Project Workflow Management[1]

Project Estimating Process[2]

By Dan Epstein

Note: *This article is based on the book Project Workflow Management: A Business Process Approach by Dan Epstein and Rich Maltzman, published by J Ross Publishing in 2014. The book describes PM Workflow® framework, the step-by-step workflow guiding approach using project management methods, practical techniques, examples, tools, templates, checklists and tips, teaching readers the detailed and necessary knowledge required to manage project "hands-on" from scratch, instructing what to do, when to do and how to do it up to delivering the completed and tested product or service to your client.*

The project workflow framework is the result of Dan's research into the subject, having the following objectives:

1. *Create the virtually error-free project management environment to ensure significant reduction of project costs*
2. *Reduce demands for highly qualified project managers using the step-by-step workflow guiding approach.*

While PM Workflow® is the continuous multi-threaded process, where all PM processes are integrated together, this article will attempt to describe the estimating group of processes as a stand-alone group that can be used independently outside of PM Workflow® framework. It will be difficult in this article not to venture into processes outside of the current subject, such as planning, quality, communications and other management processes, so they will be just mentioned. However, to get full benefit and the error free project management environment, the complete implementation of PM Workflow® is required. In order to understand how PM Workflow® ensures this environment, I strongly recommend reading my article Project Workflow Framework – An Error Free Project Management Environment *in the PMI affiliated projectmanagement.com (*https://www.projectmanagement.com/articles/330037/Project-Workflow-Framework--An-Error-Free-Project-Management-Environment*)*

The article above provides the overview and explanation of how the project workflow framework works and achieves the established objectives.

For more information, please visit my website www.pm-workflow.com

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Purpose

The purpose of the Estimating process is to describe the steps for developing size, effort, cost, schedule and critical resource estimates for a project throughout its life cycle. P12A and P12B have essentially the same content, but used for different purposes and placed in different areas of the Planning Frame.

Accuracy of Estimates

Accuracy of estimates depends on:

- Level of detail – i. e. the degree of decomposition of the Work Breakdown Structure.
- Risk assessment results and the remediation plan.
- Quality of requirements.
- The point in the project lifecycle where the estimating took place.
- The estimator's experience.
- The estimating method.

There are three levels of estimating accuracy:

1. **Ballpark estimates** - Ballpark or initial estimates are made when little information about the project is available and there are no detailed requirements, except the initial project request. In order to do estimates, the delivery team must be familiar with the similar types of project and the technology used. This type of estimate is also done when significant risks are involved. The accuracy range of the ballpark estimates has a range of -25% to +75%.

2. **Preliminary estimates** - Preliminary estimates are performed immediately after completion of Business Requirements. Those estimates heavily depend on the team's familiarity with similar projects, business, and technology with no high risks present. A high level WBS should be used to do this type of estimating. Preliminary estimates are used to establish the preliminary project budget and are often used to establish initial project funding. The accuracy range of preliminary estimates never exceeds -10% to +25%.

3. **Accurate estimates**. - Accurate or definitive estimates are prepared from a well-defined detailed data and WBS, using techniques described below. This type of estimate is done just before the project plan package is created or updated. The estimate may not cover the entire project, but only the well-defined next stage of the project plan. It is not usually possible to do accurate estimates for the entire project, because the lack of detailed information for the required activities in the distant future. The best accuracy that can ever be achieved has a range of –5% to +10%.

Note: *In some organizations, where delivery managers with no real project management experience are constantly under pressure from senior management, the PM may face demands for accuracy of estimates better than -5% to +10% or even +– 0%. Since this is an unrealistic and unachievable accuracy, project managers are forced to use tricks to match real cost to estimates. Since the project scope changes are*

inherent in all projects, one of those tricks is overestimating or underestimating scope changes to keep the visibility of the overall project cost within the required accuracy of estimates in accordance with managers' demands. Another trick is using reserve activities for each group of tasks, which are adjusted as necessary to match costs to estimates. In fact, most managers are aware of this, but due to demands from senior management or temptations to report excellent achievements to the CEO, they keep of this practice 'under wraps'. We assert that these tricks provide no real benefits whatsoever and in fact threaten the project, and even may cost the project manager his/her job.

Types of Estimates

There are four types of project estimates:

1. **Size and complexity** (Software projects only): Estimates of the project complexity, which are a measure of the project sophistication and the number of inputs and outputs combined with technology used.
2. **Effort**: Estimates of time required to complete tasks outlined in the Work Breakdown Structure.
3. **Cost**: Estimates based on the effort estimates and resource rates.
4. **Critical Resources**: Estimates of resources, which are needed to support research, design, development and testing.

Documenting Estimates

The Project Control Book (PCB) documentation should instruct how to document and store the Estimates and Assessment Forms related to the Estimating process and other documentation. How to build PCB is described in the book.

