Project Estimating Process

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Introduction

The described below methods of project estimating are based on PM Workflow® Framework, developed by me and described in details in the book: *Project Workflow Management - The Business Process Approach*, written in cooperation with Rich Maltzman. The book will be further referred to as "the book". You may find more of the book on authors' website www.pm-workflow.com.

The purpose of this article is to describe practical steps of the project estimating and its timing to develop size, effort, cost, schedule and critical resource estimates. Due to limitations of the article size, some process flow diagrams, their descriptions, tables and examples are not shown here. For more detailed guidance, please refer to the book.

In order to better understand the article's terminology, it is necessary to highlight minor differences in terminology, such as using the word "frame" instead of "phase," used in both ISO 21500 and the PMBOK® Guide and PM Workflow®. The difference between frames and phases is that phases imply a sequential execution. Execution of frames instead depends entirely on the workflow. The project management process flow starts with receiving request for project in the requirements management processes of the Requirements frame and ends with the project closeout set of processes in the Closing/Testing frame. Based on the control point test conditions and the project health evaluation results, the process flow may branch forth and back between specific processes in any frame.

The Project Estimating process is not a stand-alone process. It depends on results of execution of other processes and in many cases it runs simultaneously with them. The timing and type of estimates are determined by the project process flow, which leads the project manager through the flow of processes and indicates when and what type of estimate should be made. In order to better understand the estimating process, some familiarity is required with the following processes which may run concurrently with estimating:

- Project Planning
- Risk Management
- Issue Management
- Communication Management
- Scope Change
- Outsourcing
- Resource Management
- Quality Management
- Construction
- Tracking
- Testing
- Closing

Estimating accuracy

Today, the vast majority of projects are incorrectly estimated, which causes monetary losses and may threaten projects and even the entire business. The reason for poor estimates is non-compliance with requirements of estimating process, as described below.

The estimating process is executed many times throughout a project life cycle. Most estimates are done iteratively; first with low accuracy, increasing it as the project is being developed with the final best accuracy of –5% to +10%. The accuracy of each estimate depends on:

- Level of detail, i.e., the degree of decomposition of the work breakdown structure (WBS)
- Risk assessment results and the remediation plan
- Quality of business requirements and quality of project planning and execution
- The point in the project life cycle when the estimating takes place
- The estimator's experience
- The estimating method

In accordance with PM Workflow, 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 ballpark estimates, the delivery team must be familiar with similar types of projects and the technology used. This type of estimate is also done when significant risks are involved. The accuracy of ballpark estimates ranges from –25% to +75%.

2. **Preliminary estimates**—Preliminary estimates are performed immediately after completion of business requirements. These estimates heavily depend on the team's familiarity with similar projects, type of 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 of preliminary estimates never exceeds –10% to +25%.

3. **Accurate estimates**—Accurate or definitive estimates are prepared from the well defined detailed data and the WBS, using the 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 instead only the well-defined next stage of the project plan. It is not usually possible to do accurate estimates for an entire project, because of the lack of detailed information for the required activities in the distant future. The best accuracy that can ever be achieved ranges from –5% to +10%.

In some organizations, where delivery managers with no real project management experience are constantly under pressure from senior management, project managers may face demands for accuracy of estimates better than –5% to +10% or even ±0%. Since this is an unrealistic and unachievable level of accuracy, project managers are forced to use tricks to match real costs to estimates. Because 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 management's 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 results to the CEO, they keep this practice under wraps. We assert that these tricks provide no real benefits whatsoever and in fact threaten the project and may even cost the project manager his or her job.

Types of Estimates

For accurate estimating, all four types of project estimates must be used with some exceptions for size estimates:

1. **Size and complexity** (software projects only)—Estimates of the project complexity, which are a measure of the project sophistication combined with the 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 that are needed to support planning, design, development and testing

Estimates are produced, documented and stored for each new project scope change, for each frame and for the overall project after performing risk assessment and developing risk response plans. They are also performed when results of the Earned Value Analysis, described in details in the book, differs from estimates by more than 10%.

