Project Management: Planning, Execution, Evaluation and Control

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Welcome to the course Project Management Planning, Execution, Evolution and Development. I am Professor Sanjeev Choudhury from Indian Institute of Technology, Kharagpur. In this today we will be starting a new module that is Scheduling Resources and Cost. In this in the first lecture we will be talking about classification of scheduling problem and time constraint project. The concepts that will be covered in this lecture are overview of resource scheduling, then we will give it what are the different types of resource constraints, then we will talk about classifications of scheduling problem, then resource allocation method in this we will talk in this lecture about time constraint project and rest of the rest of the topics we will be covering in the subsequent lecture. To start with the resources like all of you know that a project plan requires a master plan and what are these master plan? This master plan has different components and all throughout the throughout this course so far.

So, we have covered different components how to make a master plan and first what you need for making a master plan is the project scope of work, how to make a scope of work we have discussed about it. Then work breakdown structure of the deliverables of the project thereafter we have developed the network and the network analysis using part and CPM we all have done that earlier. Now your master plan cannot be complete without resource assigning resources and making resource and cost scheduling these are the two very important steps these we will be covering today. So, that you can make a master plan in order to execute and completions of your project and all the steps are linked with the risk you assess and response the risk plan in all stages.

So, and it is said that the that a project network is not a not a schedule until resources are assigned to it. So far what we have done we so far, we have made a network planned with the assumption that resources are adequate resources are no constraint, but in real life resources are constrained. This constraint we will be putting into in the resource and cost scheduling right. Then say what are the constraints project constraints first we need to look at it there are technical constraint physical constraint then the logical constraint and the resource constraint technical constraint or the logical constraint these are the nearly the same. Suppose if these are the project you start a project it is a construction project say you

pour the foundation foundations are made first then only you can go for making the frame or the structure column and all those structures of the construction building.

Then unless that frame is done you cannot go for roof casting. So, these are the technical constraint you cannot just go on do the roof casting without pouring foundations or making a frame. So, these are the technical constraint every project must follow. Similarly, if you take a software project first the when you start it first phase is the design unless design is completed you cannot start the coding unless coding is completed you cannot do the testing. So, it is these goes upon that a technical these are the technical requirement and this has to be followed this logical path has to be followed by every project this is one type of constraint.

The another constraint is the resource constraint resource constraint may be your manpower may be your equipment may be a material if everything they comes under this suppose you make a plan for a for a wedding reception. So, what are the components of the or the activities you plan then purchase refreshment that may require one day or the one person then decorate hall then hire band if these are completed then your you can hold the reception party. So, now you see now these three jobs can be done simultaneously or parallelly provided you have resources suppose if you have three persons then what happen you plan one day then the next day you can three persons can do three these jobs you know purchase refreshment decorate hall and hire band then the third day you can hold the reception plan. So, this is a your resources are adequate now if you have only one percent your resources are not are constrained with availability of one person then what happens you plan one day then hire a band another day one person decorates hall one person one day purchase refreshers one day then you do the reception. So, resource constraint has extended your project duration here you can do it in three days when your resources are not constrained and simultaneous job can be done here your resources has as a constrained your duration has extended to five days.

So, resource constrained generally extends your delay your project this is the type of project constrained. Now classification of scheduling problem is like this one is the time constrained project here what you do here your resources are adequate over the life of the project project life cycle. So, here generally what you wanted to do that time is imposed it is fixed imposed date is given. So, time you cannot extend it is fixed. So, what you do you see the your utilizations of resources should be should be efficient and it should not vary too much.

So, in that case you do resource smoothing or resource labelling what are the how do you do that for resource smoothening it is done by. Firstly, delay the non-critical activities you know critical activities cannot be delayed if you delay the critical activities then your project will get delayed, but non-critical activities we have seen has some slack. So, the within that

slack you delay the non-critical activities then your resources will be smoothened like will be levelled otherwise suppose the resources peak you know it goes on the peak then it comes to the trough that is not desirable hm the what is desirable it is a having a smooth labelling utilization of your resources. So, then what you do you lower the peak demand hm when you delay the non-critical activities your resource requirement that you try to lower the peak demand and spread resources over the life over the life of the project. So, it gets get smoothened.

So, we will be showing it we will be doing it resource smoothing labelling just you look at it here I will explain it like there are activity 1 activity 2 activity 4 5 6 it is a network it is put it in the in the graphical form Gantt chart. So, activity 1 what it required how many days 4 days and it will require 4 workers then activity 2 requires 4 to 10 6 days and with 2 workers. Similarly, activity 3 will require 2 worker and time period required is 10 to 16 that is 6 days then activity 4 will require 2 worker and the time period required is 4 to 10 6 days. Similarly, activity 5 will require 4 worker and the over the period of 6 days then activity 6 requires 6 worker and the time period required is 16 to 24 8 days this is a project network and this network first what you find out you have to find out the critical path can you tell what is the critical path in this in this network ok. Critical path is does not have any slack critical path here are activity 1 then activity 2 activity 3 then activity 6 these are the critical path they do not have any slack, but activity 4 and 5 are the non-critical activities because you can say they have a slack from 4th day to 16 days that means they have a slack of 16 minus 4 is a 12-day slack.