Estimates are produced for each new project scope change, for each group of processes (frames) and for the overall project after performing risk assessment and developing risk response planning. The task level estimates for scope changes and the next coming frame should be fairly accurate (-5% +10%). The overall estimates for the entire project become progressively more accurate with each successive frame of the project. Each time the estimates are created, the following information should be captured in the Project Control Book:

- Date
- Frame and activity
- Inputs - describe the specific inputs used for creating the estimate (i.e., requirements document, detailed specifications, design, initial WBS)
- Assumptions made
- Constants
- Estimating method used
- Risk Assessment
- Estimates
- Any other information which helped drive the estimates, especially bases for the estimates

Tasks for developing estimates must be included in the project schedule. The Estimating Process P12 consists of the following:

1. Estimate Size (P12-1)
2. Estimate Effort (P12-2)
3. Estimate Cost (P12-3)
4. Estimate Schedule (P12-4)
5. Estimate Critical Resources (P12-5)
6. Review Estimates (P12-6)

In addition, the Estimate Effort (P12-2) and Review Estimates (P12-6) processes are decomposed further. Process P12-2 may be further broken down to:

1. Perform / Adjust Estimates (P12-2-1)
2. Validate Estimates (P12-2-2)
3. Add Overhead to Estimates (P12-2-3)
4. Perform Alternate Method Estimates (P12-2-4)

Process P12-6 consists of the following lower level processes:

1. Identify Review Team (P12-6-1)
2. Schedule Review (P12-6-2)
3. Conduct Review (P12-6-3)
4. Record Review Notes (P12-6-4)
5. Update estimates (P12-6-5)
6. Confirm Estimates (P12-6-6)

Estimating Process Flow

The ballpark (or top-down, or analogous) estimates involve using past experience and analogy of the initial project request and past projects in the same organization, making adjustments when necessary. If no similar projects had been developed in the past, and there are no reliable subject matter experts on the team, it is not possible to provide ballpark estimates.

For ballpark estimates, the process starts when the request comes via entry point 2 to the P12-1 or P12-2 processes of the Ballpark Estimating process P12B. For the preliminary or accurate estimates, the estimating process P12A starts when processes P1-P7, P11 and P14 are complete. If size estimating is the established standard within your organization, then the process flow enters Estimate Size process P12-1. Otherwise the flow enters Estimate Effort process P12-2. After efforts are estimated at step P12-3, the control point question (Ballpark Estimates?) is asked. For ballpark estimates the answer is YES. After producing ballpark estimates, the process flows back to Requirements Frame via exit point 4. The estimating process flow diagram is shown on Fig 11-1.

If the answer is NO, the flow enters the Estimate Critical Resources process P12-5. After completion of estimates, a review and approval takes place at step Review Estimates P12-6. Once estimates are reviewed and approved, the process flow exits the estimating process for Work Breakdown Structure Design / Update at step P7.

Estimating takes place several times throughout the project lifecycle:

- Producing preliminary estimates of the overall project cost and duration after the Business Requirements Document is developed. Accuracy of these estimates is –10% +25%. Those estimates may be used to establish initial funding only after performing the initial risk assessment.
- Planning tasks for the next coming project frame. Accuracy of these estimates is –5% +10%.
- Plans are updated by adding risk contingency due to risk assessment.
- Plans are made for the project scope change. Accuracy of the scope change estimates is –5% +10%.
- Project overruns budget or schedule. The accuracy depends on the cause of the project's poor performance.

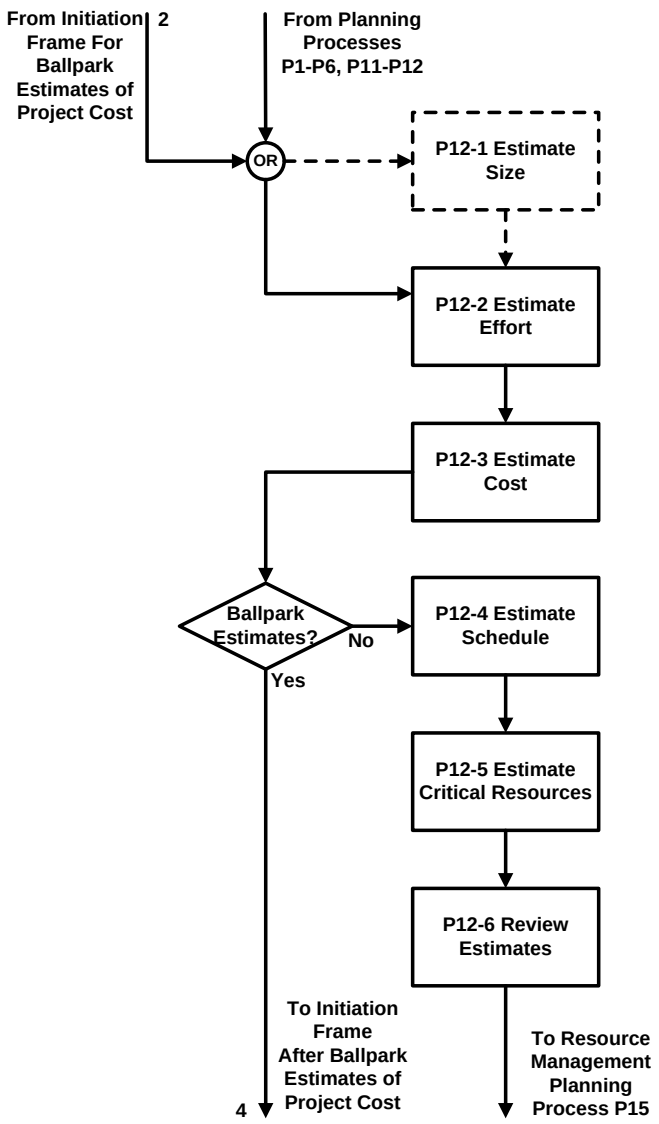


Fig 11-1 Estimating Process Flow

Estimate Size (P12-1)

Size estimates vary with the type of project, because size itself is an attribute of complexity that varies depending on the practice area of the project. The size of documentation or processes may be expressed in standard pages; the size of presentations may be expressed in number of slides, the size of a bridge may be expressed in terms of tons of steel, and the size of a software application is expressed in number of Function Points (FP) or sometimes in Lines of Code (LOC).