Task-level estimates for scope changes and the next upcoming frame should be fairly accurate (–5% to +10%). The overall estimates for the entire project become progressively more accurate as the project lifecycle progresses. Each time an estimate is produced, the following information should be captured in the project control book, as described in the textbook:

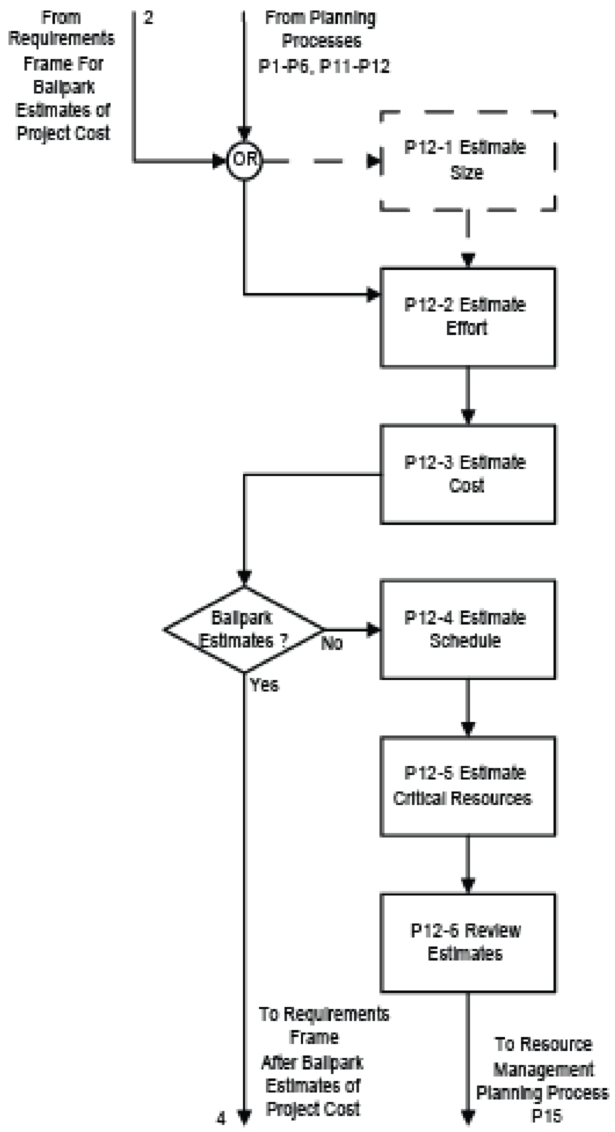
1. Date
2. Frame and activity
3. Inputs (describe the specific inputs used to create the estimate, i.e., requirements document, detailed specifications, design, initial WBS etc.)
4. Assumptions made
5. Constants
6. Estimating method used
7. Risk assessment estimates
8. Any other information which helped drive the estimates, especially bases for the estimates

Estimating Process Flow Diagram

Tasks for developing estimates must be included in the project schedule. The Estimating process is decomposed into the following subprocesses:

1. Estimate Size
2. Estimate Effort
3. Estimate Cost
4. Estimate Schedule

5. Estimate Critical Resources
6. Review Estimates



Fig, 1 - High Level Estimating Process Flow Diagram

Estimate Effort and Review Estimates processes are decomposed further. Estimate Effort process is broken down into:

1. Perform/Adjust Estimates
2. Validate Estimates
3. Add Overhead to Estimates
4. Perform Alternate Method Estimates

For detailed description of the process flow, please refer to the book.

Review Estimates process is decomposed into the following low-level processes:

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

For detailed description of the Review Estimates process please refer to the book.

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 as necessary. If no similar projects were developed in the past, and there are no reliable subject matter experts on the team, it is not possible to provide ballpark estimates.

Estimating is done many times throughout the project life cycle, as directed by the project flow:

- Ballpark estimates may be done after receiving project request, but not always.
- Preliminary estimates of the overall project cost and duration produced after the business requirements document is developed—Accuracy of these estimates is –10% to +25%. These estimates may be used to establish initial funding and done after performing the initial risk assessment.
- Planning tasks for the next upcoming project frame—Accuracy of these estimates is –5% to +10%.
- Plans are updated by adding a risk contingency as a result of risk assessment.
- Plans are made for a project scope change—Accuracy of the scope change estimates is –5% to +10%.
- Project overruns the budget or schedule—The accuracy depends on the cause of the poor project performance.

Estimate Size

For software / IT projects the Estimate Size process is executed.. 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 a process may be expressed in standard pages; the size of a presentation 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 may be expressed in number of function points or sometimes in lines of code.

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 required 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 resources with average skills. However, developing the same functionality using MVS/CICS/Cobol may take 18 months using the same number of resources. Function point analysis, combined with the statistics gathered, allows calculation of the unit cost of software development for every platform being used to develop software. Function point analysis is a method for identifying and classifying components of a system. It measures software by quantifying its functionality based on logical design. Function point analysis may be accurately performed after development of requirements.