So, this 4 and 5 can start and have to finish by latest by 16 days. So, within that from 4th early start is is 4 days and the late finish is say 16 days. So, these are the slack they are having it. So, now if you see the requirement of the of the worker it will require if this happens like this then what will be the requirement this will require 4 workers this will require 8 workers this is 2 worker 6 workers. So, we will be levelling this this schedule how to level the resources we will be doing it now we will be showing it to you let us work it in the excel sheet.

So, you can find out the you can you can see know these workers and all ok. Now these requires these require 4 workers. So, I will I will go here for 4 days this is activity 1. So, activity 1 require 4 workers for 4 days ok. So, it requires what activity 1 this is activity 1 activity 1 requires 4 workers.

Ok. Activity 1 require 4 4 4 workers ok. So, now if you see this this this one says activity 2 activity 4 activity 5 it requires 8 day 8 workers know it requires 8 workers for 6 days this will require 8 workers this is activity 2 activity 2 comma 4 4 comma 5 5 it requires how

many 8 workers ok. Now if you see this activity 2 3 activity 3 requires 2 workers activity 3 requires 2 workers ok. Now activity 6 requires how many 6-worker activities 6 require 6 workers for 8 days. So, let us require 6.

So, you can see the resource utilization is like this this activity 1 it requires 4 workers then this requires these 3 requests from 2 to 4 from start to up till 4 days till the beginning of the 4 days it will require 4 workers then from 4th day to 10th day it will require 8 workers then from 10th to 16th days it is 2 workers. So, these are see resources are varying too much now resource levelling through resource levelling what we will be doing. So, say this is the these are the critical path this is also critical path. So, what you do? So, activity here the activity 1 will require 4 days this is requiring 4 days. So, this is 4 days now for resource levelling what we do this activity 2 is a critical path.

So, you take activity 2 and activity 4 and activity 5 we are we can shift it because it is a it is a non-critical activity it has slack. So, what we do here say you next, we take it will take 4 days ok. Here activity 2 and 4 2 2 2 and 4 we are taken 2 and 4 it will take 4 workers ok this is taking 4 workers then what we will be here it will be activity 3 and activity 5 activity 3 and 5 will require how many 6 workers. So, this activity here you are doing here activity 3 and 5 it will require how many 6 workers 6 workers. Now the last one last one activity activity 6 this is the final one it will also require 6 workers hm activity 6 will require activity 6 will require see it has levelled it has levelled very nicely say this from beginning to up to 10th day it will require 4 workers and from the 10th day to the end of the project 24th day it will require 6 workers see here it was peak and down up and down is was too much now it has finally, it has been levelled this is the concept of levelling you delay the non-critical activity here what we have done we have delaying the non-critical activity and spread the available resources over the life of the project hm project life.

So, this is the generally the concept now. So, we you have got the concept of resource smoothing and the levelling. So, now, next we will be going. So, this has been done. Next, we will be going the another problem for resource allocation this is the problem please go through it then we will be solving this resource allocation problem it says the problem says for a limited resource of 10 men schedule the network tabulated below for minimum idle mandate used for each activity one of the crew sizes available no in between assignment in between assignment can be made draw the network showing the critical path.

So, what happens these are the jobs you have to first make the a network the jobs are 1 3 2 3 2 4 these are activity on arrow these are the resource requirement like resource requirement that mandates required 30 36 12 this way and the crew size are available crew size are say this minimum 5 normal 6 and maximum 10 you have to choose any one of the crew size any

one of the crew size and once you decide one crew size you have to deploy for that activity completions of the activity for that crew size then you cannot change the crew size in between this assignment this activity is finished. So, first what we do we develop a network then we will be doing it. So, network how do you how do we develop it let me now draw the network first then we will be going through the problem going to we will be doing the rest of the thing. So, it is 1 2 no let me draw the network first. So, network is say it is so, network is say it is 1 2 then 1 3 1 3 then 2 4 2 4 then 1 3 then 2 4 then 1 3 then 1 4 then 1 3 then 2 3 then 5 4 5 3 5.

So, what are the resources given this is 30 this is 12 this is also given 12 this is 36 1 3 is 36 3 2 5 is 30 and this is 20. So, what is the resource given this is 30 this is 12 this is also given 12 this is 36 1 3 is 36 3 2 5 is 30 and this is 20. So, what is the critical part you have to find it out. So, critical part is 30 plus 12 42 plus 20 42 plus 20 is 62 this is 30 that is 1 2 3 4 5 6 7 8 9 10 12 12 13 12 14 14 14 15 equals to 62 days then here 30 plus 12 42 plus 30 is 70 1 2 3 5 equals to 70 is 2 then 1 3 3 4 5 is 12 and this is 12. So, this is 12 and this is 12 and this is 13 and this is 12 and this is 25 this is 36 plus 30 equals to 66 days.

So, critical part is 32 1 2 3 5 this is the critical part. So, this is the critical part. So, this is the critical part. Now, we will be the resource allocation the problem is given we will be doing the resource allocation. So, what we did is that this was this is the network what we have done it.

