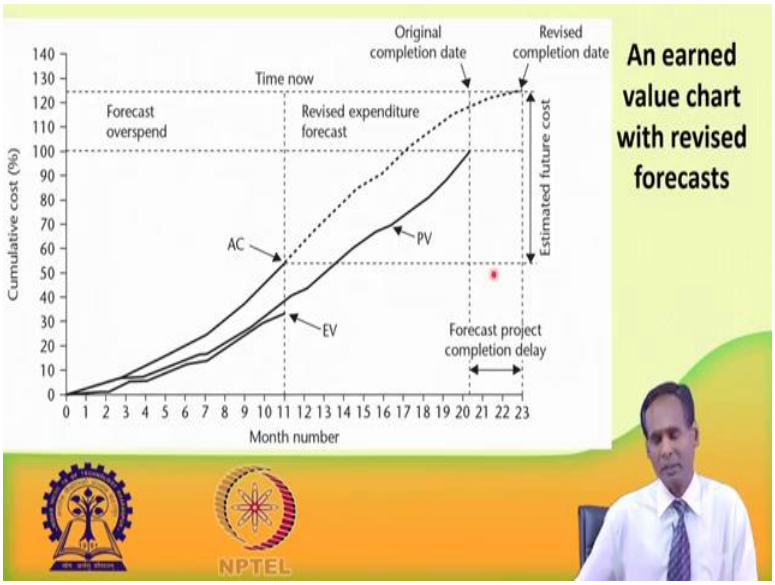

So, once as you have computed the SPI etcetera then you can revise the forecast. As I have already told you that the CPI can be used to revise the cost estimate. Similarly, SPI can be used to divide the project duration; so once CPI and SPI are done; they have found out; you can also what revise the whole estimate see. After computing the CPI and SPI the earned value chart; it can be revised the other parameters can be revised, you can prepare a revised earned value chart.

So, this is the example of an earned value chart with revised forecast. You can see here that this is; this vertical line is the today's time or the today's date. So, this was the earned value and this is the actual value; you can see that. So, today this is the actual value, but based on this planned value and based on the current progress, you can estimate that you can again forecast that the actual cost will be now increasing and may come to this.

So, similarly the time it was previously estimated according to planned value the work will be completed here. But as the progress is there as you are observing the progress, now the project will be completed almost at this time, so this gap we call as the forecasted project completion delay. Similarly, this was the original plan regarding the cost, but actually it is estimated revised estimate for the expenditure is this. So, this we call them as the revised expenditure forecast. So, this was the original completion date you can see and this is the revised completion date; so this gap we call that the forecasted project completion delay.

And similarly, as we have already seen that this was the actual cost; this was the estimated actual cost; this is the estimated future cost what actually you can say that this is the what? This value is the we can say sorry this value as the actual cost; you can see this the actual cost and now it was the revised cost; this value is the revised cost. So, this gap we call as the estimated future cost this is the; revised expenditure forecast. So, in this way if you know the CPI and SPI; you can prepare a revised earned value chart. From the revised earned value chart, you can estimate the forecasted project completion delay; as well as you can know the estimated future cost.

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This earned value analysis has not again up to this we have seen; this also we have completed ok. The earned value analysis has not yet gained much what acceptance universal acceptance ok. Why? Let us see what is the reasons. Earned value analysis has not yet get universal acceptance for use with software development projects. It might have worked perfectly for or it; this earned value analysis might have been worked for other projects. But earned analysis has not yet gained universal acceptance for use with the software development projects.

What is the reason; let us see that perhaps largely because of the attitude that whereas, a half built house has value reflected by the labour and material that have been used. But a half completed software project has virtually of no value at all; it is very much true that a building you have given for contract.

So, a half build building has some value is it not it? In terms of what the labour and material that have been used, but a software unless it is fully completed fully installed and tested nobody will use it does; it does not have any value at all. So, that is why this earned value analysis has not gained what universal acceptance to be used in software development projects ok.

So, this is the so; this is to misunderstand you purpose of earned value analysis which is a method for tracking what has been achieved on a project ok. So, that is why this is to misunderstand that the purpose of the earned value analysis which is normally carried out or which is a method for trafficking what has been achieved for a on a project; which is measured in terms of the budgeted cost of completed tasks or products.

