

Planning of Project Time and Monetary Resources

With planning of project time and monetary resources we can understand determination of amount of time and money what is appropriate to implement project scope. For success of project management it is very important that scope agreed with product owner is consistent with usable time and costs. This principle is "project triangle" indicating that usable time and costs must be in correspondence with scope to implement. It is project manager responsibility to create and hold this situation. Project manager must plan work processes and required resources to implement project scope. Activity estimation and cost planning is the subject of this lecture.

Estimation of Activity Resources and Developing Schedule by PMBOK

In previous lecture I described activity definition and sequencing processes. In today's lecture I continue with time planning processes, namely with estimating activity resources, estimating activity durations and developing schedule.

These processes with corresponding inputs and outputs are presented on the next figure:

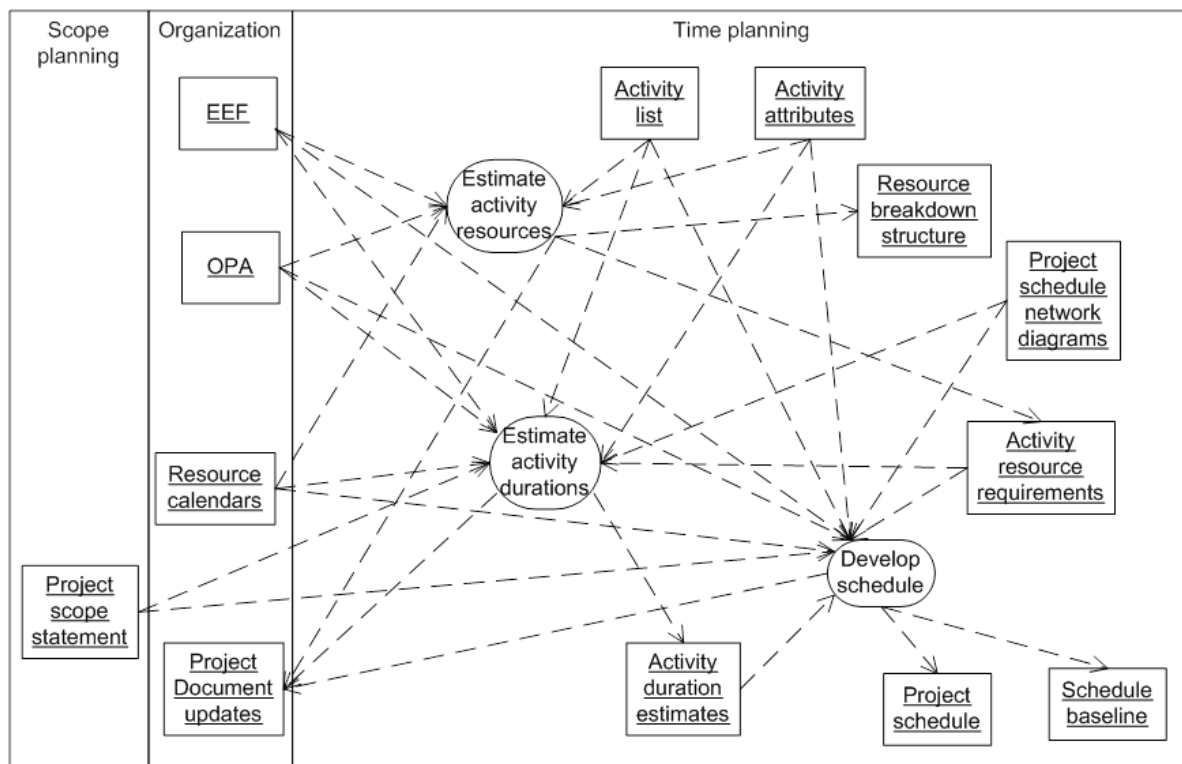


Figure 1. Estimation of Project Activities and Developing Schedule Processes

Estimating Activity Resources

Identifying the quantities of resources needed for the project's activities. Resources are anything having a monetary cost and include materials, equipment, licenses, fees, and personnel needed for the project's activities.