Function Points are units of software project complexity, which are associated with the functionality of the software application. They are not directly related to effort needed to develop the application, even though such dependency exists indirectly and may be used to rate the developer's efficiency. Thus, if the application size is calculated as 400 Function Points, then developing that application with MS Visual C++ may take, for example, 6 months using 5 average skilled resources. However, developing the same functionality using MVS/CICS/Cobol may take 18 months using the same number of resources. Function Points Analysis (FPA) combined with the statistics gathered, allows figuring out the unit cost of software development for every platform being used to develop software. FPA is a method of identifying and classifying components of a system. It measures software by quantifying its functionality based on logical design. FPA may be accurately performed after development of requirements.

This type of estimate takes into consideration inputs/outputs, application files, database tables and other parameters, so it may be performed for new, not yet developed and also older, completed projects. This way it is possible to create historical data for software developed years ago, provided that the actual development efforts have been recorded. Thus, it is possible to determine that project A, which was developed on Java platform three years ago, has 500 Function Points and its cost was $250,000. Thus, the cost of one function point was $500/FP. Project B last year also used Java platform and the cost of one function point was $505, which is about the same. So, if a subcontractor is developing a Java project having the cost of $700/FP, he/she is either overcharging, has been executing ineffective projects, and/or is using poorly qualified resources.

The size estimates for software projects may also be produced using Constructive Cost Model (COCOMO). Their output is measured in Lines of Code.

Other advantages of using Function Point Analysis:

- Provides validation of estimates made by the delivery team members
- Controls delivery team productivity
- Improves the planning of the workload and resource planning

Function Point Analysis is a complicated method to use. Therefore, only a trained Function Point analyst can provide the Function Points estimates. A Function Point Count spreadsheet is provided free of charge by the International Function Points User Group (IFPUG) and may be used as a tool. Also, there are commercial tools available that automate the process of Function Point Analysis.

However, Function Points are not applicable to all software activities, because many of those activities, such as software maintenance, redesign for performance improvement and others, do not normally add functionality to existing applications. Therefore, those activities do not add function points, though the effort to perform those activities may be significant.

Using Function Points is especially important for off-shore software development projects. The most qualified offshore vendors use it as a standard size estimating technique without admitting it. You should request offshore vendors to formally use it and provide you with results, since the change in the offshore vendor efforts per Function Point will signal an offshore vendor team performance change. It also may allow you to evaluate their performance as a comparison with industry standards or even determine whether using offshore resources provides any real benefit, despite their stated lower hourly rate.

Table 11-1 Task Estimating Worksheet

Task Estimating Worksheet

Project Name:
Estimator:
Date:

Check	Task	Optimistic (hours)	Pessimistic (hours)	Most Probable (hours)	PERT Result (hours)
	Activity 1				
	Subactivity Level 1				
	Subactivity Level 2				
√	Task 1	17	24	22	21.5
	Task 2				
√	Subtask 1	29	34	31	31.2
√	Subtask 2	3	7	5	5.0
√	Task 3	9	15	11	11.3
√	Task 4	7	10	9	8.8
	Subactivity Level 3				
√	Task 1	34	39	35	35.5
√	Task 2	21	30	26	25.8
√	Task 3	16	22	19	19.0
√	Task 4	20	27	22	22.5
√	Task 5	30	38	36	35.3
	Activity 2				
	Subactivity Level 1				
	Subactivity Level 2				
√	Task 1	14	19	16	16.2
√	Task 2	15	21	18	18.0
√	Task 3	14	16		5.0
	Subactivity Level 3				
√	Task 1	24	35	29	29.2
√	Task 2	22	35	31	30.2
√	Task 3	20	24	23	22.7

√	Task 4	17	21	18	18.3
		Net estimated effort		**355.5 hrs**	

Estimate Effort (P12-2)

The effort, or estimated labor hours per task may be calculated using one of the following major types of estimating:

- Top Down
- Parametric
- Bottom Up

Top Down Effort Estimating

This type of estimating is possible if there is a sufficient amount of statistics and experience available from similar projects developed in the past. Top down estimating is most suitable for the ballpark and preliminary estimates. It is performed by the subject matter experts familiar with similar projects. Top-down estimating methods include the following elements:

- **History of past projects and the available statistics.**
  This method is also called Analogous Estimating method. Based on past recorded project statistics, the new project is compared with the historical data. If similar projects were found in the past, they are evaluated and a new project is adjusted in accordance with the difference in project scales. Even if the actual work efforts were not recorded, it is possible to find them by using the number of delivery team members involved in the project and the length of development.