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Now, let us quickly take a small example; so, suppose there are three tasks to be performed in a project specifying a model which what it is planned to take 5 days coding module; coding the module it is planned to take 8 days and testing the module is planned to 6 days. So, now let us say we will observe the progress on the beginning of the 20 dead date; 20 date or 20th day. So, you can say planned value will be how much? 5 plus 8 plus 6; so 19 days. If everything, but testing is not completed if everything is completed, but the testing is left if everything, but testing is completed then EV becomes how much? So, 5 plus 8 there is 13 days.

So, now we will compute schedule performance we know the formula for schedule performance schedule variance is equal to EV minus PV; so, 13 minus 19 which is negative; so minus 6 and schedule performance indication SPI is equal to EV by P V. So, EV is equal to 13 by 19 is equal to 0.68.

So, here you can see that SPI is negative as well as a scheduled performance indicator is less than 1. So, both the things suggested that actually we require schedule value schedule variance positive and schedule performance indicator should be greater than 1. So, since SPI is negative, as well as SPI is less than 1, this indicate that the project is lagging behind the schedule.

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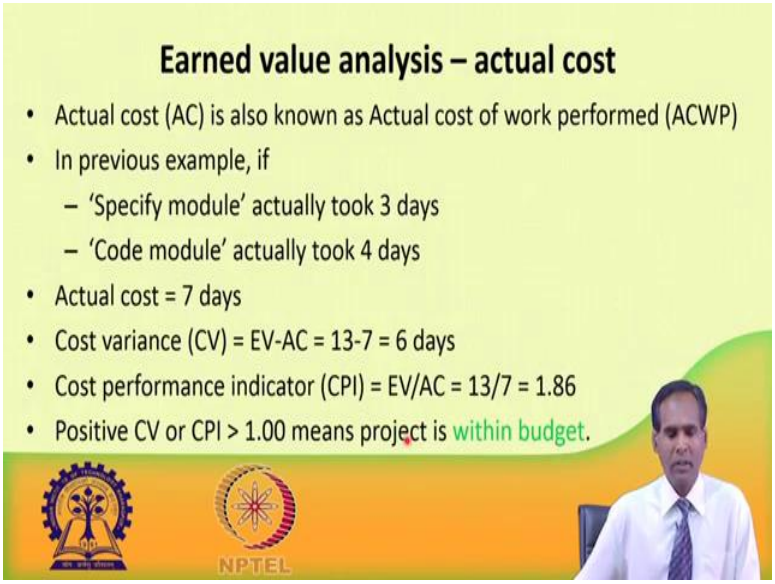

Now, let us use actual cost in this example; we know that actual cost is also known as actual cost of work performed or ACWP. So, let us again consider this previous example; suppose in this previous example specify module actually took 3 days; it is planned for 5 days, but actually it has taken 3 days. Similarly coding module actually took 4 days, but it was planned for 8 days. So, now the actual cost will be how much? 7 days, I have already told you these cost means also you can use the work dates; so actual cost will be 7 days. So, now you can perform can compute cost variance CV which is equal to EV minus AC.

So, a EV we have already what calculated earlier that is 13 days and minus AC; actual cost is 3 plus 4, 7; so it is 6 days. Again now it is positive; a good symbol and cost

performance indicator or CPI is equal to EV by AC; 13 by 7 is equal to 1.86. So, you see both the cases cost variance is positive as well as cost performance indicator is greater than 1. So, this indicates that the project is within budget; within budget ok. So, positive CV or CPI is greater than 1 means the project is within a budget; it will not exceed the planned budget; so this is under control.

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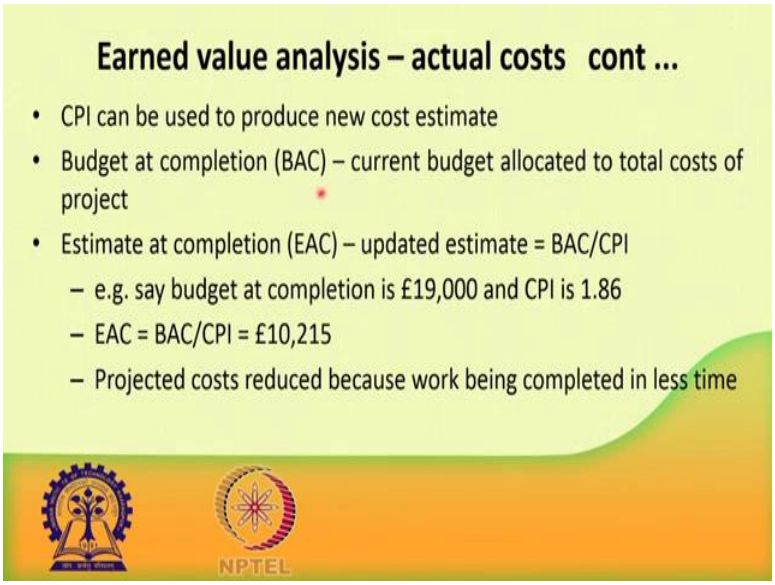