Because this type of estimate takes into consideration inputs/outputs, application files, database tables and other parameters, it can be performed for new, not yet developed projects as well as older, completed projects. It is thus possible to create historical data for software developed years ago, provided the actual development efforts were recorded. For example, it is possible to determine that project A, which was developed on a Java platform 3 years ago, has 500 function points and cost $250,000 or $500 per function point. Project B, developed last year also on a Java platform, cost $505 per function point, which is about the same. Therefore, a subcontractor developing a Java project with a cost of $700 per function point is either overcharging, is ineffective in executing the project and/or is using poorly qualified resources. Size estimates for software projects can also be produced using the Constructive Cost Model (COCOMO), where output is measured in lines of code.

Other advantages of using function point analysis include:

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

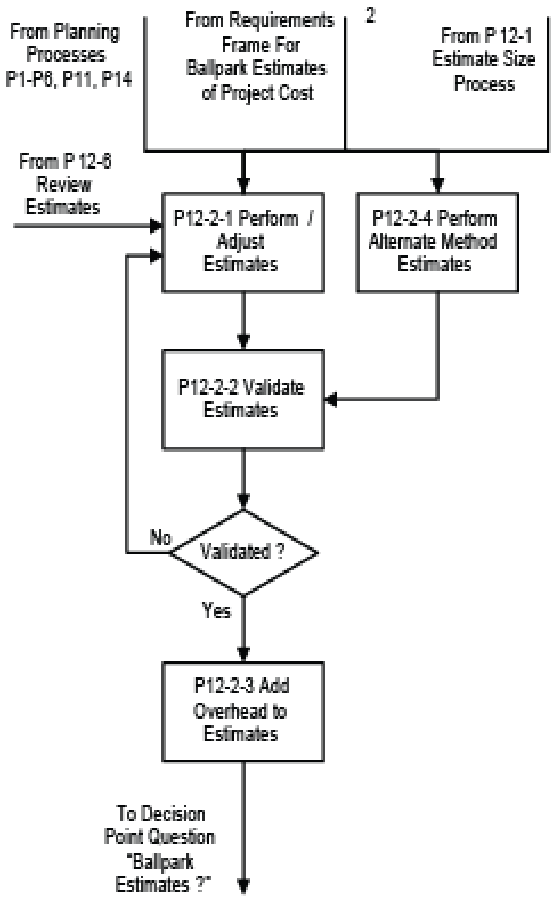
Function point analysis is a complicated method to use. Therefore, only a trained function point analyst can provide function point estimates. A function point count spreadsheet is available free of charge from the International Function Point Users Group (IFPUG) and may be used as a tool. Also, there 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, although the effort to perform those activities may be significant.

Use of function points is especially important for offshore software development projects. The most qualified offshore vendors use function points as a standard size estimating technique without admitting it. You should ask offshore vendors to formally use function points and provide you with results, since a change in an offshore vendor’s cost per function point will signal a change in offshore vendor team performance. It also may allow you to evaluate an offshore vendor’s performance by comparing it with industry standards or even determine whether using offshore resources provides any real benefit, despite the stated lower hourly rate.

Estimate Effort

Effort estimates provide labor estimates for the project. The cost and schedule estimates are derived from effort estimates. The effort, or estimated labor hours per task may be calculated using one of the following major types of estimating, albeit with different accuracy:

- Top down
- Parametric
- Bottom up



Project Effort Estimates

For detailed description of the process flow diagram and all processes, please refer to the textbook.

Top-Down Effort Estimating

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

History of past projects and available statistics—This method is also called the analogous estimating method. Based on past recorded project statistics, the new project is compared with historical data. If similar projects were completed in the past, they are evaluated and the new project is adjusted in accordance with the difference in project scales. Even if the actual work effort was not recorded, it is possible to find it by using the number of delivery team members involved in the project and the length of development.

Opinions of subject matter experts—If team members do not have direct experience in a particular type of project or the technology used, experts outside of the team can be used to provide advice on estimates. They also may be able to help with project implementation.

High-level Work Breakdown Structure (WBS)—A detailed WBS often reaches five or six levels of a tree-like structure. A high-level WBS usually has two and rarely three levels. The lowest level tasks are estimated using the top down estimating methods.

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 calculate the probability of completing tasks within a certain time period based on past experience, by taking advantage of parameters (rates) such as $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 statistical data collected for prior projects. This method is rarely used in software development, but cannot be excluded from consideration. It may potentially be within the range of accurate estimates, even though it is most likely within the range of initial estimating.