- **Opinion of the Subject Matter Experts (SMEs)**
  If members of your team do not have direct experience in this type of project or the technology used, get experts outside of your team, who can provide advice on estimates. Try to also get their help with the project implementation.

- **High Level Work Breakdown Structure**
  Detailed WBS often reaches five or six levels of a tree-like structure. High level WBS usually has two and rarely three levels. The lowest level tasks are estimated using the described above estimating methods. For ballpark estimates, the high level WBS is rarely used.

Top-Down Effort Estimating is usually used in projects that do not (yet) have a detailed WBS on a task level.

Parametric Effort Estimating

This estimating method is used by estimating tools that are based on statistical methods, such as Monte Carlo Analysis. Those tools will calculate the probability of completing tasks within a certain time period based on past experience, taking advantage of parameters (rates) such as *US$300 per square foot*, or *3 Engineers per 70-user network design*. Sometimes estimates for one or several components may be expanded for the entire project. Parametric estimating is as

accurate as the amount of statistics collected during prior projects. This method is rarely used in software development, but cannot be excluded from consideration. This method may potentially be within the range of accurate estimates, even though mostly it is within the range of initial estimating.

Bottom Up Effort Estimating

This is the most accurate detailed estimating made by several subject matter experts for all tasks of the detailed fully decomposed WBS and opinions of multiple SMEs.

In order to eliminate subjective factors in estimating, the Program Evaluation and Review Technique (PERT) method should be used for effort estimating. Each estimator provides three estimates for each task in WBS. One is an optimistic estimate (O), another is a pessimistic estimate (P) and the third one is the most probable estimate (M). The resulting calculation is: **Estimate = (O + P + [4*M]) / 6.**

Past experience shows that if only one estimate, rather than three, is requested from experts, they most often provide the optimistic estimate. The request to provide three estimates for each taskforces them to think about all possible issues in implementing that task. If results from several estimators differ by more than 5%, their estimate is returned back to them along with the attached results from other estimators. They have to review estimates and submit it again. This anonymous, iterative format for honing an estimate is sometimes called the Delphi method.

Estimates from delivery team members usually provide only the net effort required to complete project tasks. Therefore they are low even if the PERT technique is used, because they overlook daily overhead such as managing email, meetings and time reporting. The project manager must add those activities to project estimates. Also estimates provided by the subject matter experts do not take in account the resource utilization and neither results of the project Risk Assessment. Results of risk assessment may dramatically change estimates or even determine that project cannot be delivered as planned.

The bottom up estimating can be performed if there is a detailed WBS available from the Project Planning Process. In order to achieve accurate estimates (-5%+10%), no task in WBS should have effort over 40 hours with best results achieved for tasks of 24 to 36 hours. Usually it is not possible to have that level of detail for the entire project, unless the project is in the late stages of implementation. Only the next coming project frame may have accurate estimates after the frame planning is complete. The later we are in the project lifecycle, the better the overall accuracy of estimates.

In practical terms, the project manager may distribute estimating worksheets to the subject matter experts. They have to provide the lowest level tasks estimates. As mentioned above, no task should exceed 40 hours. If any task appears to be longer than 40 hours, the further breakdown of the task must be made.

Thus, under Activity 1, Task 1 is the lowest level task and should be estimated. On the other side, Task 2 has further breakdown to Subtask 1 and Subtask 2. Therefore, Task 2 is not the lowest level task and should not be estimated, while Subtask 1 and Subtask 2 should. The example of the Estimating Worksheet is shown in Table 11-1.

Estimate Effort (P12-2) Process Flow

This activity consists of four processes:

1. Perform / Adjust Estimates (P12-2-1)
2. Perform Alternate Method Estimates (P12-2-4)
3. Validate Estimates (P12-2-2)
4. Add Overhead to Estimates (P12-2-3)