So, CPI can be used to produce new cost estimates that we have already shown in the earlier slide; CPI can be used to produce new cost estimates. So, budget at completion now let us see what is the budget at completion. So, budget at competition I have already told you this represents the current budget allocation to total cost of a project. So, and estimate at completion this also we have defined earlier this is the updated estimate which is equal to BAC by CPI. So, for example, say the budget at completion is given you a as 19000 and CPI is given as suppose 1.86, then EAC can be computed as BAC by CPI is equal to 10215.

Now you can see that it is the budget it is reduced, the project cost is reduced project projected cost is reduced because work being completed in less time; is not it? Because you can see that budget at completion estimated 19000, but now it is reduced to 10215. The projected cost is reduced because the work being completed in less time, the work it is completed in less time that is why this has happened. is not it?

And we have already seen earlier that the work is what it was planned it is what taken let us see cost performance indicator is 1.86 and why? Because this you has planned to be over completed in 8 5 plus 8; 13 days, but actually it is taking 4 plus 3 7 days; so that is why it is what it is taking less days. And since your how we are computing that CPI is equal to 1.86 previous value we have used here this 1.86 you have used. And hence and the budget at completion even if it is estimated 9000 and we are finishing the work much early that is why the cost is reduced. So, the projected cost is reduced because the work being completed in less time.

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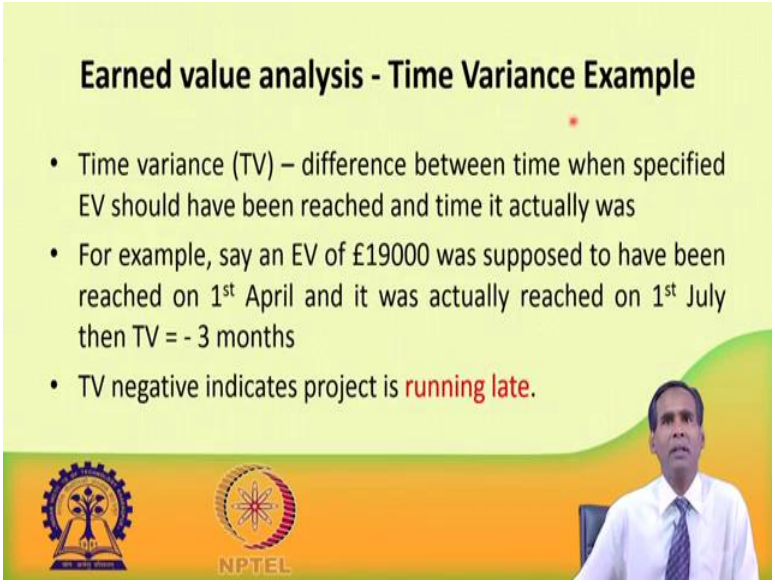

So, let us again explain this time value; time variance as an example. So, and I have already told you time variance means the difference between the time when specified EV should have been reached and the time it actually was what is the current time. For example, say on a EV of 19000 was suppose this EV. So, we have expected that this 19000 pound; for example, say an EV of pound 19000 was supposed to have been reached on 1st April; it should have this job should have been done by 1st April. And it was actually found that it was reached it was completed on first July, then TV is equal to how much? 1st April minus 1st July you can say.

So, fourth month this is seventh month that is it will be minus 3 months. So, negative symbol indicates that TV negative indicates the project is running late ok. So, this is the

conclusion this is the inference that your TV is coming negative and the TV is negative means; it indicates that the project is running late.