Bottom-Up Effort Estimating

This is the most accurate detailed estimating method. Several subject matter experts provide estimates for all tasks in the detailed fully decomposed WBS. In order to eliminate subjective factors in estimating, the Program Evaluation and Review Technique (PERT) should be used for effort estimating. Each estimator provides three estimates for each task in the WBS: an optimistic (O) estimate, a pessimistic (P) estimate and the most probable (M) estimate. 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. A request to provide three estimates for each task forces them to think about all possible issues in implementing each task. If the results from several estimators differ by more than 5%, their estimates are returned to them along with the results from the other estimators. The experts review the estimates and submit them 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 PERT is used, because they overlook daily overhead, such as managing e-mail, meetings and reports. The project manager must add those activities to project estimates. Also, estimates provided by subject matter experts do not take into account resource utilization or results of the project risk assessment. The results of risk assessment may dramatically change estimates or even determine that a project cannot be delivered as planned.

Bottom-up estimating can be performed if a detailed WBS is available from the project planning process. In order to achieve accurate estimates (–5% to +10%), no task in the WBS should require over 40 hours of effort, with best results achieved for tasks of 24 to 36 hours. The reason for those numbers is described in the Planning frame section of the book. In the early stages of a project it is not usually possible to provide that level of detail for the entire project until the late stages of implementation. Only the next upcoming project frame may have accurate estimates after the current frame planning is complete. The later a project is in the project life cycle, the better the overall accuracy of estimates. In practical terms, the project manager distributes estimating worksheets to the subject matter experts, who provide the lowest level tasks estimates. As mentioned above, no task should exceed 40 hours. Any task that appears to take longer than 40 hours must be further broken down.

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 corrective action. 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 estimates recorded in the task estimating worksheet (Table 1) will be stored in the project control book. Updates are necessary through the project life cycle.

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

Table 1 - Task Estimating Worksheet

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 the WBS, depending on an 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 effort cannot be added as additional effort overhead. Note that it is a good practice to include project management effort in the WBS as a work stream.

Validate Effort Estimates

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

- Perform Alternate Method Estimates
- 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
- Compare estimates to historical data for similar projects or tasks completed earlier
- Compare the cost of one function point with industry and/or local standards (software projects only)

Effort Overhead

The following are components of effort overhead:

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

There is a distinction between effort overhead and cost overhead, which are counted separately and use different criteria for calculation.

Unproductive Time Overhead

Delivery team members spent around 20% of their time on phone conversations (some of which may be personal, but still legitimate), ad hoc meetings, conversations, 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 the 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, as compared to the total time claimed by the resource. It is not possible to achieve 100% resource utilization. This means that if 5 full-time resources are available to work on a project 8 hours a day for 4 weeks, they will charge the project for 800 hours. However, the net effort to accomplish their tasks is less than the claimed by them 800 hours.

Due to planned task interdependencies, some of the tasks performed by resource B cannot start until other tasks, performed by resource A, are completed, which causes patches of idle time in resource B utilization. To reduce idle time and increase resource utilization, resource leveling must be attempted. Resource leveling is a technique available in almost every automated project scheduling tool to examine an uneven resource load and automatically balance it, *when possible*, also resolving resource over-allocation. Resource leveling does not do well with balancing, but does a good job on over-allocation. It is not possible to completely eliminate idle time. More about resource leveling may be found in the Planning frame section of the book.

Let's say a resource is assigned for 100% availability to a project for 2 weeks, from Monday through Friday. During this time, the resource completes 3 tasks with a 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 the resource does additional work unrelated to the project and charges that time to non-project activities.

The efficiency of resource utilization depends on the project manager's planning skills. A skilled project manager 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 the inefficiencies (such as e-mail and telephone time) described above as unproductive time overhead.

Risk Assessment and Risk Response Activities Overhead

Every project has risks, which add extra effort and extra costs. While costs are derived from effort, there are components of risk that are expressed in terms of cost, such as expected monetary value of risk, and are not direct results of project effort. Those components of risk that require extra effort are risk assessment and planning efforts to reduce or eliminate the probability of a risk occurring and its severity if it does occur. (A risk assessment tool is available for download from the authors' website www.pm-workflow.com).

Efforts to develop a risk response vary depending on the total number of risks identified 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 require more time and extra cost. Usually, no risk response is planned for risks with low ratings. If exceptional or high risks are identified, the project should not continue until a new approach is developed and a new risk assessment does not reduce those levels of risk.

For example, if the delivery team is experienced with only some aspects of the project and not with others, then an assessment must be done 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 a significant increase in 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, which allowed this situation to occur in the middle of the project. Project managers themselves clearly can be a major source of threat to a project! More about Risk Assessment process may be found in the book.

Example of Calculating Overhead Effort Estimates

An example of calculating overhead effort estimates is shown in Table 2.

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; rather, it is the project manager's duty to do so.