The quantity designations will depend upon the type of resource:

- resource quantities for personnel may be expressed in hours, work days, or work weeks
- the quantity designations for materials to be consumed will be expressed in whatever unit is applicable (cases, boxes, pounds, tons, kilograms, and so on)
- quantity designations for equipment or facilities would likely be expressed as a unit of time (hours, weeks, or months)

Estimating Methods

- Top-down estimating form of expert judgment through which an item is looked at broadly and a generalized estimate created
- Bottom-up estimating provides estimates for each component activity, and then aggregates these into an overall estimate

Effort Estimation Methods in the Context of Software System Development

Calculating size - sizing by analogy or sizing by analysis where

- sizing by analogy is based on experiences from previous projects.
- sizing by analysis - Function Point Counting, Feature Points, Predictive Object Points, Use Case-s, Story Points etc.

Algorithmic software cost estimation model CONstructive COst MOdel (COCOMO) - program size is expressed in estimated thousands of lines of code (KLOC)

Estimating Accuracy

- Rough order of magnitude estimate - these are usually top-down estimates made by expert judgment. The variance range for this type of estimate is expected to be -25% to +75% of the final actual figure
- Budget estimate - these have less variance than rough order of magnitude, but they are still broad estimates. The variance range for this type of estimate is expected to be -10% to 25% of the final actual figure
- Definitive estimate - this type is the most accurate estimate. The variance range for this type of estimate is expected to be -5% to 10%

Estimating Activity Duration

How long the activity will take expressed in a work period (day, hour). Usually number of days where 1 or more resources actually at the activity work

The bases for duration estimation are size of effort, number of resources and work hours of every resource per work day

Estimation Methods

- Using calculation method: duration = effort size/ resource quantity / resources work hours number per work day, for example: 10 hours effort / 2 people / 2 hours per work day = 2,5
- Using PERT (Program Evaluation and Review Technique) method (calculating weighted average duration) - $WAE = (OE+4*MLE+PE)/6$

Schedule Development

Develop Schedule is the process of analyzing activity sequences, durations, resource requirements, and schedule constraints to create the acceptable (realistic) project schedule. An approved project schedule can serve as a baseline to track progress. Schedule development is an iterative process because project manager must periodically revise this schedule according real life corrections.

Inputs for the schedule development are outputs from previous steps (activity definitions, sequencing etc); resource calendars (personnel and equipment availability times for the project; project scope statement; project calendar (available time to completion of project work).

Tools and techniques for schedule development are for example:

- critical path method
- critical chain method
- resource leveling
- schedule compressing

Critical Path Method

The critical path method calculates the theoretical early start and finish dates, and late start and finish dates, for all activities without regard for any resource limitations, by performing a forward and backward pass analysis through the schedule network

Critical Chain Method

Critical chain is a schedule network analysis technique that modifies the project schedule to account for limited resources. Initially, the project schedule network diagram is built using duration estimates with required dependencies and defined constraints as inputs. The critical path is then calculated. After the critical path is identified, resource

availability is entered and the resource-limited schedule result is determined. The resulting schedule often has an altered critical path. The critical chain method adds duration buffers that are non-work schedule activities to manage uncertainty

Resource Leveling

Resource leveling is a schedule network analysis technique applied to a schedule that has already been analyzed by the critical path method. Resource leveling can be used when shared or critical required resources are only available at certain times, are only available in limited quantities, or to keep resource usage at a constant level. Resource leveling is necessary when resources have been over-allocated, such as when a resource has been assigned to two or more activities during the same time period, when shared or critical required resources are only available at certain times or are only available in limited quantities. Resource leveling can often cause the original critical path to change

Schedule Compression

Schedule compression shortens the project schedule without changing the project scope, to meet schedule constraints, imposed dates, or other schedule objectives

RUP Guidelines to Partition Effort and Schedule

In RUP project effort and schedule can be partitioned in 3 phases:

- partition project effort and schedule across phases
- partition phase effort and schedule across iterations
- partition iteration effort and schedule across disciplines