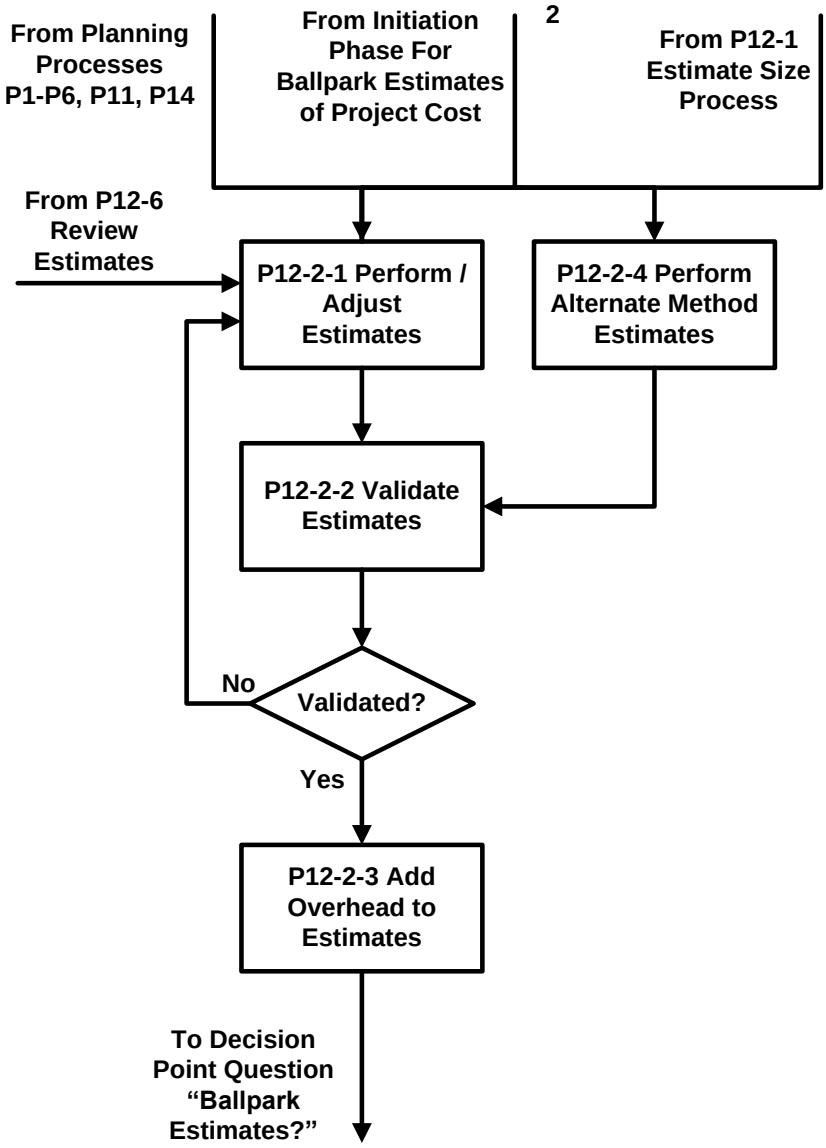


Fig 11-2 Estimating Effort

Effort estimates provide labor estimates for the project. The cost and schedule estimates are derived from effort estimates. The Estimating Effort Process Flow is shown on Fig 11-2.

Perform / Adjust Effort Estimates (P12-2-1)

Project efforts reflect labor to complete the identified project tasks. The efforts estimate can be done using the methods described above. As the project progresses and more details surface, re-estimating the effort is required using the bottom-up approach. Tracking variances outside the acceptance criteria range, obtained during the Construction Frame, will require taking corrective actions. Except for initial estimates, all estimates and adjustments must use the existing project schedule or relevant parts of it. The schedule should be built in accordance with the project planning processes and the list of all available detailed tasks.

The recorded estimates in the Task Estimating Worksheet will be stored in the PCB. Updates are necessary through the project life cycle.

Validate Effort Estimates (P12-2-2)

Effort estimates can be validated in one or more of the following ways:

- Have multiple experts provide estimates, review the estimates anonymously and come to a consensus (the Delphi method)
- Compare results of the main and the alternative estimating methods
- Validate by comparing to historical data for similar projects or tasks completed earlier
- Validate estimates by comparing the cost of one function point with the industry and/or local standards (software projects only)

If effort estimates do not validate, the process flow is returned to the Perform / Adjust Estimates process P12-2-1 for new estimating or adjustment.

Add Overhead to Effort Estimates (P12-2-3)

Net estimated project effort represents effort to perform tasks initially listed in the Task Estimating Worksheet and later transferred to the project plan. There are, however, additional efforts which are called unproductive efforts. They may or may not be recorded in WBS, depending on your organization's methods, tools, and processes. Whatever is recorded in the schedule should not be counted again as unproductive time or overhead. For example, if project management tasks, such as developing the WBS, the communication plan, and so on, are included in the schedule, the project management efforts cannot be added as *additional* effort overhead. Note: it is a good practice to include project management effort in the WBS as a work stream. The following are components of the effort overhead:

- Unproductive time
- Project management and other management activities
- Low resource utilization
- Risk assessment activities

There is a distinction between efforts overhead and cost overhead, which are counted separately.

Unproductive Time Overhead

Delivery team members spent around 20% of their time on phone conversations (some of them may have personal character), ad hoc meetings, conversations, coffee breaks etc.

Project Management and Other Management Activities Overhead

Project management effort tends to comprise between 10% and 20% of the total project effort. Often other managers, like resource managers, line managers and functional managers charge several hours a week each to your project. This may constitute another 2% to 5% of the total project effort.

Resource Utilization Overhead

Resource utilization is the percentage of time that a resource is actually working on the scheduled tasks in comparison with the total time claimed by resource.

It is not possible to have 100% resource utilization. That means, if 5 full time resources available working on a project eight hours a day for four weeks, they will be charging the project for 800 hours. However, they may be accomplishing tasks with the total scheduled effort of much less than 800 hours. Due to planned tasks interdependencies, some of the tasks performed by resource B cannot start until other tasks, performed by resource A, are completed, which causes idle time patches in resource B utilization. To reduce idle time and increase resource utilization, resource leveling must be tried. Resource leveling is a technique available in almost every automated project scheduling tool to examine the uneven resource load and automatically balance it, when possible, also resolving resource overallocation. It does not do well balancing but does a good job on overallocation. It is not possible to completely eliminate idle time.

Let's say a resource is assigned for 100% availability to the project for two weeks, from Monday through Friday of the following week. During this time the resource completed three tasks with the planned total effort of 75 hours. If the resource is not assigned any other work for the remaining 5 hours, he or she will claim 80 hours of labor regardless of the total effort. Therefore, the cost of labor should be calculated for the entire period between the first and the last day of availability, unless he or she does additional work unrelated to the project and charge this time to non-project activities.