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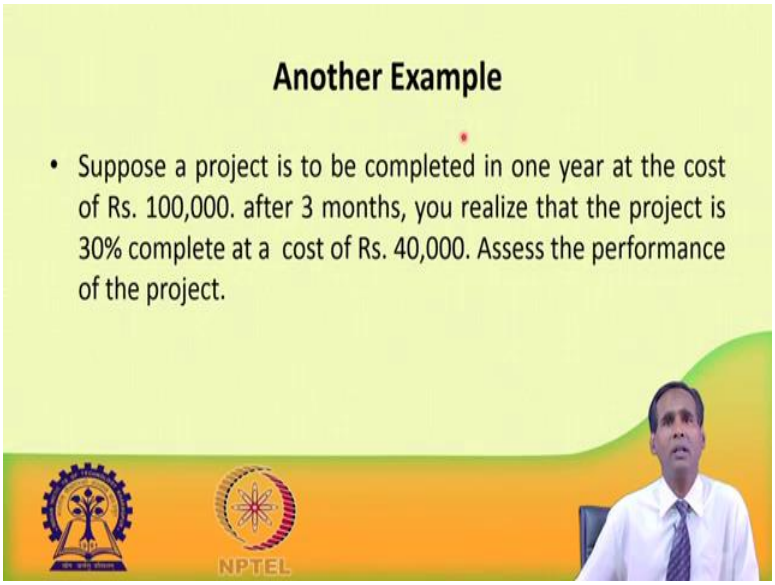

Let us quickly take another 2 minutes this another small example. Suppose a project is to be completed in 1 year it has to be completed in 1 year at the cost of rupees almost 100000. After 3 months, you realize that the project is only 30 percent complete at a cost of 40000, then assess the performance of the project how can assess let us see.

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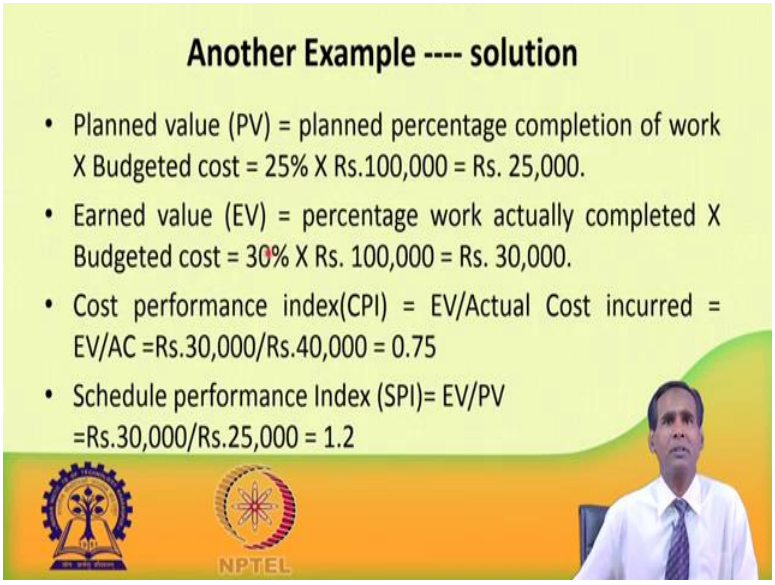

We have to find out the planned value, the budgeted cost the sorry the earned value budgeted cost, CPI, SPI etcetera. You can know the planned value what is the planned value? See planned value it is given here, how much? 100000, but we are evaluating when? After 3 months.

So, a year is 12 months, after 3 months means 25 percentage. So, planned value means the planned percentage completion of work into budgeted cost. Budgeted cost is 100000, the planned percentage of completion is after 3 months means it is 25 percentage to 25 percent in 100000 coming to be 25000. Earned value I have already told you earned value also can be represented as a percentage of EV.

So, within the problem it is that how much? Only 30 percentage completed here. So, here earned value EV is equal to percentage work actually completed into budgeted cost. So, what percentage of work was completed? Is 30 percent into what is the budgeted cost? 100000; this is coming to be 30000. Now, you can easily compute CPI and a SPI. So, CPI is equal to what? EV minus actual cost EV divided by actual cost; EV is equal to 30000 and actual cost is you have already given in the problem actual cost is 40000.

So, this 30000 by 40000 is coming to be 0.75 and schedule performs index SPI is equal to at EV by PV; EV we have already seen 30000, PV we have sorry EV by PV. So, EV is computed to be 30000 PV is computed to be 25000; so 30000 by 25000, coming to be 1.2. So, here you can see that CPI is less than 1 and SPI is greater than 1.