Now, we will be going to the excel sheet to solve this problem yes these are the problem that were these are the problem this resource allocation for a limited resource of 10 men schedule the network tabulated below for minimum ideal mandate use for each activity one of the crew size available no in between. So, this is given. So, we have done the network network. Now, how do you allocate you have to allocate these people the 10 men 10 it is given 10 men. So, this is the 10 men and you are available to you for each day.

So, you have to allocate them. So, how do you find it out say the you sum it up this mandate required is 140 30 plus 36 plus 12 140. So, total mandates are 140. So, sigma this is the mandates sigma mandates 140. So, if you have how many days how many people maximum you get 10 persons per day. So, it will be you will be requiring 14 days no 140 men days that is you require 14 days this is because that 140 equals to 140 140 equals to 140 men days.

Divided by 10 men 10 men. So, you get equal to 140 you will be requiring 14 days 14 days. So, this we have drawn it for 14 days. Now, what you do how do you allocate you

allocate it this way like suppose this first 1 2 you have to allocate you have to do 1 2 you have to select a crew size 5 6 10. Suppose I select a crew size of 6 then how many days it will require it will require 5 days 5 into 6 is 30 days. So, I get it say 6 men days you require for 5 days hm then you have 10 men.

So, you will be doing 10. So, what you will be doing then is the 1 2 3 1 2 3 is how what are the crew size 4 9 12. So, if you which one you will choose you I will choose 4 because I have already used 6 for this. So, I have remain it maximum is 10. So, I have remaining 4. So, I will choose 4 this 4 for the next 9 days because it will require 9 days now if you if you choose had you if you had more people say that 4 into 9 36 if this is the 36 men days then 2 3 require 12.

So, 2 2 3 2 2 3 requires 12. So, you have to choose 1 3 either 3 4 6 you can choose any anything, but when should your when you will you will be doing that ok this you have to auto sum know then you will get it ok. So, you can see first these days you have been all have been your 10 days is fully utilized 10 days fully utilized up to this. Now, from 6 days these will start when 2 2 3 2 2 3 2 can 2 2 3 can only start when 1 and 2, 3 can only start when 1 and 2 and 1 1 2 is complete then only 2 3 is can start. So, here it is 1 2 is completed on 5th day. So, it can start from here you can choose anything you can choose the 2 3 3 4 6.

So, which one you will be choosing you can choose 3 also you can choose 6 also suppose I choose I this is the discretions of the manager. So, suppose I choose 3 then how many how many days it will be require is 12-man days then you will require 4 days 4 into 3 is 12. So, if I choose 3 it will take it will take 4 days. So, 7 another now the next is 2 4 2 4 is also required say 12-man days 3 4 6. So, I will have to choose again here 3 3 and activity durations will be 4.

So, these will be again this will be sorry. So, this will again be 3 and it will also require 4 days see it has been utilized fully utilized know then what is that your 2 4 we have done it. So, now, it is 3 5 and 4 5 after 2 4 is completed you can start only the 4 5 and after 2 3 and 1 3 is completed you can start 3 5. So, 3 5 will require how many days it will require it is 3 5 is 5 6 10 suppose I will prefer 6 I will prefer 6 and this will take how many days 5 days. So, here I will take 6 days and it will take 5 days then what is left is 4 5 4 5 will require 20-man days and the available crew size are 4 5 10.

So, what I will I will prefer I will prefer 4. So, and if you prefer 4 then how many days it will take 5 days. So, 4 I will prefer for 5 days ok. So, now, let us see the autosome see it has

been or 10 men has been allocated for over the 14 days because we require 14 days for 140 by 10 14 days we require that. So, so this this is the resource allocation there are many ways of doing it as a this is a trial and error method suppose if I had taken now this is one suppose I have taken here 6 days say here is the 10 days.

So, here this one 2 3 can be having 6 days you can take 6 days also here suppose I take 6 days here also 6 days ok then what happens then the then you can see the you do not require this then what you have to do you have to the 6 6 days you have to do it will take only how much this will take only if you put it 6 2 days if then it will be 6 days it will be 2 days then the 2 4 2 4 is 12 2 4 then we can do it here 6 days 6 days hm see it becomes 10. So, we can also 2 4 here 6 days with become 2 days then you can this is another way you can allocate the so there are many ways you can do that similarly here also that you can you can change it. So, these are the resource allocation we do it ok. So, we have found done both the resource allocations and resource levelling now now we will be yeah. So, to sum up what we have discussed in this module this module deals with scheduling resource and cost it demonstrates classification of scheduling problems which are of 2 types namely time constraint project and resource constraint project there are various algorithms and heuristics available to solve this problem which are largely based on trial and error.

Now resource smoothing or levelling is generally done in time constraint project that is project must be completed by an imposed date and resources shall be used as necessary and sufficient and it is provided that the adequate resources are available this tries to even out varying demands of resources by using slack that is delaying the non-critical activities. Now, for the reference book these are the reference book you can consult for enhancing your further knowledge on resource management and resource scheduling and cost and also you should solve some problems on this that will that will give you better insight. Thank you very much for attending this lecture.