The efficiency of resource utilization depends on the project manager's planning skills. A skilled PM may reach 90% resource utilization at best. In other words, 10% or more of resource time is often not productive due to inefficiencies in resource utilization. Note that this is in addition to inefficiencies (such as email and telephone time) described above as unproductive time overhead.

Risk Assessment and Risk Response Activities Overhead

Every project has risks which add extra efforts and extra costs to the project. While costs are derivatives from efforts, there are components of risk which are expressed only in cost, such as Expected Monetary Value of risk and are not direct results of project efforts. Those components

of risk which require extra efforts are risk assessment and planning efforts to reduce or eliminate the probability of risk occurrence and its severity, if the risk occurs. Each risk assessment may be done using the Risk Assessment Tool which may be downloaded from the publisher's site. Efforts for developing risk response vary depending on total number of identified risks and the overall risk rating of the project. The ballpark numbers for risk response planning are 5 hours for medium risk and 16 hours for high risk. The actual implementation of the planned risk response activities may take more extra time and cost. Usually, no risk response is planned for risks with low ratings. If there are exceptional or high risks identified, the project should not continue until a new approach is developed and new risk assessment does not contain those risks.

For example, if the delivery team is experienced only with some aspects of the project and not with others, then the assessment must be made to determine the risk of developing each unfamiliar area. If efforts are planned to reduce risk probability and/or severity or to implement the risk response activities for the accepted risks, this may present significant increase of project cost estimates. The lack of experience may become very expensive to fix, if the team has to switch to a different method in the middle of project implementation and redesign some of the project elements. The same must be said about the project manager's lack of experience, who allowed this situation to occur in the middle of the project. The project managers themselves should clearly be a major source of threat to the project!

Example of Calculating Overhead Effort Estimates

Table 11-2 Example of Calculating Overhead Effort Estimates

#	Effort	%	hours
1	Net Estimated Effort		355.5
2	Unproductive Time	20%	71.2
3	PM Effort	15%	52.9
4	Management Effort	5%	17.3
5	Resource Utilization Overhead	15%	52.9
6	Risk Planning and Risk Response Analysis	10%	35.6
	TOTAL Effort		585.4

Note: *The major issue with the accuracy of project estimates is failure to include at least some of these overhead effort estimates. It is not the responsibility of the project team members, even the most experienced ones, to include the above overhead; it is rather a project manager's duty to do so.*

The Example of Calculating Overhead Effort Estimates is shown in Table 11-2.

Perform Alternate Method Estimates (P12-2-4)

An alternate estimating method may be used to develop a second set of estimates. Results of the alternate estimating are used for validation of effort estimates in the process Validate Effort Estimates P-12-2. For example, if the main estimating method is the bottom up estimates, then the top down or the function point estimates should be used, even if their accuracy is lower than the bottom up method.

Estimate Cost (P12-3)

Cost estimates are derivatives of efforts estimates, when efforts in hours are multiplied by the hourly rate of resources plus additional factors, such as setting up development and test environments, cost of training, computer equipment, licenses, travel expenses, etc.

Usually, resource rates that project managers receive from management include the cost of resources and many other indirect costs. Entering rates into project scheduling tools will automatically determine the unadjusted cost of the project. In order to determine the total cost, the following cost adjustments will be made:

- Risk Contingency
- Expected Monetary Value of accepted risks
- Project Infrastructure and tools
- Test Environment
- Travel
- Training expenses
- Cost of vendor's performed project activities

Risk Management strategies are described the Chapter 6 of the book. The risk contingency fund is allocated to deal with implementation of risk plans to eliminate or contain risks in order to reduce their impact and also to handle unexpected risks.

The goal of Risk Management is to allow focus on the most important project risks and, after analysis and development of response plans, eliminate or significantly reduce all high and exceptional risks, as well as reduce most of the medium risks to the level of low risks. However, all low and some medium risks are accepted, because the losses due to their occurrence are lower than the cost of preventing them. If they become issues (triggered risks) during the course of the project, they will cause losses equivalent to the Expected Monetary Value (EMV) of accepted risks. EMV is a statistical assessment of project losses due to risks, not a prediction of final cost.

EMV = Probability * Severity

As an example, four risks are identified in a small project, as shown in Table 11-3.

Table 11-3 Risk Contingency Calculation Examples

	Risk	**Probability of Occurrence (%)**	**Severity or Max Loss ($)**	**Monetary Value ($)**
1	The project schedule is tight but achievable (80% confidence)	20%	$ 7,000	$ 1,400
2	There are some doubts on contractor's timely delivery (bypass is available)	30%	$ 5,000	$ 1,500
3	Project Manager does not have significant experience and may not be able to deliver on time	40%	$10,000	$ 4,000
4	Database failure may occur	10%	$5,000	$ 500
	TOTAL EMV			$ 7,400

Note: *Based on the Table 11-3, there should be a risk contingency fund of $7,400 due to the described risks. Risk #3 is the highest risk, but risking $4,000 in this project is acceptable. However, if the project is much bigger (the cost is around $7,000,000) and the maximum loss due to inexperienced PM is $1,500,000, then EMV is $600,000. In this case, consideration should be given to assign a more experienced PM. If no local resources exist, an experienced consultant PM may be hired.*