Partition Project Effort and Schedule across Phases

Is presented in the next table:

Table 1. Partition of Effort and Schedule in RUP Phases

Phase	Start date	End date	Schedule	Effort
Inception	2003-01-06	2003-01-31	4 weeks (15%)	600 hours (8%)
Elaboration	2003-02-03	2003-03-14	6 weeks (21%)	1400 hours (17%)
Construction	2003-03-17	2003-06-06	12 weeks (43%)	4800 hours (60%)
Transition	2003-06-09	2003-07-18	6 weeks (21%)	1200 hours (15%)
Total			28 weeks	8000 hours

Partition Phase Effort and Schedule Across Iterations

In order to get schedule and effort of one iteration. In partitioning schedule, it is usually easiest to divide the phase into iterations of equal length or first iterations longer. Same way with partitioning effort. Iterations of equal length within a phase usually require equal effort. Allocate more effort to longer phases and less to shorter ones, so that the total effort per week remains relatively constant within a phase. Pictorially expressing:

Table 1. Partition Phase Effort and Schedule Across Iterations

Phase	Iteration	Schedule	Effort
Inception	I1	4 week	600 hours
Elaboration	E1	3 weeks	700 hours
	E2	3 weeks	700 hours
Construction	C1	6 weeks	2400 hours
	C2	6 weeks	2400 hours
Transition	T1	6 weeks	1200 hours

Iteration effort and schedule partition example across disciplines

This example is presented in the following table:

Table 2. Partition of Iteration Effort and Schedule across Disciplines

Discipline	Inception	Elaboration	Construction	Transition
Business Modeling	10%	5%	-	-
Requirements	20%	20%	5%	5%
Analysis & Design	10%	20%	15%	5%
Implementation	5%	20%	30%	20%
Test	5%	10%	20%	35%
Deployment	5%	5%	10%	20%
Config. & Change Mgmt.	5%	5%	5%	5%
Project Management	20%	10%	10%	5%
Environment	20%	5%	5%	5%

Cost Planning

Cost planning consists of cost estimating and budget determination. These processes and corresponding inputs and outputs are presented on the following figure:

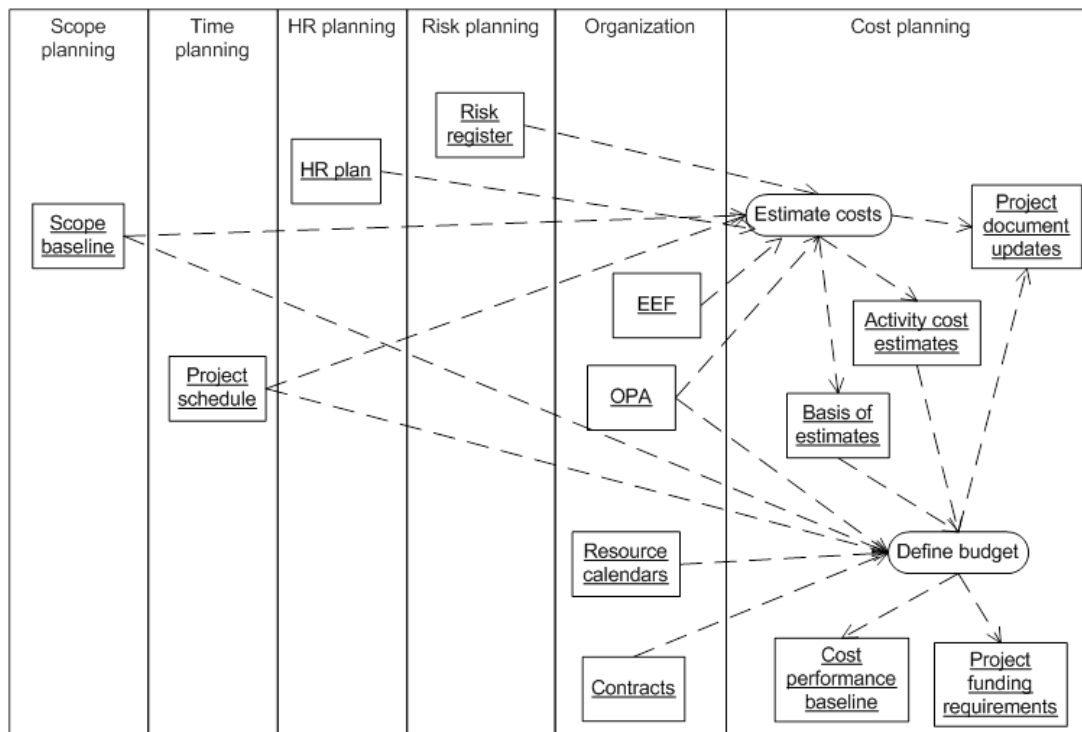


Figure 2. Cost Planning Processes

Cost Estimating

Cost estimating is the process of developing an approximation of the monetary resources needed to complete project activities. Costs are estimated for all resources that will be charged to the project: labor, materials, equipment, services, and facilities, as well as special categories such as an inflation allowance or contingency costs. Cost estimate is a quantitative assessment of the likely costs for the resources required to complete the activity. They are a prediction that is based on the information known at a given point in time

Cost types:

- Direct costs -attributed specifically to a detailed or summary activity of the project; goods or services are used exclusively for the project
- Indirect costs - incurred by the project, but the goods or services are also used for non-project activities
- Variable costs - fluctuate and can't be predicted with absolute certainty; travel or transportation costs for example
- Fixed costs - static throughout the project or have only a small likelihood of fluctuation; rents, leases, licenses, salaries, and fixed fees for example

Cost Estimating Outputs

- Activity cost estimates: quantitative assessments of the probable costs required to complete project work; costs are estimated for all resources that are applied to the activity cost estimate including direct and indirect costs
- Basis of estimates: the amount and type of additional details supporting the cost estimate; should provide a clear and complete understanding of how the cost estimate was derived
- Supporting detail for activity cost estimates may include:
 - documentation of the basis of the estimate (i.e., how it was developed)
 - documentation of all assumptions made
 - documentation of any known constraints
 - indication of the range of possible estimates (e.g., \$10,000 ($\pm 10\%$) to indicate that the item is expected to cost between a range of values)
 - indication of the confidence level of the final estimate

Budget Determination

Budget determination is the process of aggregating the estimated costs of individual activities or work packages to establish an authorized cost baseline. This baseline includes all authorized budgets, but excludes management reserves. Project budgets constitute the funds authorized to execute the project. Project cost performance will be measured against the authorized budget

Output of budget determination is an authorized time-phased budget at completion (BAC) used to measure, monitor, and control overall cost performance on the project. It is developed as a summation of the approved budgets by time period. In the earned value management technique the cost performance baseline is referred to as the performance measurement baseline (PMB).

Sample budget structure may contain following parts:

- Labor/Personnel
- Professional, Contracted, or Outside Services
- Supplies, Materials
- Equipment, Hardware, and Software
- Training, Travel
- Licenses, fees
- Indirect Costs

Used Literature

- IEEE Guide--Adoption of the Project Management Institute (PMI(R)) Standard A Guide to the Project Management Body of Knowledge (PMBOK(R) Guide)--Fourth Edition,
<http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=6086683>

- Plan and Schedule Development, http://www.nehimss.org/070518_Project_Management/Chance_Reichel_Templ_TaskID_WBS_05_12_00.doc
- Eric Lopes Cardozo, DJ de Villiers. Project planning best practices, The Rational Edge, August 2003, http://www.ibm.com/developerworks/rational/library/content/RationalEdge/aug03/m_projectplanning_dd_ec.pdf
- COCOMO, <http://en.wikipedia.org/wiki/COCOMO> or http://csse.usc.edu/csse/research/COCOMOII/cocomo_main.html
- Schedule Management Template, <http://www.projectmanagementdocs.com/project-planning-templates/schedule-management-plan.html>
- Cost Management Template, <http://www.projectmanagementdocs.com/project-planning-templates/cost-management-plan.html>