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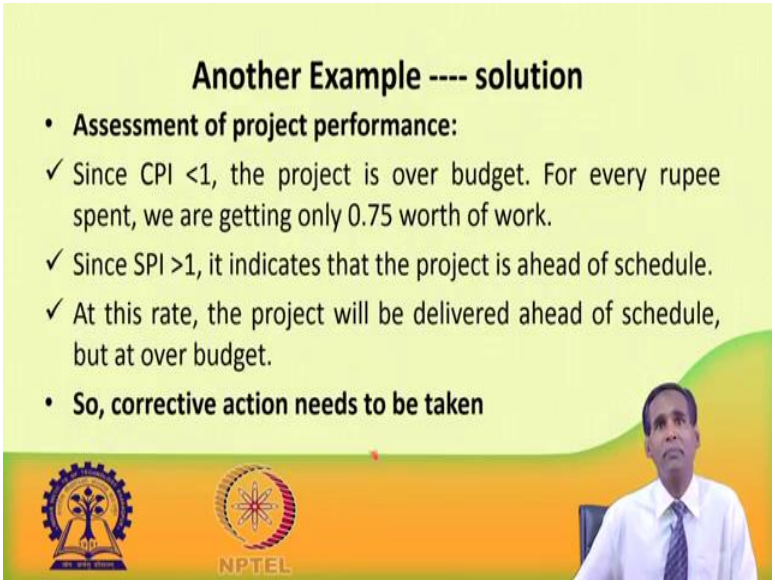

So, what is the conclusion we can draw? So, the assessment of project performance is as follows since CPI is less than 1, it is infer that the project is over project because CP is CPI less than 1, it should be greater than 1. So, CPI since it is less than 1 it is estimated that the project or; it can be infer that the project is over budget.

Here you can see that for every rupee spent we are getting only 0.75 worth of work; see the CPI 0.75; its meaning that for every rupee spent, we are getting only 0.75 worth of work. And you have already see SPI is greater than 1; it is 1.2; since SPI is greater than 1, it indicates that the project is ahead of the schedule; we are not lagging behind the project is ahead of the schedule ahead of the schedule.

So, if the project is moves the; if the project moves at this rate. So, if the project moves at this rate or the progress is made at this rate, then the project will be delivered ahead of the schedule much before of the scheduled time the project will be delivered. The project will be delivered ahead of the schedule, but at over budget but at over cost the cost will be more. So, since the cost will be more we have to do something.

So, here are corrective action needs to be taken since the money you know; it will take more cost even if the schedule it will be delivered early. So, even if the project will be delivered much early than the what planned schedule but the project is what; it is exceeding the cost it is at over budget. So, necessary corrective action needs to be taken in order to what reduce the budget or in order to reduce the cost.

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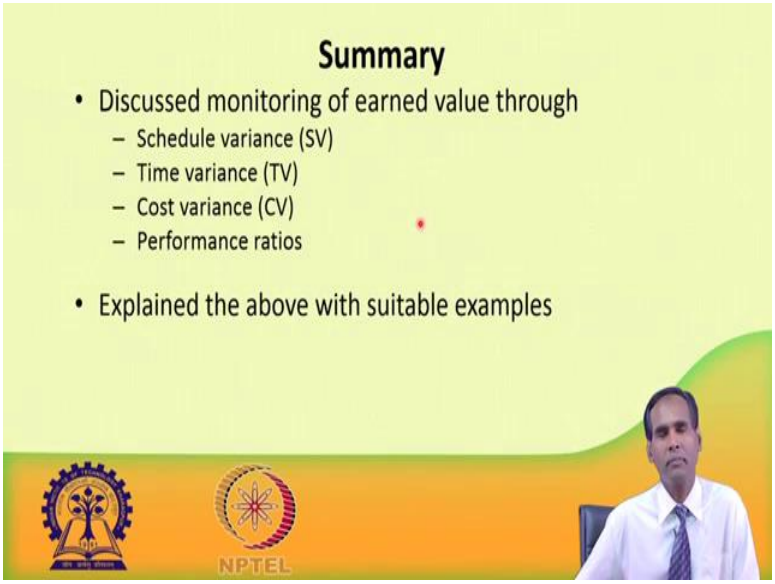

So, these things already we have seen. We have already seen these things we have discussed this monitoring of earned value through different techniques, different parameters such as schedule variance time variance cost variance and performance ratios. We have explained the all the how to calculate the above parameters; now we have explain the above with suitable examples ok.

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We have taken from these references.

Thank you very much.