#	Effort	%	hours
1	Net Estimated Effort		355.5
2	Unproductive Time	20%	71.2
3	Project Manager's 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

Table 2 - Example of Calculating Project Overhead

Perform Alternate Method Estimates

An alternate estimating method should be used to develop a second set of estimates. Results of the alternate estimates are used to validate effort estimates in the Validate Estimates process. For example, if the main estimating method is bottom-up estimates, then top-down or function point estimates should be done, even if their accuracy is lower than those done using the bottom-up method.

Estimate Cost

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

Usually, resource rates that project managers receive from management include the cost of resources plus 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 must be made:

- Risk contingency
- Expected monetary value of accepted risks
- Project infrastructure and tools
- Test environment
- Travel
- Training expenses
- Cost of outsourced project activities

Risk management strategies are described in Chapter 6 of the textbook. 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 of accepted risks. **Expected Monetary Value = Probability * Severity** is a statistical assessment of project losses due to risks, not a prediction of final cost.

As an example, four risks are identified for a small project in Table 3.

	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

Table 3 - Example of Risk Contingency Calculation

Based on Table 3, there should be a risk contingency fund of $7,400 due to the risks identified. Risk #3 is the highest risk, but risking $4,000 in this project may be acceptable. However, if the project is much bigger (the cost is around $7 million) and the maximum loss due to the inexperienced project manager is $1.5 million, then the expected monetary value is $600,000. In this case, consideration should be given to assigning a more experienced project manager. If no local resources are available, an experienced consultant project manager may be hired.

An example of cost estimates is provided in Table 4.

#	Items	Cost
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

Table 4 - Example of Risk Cost Estimates

Estimate Schedule

Schedule estimates are based on the WBS after the effort estimates for all tasks, task dependencies and resource assignments have been added to it. 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 for building the project schedule are described in Chapter 7. It is assumed that effort overhead has already been taken into consideration when building the project schedule.

Estimate Critical Resources

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

- Cost of general purpose computers, workstations, desktop computers, laptops, printers, etc.
- Cost of wide- and local-area networks, Internet, etc.
- Cost of heavy equipment in the construction business
- Cost of 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 stated in the statement of work that those costs are not included in the cost case and must be added separately. Even if responsibility for acquisition of critical resources lies outside of the delivery team, the project manager must identify the 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 project control book. This information will be communicated to all affected groups.

Notes on Vendor Estimating

There is a strong trend today, especially in the software and electronics industries, to outsource parts of projects to offshore vendors. Other than vendor selection, the second most important component of offshore outsourcing is providing the vendor with a carefully developed requirements document. The price quoted by the vendor will be as reliable as the requirements submitted to the vendor. Most failed projects from reputable vendors are due to negligence by the delivery organization in providing vendors with good quality requirements. Should a dispute arise between the parties, a court of law may not find the vendor legally bound to honor the quoted price, even in the case of a fixed price contract, if requirements do not conform to requirements standards established in the organization.

When requirements are forwarded to a vendor, the vendor will be bound by the statement of work, which contains, among other things, the project price quoted by the vendor as a fixed or time and materials price.

There are several variations of a fixed price quote, which may include an incentive clause, a penalty clause, and so on, in accordance with the standards and the overall agreement between the delivery organization and the vendor. A time and materials quote will provide the ballpark or preliminary estimates, even though the actual bills from the vendor will be on the basis of time and materials reimbursement plus a fixed price or fixed percentage, which must be documented in the statement of work. Time and materials may have some advantages over a fixed price quote from a vendor. In both cases, the vendor will balance the largest possible margin against an attractive price. As more details about the project become available, the actual costs of the time and materials contract may be less than the quote in a fixed price contract.

Metrics

The following metrics, collected during the Construction Frame execution, will be gathered:

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

The project manager should update the project control book with the above metrics, which will be added to the pool of 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:

- It is identified and documented in the project control book
- All size, effort, cost, critical resource and schedule estimates are documented in the project control book
- Results of estimate reviews and meeting minutes are documented in the project control book
- Approval of estimates by the project manager is documented in the project control book
- Metrics are documented in the project control book

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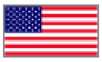

Dan Epstein combines over 25 years of experience in the project management field and the best practices area, working for several major Canadian and U.S. corporations, as well as 4 years teaching university students project management and several software engineering subjects. He received a master's 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 multi-threaded business workflow. In 2007–2008 the idea was further refined when teaching the project management class at a university. In 2009–2011 Dan continued working full time on development of the Project Workflow Management, completing it in 2012. Dan can be contacted at dan@pm-workflow.com.