Example of Cost Estimates is shown in Table 11-4:

Table 11-4 Risk Cost Estimates Example

#		
1	Total Effort (500 hours * $85/hr)	$ 42,500
2	Risk Contingency	$ 5,000
3	Expected Monetary Value (EVM) of accepted risks	$ 7,400
4	Project Infrastructure and tools	$ 5,000
5	Travel	$ 1,000
6	Training expenses	$ 3,000
7	Cost of vendor's performed project activities	$ 20,000
	TOTAL COST	$ 83,900

Estimate Schedule (P12-4)

Schedule estimates are based on the WBS after the effort estimates for all tasks, task dependencies and resource assignments are added to the WBS. All those factors are components of the project schedule, which may be built using scheduling tools, such as MS Project, Clarity, Primavera and others. Methods of building the project schedule are described in the Work Breakdown Structure Design/Update process P7.

It is assumed that effort overheads have been already taken into consideration when building project schedule.

Estimate Critical Resources (P12-5)

Critical resources needed to support design and implementation must be identified in this process. Their cost must be added to the project, unless they are expenses that may be used in other projects, called capital expenses. For example, the following costs are considered capital expenses:

- Cost of the general purpose computers, workstations, desktops, laptops, printers etc.
- Cost of the wide and local area networks, internet etc.
- Cost of the heavy equipment in the construction business.
- Cost of the general purpose machinery to produce mechanical assemblies for the project.
- Cost of furniture and buildings.

The cost of critical resources must be included in cost estimates, unless it is explicitly mentioned in the SOW, that those costs are not included in the cost case and must be added separately.

Even if the responsibility for acquisition of critical resources is outside of the delivery team, the project manager must identify critical resources to those who have that responsibility, as the project will be dependent upon them completing their tasks.

The critical computer resource estimates will be documented on the estimating form and stored in the PCB. This information will be communicated to all affected groups.

Notes on Vendor Estimating

There is a strong trend today, especially in the software and the electronics industry, to subcontract parts of the project to offshore vendors. Apart from the vendor selection issue, the second most important component of off-shoring is to provide the vendor with a carefully developed requirements document. The price, quoted by the vendor will be as reliable as requirements submitted to the vendor. Most failed projects from reputable vendors occur due to the company's neglect in providing a vendor with good quality requirements. Even in the case of fixed price quotation, a Court of Law may not find the vendor legally liable to stick to their quoted price if requirements don't conform to requirements standards established in the organization, should a dispute have the parties ending up in court.

When requirements are forwarded to a vendor, the vendor will be bound by the Statement of Work, containing, among other things, the project price quoted by a vendor as Fixed or Time & Material based price.

There are several variations of fixed price, which may include incentive clause, penalty clause - and so on, in accordance with your standards and your vendor's standards and overall agreement between the Delivery Organization and the vendor.

A Time & Material quote will provide the ballpark or preliminary estimates, even though the actual bills from vendor will be on the basis of Time and Material reimbursement plus fixed price or fixed percentage, which must be documented in the SOW.

T&M may have some advantages over the fixed price quote from the vendor. In both cases the vendor will balance the largest possible margin to avoid losses with an appealing price. As more details become available about the project, the actual costs of the T&M contract may be smaller than the quoted fixed price contract.

Review Estimates (P12-6)

The Review Estimates activity consists of the following processes, as shown on Fig 11-3:

1. Identify Review Team (P12-6-1)
2. Schedule Review (P12-6-2)
3. Conduct Review (P12-6-3)
4. Record Review Notes (P12-6-4)
5. Update Estimates (P12-6-5)
6. Confirm Estimates (P12-6-6)

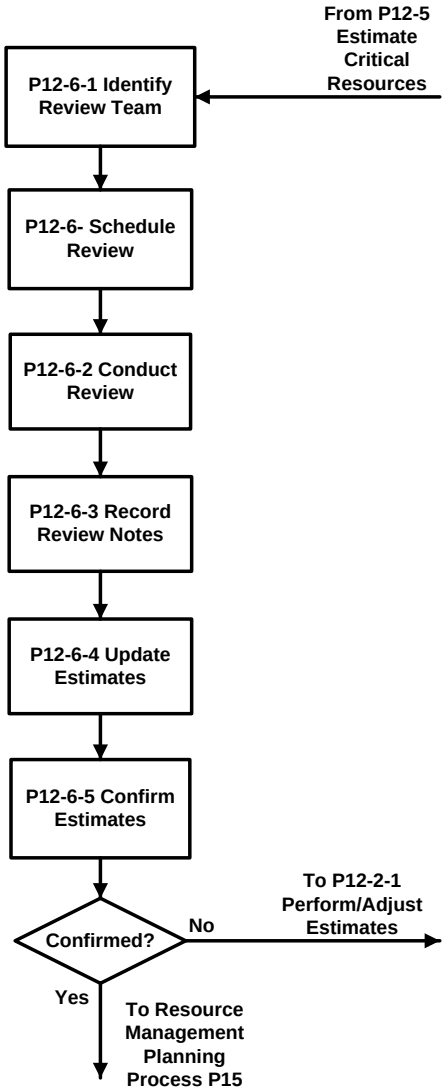


Fig 11-3 Review Estimates Process Flow

The purpose of this process is to review estimates and ensure that estimates are complete and ready to be included in the plan and budget for approval.

Identify Review Team (P12-6-1)

The review team must include the following team members:

- Project Manager
- Selected members of the delivery team
- The subject matter experts, who provided estimates
- Offshore vendor representative, if an offshore vendor is involved
- Other personnel as needed

Schedule Review (P12-6-2)

In order to perform a schedule review, at least 3 days before the review, the project manager should:

1. Send review invitations to participants.
2. Deliver the agenda and review materials with the participants.

Conduct Review (P12-6-3)

During the Schedule Review, the project manager should provide participants with the presentation of estimates, as well as their validation. The subject matter expert will answer participants' questions. When reviewing software project estimates received from the offshore vendor, compare the cost per function point with industry standards and with size estimates received from the same and from other offshore vendors. In the case if the cost per function point differs with industry standards by more than 5%, then request explanations from the offshore vendor. If explanations are not acceptable to participants, return estimates to the offshore vendor for rework, and/or consider other vendors.

Record review notes (P12-6-4)

The review minutes, including all suggestions and critique, must be recorded. After the review session is over, minutes will be sent to participants to get their consent that minutes are recorded correctly. If necessary, the appropriate correction will be made.

Update Estimates (P12-6-5)

Estimates can raise contentious issues and often it is not easy to get 100% consent from everybody. There will be different opinions from different participants in accordance with their backgrounds and interests. While some will often fight for increasing estimates, others will attempt to reduce them. After considering everybody's opinion, the final decision will be made by the project manager, because it is his or her head at stake. The subject matter experts will be requested by the project manager to make certain corrections to estimates, if necessary. Upon completion, they should send it back to the Project Manager.

Confirm Estimates (PE12-6-6)

If the project manager is satisfied with the updates to estimates, corrections will be sent back to participants for information only. It will be up to the Project Manager to make a final decision based on historical data and the confidence in the estimating process and estimators.

Metrics

This process will gather the following metrics, taken during the Construction Frame:

- Estimates versus actuals for size, effort, cost, schedule and critical resources
- Team performance metrics, based on effort to deliver one function point, if the function point information is used

The project manager should update the PCB with the above metrics, which will be added to the pool of the historical data used for validation of estimates in future projects and for further improvement of the estimating process.

Completion Criteria

The estimating process is assumed to be completed when:

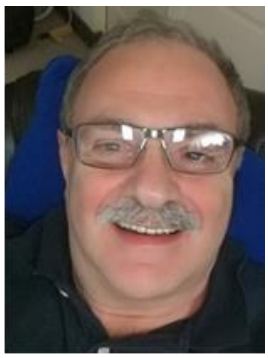
- Estimating process is identified and documented in the PCB.
- All size, effort, cost, critical resources, and schedule estimates are documented in the PCB.
- Results of estimates' reviews and meeting minutes are documented in the PCB
- Approval of estimates by the project manager is documented in the PCB
- Metrics are documented in the PCB.

Approve Closing/Testing Frame Plan and Budget (P13)

This step is executed here, after the planning of the Closing/Testing Frame is complete. Time wise, this happens between the end of the Construction Frame activities and the beginning of the Closing Frame. The final budget determined here has a definitive accuracy of -5% +10%. The process is initiated by looping back to the beginning of the Planning Frame when the Construction Frame plan is approved.

In order to have the plan approved, the estimates and the updated project plan, including the user acceptance test schedule are sent to the client and the senior business manager. By then the project is largely completed and the only major activity left before closing the project is the user acceptance test. Therefore, it is extremely unlikely that the Closing Frame budget will not be approved. In fact, the process flow does not even consider that option.

About the Author



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Dan Epstein combines over 25 years of experience in the project management field and the best practices area, working for several major Canadian and U.S. corporations, as well as 4 years teaching university students project management and several software engineering subjects. He received a master's degree in electrical engineering from the LITMO University in Leningrad (today St. Petersburg, Russia) in 1970, was certified as a Professional Engineer in 1983 by the Canadian Association of Professional Engineers – Ontario, and earned a master's certificate in project management from George Washington University in 2000 and the Project Management Professional (PMP®) certification from the Project Management Institute (PMI®) in 2001.

Throughout his career, Dan managed multiple complex interdependent projects and programs, traveling extensively worldwide. He possesses multi-industry business analysis, process reengineering, best practices, professional training development and technical background in a wide array of technologies. In 2004 Dan was a keynote speaker and educator at the PMI-sponsored International Project Management Symposium in Central Asia. He published several articles and gave published interviews on several occasions. In the summer of 2008 he published "Methodology for Project Managers Education" in a university journal. His book, *Project Workflow Management - The Business Process Approach*, written in cooperation with Rich Maltzman, was published in 2014 by J. Ross Publishing.

Dan first started development of the Project Management Workflow in 2003, and it was used in a project management training course. Later this early version of the methodology was used for teaching project management classes at universities in the 2003–2005 school years. Later on, working in the best practices area, the author entertained the idea of presenting project management as a single multithreaded business workflow. In 2007–2008 the idea was further refined when teaching the project management class at a university. Since 2009, Dan has continued working full time in Project Management. Dan can be contacted at dan@pm-workflow.com.